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STRATEGY RESEARCH PROJECT

SOLDIER INVOLVEMENT IN EARLY EQUIPMENT PROTOTYPING

BY

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USAWC STRATEGY RESEARCH PROJECT

Soldier Involvement in Early Equipment Prototyping

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ABSTRACT

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PURPOSE OF THE REPORT: To provide a detailed examination of the impacts and issues associated with involving soldiers in early equipment prototyping. Based on this examination, this paper provides recommendations for better utilization of soldiers in the future.

ABSTRACT: Early user involvement has many known benefits and has been used by civilian industry to find problems in products before the products are fully distributed. Early soldier involvement also provides benefits that can lead to significant cost avoidance, but has additional complex political and economic ramifications that must be addressed. Areas of examination included impacts of differing expectations by affected stakeholders (Users, DOD, ARSTAF, Congress), impacts on the final configuration design, impacts on soldier training, and impacts if prototypes are deployed early - before the First Unit Equipped date. Civilian methodologies for early customer involvement will also be examined and contrasted for relevance.

RESEARCH TRAVEL	
Date	Location
30 Nov-2 Dec	El Paso, TX (TMD Conference/User Interviews)
2-4 Mar 00	Huntsville, AL (Contractor/Project Office Interviews)
13-17 Mar 00	Washington, DC (Government/Contractor Interviews)

TABLE 1 TRAVEL ASSOCIATED WITH RESEARCH PAPER

VALUE TO THE ARMY: Research and recommendations will enable Army Acquisition and Operations elements to avoid pitfalls of too little or too much soldier involvement. A better understanding of potential pitfalls will also enable more accurate cost estimations.

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SOLDIER INVOLVEMENT IN EARLY EQUIPMENT PROTOTYPING

> "Show me a man who doesn't make mistakes and I'll show you a man who doesn't do anything." - Theodore Roosevelt

However,

> "A man who has committed a mistake and doesn't correct it, is committing another mistake." - Confucius

Early soldier involvement in the materiel development process has increasing emphasis and is a widely accepted "best practice." How extensively soldiers are involved, when they get involved, and how the process is managed varies greatly from one system to the next. Since systems are different, the use of soldiers will be different for each, but an understanding of the successes and mistakes of past efforts would improve the process and likely reduce costs. The core lessons cited in this paper come from my experiences as the Product Manager of the Theater High Altitude Area Defense (THAAD) User Operational Evaluation System (UOES) augmented by research into other Army weapon system development and commercial equipment development programs. This research paper addresses specific challenges associated with early soldier involvement in equipment prototyping including: issues of when to involve soldiers; how to manage soldier expectations; lessons in capturing soldier input; determining which soldiers to use; equipment upgrade concerns; contractor involvement; safety; and future directions including parallels with increasingly popular Advanced Concept Technology Demonstration programs.

THEATER HIGH ALTITUDE AREA DEFENSE (THAAD) USER OPERATIONAL EVALUATION SYSTEM (UOES)

Normally the Program Definition/Risk Reduction (PD/RR) phase of a program yields enough hardware and software to offer decision makers confidence that key program risks have been mitigated before entry into the Engineering and Manufacturing Development (EMD) phase. However, the resultant hardware and software may or may not have much utility to a warfighter. During Desert Storm, a few systems were brought into the war before operational testing was complete, such as Patriot Advanced Capability 2 (PAC-2) and the Joint Surveillance Target Attack Radar System (JSTARS). With the wartime success of those systems, key Defense Department officials decided that if the THAAD system, which was about to enter into PD/RR, was packaged a little smarter up front in its development, then the system's utility in a National Emergency would be greatly enhanced. Congress embraced the concept, recognizing the critical need for a system designed specifically to defend against the growing proliferation of longer-range Theater Ballistic Missiles to be fielded as soon as possible. In the Missile Defense Act of 1991 Congress expressed its desire for an early capability. The Senate Armed Services Committee was even more specific in 1992 about the need for the THAAD UOES:

> The committee recognizes that Third World ballistic missile threats are already emerging that tax existing US TMD capabilities. Accordingly, the committee endorses current SDIO plans to develop, test, and field UOE prototypes for the THAAD system by 1996.[1]

The THAAD UOES concept satisfies the Congressional language that spawned it and attempts to maximize the benefits offered to the materiel developer by an early system prototype. The UOES provides early soldier input to the materiel developer and has already proven it can save scarce future Research, Development, Test and Evaluation (RDTE) dollars by putting actual equipment in the hands of soldiers "early and often" to solicit important design feedback information. Examples of changes already made or planned for the THAAD system include: switch changes, cable rerouting, durability enhancements, improvements to operator/computer screen interfaces, and safety improvements that will prevent injury to soldiers and equipment damage.

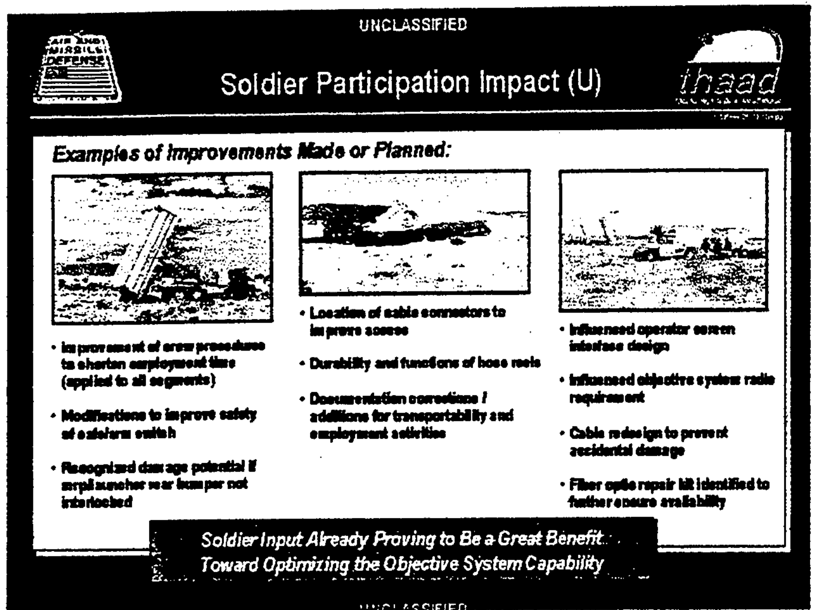

FIGURE 1 SOLDIER PARTICIPATION IMPACTS

The UOES also provides warfighters with early operational assessments that will enable a more optimized synergism of the THAAD system with other battlefield elements such as the Patriot PAC-3 system and Navy Theater Missile Defense (TMD) systems. Finally, the UOES equipment, together with trained soldiers, could provide a critical interim Anti-Tactical Ballistic Missile (ATBM) capability to engage rapidly proliferating longer-range threat missiles in the event of a National Emergency – prior to fielding of the objective THAAD system.

> ...this is not an abstract or a theoretical threat to our forces. The threat is real today and the threat will only increase in the years ahead. That is why theater and national missile defense development has been a priority for the Joint Chiefs and the unified commanders.[2] [General Shelton, the Chairman of the Joint Chiefs of Staff]

WHEN TO INVOLVE USERS/SOLDIERS

Although almost everyone universally agrees that soldier input is valuable, the time when soldiers are brought into the development process is widely varied. The contractor

Project Manager (PM) for the Family of Medium Tactical Vehicles (FMTV) at Stewart Stevenson agreed that soldiers definitely provided valuable input[3]. His belief was that soldiers should be involved as early as the Operational Testing phase. In contrast, the Navy PM who evaluated a new replacement for the EA-6B Prowler aircraft involved soldiers much earlier in the process, at the design stage, while the drawings were still in draft form[4]. According to the Navy PM, it was very likely that input he had received from those soldiers would have saved over two years in the development effort. However, the Navy PM's claims were never proven, since the program was not funded. The current team at FMTV trucks has seen the value of soldier involvement and is now incorporating many modifications based on soldier feedback into the production design. For example, the shrouds over the taillights were strengthened when it was determined that rather than using the ladder intended for mounting and dismounting from the rear of the vehicles, soldiers simply jump into the rear of the trucks by grabbing a side member and stepping onto one of the shrouds. The shrouds had not been designed to accommodate a soldier's weight. The FMTV team is able to make this and many other smart changes to vehicles in production or during upgrade operations.

According to many sources, including the Program Manager's Notebook issued at the Fort Belvoir Advanced Program Management Course (APMC), the cost and impacts of changes are significantly greater as the development process goes on. Changes made during the PD/RR phase of development, cost significantly less than changes made during the EMD phase. Likewise, changes in the EMD phase, made before fielding, cost significantly less than changes made during production when hard tooling must be modified. The THAAD team estimates that nearly $25 million in cost avoidance has been realized as a result of changes made early in the PD/RR phase rather than later in the development cycle.

Soldiers get excited about the chance to operate new hardware early, and their feedback is the most significant system designer benefit. There are also significant challenges relating to having them aboard early in the design process. These challenges are surmountable if they are identified early and addressed in the planning phase. When the novelty of being on a new system is over, soldiers' expectations, training, and stabilization all must be addressed and re-addressed. It is common parlance in the field that a good soldier can make good equipment look even better; a soldier also will not hesitate to tell you that equipment is junk. Educating soldiers regarding their roles and the expected hardware/software evolution is imperative to maintaining their perspective and making the system all it can be throughout its development.

While equipment is still in prototype form and soldiers do not yet have the new system's Military Occupational Specialty (MOS), the soldiers are promoted primarily based on mastery of the tasks associated with operating the already fielded systems they came from (the systems from their parent MOS). If soldiers are involved with prototype equipment over a long period, they need to be trained not just on the prototype system's specific tasks, but also on the tasks related to their parent MOS's. Training can be a formidable challenge during protracted periods of soldier involvement and requires flexible alternative approaches. This may be necessary because of the potentially large segments of time that the prototype equipment is back in the hands of the contractor for design, maintenance, and testing. Computer based training modules are well liked and provide the opportunity for training with very little notification.

Another issue of extended soldier involvement is that soldier turnover will be inevitable over the years that the system spends in development. Repeated soldier training is expensive, but is essential to meeting the rotational demands of the standing Army and to satisfy the individual growth needs of the soldiers to avoid career progression problems. In summary, the use of soldiers is likely to have great benefit, if incorporated early in the process. Protracted involvement issues, such as adequate training, can be mitigated through adequate up-front planning.

MANAGING SOLDIER EXPECTATIONS

Soldiers are an integral part of nearly all weapon systems and can have significant influence on apparent equipment performance. There is a saying that goes, if a scientist is asked, "Does a system work?" he will say, "Yes, if it works once." If an engineer is asked, he will say, "Yes, if the system works most of the time." If an end-user or soldier is asked, he will say "No, if the system fails once." This adage was illustrated in the Ground Based Sensor (GBS) Non-developmental Item Candidate Evaluation (NDICE) conducted at the Fort Bliss, Texas Short Range Air Defense (SHORAD) test range in spring 1991. Seven radars competed for a chance to become the next Air Defense Artillery (ADA) forward area sensor in repeated tests involving 72 fixed and rotary wing aircraft passes (simulating friendly and hostile aircraft) over supported Avenger weapon systems in each one-hour test period. The eventual winning radar had an opportunity to win over a year earlier, with no competition, but had forced a competition through its apparently poor performance. What made the difference a year later that allowed the radar to go from unsatisfactory to outstanding? When asked, the contractor's engineers replied that they had made software modifications that "de-tuned" the radar somewhat, resulting in slightly less sensitivity. The radar still had ample capability to meet all ADA requirements, but most importantly the radar confused user soldiers with fewer false targets (a target appears on the soldier's display that is not really there). When questioned, soldiers revealed that when they encountered high false target rates they lost confidence in the sensor. One of the many factors that contributed to the radar's final selection as the winning candidate was the soldiers' confidence in the radar and their willingness to rely on the radar data when conducting simulated Avenger engagements. The winning radar has been fielded and is known today as the highly successful Sentinel radar[5].

In the civilian sector, the Callaway Golf Company, with over 2400 employees, is one of the world's leading producers of golf clubs and golf club products.[6] Callaway is successful at least partly because of their concerns with managing the expectations of their well-defined customer base. Callaway's interface with their customers is primarily through the physical ergonomics of their equipment. However, customer expectations are also affected by the perceptions of performance built through advertising and product appearance. Television announcer and magazine columnist, Mr. David Feherty recently speculated that Tiger Woods "could take any bag [of golf clubs] in the room and still find a way to win."[7] Perhaps with Tiger's mastery of the game that statement may be true, but for most golfers confidence can also be gained simply by the perception that they are using a superior product.

> Since, under the Rules of golf, miracle apparatus isn't allowed, most people buy based on perceptions created by the media. One must be alert to the fact that when acquiring one brand of golf equipment that there is very little difference in what that equipment can physically deliver over another. Often, when a person tries club A versus club B at a test driving range, they get excited about club B and report how much better it is than A.[8]

In order to become a leading producer of golf equipment, Callaway has learned both the importance of superior technical performance, as well as the importance of creating psychological advantages. Mr. Tom Preece, the Callaway Director of Research and Development Operations, states that for Callaway to go forward with a product it must satisfy each of three criteria; performance, perception, and producibility. The new product must perform better in some way over an existing product. The product must create a desired positive perception, e.g., it must look "forgiving"; it should sound good (this is acoustically analyzed in their laboratories); and it should be consistent with brand awareness (shared features like logos that are common with other elements of the product line). Finally, the product must be able to be produced at consistent quality levels and at competitive cost levels.[9] Perceptions are important.

A critical element of the THAAD UOES development has also been the management of expectations. If the expectations of the warfighter, or key materiel acquisition decision-makers, are too high, then continued development of the intended objective system may be curtailed. For instance, in an era of tightening RDTE budgets, the prevailing thought is "why spend more on the objective system if the prototype is good enough?" The THAAD UOES creates a first impression that it is a highly capable end product, based on well-packaged system segments, incorporating many Military Off-The-Shelf (MOTS) components and Government Furnished Equipment (GFE). Together with sharp and highly motivated soldiers from the 1-6 Air Defense Artillery (ADA) Brigade, and two successful intercept missions, many visitors of the equipment might justifiably leave with the impression that the end-product capability is now there.

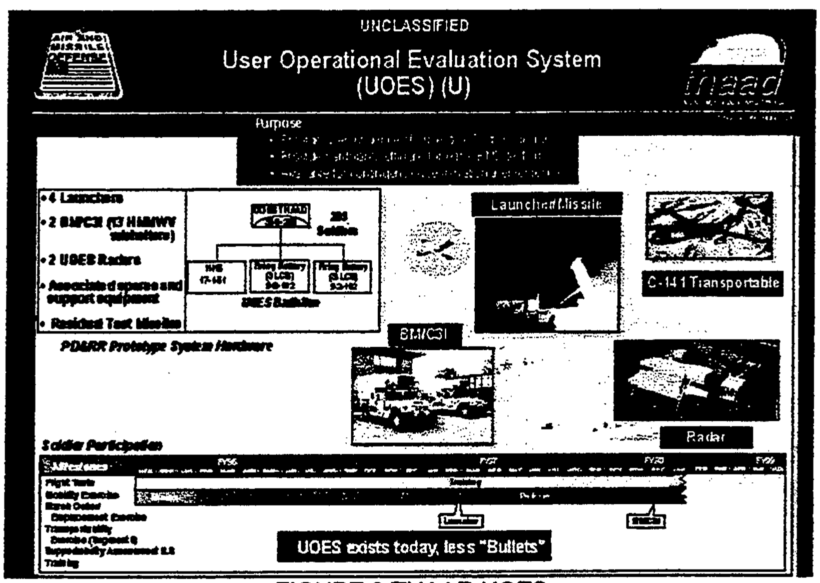

FIGURE 2 THAAD UOES

Warfighters may come to rely too heavily on the systems perceived capabilities and deploy it sooner, at the expense of the more robust fielded system's development. However, to be as effective as warfighters require, hundreds of thousands of lines of software code must still be completed. Also, upgrades to the equipment must be accomplished to make it sufficiently rugged for soldier use, and comprehensive testing and evaluation must continue in order to prove performance.

Furthermore, a dilemma exists if expectations of the prototype performance are too low. The objective system may be unfairly judged by the shortcomings and aberrations typically associated with developmental hardware and software. The THAAD system has made remarkable progress in developing and integrating a complete weapon system including launchers, radars, battle management systems, and missiles. Many criticisms have been levied against the missile segment's problems in not hitting a target until the seventh and eighth attempts. Yet, there have been repeated successes of all the ground segments and continued progress has been made toward missile design robustness and producibility. Many successful weapon systems in the field today required significantly more attempts and/or development time early in their prototype stages. A valuable interim capability might not be appropriately exploited in a contingency situation due to a jaundiced early expectation.

ENHANCED FIBER OPTIC GUIDED MISSILE (EFOGM)

The use of soldiers in the design of the Enhanced Fiber Optic Guided Missile (EFOGM) is an example of a well-planned evaluation conducted early in the development process. The use of soldiers was carefully planned to ensure that they understood the state of performance of the current prototype equipment and their role in influencing the final product. A potential downfall of early soldier use is that the soldiers will expect the prototype equipment they are working with to be representative of the final product. As in the Sentinel radar case, soldier feedback can result in relatively small changes that can yield large changes in equipment performance.

Availability of soldiers is becoming more and more of a premium, the draw down of the Army to current levels has led to an increasing Operational Tempo (OPTEMPO) and requires that soldier involvement be well planned ahead of time to ensure the maximum benefit.

The EFOGM early soldier evaluation was planned and conducted less than three months after a contract was awarded to build a prototype system[10]. Key stakeholders, including the government EFOGM project office, user soldiers from Fort Benning, and the equipment's prime contractor Raytheon, were cooperatively involved throughout the planning and conduct of the soldier evaluation. Preparation activities included an early safety assessment and interim safety release to cover the scope of expected soldier involvement; development of a data collection plan; questionnaire development; and identification of environmental factors that might affect performance (noise, light, etc.). A pre-evaluation was conducted including representative soldiers and a contractor system orientation. The lessons learned from the pre-evaluation were then used when the evaluation was conducted on the following day. Each day's testing concluded with soldier out-briefs and questionnaires to capture perishable soldier impressions. The entire evaluation required less than one week and fewer than 20 soldiers, but yielded significant design recommendations such as[11]:

1. Creation of channel guides for missile retaining pins to ease reload operations; especially at night.
2. Redesigned gunner console screens to be thinner (more room needed) and to be non-glare.
3. Added a fold-down step for soldiers to gain access to roof racks; videotape revealed that soldiers were stepping on antenna mounts to gain roof access (similar to FMTV finding where soldiers were stepping on taillight guards; except that EFOGM could change the design much earlier, in the prototype stage rather than in the production stage, resulting in much greater savings).

4. Changed filter locations to make more accessible for required periodic maintenance.

5. Added inside blackout curtains to reduce nighttime detection from screen glare.

6. Changed missile canister lift points.

7. Changed gunner screen displays to be more intuitive and to guide gunners through correct steps.

CAPTURING USER INPUT

For extended periods of soldier involvement, a formalized method of capturing and tracking soldier input is necessary to maximize the potential design benefit. THAAD accomplished this task by developing a soldier Comment Tracking System (CTS); by making minor modifications to a program originally written for a government power company. The web-based program collects soldier suggestions and allocates those inputs through a project office point of contact to the appropriate government and/or contractor persons for consideration and evaluation. A significant added benefit is that soldiers get credit for their inputs and can see the progress of their suggestions. The increased visibility encourages even greater soldier participation in the process. As a result of early soldier involvement and

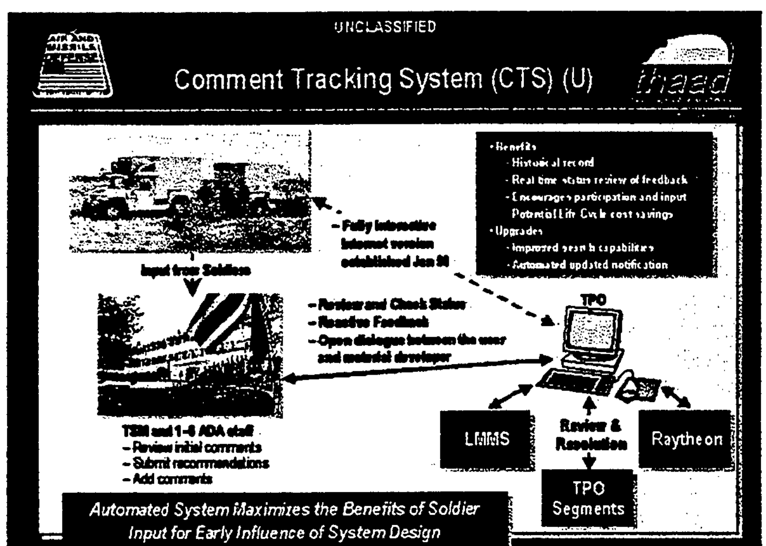

FIGURE 3 COMMENT TRACKING SYSTEM

the use of the CTS, hundreds of inputs have been formally collected with an estimated savings of $24.5 million in future cost avoidance.

USER/SOLDIER REPRESENTATION

The Callaway Golf Company selects focus groups, (early users) based on known demographic differences that align with their product lines, e.g., seniors, high-handicappers, women, etc. Similarly, soldiers must be representative of the soldiers who will eventually crew the equipment when fielded. Unlike the Callaway example, where established demographic sectors already exist, military applications involving new equipment often call for an associated new MOS group to man or support the system. These new specialties are not likely to be available until very close to the First Unit Equipped (FUE) date. The THAAD UOES solved this challenge by using soldiers having an MOS that was closely equivalent to that of the THAAD system. Therefore, soldiers with Patriot MOS's were used in THAAD's system-unique crew positions due to the fact that they had the closest match to the skills required during the early testing periods.

PROTOTYPE UPGRADES

Once the formal testing of prototypes is over, there is a natural user desire to upgrade the prototype. THAAD experienced desires from some who stated that, "with the UOES you get what you get" contrasted with others who had questions about why a certain objective system capability could not be "pulled back" earlier than was planned for into the UOES. The decision to completely or partially upgrade the prototype hardware and/or software is unique to each system developed, while it also involves tradeoffs of cost, performance, equipment availability, and impacts to the objective system schedule.

The decision to upgrade the THAAD UOES toward more objective system capability required a detailed analysis. Many variables were analyzed including: the costs to implement the upgrades, the expected remaining useful life of the improved prototype, the time that the prototype would be unavailable while it was undergoing upgrade, the extent of the testing that would be required for the upgraded system, and the risk to the timelines and cost parameters of the objective system. Members of the THAAD Project Office teamed to examine the cost, schedule, and performance impacts of different options to upgrade the UOES system once the formally planned testing was completed and the next development phase began. In the final analysis, elements of the THAAD system will likely undergo only very specifically agreed-to upgrades. The THAAD team found that the costs to upgrade the system were not completely predictable nor were they included in current budgets. If the prototype was improved, it would have less useful life the more it was upgraded (it would spend more time back at the laboratory rather than available for testing, soldier use, or contingencies). The soldiers would get less time with the equipment the more it was back in the contractor's hand being upgraded. Many test issues emerged if the configuration was allowed to continually evolve (how many changes could occur before the configuration was no longer consistent with the tested baseline?). Most importantly, the objective system timeline was put at risk the more that the system was upgraded. To upgrade the prototype, resources and time would be drawn away from, and adversely impact, the objective system development.

An independent review team, headed by Dr. Richard G. Rhoades, examined the options of upgrading or refurbishing the radar elements. They found that even for the less expensive options, "These lower cost modifications all suffer from the drawback of being 'dead end engineering' when viewed against the radar requirements" necessary to support an initial fielded capability.[12] Upgrade, test, support, and dead-end engineering costs are not programmed and do not support the objective system development. For THAAD, there were no comprehensive system upgrades planned, only very specific changes were made based on a case-by-case analysis of the overall benefits versus the costs to implement.

CONTRACTOR INVOLVEMENT PLANNING

The contract must be written to facilitate soldier involvement. The THAAD Lockheed contract included specific language that established soldier involvement up-front in the contract/proposal process. Conversely, the THAAD Radar Raytheon contract did not initially include language to develop the radar elements with soldier involvement. The Raytheon team successfully incorporated soldier involvement after many meetings, and a contract modification was accomplished, specifying the scope of soldier integration. Significant soldier dissatisfaction about their inability to be more involved with the radar equipment could have been avoided if the proper language had been agreed upon prior to contract award. Proper contractual language would have also provided a much better accounting of the projected cost impacts, the schedule requirements, the training support, and the maintenance requirements for the system.[13]

The Program Management Office (PMO) and Prime Contractor team together will have their focus divided between the prototype and the objective system development. From a PMO/contractor perspective, the main effort needs to be focused on the objective system with the prototype in support. Challenges include split resources (dollars, people, and time) for running simulations, conducting testing, and hardware/software maintenance. Simulations and changes to hardware and/or software are run in Hardware-in-the-Loop (HWIL) facilities. In order to develop the objective system and to fix problems with prototype systems, either separate facilities are needed, or the same facility must be capable of handling both the old and the new hardware/software. The people who run those facilities need training. Likewise, maintenance and budget personnel will have the daunting task of planning and executing repair and maintenance actions, on both old and new systems, simultaneously.

SAFETY RELEASES

Involving soldiers in early equipment prototyping, by definition, involves soldier interactions with hardware and software that has been incompletely tested. Close involvement with TECOM safety personnel can keep schedules and plans flowing smoothly. Safety releases may be required for each equipment change in configuration. The THAAD and EFOGM teams involved TECOM safety personnel in design meetings, contractor test events, and planning meetings. Regular safety personnel involvement is essential to ensure that soldier safety is never compromised and that soldiers and contractors are not delayed in developmental activities.

DELL COMPUTER CORPORATION

The Dell Computer Corporation is the largest producer of personal computers in the United States with over 36,500 employees working in over 38 countries.[14] Lessons from how Dell successfully allocates their resources by packaging largely existing subcomponents to satisfy customer requirements, have parallels with the Army's need to make best use of all currently available hardware and software in more innovative ways. Dell pursues six phases of product development in what they term "Dell's Direct Business Model". While different in number and name, Dell's six phases of product development correlate loosely with Department of Defense phases of development. Dell is very different from military developers and typical hardware producers in the relationship of resources applied over the development lifecycle. Dell places relatively little emphasis on subsystem research and development. Instead, Dell initially focuses its greatest resources on gaining a thorough understanding of customer requirements, and later, the company focuses on customization, delivery, and support.

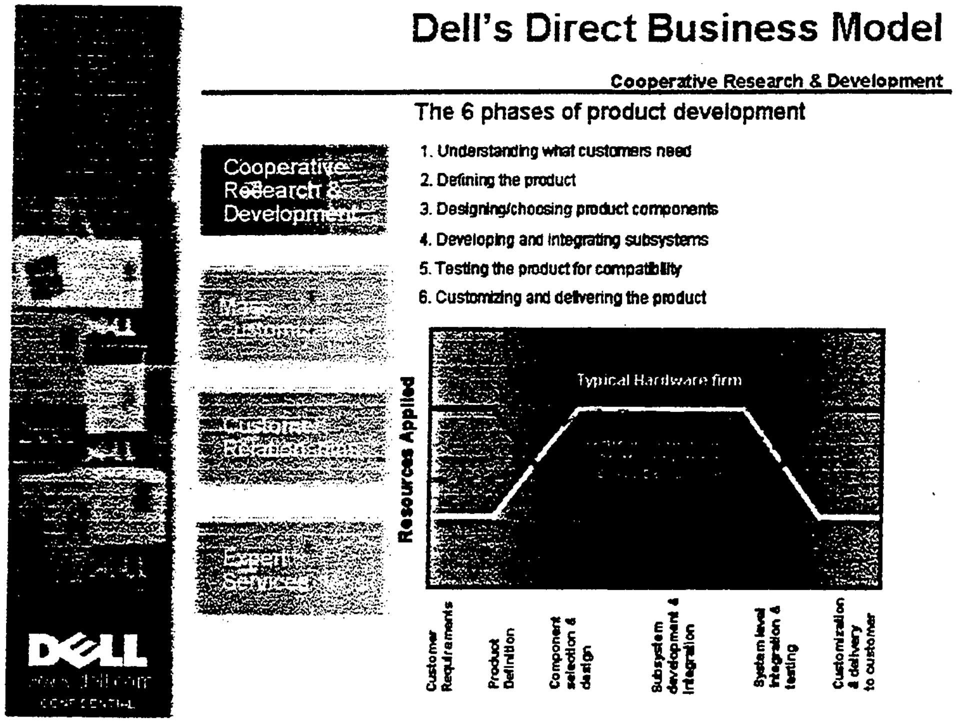

FIGURE 4 DELL BUSINESS MODEL (PROPRIETARY)[15]

Customer requirements are first identified through the use of focus groups and later verified through pilot computer runs to ensure customer needs have been met. Once potential user requirements are established, Dell is unique in its ability to rapidly customize computers to meet individual customer orders, regardless of the number of configuration and quantities ordered. Dell is also unique in its ability to create customized, project managed, customer support packages. Vice president, Mr. Frank Miller (MG(R), USA) states the Dell customization position as, "Lead, follow and lose money, or get out of the business." This model may have military applications in areas where the requirements are relatively stable and well understood. Also, this model applies significantly greater resources than applied under typical military applications, early in the requirements definition phase. Furthermore, Dell understands an issue that is also pertinent to the Army; specifically, by having a solid understanding of customer requirements up-front, they have become a much more efficient producer by wasting less on follow-on development and redesign.

ADVANCED CONCEPT TECHNOLOGY DEMONSTRATIONS (ACTD)

Advanced Concept Technology Demonstrations have been devised as a means to more quickly exploit emerging technologies, or to more quickly mature promising advanced technologies to solve military needs. Materiel development costs and timelines have been under intense pressure to grow smaller, or to grow at a slower rate. This pressure has spawned a number of acquisition streamlining initiatives including the ACTDs. Thus far, the popularity of ACTDs is evidenced by their growth from 26 candidates in fiscal year 2000 to 55 candidates in fiscal year 2001 (so far).[16] Like the THAAD UOES, the hallmarks of the ACTD program are to provide a rapid response to user requirements and provide an interim capability; to develop strong user/operator involvement in order to develop new tactics, techniques, and procedures; and to provide a fieldable capability.

A key difference from the THAAD UOES is that once the ACTD completes a nominal 2 to 4 year period of development and integration, technical testing, and an assessment of the military utility; there are three general courses of action that can be pursued. These three courses of action include times when the ACTD should be stopped completely; the ACTD should be modified or extended to continue maturation of the technologies; or the ACTD should be inserted, where appropriate, into the traditional materiel development process, e.g., the EMD or Production phase depending on demonstrated technological maturity and urgency of need. Also, instead of the nominal 2 years where the ACTDs are provided some sort of limited fielding for operational use, the UOES would have been used similarly, but at least 2 to 3 times as long. Currently, segments of the UOES are being evaluated for continued use past 2002, which is ten years after many of the initial components were designed and purchased. Finally, the number of soldiers dedicated to the UOES was an unprecedented 295. Today, due to the protracted timeline of system development, the number of soldiers is being reduced significantly depending on likely missions and need, until a fielded system is available for use.

Since ACTDs are becoming a more popular shunt to the traditional acquisition process, the 2-year transition period during which ACTDs are provided to the user, following the development and assessment period, should be and is an area of great emphasis. The ACTD issues of merging into the traditional acquisition process and determining the requisite reliability and testing are accomplished to ensure effectiveness and suitability, while many of the same issues experienced by the THAAD UOES must also be resolved. In many cases where the need is potentially urgent, the user may have some number of soldiers dedicated to operation of the ACTD prototype. Consideration must be given to the number of soldiers involved, their continued training, and the likely gap between the funded 2-year transition and the availability of the next generation of hardware/software. The user is not likely to want to part with the equipment that, while prototype, is filling an urgent need. However, extending the useable life of the hardware involves the same tradeoffs that THAAD initially experienced, such as cost increases over time, the risk to the objective system development, and the time away from soldiers required for upgrade and/or maintenance.

CONCLUSIONS

The use of soldiers early in the acquisition process has clear application in the development of future army systems. Early user employment has been shown to be valuable in different military applications and is also an industry best practice. Some of the military lessons-learned or industry best practices described in this paper could save resources, reduce developmental risks, and help to properly shape expectations. Once a program moves past the prototype phase, the materiel developer must focus firmly on the objective system. Residual ACTD or prototype hardware can be "distractions" to development, and should be managed by a few key persons on the government and contractor team to leverage appropriate resources, on an individual basis, to solve the issues at hand. The remainder of the development team should move forward by implementing the prototype lessons learned toward development of the objective system that will meet the user's requirements. The prototypes should not be dismissed with a "you get what you get" arm wave. A focus group can identify the reasonable efforts necessary to establish a smart baseline capability. That baseline capability should have input from warfighters and decision makers who will need operational information at any available fidelity. Information on reliability will be scant, software evolution must be monitored and explained in operational terms, and the impacts of commercial hardware typically used in prototype development must be explained. Understanding a prototype system's limitations will allow the warfighter to plan properly and gain the maximum synergism of the prototype with other battlefield systems. While clearly <u>not</u> intended to be the objective system, prototypes such as the THAAD UOES may still provide significant operational benefits and capability while the objective system development continues.

RECOMMENDATIONS

There is no "silver bullet" to precisely address how soldiers should be incorporated into the materiel acquisition process. However, some basic principles emerge repeatedly regardless of whether the user is a soldier or a civilian.

1. Soldier involvement should occur as early as possible in the process, preferably before a prototype is actually built. Appropriate soldier involvement should be in the design phase when a drawing review is being conducted, as exhibited in the EA-6B follow-on program; or focus groups could be employed, as typically used by commercial companies like Dell Computer and Callaway Golf.

2. Soldier involvement should be carefully planned. Specific considerations of the plans should include selection of representative users – whether it is by an Army breakout of representative MOS's or by Armed Forces Qualification Test scores. Plans should include specifics on how many users will be required (fewer at the very early stages is generally better); how long the users will be needed for the evaluation; and what tasks the users will be expected to perform.

3. Expectations must be actively managed. All affected stakeholders should be identified, e.g., users, testers, Congress. During test periods, explanations should be provided describing the purposes of the evaluation, along with a description of the prototype nature of the hardware and/or software being evaluated.

4. User inputs should be formalized. Formal collection of inputs ensures maximum benefits from early user involvement. It also helps to later justify the costs associated with early user involvement against the cost savings realized from user suggestions. A long-term collection like the THAAD CTS is appropriate for protracted user involvement, or a short-term collection like the EFOGM is appropriate for limited duration user involvement.

5. User involvement should be repeated wherever feasible, throughout the development process. Different users are likely to generate different design inputs – even if all users are using the same equipment baseline. When baseline

changes do occur, early user input can be used as a cost effective means to validate or refute the value of the change.

ENDNOTES

[1] Senate Armed Services Committee Conference Report. 7 July 1992.

[2] General Henry H. Shelton, chairman of the Joint Chiefs of Staff, comments made during a DoD News Briefing at the Pentagon on 20 January 1999.

[3] Information on Family of Medium Tactical Vehicles trucks was obtained during a plant visit to the Stewart and Stevenson truck plant on 2 November 1999. Many helpful persons assisted in the visit including Mr. Mike Hauser the General Manager of Program Management.

[4] Based on conversations with Dr. Ernst Seglie Science Advisor for the Office of the Director of Operational Test and Evaluation (DOTE) on 28 October 1999 at the Center for Professional Development and Training in Austin, Texas.

[5] Information in this paragraph comes directly from the author's experience as the test co-designer and as a principal test conductor for the GBS test completed in spring 1991.

[6] Information on the Callaway Golf Company was obtained through email correspondence, a conversation with Pam from Customer Service, and the Callaway web site, http://www.callawaygolf.com.

[7] Feherty, David. "Talking (Club) heads." Golf Feb. 2000: 148+.

[8] Golf Engineering LLC. "Golf clubs designed for style, engineered to perform." (February 2000): [Internet]. 25 February 2000. http://www.golfengineering.net/.

[9] Callaway Golf Company Research and Development information was obtained during a phone interview with Mr. Tom Preece, the Research and Development Director of Operations on 6 March 2000.

[10] Enhanced Fiber Optic Guided Missile Project Office Report No. EFOG:95:019, Final Report for the Fire Unit MANPRINT Early Soldier Evaluation of the Enhanced Fiber Optic Guided Missile (EFOGM) (Redstone Arsenal, AL, October 1995).

[11] Based on an interview with Mr. Joe Harkey from Nichols Research Corporation who supported the EFOGM Logistics Division during the evaluation. Interview was at Austin, TX on 6 April 2000.

[12] "Report of UOES Radar Supportability Review Team." Draft Report. Undated.

[13] Based on interviews with LTC Michael Smith, the THAAD Radar Product Manager, at Huntsville, Alabama on 3 March 2000.

[14] Information on the Dell Computer Corporation was provided during a company briefing and plant tour on 16 February 2000.

[15] Chart provided with specific limited permission to use only for this paper. Further use of this chart must be requested directly from the Dell Computer Corporation.

[16] Based on an interview with Mr. Christopher F. Fornecker, the Assistant Deputy Under Secretary of Defense (Advanced Systems and Concepts) for C4I, at the Pentagon on 17 March 2000.