STUDY REPORT
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ARMY EFFORTS TO IMPLEMENT INTEGRATED PRODUCT & PROCESS MANAGEMENT (IPPM)

PREPARED
BY

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STUDY REPORT - ARMY EFFORTS TO IMPLEMENT INTEGRATED PRODUCT AND PROCESS MANAGEMENT (IPPM)

EXECUTIVE SUMMARY

Objectives: At the request of the U.S. Army Materiel Command IPPM Working Group, our staff examined the ways the Army can participate in the design process, add value, contribute expertise, and not interfere with the contractor's design responsibilities.

Methods: The staff surveyed Army Project Management Offices by phone to identify development programs that incorporate an IPPM approach or segments of that approach. They conducted a series of telephone interviews with functional organizations, project offices and contractors to examine the character of the IPPM relationships between the Army and industry.

Results: This report examines a span of IPPM activity exemplified by the development history of eight weapon system programs. Six of these systems have support from joint Army and contractor IPPM teams. Across the board, the joint teams are alike in one important aspect; the simultaneous involvement of many disciplines.

Conclusions:

- There are mixed feelings on the physical separation of teams. Some felt that collocation was a must for maximum benefits while others felt comfortable working around that barrier with electronic communications media and appropriate meetings.

- A reluctance to disclose proprietary information is, in some relationships, troublesome.

- A process should be in place for settling disputes. So far, however, no one is generating much controversy and no contractual difficulties or legal disputes are apparent.

- Nearly everyone emphasized the need to clarify what is expected of the team up-front. Formal ground rules and procedures should be established right away.

- Ideally, joint teams should receive team building and technical training together.

- One of the first items on any joint team's agenda should be a thorough scrub of the contract requirements. The scrub clarifies meanings, ends misconceptions, discloses intent, and finds places to save time and money.

- Perhaps the Army member's most important function in a joint team is to provide a solid explanation of the requirements. Many emphasized the importance of having users (e.g., soldiers) on the teams.

- There was much said about benefits and how they might be computed. Most felt there would be savings in lead times, prototype development, and engineering change processing. Others mentioned constraints such as the number of meetings, difficulty with communications, and data security. Most saw the positive aspects of IPPM but no one mentioned that they had attempted, or might attempt, a controlled analysis to evaluate the benefits.

- Top management support was absolutely essential in every case.

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I. INTRODUCTION

Our organization has participated in a three-year series of Concurrent Engineering workshops sponsored by the Army Materiel Command (AMC) Integrated Product and Process Management (IPPM) Working Group. During a meeting at the Armament Research, Development and Engineering Center in June 1994, we agreed to examine the ways the Army can participate in the design process, add value, contribute expertise, and not interfere with the contractor's design responsibilities. The Working Group concisely described the full scope of the issue for us:

> *"Design versus Performance Reviews - How can the Government participate as a valued member of the design review process, contributing their experience and insight, without relieving the contractor of design responsibility? The Working Group will investigate the factors (cost, legal liabilities, etc.) involved in Government participation in the design process."*

Our staff surveyed Army Project Management Offices by phone to identify development programs that incorporate an IPPM approach or segments of that approach. The preliminary search found several weapon systems appropriate for further review. Then began a series of telephone interviews with functional organizations, project offices and contractors to examine the character of the IPPM relationships between the Army and industry. We interviewed four people from the functional organizations, eight from the project offices, one from a Defense Plant Representative Office, and two from contractor offices. In addition, one of our investigators works almost full time for a project office that proactively applies the approach. His own experiences provided an ample supply of information.

Before the first interview, each investigator sent a checklist to each subject who wished to participate. Both sender and receiver used this checklist as a guide. The sections of this report and the system stories in the appendices follow the pattern set by that checklist. For the sake of being factual and keeping the trust of our sources, we sent every story back to its origins for comment.

II. SYSTEMS SURVEYED

This report examines a span of IPPM activity exemplified by the development history of eight weapon system programs. Three of these programs enable product improvements such as better targeting capabilities for the TOW Missile and the Apache Helicopter and a smarter command and control architecture for the Bradley Fighting Vehicle. Four programs are developing new systems; the Close Combat Tactical Trainer, the M6 Smoke Grenade Discharger, the XM8 Armored Gun System, and the Composite Armored Vehicle. Only one, the Heavy Assault Bridge, is a Nondevelopmental Item.

The program maturities of these systems fall into three groups. The newest one in the Concept Exploration and Development Phase is the Composite Armored Vehicle. The oldest, at or very near to the end of Engineering and Manufacturing Development (EMD), are the M6 Smoke Grenade Discharger, Armored Gun System and Longbow Apache. The other systems are still a year or more away from the end of the EMD Phase. None of them are in the Demonstration and Validation Phase.

III. CONTRACTS

Contract provisions are just starting to play a part in establishing an IPPM relationship between the Army customer and the supplier.

The contracts for the most mature group of systems reveal nothing to suggest or require the use of an IPPM approach. Although these programs began before Concurrent Engineering and IPPM were development strategies accepted with the Department of Defense, there is evidence that the approach still took root. For example, the Director of Edgewood Research Development and Engineering Center met with the contractor for the M6 Discharger. He explained how the Army planned to organize IPPM teams and wanted them to become active participants. The M6 contractor was very receptive to the idea. In the Armored Gun System, however, the relationship did not include the use of joint Army and contractor teams. The contractor used the approach but the Army did not. Similarly, the Longbow contractor engaged in a self-funded redesign effort that led to the use of Integrated Product Teams. The Longbow teams included contractor and vendor members but the Army did not participate with them actively. The Army did not change its traditional oversight structure or methods for the Longbow.

For the newest system, the contract has IPPM provisions. The original contract for the Composite Armored Vehicle had brief coverage but a later modification included more provisions for IPPM funding and training. Joint Army and contractor teams are now operating.

All four systems in the middle age group have support from joint IPPM teams. The contracts were the catalysts for joint IPPM on the TOW Improved Target Acquisition System and the Close Combat Tactical Trainer. The Heavy Assault Bridge contract had no such provision. The contractor adopted the approach independently. The Product Management Office for the bridge followed suit by organizing its staff to operate in the same mode with the contractor. A similar sequence of events brought the Bradley Fighting Vehicle teams into joint operation.
None of these contracts imposed any limitations on how the teams could organize.

IV. THE JOINT TEAM

Across the board, the joint Army and contractor teams are alike in one important aspect; the simultaneous involvement of many disciplines. All teams generally include specialists representing the interests of the combat developer, quality, producibility, logistics, maintainability, engineering, software, contracts, cost and the functional organizations. Also, they include test and evaluation agencies, defense plant representatives, component vendors, and soldiers representing the schools.

There are variations in team organization but most programs use some form of hierarchical structure. You will generally find a senior oversight or policy team above, one or more systems integration or functional interest subteams amid, and several execution subteams below. Each program has tailored its organizational structure for efficient administration.

The execution subteam does the focused development work. It owns a subsystem or a technology vital to several subsystems. It tends to be commodity oriented; its origin often corresponding to the work breakdown structure. It has a designated leader and multidisciplinary members from the contractor, subcontractor and Government. The execution subteam has responsibility, authority and money. It plans and controls those processes fundamental to program success. It maintains daily program activity and vigilance over performance, schedule, cost and supportability.

V. TEAM FOUNDATIONS AND CULTURES

The Close Combat Anti-armor Weapon System Project Office chartered the joint Team **TOW ITAS**. The charter defined the scope of activities, responsibilities, and powers. A month after contract award, Team TOW ITAS met for a week at the contractor's facility. The Army Project Manager described the rules and assignments for the project. Texas Instruments, the winning contractor, presented a briefing to overview the contract and their top level plans for executing it. The execution subteams met separately with their functional counterparts, got to know one another, and perused parts of the contract that applied to their areas of responsibility. Then the subteam members agreed on whom did what. Texas Instruments already had a well established and tested Integrated Product Development Process (IPDP) and a comprehensive training program. All contractor team members and five Government team members received the IPDP training. These five now help the Government team.

During the early months of the **CCTT** contract, the prime contractor sponsored three meetings among all team members. The members represented the interests of the teaming contractor companies, the Army Program Manager and the Army users. The particpants addressed team missions, ground rules and operating procedures. The organizational foundation included empowered multi-disciplined teams, a high level of user involvement, and life cycle product ownership. The participants detailed a hierarchy of processes describing the operation of all levels of the organization from the program office, down through the Concurrent Engineering (CE) teams, subteams, and working groups. These processes included the handling of contract baseline change requests, generation and delivery of contract data, and day to day execution of team activities.

The CE teams' missions established responsibilities for design, development, integration, test and delivery. The teams were also responsible for preparing the design, test and support documentation for their products. They were to become self-managed and empowered to the extent allowed by the contract requirements and the program constraints.

Besides CE teams, working groups formed to address certain areas that affected all CE teams. These working groups, in contrast to the multifunctional CE teams, included those who had a functional interest in the working group's area of concern. An example is the Software Working Group that is responsible for ensuring the software development processes provides training-effective software. Another is the Data & Models Working Group that is responsible for identifying the set of models and associated data used throughout the CCTT.

Clear ground rules for joint interaction and training opportunities were just as important to the **Heavy Assault Bridge** Integrated Product Team. Army members took training courses in cost plus award fee contracting. General Dynamics Land Systems and Army personnel learned the proper use of PERT charts. Team facilitators from General Dynamics received training to help them guide the execution subteams.

The Army members of the **Bradley Fighting Vehicle** Product Development Teams also took special classes in cost accounting. The United Defense Limited Partnership, the Bradley prime contractor, purchased the Texas Instruments IPDP package and held a workshop, including Government representatives, to introduce the package to the Bradley team members. United Defense is making IPDP a corporation-wide policy. This corporation is also the prime for the Armored Gun System and the Composite Armored Vehicle. Their corporate philosophy is spreading to these systems.

Top ranking Tank-Automotive Research, Development and Engineering Center and United Defense managers met to tailor the Texas Instruments package to the **Composite Armored Vehicle**. When they finished, intermediate managers from both sides tailored it again to pave the way for a detailed tailoring by the stakeholders in the execution subteams. The tailoring sessions corrected flawed expectations and misconceptions and identified contact deficiencies or mismatches.

Equally innovative methods broke the ice elsewhere. Within the Army team for the **M6 Discharger**, just about anything that helped the team members to get acquainted, and was in good taste, was fair game. This team established its rules of conduct early. The rules included a mission statement and procedures for teaming, decision making and how meetings would be conducted. Intense team training started early and continued to the point that the team felt it should stop so the work could proceed. Edgewood's top management encouraged off-site team meetings. The team tried all sorts of ideas; team luncheons and dinners and activities such as bowling a few lines during working hours.

VI. THE ART OF CONTACT

Face-to-face meetings allow a feeling of trust to flourish while making the exchange of information accurate. The joint teams meet this way but with controlled frequency. The controls are self imposed, imposed by geographic separation, set according to available communications media, or combinations thereof. Progress in electronic information exchange is relieving the necessity to meet face-to-face. Virtual contacts are increasing. Concurrent action and cost will benefit from them.

The Product Manager for the **TOW ITAS** sponsors weekly meetings of the execution subteams at Redstone Arsenal and his counterpart in the Texas Instruments - Dallas facility does too. Texas Instruments has a representative living in Huntsville, Alabama who always attends the meetings. At least one Government representative attends the weekly meetings in Dallas. Also, team personnel from both parties travel to meet their counterparts as needed. Redstone personnel do not work in a common office but reasonable proximity and good communication systems still allow the team members to work together effectively. Phone, datafax and videoconferencing communications are in extensive use. For timely review of drawings and other data, Redstone has on-line, real-time access to the TOW ITAS data base in Dallas.

The teaming contractor companies gathered personnel assigned to the **CCTT** Program into an Integrated Development Team (IDT) in Orlando, Florida for the duration of the development effort. Within the IDT, they created five coordinated CE teams; a Systems Integration CE team and four CE teams to address the development of the four CCTT subsystems. The teaming companies; Loral Federal Systems Company (the prime contractor), ECC International, Evans and Sutherland, SAIC, PULAU, and Dynamics Research Corporation have maintained key personnel at the Orlando Integrated Development Facility.

The site occupied by the eighty-member Army team, the Army Program Manager and his Program Directors is less than one mile from the contractors' facility. All lead functional personnel in the Army team are active members of the IDT and participate in the assigned CE development teams. One Army Captain and two Army Sergeants, permanently stationed at the contractors' facility, provide real-time input on questions concerning Army doctrine and tactics. They also provide a situational awareness for the Training and Doctrine Command (TRADOC) and the user community. To fulfil this role, they serve as CE team members wherever their input and influence can be most effective.

User Exercises provide further user participation. These exercises begin upon completion of each of the seven software spiral builds that partition the software development effort. In each User Exercise, a team of experienced active duty soldiers performs tactical exercises designed to test the increasing functionality of the software. The User Exercises provide iterative user feedback throughout the software development process and help ensure the resulting software will meet the training needs of the Army.

Participation in the IDT, CE teams, and working groups occurs in several ways. The most visible is by the routine attendance of all team members, including the Army functional and user representatives, at the regularly scheduled team meetings. The convenient location of all participants facilitates regular attendance. In addition, email links all members and all members have access to the Contractor Integrated Technical Information Service (CITIS). This high degree of interaction allows the IDT to function as a close coupled organization.

Government personnel participate regularly in the meetings that General Dynamics holds. This is easy for them. The **Heavy Assault Bridge** Product Management Office is about two miles away from the General Dynamics facility in Sterling Heights, Michigan. General Dynamics uses a PC-based CAD system with 3-dimensional modeling capability. The CAD display is large enough for the members to see during meetings. Their proximity to each other is a definite plus in achieving face-to-face interaction. Both parties use phone and fax communications also. The Army has electronic access to the technical data package and the Logistics Support Analysis Record in the contractor's database. Subteam meetings convene as necessary to develop the producibility package for each part of the design. In addition, monthly joint meetings provide the opportunity review progress and address problems on the entire program.

The primary role of the **Bradley's** Army team is in their membership on the United Defense development teams. The Army team meets once or twice a month, depending on travel schedules. The purpose of the meeting is to update all team members on overall status of the program and to resolve any problems. The Army's role on the contractor teams varies; sometimes the team member is a leading contributor in problem solving, other times the Army member just listens. Although team members travel widely, they cannot attend every meeting. The development teams meet every week in San Jose making it hard to attend every meeting and continue living in the Detroit metropolitan area. An Army team member will occasionally visit United Defense for a reason other than a team meeting and will usually adjust the travel schedule and attend. Physical travel is still the preferred method of communication. The Project Management Office is on the United Defense voice mail system. Plans are in place to incorporate the Joint Computer-aided Acquisition and Logistics Support system and the Digital Storage and Retrieval Engineering Data System into the Bradley program.

Army interaction with United Defense on the **Composite Armored Vehicle** is frequent. Daily phone calls, monthly co-chaired meetings, quarterly in-process reviews, and e-mail keep both parties in touch. The e-mail system has extra features making it possible to transfer engineering drawings and various reports, manipulate them, and approve their status. Its virtual workplace capabilities are especially important in view of the time zone separation of the parties.

Personal contacts were very frequent between the **M6 Discharger** teams. Both parties travelled extensively between Edgewood Arsenal and the Brunswick facility in Deland, Florida but not according to set schedules. Nothing was ever just "thrown over the wall" by either group. Electronic mail was not available between the two groups but Edgewood used it extensively among themselves. There was never any rejection of Contract Data Requirements Lists or ideas because "it just isn't right." Instead, written and oral communications explained what the Government needed and why. Most written or telephonic messages and personal discussions included suggestions on how to get there; making Brunswick part of the team.

VII. WHAT WORKS?

We have come back to the core. Just how does the customer participate in the design process, add value, contribute expertise, and not interfere with the contractor's design responsibilities? Our search ends in three areas that may hold the answer: ground rules, open communications, and fair play.

Clear ground rules are in effect for Team **TOW ITAS**. The contractor is totally responsible for the design and for meeting the requirements of the contract. The Government's role is to advise, make suggestions and help where it can. The contractor may take whatever advice he wishes but he is totally responsible for meeting contract requirements. The subteams decide matters whenever possible. This works well because the members were able to establish ownership of the process during the kick-off meeting. Issues that cannot be resolved by the subteam or recommendations that require efforts outside the scope of the contract take an upward route to the Texas Instruments Product Manager. If necessary, issues go to the Army Project Manager for resolution.

The approach taken on the TOW ITAS project has reduced the need for formal reviews. Formal Program Reviews with the contractor occur semi-annually not monthly. The contractor prepares fewer deliverables because the Government has ready access to information as it develops. To reduce costs further, the Government requests only one copy of each deliverable. No problems have arisen concerning proprietary information. The emphasis is on the use of non-proprietary commercial technology.

In contrast to TOW ITAS and contrary to what most literature on Concurrent Engineering suggests, the need for formal reviews in the **CCTT** Program continues. Separate formal design reviews address the software and hardware portions of the system.

For software, a series of IPRs has replaced the formal Preliminary and Critical Design Reviews. These IPRs for each software module examine, successively; the Requirements, the High level code, and the Low level code. While these reviews are still formal in the sense that Government approval is required to complete them, they are more in line with IPPM principles by allowing accomplishment through a nearly continuous interaction of all interested personnel.

The more traditional approach to formal design reviews is in effect for the CCTT hardware. The retention of these reviews allows the Government to use them for two purposes. The first is to provide a formal mechanism for Government approval of the hardware design. The second purpose is to provide a forum in which the hardware design can be presented top-down to those TRADOC representatives who did not have the benefit of direct participation in the IPPM process.

IPPM is making a positive impact on the cycle time for Government acceptance of Contract Data Requirements List item deliveries. Because the process for developing the contract data includes participation by the Government team members, who are also responsible for accepting the delivered data items, there is an evident reduction in the time required to review and accept the delivered data. Occasionally, the cycle time does not improve. The usual cause is the delay in reaching a CE team consensus on the abiding conflict between what is acceptable data and meeting contract requirements for on-time delivery.

As part of the Simulation, Training and Instrumentation Command (STRICOM) compliance with the DOD Continuous Acquisition and Life-Cycle Support (CALS) initiative, the contract Statement of Work (SOW) included a requirement that the contractor implement a CITIS. In preparing the contract SOW, the Army placed great confidence in the ability of the CITIS to perform in two areas. The first was in using the CITIS as the vehicle of choice for delivery of Contract Data. The second area was in applying it as a tool for accessing other contractor data not specifically required by the contract. Because CITIS was expected to allow Army access to this second area, the Contract Data Requirements List (CDRL) received a thorough scrub to remove any requirements for documents where the data would be available through the CITIS. The CCTT implementation of the CITIS fell short of fulfilling expectations in both areas. Early difficulties involved local area network speed, capacity, and connectivity problems. Those resolved, more difficulties resulted from the Army's and the contractors' wishes to control mutual access to data and network systems. So the program participants sometimes resorted to the delivery of hard copy data to circumvent the CITIS altogether. These lingering difficulties highlight that Government and industry efforts to define and implement a successful CITIS remain incomplete, especially where the working environment is rich in proprietary information.

The implementation of IPPM in the CCTT development process evolved as the work progressed. Three changes dealt with the role of the Government in the CE teams, the balance between meetings and individual work time, and the management visibility of problems.

A PM CATT memorandum, issued early in the program, firmly placed the responsibility for delivering a quality training system to the field on the Army team members. They would do this by full participation in the IDT CE teams. Over time, however, Army team members perceived an increased pressure to make design decisions "on the fly" in team meetings. This perceived shift in responsibilities caused them to draft a formal set of guidelines. The guidelines included fourteen specific roles. Fully half of them addressed improved communication, within and between CE teams and between contractor personnel and the PM

Office and the user community. The remaining roles stated the Government's responsibilities to review and accept the design, ensure quality products, and evaluate contractor performance.

The second change to the IPPM process involved the time spent at meetings and the time used for individual labor. Initially, mandatory attendance at CE team meetings was stipulated to guarantee participation by all. As more and more working groups and standing meetings convened, many functional members serving on multiple CE teams became unable to conclude their individual work. A Process Action Team (PAT) in the second program year addressed a growing dissatisfaction with the IPPM process. While it addressed many issues, the one important concern it settled was a readjustment to the balance between attending meetings and accomplishing individual work.

The third adjustment of the process occurred after it became apparent that issues affecting more than one CE team and conflicts between teams were not receiving sufficient management attention. Weekly focus meetings established at both the lead engineer and program office level now provide a forum for a nearly real-time identification and resolution of these issues.

The ground rules for the joint interaction on the **Heavy Assault Bridge** are simple and clear. General Dynamics is responsible for providing a product that meets the purchase description and for complying with the other contract requirements. The Government is responsible for providing recommendations and evaluations as the designs and plans progress.

Joint participation provides the skill levels required for each subteam. There is as much commonality of personnel between the different subteams as possible. A subteam frequently begins its work with a brainstorming session. Iterative meetings deal with alternatives in increasing detail. The subteam walks through the design, creates manufacturing process flows, positions machines and finds manufacturing process limitations. Parts may be combined in various ways to eliminate or simplify manufacturing operations or to simplify logistics support. The result is a producible design and plans for efficient manufacturing. Information from the meetings is captured in a producibility package. The package contains design constraints, manufacturing process limitations, logistics impacts and design recommendations. The producibility package represents the subteam consensus and is the basis from which the designers, manufacturing planners and logistics planners complete their work for that given part of the design. The lengths of the meetings vary. The subteam meets as necessary to complete its mission.

Analytical approaches serve to develop data to aid in decision making when the best choice is not obvious. The Heavy Assault Bridge subteams apply an extensive set of computer based tools; Design for Manufacturability; PC-CAD; Variation Simulation Analysis; and Virtual Prototyping to model the part, fixture, machine tool and working elements such as cutting tools, and to simulate an entire factory operation.

General Dynamics welcomes Government participation. They do not want to spend time and money developing designs and plans that will be found unsuitable to the Government sometime later in a review. By working in the IPPM mode, there has been very little problem reaching decisions that are acceptable to both parties. When problems threaten an agreement, the approach is to perform more in depth analyses to develop data on which to base a decision. Cost is the most frequent decision driver. Other forces that drive decisions include design requirements, schedule, human factors and maintainability.

The Government members of the **Bradley** team believe they are adding value to the teaming process. Their contributions are in two primary areas; helping to understand the Army requirements and making their team aware of integration issues involving other teams. The involvement level of a Government representative is totally dependent on personal commitment. Some get very involved, others just sit and listen. There is very little decision making by Government team members. This is due to a concern about contractual issues and authorization to direct such issues. Expenditure tracking is the primary task of each Government team member. Each team member has several cost accounts, each divided by work breakdown structure. The Government team member reports cost performance monthly.

The ground rules for the **Composite Armored Vehicle** are consistent with those in the Texas Instruments methodology in use at United Defense. Both parties observe the rules and so far there has been no need to modify them. Cost and schedule impacts are considerations of every team decision. An advantage of the extensive teaming is that the Government Team can get a good handle on overfunded, underfunded, or previously unforseen needs. Familiarity with contract provisions is essential. Thus far, there has been no conflict over proprietary information transfer and intellectual property protection.

A small barrier to joint teaming has been United Defense's unfamiliarity in working with Government personnel in such a close manner. The personnel we interviewed believe that both parties will overcome this barrier as they become more familiar and confident with the terms of the contract.

Easier prevention and elimination of misconceptions through teamwork is one big benefit. The Army provided a prioritized list of its expectations in the contract and intends to update the list as the program evolves. This aids the contractor in understanding the Government's needs and guides programmatic and technical trade-offs. The list helps reduce controversy in decision making.

The Army Project Leader for the **M6 Discharger** said the thing that made the team work was making sure everyone knew about everything that was going on. There was constant contact with the contractor and between team members. The team defined their primary role as, being helpful to Brunswick while avoiding an adversarial relationship.

Before the teams formed, each functional discipline had a priority to get the project finished on schedule, but the disciplines' priorities always differed with one another. When people joined the team and helped to decide issues, including priorities, they were able to keep the project completion - type classification of the Discharger - in mind. They modified individual concerns with overall project concerns. This behavioral change spread quickly through the team. The Project Leader could not recall even one experience with member incompatibility.

VIII. AFTERTHOUGHTS

After examining the customer-supplier relationships among the joint Army and contractor teams, several thoughts linger.

The barriers in these relationships are many. Some are real and some are not. Some persist and some do not. Those that persist are surmountable.

> Team Location: The results are mixed on the physical separation of teams. Some felt that collocation was a must for maximum benefits while others felt comfortable working around that barrier with electronic communications media and appropriate meetings. In many cases, the Army's physical presence was preferred.
>
> Proprietary Information: A reluctance to disclose proprietary information is, in some relationships, troublesome. Money and reputations are at stake here. Fair play, trust, and wise legal counsel become supremely important.
>
> Dispute Settlement: Several suggested the need to have a process in place for settling disputes. As a ground rule, that is sensible. The current situation is a bit puzzling, however. The Army participants are not generating much controversy and no contractual difficulties or legal disputes are apparent.

Most of the catalysts for success in these relationships are based on common sense.

> Ground Rules: Nearly everyone emphasized the need to clarify what is expected of the team early. They suggested that formal ground rules and procedures be established up-front.
>
> Training: Ideally, joint teams should receive team building and technical training together. The right people need training in communications, procurement practices, Army and contractor operating principles and preferences, cost accounting, work scheduling, and applying a variety of computer software tools.
>
> Contracts: One of the first items on any joint team's agenda should be a thorough scrub of the contract requirements. The scrub clarifies meanings, ends misconceptions, discloses intent, and finds places to save time and money.

Interpreting Requirements: Most respondents felt that the Army member's most important function in a joint team was to provide a solid explanation of the requirements. Many emphasized the importance of having users (e.g., soldiers) on the teams.

Benefit Quantification: There was a lot of discussion about benefits and how they might be computed. Most felt there would be savings in lead times, prototype development, and engineering change processing. Others mentioned constraints such as the number of meetings, difficulty with communications, and data security. Most saw the positive aspects of IPPM but no one mentioned that they had attempted, or might attempt, a controlled analysis to evaluate the benefits.

Management Support: Top management support was absolutely essential in every case.

APPENDICES

TUBE LAUNCHED OPTICALLY TRACKED WIRE GUIDED (TOW) MISSILE IMPROVED TARGET ACQUISITION SYSTEM (ITAS)

The TOW ITAS is a materiel change, technology insertion to accommodate TOW 2 on the High Mobility Multipurpose Wheeled Vehicle and ground mount systems. ITAS provides improved target detection and acquisition range, improved probability of hit, and enhanced fire control capabilities that will upgrade the anti-armor punch of light forces. Features include a second generation forward looking infrared detector to extend the ability to detect and recognize targets, a day sight, automatic target tracking, automatic boresighting, range finder, embedded built-in test/built-in test equipment, and embedded training. The ITAS accommodates all TOW missiles and has provisions to accommodate future new missiles. The ITAS is a Category III acquisition but, for test and evaluation oversight purposes, it is a Category I system. The ITAS project is under the direction of the Program Executive Officer, Tactical Missiles. The TOW ITAS Product Manager reports to the Project Manager, Close Combat Anti-armor Weapons Systems (CCAWS).

The TOW ITAS is in the Engineering and Manufacturing Development (EMD) phase. The Army competitively awarded an EMD contract to Texas Instruments (TI), Dallas, Texas on 30 April 1993. The Preliminary Design Review (PDR) concluded in November 1993 and the Critical Design Review (CDR) in August 1994. Both reviews were event, not schedule, driven. Satisfactory completion of predetermined milestones along paths to discrete events brought both reviews to a successful closure. Texas Instruments delivered three prototypes for test and evaluation. Preproduction Testing is underway and Limited User Tests will start in May 1995. Four more prototypes will be delivered in October 1995 for Preproduction Qualification Testing. A pilot line under construction will prove out production processes, work instructions, tooling and test equipment. The first units from the pilot line in April 1996 will support the Initial Operational Testing and Evaluation. April 1996 also will mark the Milestone IIIA decision.

An appointed team of government personnel wrote the TOW ITAS Request for Proposal (RFP). They streamlined the RFP and organized it to address program management, design, configuration management, production, and test. The resulting RFP did not have separate sections for each of the traditional functional areas. The RFP did request that the contractor organize a Concurrent Engineering (CE) team to execute the EMD contract. There were no limitations imposed on how the team was to be organized. The TI proposal outlined their CE team organization. An Army Materiel Command Roadshow II reviewed the RFP and provided comments to the CCAWS Project Management Office in the fall of 1992.

The CCAWS Project Office organized and chartered a Joint Industry-Government Team, called Team TOW ITAS, to define, plan, control and direct critical processes in EMD and production. They enrolled all functional disciplines and test and evaluation agencies in Team TOW ITAS. The scope of team activities included identification and continuous improvement of processes critical to program success. The Team had to ensure: synchronization of program activities; open, rapid communications; real time problem solving; and application of appropriate skills, resources, and timely management decisions. However, the Team could not alter independent evaluator's missions in any way nor could they usurp the Test and

Integration Working Group's (TIWG) prerogatives. Three elements compose the team: the Executive Steering Group (ESG); the Management Working Group (MWG); and the Functional Execution Element (FEE).

The ESG provides senior level oversight and overall policy direction. The PEO, Tactical Missiles is the chair. Members include: representatives from the offices of the Deputy Undersecretary of the Army for Operations Research; Commander, U.S. Army Missile Command (MICOM); Commandant, U.S. Army Infantry School (USAIS); senior level management representatives from the Army Materiel Systems Analysis Activity (AMSAA), Operational Test and Evaluation Command (OPTEC), Test and Evaluation Command (TECOM), and Night Vision and Electronic Sensors Directorate (NVESD); and the Contractor Vice President. The ESG meets annually or more often as required.

The MWG provides programmatic guidance and direction. The Project Manager, CCAWS is the chair. Members include a director level contractor representative and, generally, director level representatives from MICOM, USAIS, AMSAA, TECOM, NVESD, and other organizations that have direct involvement or oversight responsibility for the program. The MWG meets semi-annually or more often as required.

The FEE manages daily program activity, focusing on performance, schedule, cost and supportability. The FEE is responsible for early problem identification and course of action recommendations. The FEE addresses the ESG/MWG via the TOW ITAS Product Manager. Its normal forum is the daily workplace and the management interchange meetings. The FEE has both government and contractor representatives from all the functional areas. Also included are representatives from the Defense Plant Representative Office (DPRO), USAIS, AMSAA, TECOM, and other organizations. The FEE will not meet as a complete entity after the initial kick-off meeting so FEE members will keep abreast of activity through the MWG and the TOW ITAS Product Manager channels. The Product Manager sponsors weekly meetings of key FEE personnel at Redstone Arsenal.

Soldier users have been an integral part of the ITAS project. A user representative served on the Source Selection and Evaluation Board. An early Users Demonstration in August 1993 at Fort Benning and Redstone Arsenal included appropriate Military Occupational Specialty representatives. The demonstration allowed soldiers to evaluate prototypes and concepts as a part of the path to the PDR. Ongoing Limited User Tests provide user evaluation early in the project. A user also participates in the MWG and ESG meetings.

The entire FEE team met together for a one-time kick-off meeting about one month after contract award. The meeting held at the contractor's facility lasted one week. The TOW ITAS PM started the meeting by laying the ground rules for the project and instructing the team what to accomplish. The contractor presented a briefing to overview the contract and their top level plans for executing it. After the contract briefing, the government and contractor FEE members met in groups with their functional counterparts. As instructed, the team members got to know each other and, line by line, perused those parts of the contract relating to their areas of responsibility. They had to understand the contract and agree about what was to be done and by whom.

Clear ground rules are in effect for Team TOW ITAS. The contractor is totally responsible for the design and for meeting the requirements of the contract. The government's role is to advise, make suggestions and help where they can. The contractor may take whatever advice he wishes but he is totally responsible for meeting contract requirements.

TI has a well established Integrated Product Development Process (IPDP). The company has used the process on several projects and has developed a comprehensive training program. All TI members of the FEE team received the IPDP training. Five government members of the FEE team also participated in TI's IPDP training. These five government members help to facilitate the operation of the government FEE team. As an adjunct to TI's IPDP, the contractor and government partners jointly developed and monitored a series of tailored paths to prominent scheduled milestones (e.g., PDR, CDR, and Test). These paths define the successful entry and exit criteria.

Government members of the FEE team meet weekly at the CCAWS project office to exchange information and coordinate plans. TI has a resident representative stationed in Huntsville who attends these meetings. Government members of the FEE team also participate as needed in a monthly briefing to the PM, CCAWS. While government personnel do not work in a common office at MICOM, reasonable proximity and good communication systems still allow the team members to work together effectively. Contractor members of the FEE team work together at the TI facility in Dallas, TX. The contractor team meets weekly at TI. At least one government FEE representative attends these meetings. Government personnel from the FEE team travel to TI to meet with their counterparts as needed. The heaviest concentration of government personnel at TI was between PDR and CDR. Besides face-to-face meetings, phone, fax and videoconferencing communications are in extensive use. Government personnel have on-line, real time access at MICOM to TI's TOW ITAS data base, for timely review of drawings and other data.

The FEE team makes its own decisions whenever possible. This works well because team members were able to establish ownership of the process during the kick-off meeting. Issues that cannot be resolved by the FEE or recommendations that require efforts outside the scope of the contract take an upward route through the MWG to the ITAS Product Manager. If necessary, they go to the CCAWS Project Manager for resolution.

The people that work on each of the Work Breakdown Structure (WBS) elements track the expenditures for those elements. The contractor prepares the cost performance report which shows expenditures for each WBS element. One government FEE member, who works on a given element and appointed to track expenditures for that element, tracks it. The government member reviews the report with his contractor counterpart to ensure that budget and schedule are maintained. A joint videoconference cost review convenes once per month to track overall program costs.

The approach taken on the TOW ITAS project has reduced the need for formal reviews. Formal Program Reviews with the contractor occur semi-annually rather than monthly. The contractor prepares fewer deliverables because the government has ready access to information as it develops. To reduce costs further, the government requests only one copy of each deliverable.

No problems have arisen concerning proprietary information. The emphasis is on the use of non-proprietary commercial technology. There is no proprietary process involved in the production of the ITAS.

The concurrent engineering approach taken for the TOW ITAS project has been effective in controlling cost and schedule. The timely, direct communications are increasing the effectiveness of the personnel assigned to the program.

Persons Interviewed:	LTC Tom Harrison, Product Manager, TOW ITAS, DSN 645-0318 Mr. Tom Hart, Production Manager, MICOM Systems Engineering and Production Directorate, Production Engineering Division, DSN 779-6566
Interviewed By:	Mr. Walt Roll, Industrial Engineer, AMXIB-P, DSN 782-5617

CLOSE COMBAT TACTICAL TRAINER

Since the beginning of the Close Combat Tactical Trainer (CCTT) program, there has been a continuing emphasis placed on applying the principles of Concurrent Engineering (CE) to the development effort. In an early memorandum, COL Shiflett, the Program Manager for Combined Arms Tactical Trainers (PM CATT), observed, "CCTT is a complex system with literally thousands of requirements, many of which are subjective by their very nature." He continued, "CE will allow us to mature the customer's requirements as the design evolves and . . . allow everyone who is affected by the trainer's design, which is just about all of us, to have an input into the design early enough to prevent surprises . . .." Thus, CE was to improve the exchange of information needed to ensure the contractor understood, and could execute in the CCTT training system, the complex behaviors being sought by the Army and to reduce the risks involved in development of this important Army training system. This appendix to the study report will provide some background on the CCTT program, explain CE implementation, and discuss some results of that effort.

The CCTT is a collective training system in which armor and mechanized infantry units man full-crew simulators of their weapons systems to conduct unit training in a combined arms environment. Simulated elements replicating combat vehicles, weapons systems, and command and control elements are networked using Distributed Interactive Simulations (DIS) protocols for real-time, fully interactive, collective task training on computer generated terrain. The CCTT system will initially support maneuver company commanders in planning, conducting, and reviewing their unit's training on a free play, computer-generated synthetic battlefield. The CCTT will enhance current training systems and replace some, but not all, field training.

The CCTT is based on proof of principle work by the Defense Advanced Research Projects Agency (DARPA) and the Army in the Simulations Network (SIMNET) program. This technology demonstration program concluded with a platoon-level force development test and evaluation and an independent verification and validation. Both efforts concluded the validity of the technical approach. The technical approach demonstrated in the SIMNET program was to network a set of training systems similar to the Conduct of Fire Trainer that emphasize collective rather than individual skills.

A CCTT training site will be composed of simulator modules, work stations, a computer network and the software to accomplish training on the equipment. Simulator modules will be provided for the M1A1, M1A2, M2/M3A2, M113A3, M981, and HMMWV tactical vehicles. Each module will have training positions for a full tactical vehicle crew. A Dismounted Infantry module will provide stations for a Platoon Leader, Squad Leaders, and Forward Observer. The functions of the Battalion Operations Center, including air fire support, field artillery, and command and control, will be performed at work stations that will provide an interface to the simulated battlefield. Additional work stations will be provided for instructor/operators to control the Semi-Automated Forces (SAF), i.e., the virtual contingent of the battlefield, and to control overall CCTT system functions. Each student module will be designed around a commercial, general purpose computer processor and an image generator that, together, will control the operation of the module and provide the visual battlefield scenes. The status of the simulator modules, the work stations, and the simulated battle field will be communicated over the fiber optic network using the DIS protocol.

The CCTT development is an Acquisition Category II program that is currently in the third year of a five year development effort. A Milestone IIIa decision to authorize production of long lead items is planned for April 1997. A Milestone III decision for full production is expected to follow in October 1997 after successful completion of the Initial Operational Test and Evaluation.

Based on an open competition, a cost plus award fee contract worth approximately $130 million was awarded in November 1992 to IBM Federal Systems. The contract covers the development and manufacture of one fixed site and two mobile installations, consisting of thirty eight fixed site and eleven mobile prototype training modules with ancillary equipment. The contract also contained cost plus incentive fee options worth over $270 million for production of 68 Quickstart, 103 mobile, and 322 fixed site modules with all the required related equipment. IBM Federal Systems has since been acquired by Loral and is now the Loral Federal Systems Company.

The Quickstart option will procure M1A1 and M2/M3A2 modules to be used in conjunction with existing SIMNET equipment. As production fixed sites are fielded, Quickstart modules at the CCTT sites will then be incorporated in the production CCTT system. Because the contractor successfully demonstrated engineering design models for the M1A1 and M2/M3A2 modules, the option for Quickstart modules was awarded in October 1994.

The Statement of Work (SOW) for the CCTT contract stressed the use of a spiral/incremental development approach and the use of non-developmental software and hardware in the CCTT design. A heavy emphasis was also placed on reuse and re-engineering existing and developed software. In addition, the SOW required the contractor to use a system design process that concurrently integrated the efforts of all functional areas including Producibility Engineering and Planning, Software/Firmware, Product Assurance, Test and Evaluation, Logistics, and Configuration Management.

For the CCTT development effort, IBM gathered a team composed of ECC International, Evans and Sutherland, SAIC, PULAU, and Dynamics Research Corporation. As a way to overcome the difficulties of coordinating the efforts of this diverse team, and in response to the SOW requirement to integrate the efforts of all functional areas concurrently, IBM proposed that personnel assigned to the CCTT program from all team companies be gathered into an Integrated Development Team (IDT) for the duration of the effort. This IDT is located in the CCTT Integrated Development Facility (IDF) that is itself less than a mile from the PM CATT offices in Orlando, FL. Two of the subcontractors are performing major portions of their work at their base facilities. They are ECC International, also located in Orlando, which is responsible for manufacture of the simulator hardware and Evans & Sutherland, located in

Salt Lake City, Utah, which will be supplying the image generators. Both companies, however, maintain lead functional personnel at the IDF who coordinate the work with their base facilities.

The IDT is structured into five coordinated CE teams assigned by major system components or products. Under the guidance of the System Integration CE team, individual CE teams address development of the modules, the visual system, the SAF, and the work stations. Each of the four area teams has members from all functional areas.

The Army team is led by the PM CATT who manages the CCTT through Program Directors. These directors are assisted by a team of about eighty functional members drawn from the Simulation, Training and Instrumentation Command (STRICOM), the Naval Air Warfare Center - Training Systems Division, several other Army agencies and offices, the Defense Contracts Management Administration Office, and Nations, Inc., a support contractor. They represent a full range of functional specialties from system architecture, hardware and software engineering, production engineering, logistics, MANPRINT, Test, Safety, Software metrics, and Independent Verification and Validation. All lead functional personnel in the Army team are active members of the IDT and participate in assigned CE development teams.

Three representatives of the active Army, one captain and two sergeants, are permanently stationed at the IDF to provide on site, real-time input to the IDT on questions concerning Army doctrine and tactics. They also provide an "on-the-scene" situational awareness for the Training and Doctrine Command (TRADOC) and the user community. To fulfil this role, they serve as CE team members wherever their input and influence can be most effective.

Additional user participation is provided by User Exercises. These exercises are performed following the completion of each of seven software spiral builds into which the software development effort was partitioned. In each User Exercise, a team of experienced active duty soldiers performs tactical exercises designed to test the increasing functionality of the software. These User Exercises provide iterative user feedback throughout the software development process and help ensure the resulting software will meet the training needs of the Army.

During the early months of the contract, IBM held three off-site meetings of all personnel involved in the CE teams. At these meetings, team missions and CE ground rules and operating procedures were presented. The principles on which the teams were organized included empowered multi-disciplined teams, a high level of user involvement, and life cycle product ownership. A hierarchy of processes was detailed describing the operation of all levels of the organization from the program office, down through the CE teams, sub-teams, and working groups. These processes covered such areas as processing contract baseline change requests, generation and delivery of contract data, and day to day execution of the CE team activities.

The CE team missions gave them responsibility to design, develop, integrate, test and deliver their assigned portion of the system. The teams were also responsible for producing the design, test and support documentation for their products, and were to be self-managed and empowered to the extent allowed by the contract requirements and the program constraints.

In addition to the CE teams, working groups were formed to address certain areas that affected all CE teams. These working groups, in contrast to the multi-functional CE teams, were composed of members who had a functional interest in the working group's area of concern. Examples of working groups include the Software Working Group, which is responsible to ensure that the software development processes guarantee training effective software, and the Data & Models Working Group, which is responsible for identifying the set of models and associated data for use throughout the CCTT.

Participation in the IDT CE teams and working groups is accomplished in several ways. The most visible is by the routine attendance of all team members, including the Government functional and user representatives, at the regularly scheduled team meetings. This regular attendance is facilitated by the co-location of all participants. In addition, all members are linked by e-mail and access to the Contractor Integrated Technical Information Service (CITIS). This high degree of interaction allows the IDT to function as a close coupled organization of both the Contractor and the Government team members.

Most literature on CE suggests formal reviews in a program can be reduced because of the increased communication between the contractor and the Government. This has not been directly evidenced in the CCTT development effort. In this program, separate formal design reviews are held for the software and hardware portions of the system. For software, a series of In Process Reviews (IPRs) has replaced the formal Preliminary and Critical Design Reviews. These IPRs are held for each software module and address, successively; the Requirements, the High level code, and the Low level code. While these reviews are still formal in the sense that Government approval was required to successfully complete them, they are more in line with CE principles by allowing review of the software to be accomplished through a nearly continuous interaction of all affected personnel.

The more traditional approach of holding formal Preliminary and Critical Design Review was selected for the CCTT hardware. Retention of these reviews allowed the Government to use them for two purposes. The first was to provide a formal mechanism for Government approval of the hardware design. The second purpose was to provide a forum in which the hardware design could be presented in a top-down manner to the TRADOC representatives present who had not had the benefit of participation in the CE design process.

The CE process has demonstrated an impact on the cycle time for Government acceptance of Contract Data Requirements List (CDRL) item deliveries. Because the process for developing the contract data included participation by the Government team members, who are also responsible for accepting the delivered data items, there has been a reduction in the time required for review and acceptance of the delivered data. The situations where this has not occurred have generally been the result of the conflict between achieving CE team consensus on what is acceptable data and meeting contract requirements for on-time delivery.

As part of STRICOM compliance with the DOD Continuous Acquisition and Life-Cycle Support (CALS) initiative, the SOW for the CCTT program included a requirement that the contractor implement a CITIS. In preparing the contract SOW, the government placed great confidence in the ability of the CITIS to perform in two areas. The first area was the use of the CITIS as the vehicle of choice for delivery of Contract Data. The second was as a tool for Government access to contractor data, both the data being prepared for submission as a CDRL item and contractor data for which formal submission was not specifically required by the contract. Because CITIS was imagined to allow access to this last area of contractor data, the CDRL was scrubbed thoroughly to remove any requirements for documents where the data was envisioned to be available through the CITIS.

In the CCTT program, the implementation of the CITIS has fallen short of meeting both roles. Early in the program, the difficulties that had to be addressed included local area network speed, capacity, and connectivity problems. Once these were resolved, it became apparent that even more difficulties resulted from the desire to control access to data and network systems, on the part of both the Government and the contractor. In some cases, the program has resorted to the delivery of hard copy data to circumvent the CITIS altogether. These difficulties in the CCTT program have served to highlight the fact that much work for both the Government and industry remains to be done to define and implement a successful CITIS.

As is evidenced in any human endeavor, the implementation of CE in the CCTT development process evolved as the work progressed. Three changes that have occurred in the CCTT program have dealt with the role of the Government in the CE teams, the balance between meetings and individual work time, and the management visibility of problems in the program.

Early in the program a PM CATT memorandum firmly placed the responsibility for delivering a quality training system to the field on the Government team members. This they were to do by full participation in the IDT CE teams. Over time, however, Government team members perceived an increased pressure on themselves to make design decisions 'on the fly' in team meetings. This perceived shift in the responsibilities of the Government members caused them to draft a formal set of guidelines for their role in the CE teams. This set included fourteen specific roles, fully half of which addressed the role of improving communication, within and between CE teams, and between contractor personnel and both the PM Office and the user community. The remainder of the roles stated the Government's responsibility to review and accept the design, ensure quality products, and evaluate contractor performance.

Another change to the CE process adjusted the balance between mandatory attendance at CE team meetings and time for individual labor. In establishing the CE process, mandatory attendance at CE team meetings was required as a way to ensure participation by all. Over time, progressively more working groups and standing meetings were scheduled. As many functional personnel served on multiple CE teams, this increase in the number of meetings quickly began to prevent them from accomplishing individual work. During the second year of the program, a Process Action Team (PAT) was formed to address a growing dissatisfaction with the CE process. While many issues were addressed by the PAT, the one concern it acted upon was to readjust this balance between attending meetings and accomplishing individual work.

Another adjustment of the CE process occurred when it became apparent that issues affecting more than one of the CE teams and conflicts between teams were not receiving sufficient management attention. As a result weekly focus meetings were established at both the lead engineer and program office level to provide a forum for a nearly real-time identification and resolution of these issues.

Concurrent Engineering has been implemented in the CCTT program in response to the need to create a strong user focus which results from the CCTT being a complex training system whose primary product is changing collective human behavior.

Concurrent Engineering has been implemented by multi-functional teams composed of both contractor and Government members who are empowered and self managing within the bounds of the contract requirements and program constraints and who are responsible for their products throughout the life of the program. Difficulties have been experienced in adapting CE processes to CCTT development and in developing a CITIS to support the CE environment. However, in spite of the difficulties, Concurrent Engineering is proving to be a useful tool to increase communication among all functional elements and aid in successful program execution.

Persons Interviewed:	Mr. Mike Edwards, Project Director, CCTT, AMCPM-CATT, DSN 960-4305
	Mr. Kent Brookins, Project Director, CCTT, AMCPM-CATT, DSN 960-4333
Interviewed By:	Mr. John Wheeler, AMXIB-P, DSN 793-4619

AH-64D LONGBOW APACHE HELICOPTER

The AH-64D Longbow Apache is a product improvement to the AH-64A Apache to enable this upgraded airframe to fire radar frequency guided Longbow Hellfire missiles. Also, many AH-64D's will receive a Fire Control Radar kit that enables rapid detection, classification, and prioritization of enemy targets. The total Longbow system significantly improves the adverse weather fighting abilities of the AH-64A, provides true fire-and-forget capability, and increases target acquisition efficiency. The AH-64D development program is an Acquisition Category ID (ACAT ID) upgrade to an existing system. The program is near the end of Engineering and Manufacturing Development (EMD) and expects to begin Low Rate Initial Production (LRIP) in October 1995.

McDonnell Douglas Helicopter Systems (MDHS), in Mesa, Arizona, is the prime contractor for the airframe upgrade and system integration efforts. They are responsible for the design and production of the upgraded aircraft. The $621 million development contract began in August 1988. Since this program began before Concurrent Engineering (CE) and Integrated Product and Process Management (IPPM) were development strategies accepted within DOD, there are no contract requirements for their use.

MDHS's desire to improve aircraft performance, reliability, and maintainability, decrease production and life cycle support costs, incorporate MANPRINT improvements, and accommodate future subsystem growth led to the use of Integrated Product Teams (IPT's). At their own expense, MDHS formed eight component focused IPT's (one for each subsystem under redesign) with a high level IPT to serve as an overall system integrator. Each subsystem IPT had members from all functional areas. Similarly the integration IPT included members from the subsystem IPT's with other functional area members as required. In cases of purchased subsystems or components thereof, the component supplier also became a team member. Subsystem teams met as needed, while the integration IPT met weekly. MDHS made agreements with suppliers by which if they achieved a design that met MDHS's performance, cost, and reliability goals then they would be guaranteed production contracts.

Because the contractor self-funded the redesign efforts, the Government did not participate actively on the IPT's, nor did they make any changes to their traditional oversight structure or methods. The contractor used Unigraphics computer-aided design (CAD) systems to create and transmit designs between team members and between teams. Off-site suppliers received CAD designs via modem using the Initial Graphics Exchange Standard (IGES) format data files. MDHS could use this capability to send CAD files to some Government agencies, such as the Military Traffic Management Command (MTMC), but not to the Aviation and Troop Support Command (ATCOM) or the Project Management Office (PMO) due to a lack of compatible technology. Also, they used the CAD system to create an "Electronic Development Fixture," in which designs could be analyzed for physical interfaces and tooling development.

Each IPT had the power to make its own decisions regarding its subsystems if those choices fell within the existing budget. Each team bucked out-of-budget decisions up the chain. First, they established their own design requirement targets and goals and then created and evaluated design alternatives via trade studies. At decision points the team members voted on each design alternative using a pre-established set of prioritized functional area "weighting factors." For example, weight may be more important that cost. The members added the points for each alternative and the highest totaled alternative won. It was up to the Integration Team to decide between alternatives which impacted multiple components or IPT's.

The results of MDHS's use of CE/IPPM and IPT's have been impressive. Component redesign has led to a weight reduction of 246 pounds per aircraft, a design-to-unit-production-cost (DTUPC) reduction of $139K, a maintainability improvement of forty four percent, and a reliability improvement of eighteen percent.

As stated previously, since these MDHS teams engaged in self-funded efforts the Government did not participate with them. The Government saw the results at design reviews and program progress reviews, but no Government personnel attended team meetings. MDHS feels it may be difficult to integrate Government personnel into future IPT's and the problem may rest more with Government managers than with working level personnel. Government managers may not want to relinquish control of their functional area decisions to an empowered team independent of their control. All too commonly, Government workers lack the empowerment to make decisions anyway.

In the Longbow example, MDHS housed all team members in one physical location. Even subcontractors and suppliers had to send on-site representatives. Even so, the team members were not necessarily collocated in a common work area, and even this relatively small amount of distance created some communication problems. MDHS feels that the Government should participate on these teams in their role as the customer, however, it would require physical collocation to the contractor facility. An alternative would be to utilize the Defense Plant Representative Office (DPRO), in its role as the on-site Government agency, to serve as Government customers on the contractor IPT's. This would require the system PM to vest decision authority with the DPRO and likewise the DPRO to inform the PM of program status constantly.

MDHS isn't sure how the Government would participate in the IPT's other than as the customer. This would mean the Government would look at the design at various checkpoints within the IPT activities, versus continual and constant involvement. MDHS also wasn't sure how work assignments might be split between the contractor and Government team personnel. And finally, they aren't sure that all Government functional areas need to be or should be represented on the IPT's. A better approach would be to have one or two "generalists" on each IPT who could address multiple functional areas and overall program issues.

MDHS did have an earlier trial experience with IPT's on another program, but this was MDHS's first attempt at using multiple, commodity oriented IPT's with a hierarchical structure. MDHS feels they are weak in the area of CE/IPPM/IPT training. In the Longbow case, the only training team members received was from several corporate policy manuals; the rest was oral. It is interesting that the parent company, the McDonnell Douglas Corporation, does have an IPT training program, along with assessment criteria for division certification. The corporation has four levels of IPT certification. MDHS received certification at the lowest level (Level 1). A weakness in the area of policy and training documentation is all that kept them from a Level 2 certification. No division within the McDonnell Douglas Corporation has yet achieved Level 4 status. The Longbow teams gathered some lessons learned from MDHS's first IPT attempt.

MDHS intends to make greater use of IPT's in future contracts. Notwithstanding the absence of a quantitative cost/benefit analysis, they agree it definitely costs more to use CE/IPPM than traditional serial development methods. They are quick to point out however, that the improvements in production costs, maintainability, and reliability, coupled with the reduction in development time make CE/IPPM a favored business strategy. Indeed, MDHS could not have performed the redesign and still met production start dates without CE/IPPM.

Persons Interviewed:	Mike Columbo, MDHS, (602) 891-2359
	Jim Collier, Longbow PMO, DSN 693-5609
	Ron Trejo, DPRO, (602) 891-3709
Interviewed By:	Tom Schneider, AMXIB-P, DSN 782-7794

M6 SMOKE GRENADE DISCHARGER

The M6 Discharger is a smoke grenade launcher with independently addressable tubes. Its designers made certain that it has no radar signature in preparation for a new generation of host vehicles where stealth is important. The M6 is a new, Acquisition Category IV (ACAT IV), type classified system. Since no deployment requirements existed when the development was completed, the Army shelved the Technical Data Package (TDP) for future production.

The Army awarded the Engineering and Manufacturing Development (EMD) contract to the Brunswick Defense Corporation, Deland, Florida in September 1990. The Edgewood Research, Development and Engineering Center (ERDEC) awarded this contract several years before they started using Integrated Product and Process Management (IPPM) teams. There was nothing in the contract different from the usual Government oversight provision included in the Contract Data Requirements List (CDRL) or other schedules.

Shortly after ERDEC changed to full time team organization, Dr. Vervier, ERDEC director, attended a regular meeting at Brunswick, with the ERDEC team. He explained how ERDEC planned to use IPPM teams and told Brunswick he considered them part of the IPPM team. Apparently Brunswick was very receptive to the idea because they really became part of the team.

Army IPPM team included a project leader and ten members who represented the interests of the combat developer, quality, producibility, testing, and logistics communities. Also, functional organizations and soldiers participated part time or as needed. The contractor did not form an IPPM team as such. However, selected contractor people worked with ERDEC team members as full team members.

The Army team used a variety of ice breakers. We sensed from our interviews that just about anything that helped the team to get acquainted, and was in good taste, was fair game for ice breaking. The team established its Rules of Conduct early; including procedures for teaming, a mission statement, how decisions were to be made, and how meetings would be conducted. There was team training aplenty. Training started early and continued to the point that the team felt it should stop so they could proceed with their work. In retrospect, the Project Leader thought it was advisable to insist on intense training. It probably helped the team to function together better.

Written, telephonic and personal contacts were very frequent between the team and the contractor. Personal contacts did occur according to set schedules. Both groups travelled between sites extensively. Nothing was ever just "thrown over the wall" by either group. Electronic mail was not available between the two groups but ERDEC members used it extensively among themselves. There was never any rejection of CDRL's or ideas because "it just isn't right." Instead, written and oral communications explained what the Government needed and why. Most written or telephonic messages and personal discussions included suggestions on how to get there; making the contractor part of the CE team.

The Project Leader said the thing that made the team work was making sure everyone knew about everything that was going on. There was constant contact with the contractor and between team members. The team defined their primary role as, being helpful to the contractor while avoiding an adversarial relationship with him.

Top Management at ERDEC encouraged off-site team meetings; if that seemed a good idea to the team. The team tried all sorts of innovative ideas; team lunches, team dinners, and team activities such as bowling a few lines during working hours to help the team function. With management's commitment, the team felt free to do what would work for them.

Before the teams formed, each functional discipline had a priority to get the project finished on schedule, but the disciplines' priorities always differed with one another. When people joined the team and helped to decide issues, including priorities, they were able to keep the project completion - type classification of the Discharger - in mind. They modified individual concerns with overall project concerns. This behavioral change spread quickly through the team. The Project Leader could not recall even one experience with member incompatibility. He added people to the team and they fit in very well.

An example; the Quality Assurance (QA) representative made a special effort to develop a good relationship with the Defense Contract Administration Service (DCAS) representatives at the contractor's plant. This team member used that relationship to help both the team and the contractor.

One issue, never addressed satisfactorily, was how to handle the team when the project is over and there is no new project for the team to undertake. The team just separated somehow without prearranged plan. Downsizing at ERDEC, coupled with chance, seemed to drive the situation. Typically, another team leader with an active project needing a new member looked for a project that was ending and acquired the skills needed from a separating team. This situation still needs to be resolved at a high management level before another round of downsizing begins.

Person Interviewed: Tom Hoff, Project Leader, SCBRD-END, DSN 584-5626
Interviewed By: Bud Fox, General Engineer, AXMIB-P, DSN 782-7815

HEAVY ASSAULT BRIDGE

The Heavy Assault Bridge (HAB) will provide Military Load Class 70 vehicles the capability to cross 24-meter gaps (26 meter bridge). The HAB will have mobility characteristics comparable to the maneuver forces it will support. The base for the HAB is an Abrams tank chassis. The system consists of a bridge and launch mechanism mounted on an overhauled, converted Abrams chassis. The HAB is a Nondevelopmental Item (NDI) Integration item and is an Acquisition Category III program. The HAB program is under the direction of the Program Executive Officer, Armored System Modernization and managed by the Product Manager, HAB.

The HAB is currently in the Engineering and Manufacturing Development (EMD) phase. The EMD is in two parts. In EMD I three contractors, BMY, General Dynamics Land Systems (GDLS) and Southwest Industries, built two prototypes each for competitive evaluation. The Army selected the GDLS concept for the EMD II phase and awarded the EMD II contract in January 1994. The Critical Design Review (CDR) will commence on 17 April 1995. Following CDR, construction of vehicles will begin. Extensive contractor testing will be conducted, beginning in October 1995 and continuing for about six months. GDLS will deliver two vehicles to the government in June 1996 for Preproduction Qualification Testing, Early User Test & Experimentation, Logistics Demonstration, etc. Upon successful completion of testing, the government will contract (4QFY96) for the first four Low Rate Initial Production (LRIP) vehicles that will be used for Production Qualification Tests (PQT) and Initial Operational Tests (IOT). After successful completion of these tests, the LRIP option for thirty eight more vehicles is to be awarded (4QFY97). The First Unit Equipped target is 1QFY00. The schedule anticipates the Milestone III decision review in 4QFY99 and award of the full rate production contract in 1QFY00. Full rate production will consist of an additional 316 vehicles to be manufactured at a rate of thirty vehicles per year.

The Request for Proposal (RFP) for EMD II did not contain requirements or incentives for use of the Integrated Product and Process Management (IPPM) management approach. The RFP did include explicit requirements for program reviews and contract deliverables. GDLS did not try to negotiate any changes in the number of reviews or deliverables. GDLS began to use the IPPM approach in their organization for the EMD II program, but this was not a requirement of the contract.

The HAB Product Management Office (PMO) has organized its staff to operate in an IPPM mode with GDLS. The PMO has a team of thirteen full time people dedicated to the HAB program. Five of these, the Product Manager, secretary, chief engineer, logistician and engineer are on the PMO core staff. The remainder of the team includes full-time matrixed personnel from the following disciplines: logistics (4 persons) and one each from software, contracts, quality and cost. Other full and part time matrix personnel contribute as needed. The Engineer's School represents the user. The Engineer's School has a representative at all the monthly program meetings and other major reviews and demonstrations. A user jury, made up of Engineer's School personnel, evaluates the design as it progresses.

The basic role of government IPPM team is the same as any other PMO team. They are responsible for seeing that the requirements of the contract, primarily cost schedule and performance, are being met. What is different with the HAB team is that they are reviewing designs and plans as they develop with the GDLS team. They are providing immediate feedback, rather than waiting for periodic reviews and analysis of deliverables. This provides results that are more suitable to the government and avoids waste of time and money in pursuing approaches that would have to be changed later.

GDLS is using an Integrated Product Team (IPT) approach to the HAB project. Permanent members of the GDLS IPT are functional element managers. For the HAB project, the functional elements represented are engineering, logistics, and manufacturing. Major subcontractors participate where appropriate. Major subcontractors for the HAB are MAN/Gutehoffnungshutte Gmbh, manufacturer of the bridge, Stewart & Stevenson, manufacturer of the hydraulic power unit, and Caterpillar, manufacturer of the stabilization blade. The Sterling Heights, Michigan facility houses the collocated GDLS IPT. The functional element managers are responsible for execution of the contract. Their responsibility is largely organizational and administrative. They draw on people from their respective organizations as needed to perform the work. People with appropriate skills organize into subteams to focus on given parts of the design, which generally correspond to the work breakdown structure. This breakdown may be at the system, subsystem, or detail level. The GDLS facility holds the team meetings in which functional support personnel, government personnel and, where appropriate, subcontractor personnel participate.

The ground rules for the government-contractor interaction are simple and clear. GDLS is responsible for providing a product that meets the purchase description and for complying with the other contract requirements. The government is responsible for providing recommendations and evaluations as the designs and plans progress.

Members of the government team took training courses in cost plus award fee contracting and in the use of PERT charts, skills required for the HAB program. GDLS personnel also received PERT chart training. The GDLS functional element managers who participate in the IPT received training to help them guide the IPT. The functional element managers serve as the facilitators for the subteams. The members received extensive formal training for each software tool they must use and learned the rest by participating in the subteams.

Government personnel participate regularly in the IPT meetings that GDLS holds. This works well because the HAB PMO is only about two miles from the GDLS facility. As stated above, subteams address various parts of the design as defined by the work breakdown structure. Both government and GDLS participation is tailored to provide the skill levels required for each subteam. There is as much commonality of personnel between the different subteams as possible. A subteam frequently begins its work with a brainstorming session. Iterative meetings deal with alternatives in increasing detail. The subteam walks through the design, creates manufacturing process flows, positions machines and determines manufacturing process limitations. Parts may be combined in various ways to eliminate or simplify manufacturing operations or to simplify logistics support. The result is a producible design and plans for efficient manufacturing. Information from the meetings is captured in a producibility package. The package contains design constraints, manufacturing process limitations, logistics impacts and design recommendations. The producibility package represents the subteam consensus and is the basis from which the designers, manufacturing planners and logistics planners complete their work for that given portion of the design. The lengths of the meetings vary. The subteam meets as necessary to complete its mission.

Analytical approaches serve to develop data to aid in making decisions when the best choice is not obvious. The IPT applies an extensive set of "Design For Manufacturability" tools at GDLS. The IPT uses a PC-based CAD system with 3-dimensional modeling capability, sourced from Structural Dynamics Research Corporation. The CAD display is large enough for the members to see during meetings. The IPT uses Variation Simulation Analysis, based on an original software package from Ford and enhanced by GDLS, and a Virtual Prototyping software package to model manufacturing processes. Virtual prototyping can be used to model the part, fixture, machine tool and working elements such as cutting tools and to evaluate tool paths and conduct end of tool modeling. GDLS also can to simulate an entire factory operation. The simulation will include station requirements, throughput and fixturing requirements and, possibly, line balancing.

The proximity of the HAB PMO to GDLS is a definite plus in achieving face-to-face interaction of personnel in the two organizations. Both parties use phone and fax communications also. The PMO has electronic access to the technical data package and the logistic support analysis record in GDLS's database. Subteam meetings convene as necessary to develop the producibility package for each portion of the design. In addition, monthly government-GDLS meetings provide the opportunity review progress and address problems on the entire program.

GDLS welcomes government participation in its IPT. They do not want to spend time and money developing designs and plans that will be found unsuitable to the government sometime later in a review. By working in the IPPM mode, there has been very little problem reaching decisions that are acceptable to both GDLS and the government. When problems threaten an agreement, the approach is to perform more in depth analyses to develop data on which to base a decision. Cost is the most frequent decision driver. Other factors that may drive decisions include design requirements, schedule, human factors and maintainability.

The GDLS Cost And Schedule Status Report (CSSR) tracks costs. Costs can be tracked to the fourth level of the work breakdown in the CSSR. Government personnel analyze the CSSR carefully to identify overruns, underruns and schedule variances and review deviations with GDLS personnel.

GDLS found the HAB cost and schedule requirements for EMD II were extremely challenging. GDLS decided that the IPPM approach was the only way that these requirements could be met. Using the IPPM approach in the HAB program, GDLS planned for significantly fewer Engineering Change Proposals, fewer prototypes and about half the total engineering manhours required for a conventional approach.

Both the government and GDLS favor the IPPM approach taken on the HAB program. Government personnel have a chance to give their suggestions early as concepts develop, so it is easier to incorporate them. GDLS welcomes timely evaluation by the government to avoid expending time and money on approaches that could eventually be found unsuitable.

Persons Interviewed:	Mr. Alex Bodner, Chief Engineer, HAB Program Management Office, DSN 786-7685 Mr. Gary Insona, Manufacturing Manager, General Dynamics Land Systems, (810) 825-7672
Interviewed By:	Mr. Walt Roll, Industrial Engineer, AMXIB-P, DSN 782-5617

XM-8 ARMORED GUN SYSTEM

The XM-8 Armored Gun System (AGS) is a fully tracked, lightweight infantry support weapon system designed to replace the aging M551 Sheridan fleet. The AGS design maximizes survivability, lethality, agility, and sustainability. The AGS uses proven technology packaged to simplify deployability in support of initial entry forces. The primary weapon is the XM-35 105MM cannon that can fire all standard NATO 105MM ammunition. The fire control system is similar to the Abrams main battle tank and uses "off the shelf" components. The primary weapon can fire twelve rounds per minute. The ready rack holds twenty one rounds. The weapon system uses a modular armor approach, consisting of three levels of armor. Level I provides protection against small arms, level II provides increased KE protection, while level III provides protection against RGP-type weapons. The design integrates proven technologies to meet the requirements for a lightweight, infantry support platform.

The AGS uses an Abrams-like fire control system, has an airdrop weight of 35,830 Lbs, and carries a crew of three. The system is can travel at forty five MPH on level, paved roads. It has a cruising range of 300 miles, climbs sixty percent grades, fords water fifty two inches deep, and crosses trenches eighty one inches wide. A Detroit Diesel 550 horsepower engine and a General Electric 500-3EC Hydromechanical transmission provide motive power. Secondary weapons include a 7.62MM M240 coaxial machine gun and a .50 CAL M2 machine gun. The AGS carries thirty rounds of 105MM, 4500 rounds of 7.62MM, and 600 rounds of .50 CAL ammunition.

The AGS is a major system under Acquisition Category II (ACAT II) now in the Engineering and Manufacturing Development (EMD) phase of the acquisition process. The schedule anticipates production approval, the next milestone decision, in September 1995 for this Nondevelopmental Item (NDI).

The Army awarded the contract for the EMD phase to the United Defense Limited Partnership (UDLP) in June 1992. This contract does not require nor suggest an Integrated Product and Process Management (IPPM) approach.

The Program Manager for the AGS has not used IPPM ideas in managing the AGS program. The developmental part of the program lasted about six weeks. The remainder of the program's EMD effort has involved building and testing the prototypes. The program has been progressing on schedule and the PM-AGS anticipates a smooth transition into LRIP.

UDLP has purchased the Texas Instruments Integrated Product Development Process (IPDP) and are incorporating it as a corporate-wide policy. The discussion on the Bradley Fighting Vehicle System addresses this process in greater detail.

Person Interviewed:	Major Steve Penter, SFAE-ASM-AG, DSN 786-5576
Interviewed By:	Frank Stonestreet, AMXIB-P, DSN 782-7799

BRADLEY FIGHTING VEHICLE SYSTEM

The Bradley Fighting Vehicle System family consists of the M2/M2A1/M2A2 Infantry Fighting Vehicle (IFV) and the M3/M3A1/M3A2 Cavalry Fighting Vehicle (CFV). The armored, fully tracked IFV and CFV provide cross-country mobility and vehicle mounted fire power to mechanized infantry and cavalry units. The IFV/CFV vehicles are the complement to the M1 Abrams tank in the combined arms, close combat task force.

Vehicles with the new M2A3/M3A3 configuration will be able to conduct digital command and control operations with the M1A2 Abrams tank. The A3 version will have the same automotive characteristics as the A2 version. There will be seven major upgrades that use the latest technologies. The electronic architecture command and control will be upgraded to a 1553 digital databus. Thermal sights will be upgraded from first generation forward looking infrared (FLIR) to second generation FLIR. The other major upgrades are; fire control, navigation, commanders viewer, and embedded training built-in diagnostics.

Vehicle armament consists of a fully stabilized, dual-feed, externally powered M242 25MM automatic gun, a Tube launched Optically tracked Wire guided (TOW) Missile system, and a coaxially-mounted 7.62MM machine gun. A 600 horsepower engine/transmission propels the vehicle. The vehicle incorporates improved armor protection, spall protection liners, and more stowage. The current vehicle also includes a laser range finder, a compass/navigation subsystem, a missile countermeasure device, and an antifratricide system.

The upgrade effort to the A3 version is now in the Engineering and Manufacturing Development (EMD) phase of the acquisition process. The A3 is a major defense acquisition program under Acquisition Category IC (ACAT IC). November 1999 will mark the milestone III decision, production approval.

The Army awarded the $240 million EMD contract to the United Defense Limited Partnership (UDLP) in May 1994. The contract did not require UDLP to use an Integrated Product and Process Management (IPPM) approach.

COL Adams, Bradley A3 Associate Product Manager, is the nominal government IPPM team leader. Members of the government IPPM team are also government representatives on UDLP's Product Development Teams (PDT's). The team organizes along functional lines with selected functional areas assigned to each PDT. For example, the government software engineer is a member of three PDT's. Most of the PDT's have 7-8 government team members. Each government member represents a functional area.

UDLP has purchased the Texas Instruments (TI) Integrated Product Development Process (IPDP) and is incorporating it into a corporate-wide policy. The PDT concept being used has its roots in the document, "The role of concurrent engineering in weapons system acquisition." UDLP uses teaming in three levels:

LEVEL I - The Core Team provides general support to the A3 program. The A3 program manager leads this team which focuses on the highest levels of program execution. The core team tracks overall program process and establishes policy.

LEVEL II - The Leadership Team guides the A3 program. This team consists of representatives from all functional areas including the PDT leaders. The leadership team focuses on the processes used by the PDT's to assure consistency and adherence to contemporary organizational effectiveness principles.

The System Engineering and Integration Team (SEIT) provides technical guidance to the A3 program. The SEIT consists of managers of technical functional areas and PDT leaders. The SEIT leader is the A3 engineering manager. The team focuses on technical issues that cross PDT boundaries.

LEVEL III - The PDT's do the focused development work. All teams, except one, organize by product. There is a system integration PDT, organized along functional lines, responsible for overall final A3 integration. Each team has a designated leader and multi-disciplinary members to include UDLP, subcontractor, and government personnel.

Other teams, as needed, conduct special projects related to resolving an A3 issue may require forming a special team. The teams normally will address a specific issue and then disband when the problem is solved.

The teams interrelate. Customer requirements drive the work through the system engineering PDT down to the other PDT's. The requirements decompose into engineering tasks and specifications to be developed and integrated by each PDT. The system integration PDT handles the final integration. The SEIT handles program technical issues and the PDT leadership team handles process issues.

UDLP's PDT concept began about two years ago. The original concept was "a better way of doing business." Bradley Project Management Office personnel were members of the PDT's. The teams had their own goals. UDLP's formal commitment to IPPM began on 20 February 1995. That was the day they adopted the TI Integrated Product Development Process and designated the TI process as company policy. UDLP held a workshop, including government representatives, to introduce the process.

The primary role of the Army team is in their membership on the UDLP PDT's. The government team will meet once or twice a month, depending on travel schedules. COL Adams usually chairs the meeting. The purpose of the meeting is to update all team members on overall status of the program and to resolve any problems. The government's role on the PDT's vary, sometimes the team member is a leading contributor in problem solving, other times he/she just listens.

While the government team members do much travelling, they do not attend every PDT meeting. The PDT's meet every week making it impossible to attend every meeting, and continue living in Detroit. Occasionally a government team member will be visiting UDLP for a reason other than a team meeting; so he usually will plan to attend a PDT meeting. Physical travel to UDLP is still the primary method of communication. The Project Management Office is on the UDLP voice mail system. Plans are in place to incorporate the Joint Computer-aided Acquisition and Logistics Support (JCALS) system and the Digital Storage and Retrieval Engineering Data System (DSREDS) into the Bradley program.

The government members believe they are adding value to the teaming process. Their contributions are in two primary areas; helping to understand the Army requirements and making team aware of integrations issues involving other teams. The involvement level of a government representative is totally dependent on personal commitment. Some get very involved, others just sit and listen.

There is very little decision making by government team members. This is due to a concern about contractual issues and authorization to direct such issues.

Expenditure tracking is the primary task of each government team member. Each team member has several cost accounts, each divided by work breakdown structure. Each member took special classes to learn about cost accounting. Every month the government team member reports cost performance.

Person Interviewed: Mike King, Production Engineer, SFAE-ASM-BV-CP, DSN 786-8668
Interviewed By: Frank Stonestreet, General Engineer, AMXIB-P, DSN 782-7799

COMPOSITE ARMORED VEHICLE PROGRAM

The Army Research Laboratory (ARL) has completed the first step in the Composite Armored Vehicle (CAV) program. The Lab proved the feasibility of using thick composites as structure and armor for combat vehicles.

The CAV is now in the Concept Exploration and Development Phase. The Tank-Automotive Research, Development and Engineering Center (TARDEC) is using 6.3 funds to build the CAV Advanced Technology Demonstrator (ATD). The CAV ATD is a non-system specific twenty-two ton tracked vehicle, using a 1O5MM XM35 tank gun as a force generator.

The Army awarded a $50 million cost plus fixed fee (CPFF) development contract to the United Defense Limited Partnership (UDLP) in December 1993. The contract schedule includes a Preliminary Design Review (PDR) in April 1995 and a Critical Design Review (CDR) in December 1995. The contractor will deliver the vehicle for testing in October 1996. The original contract had only a brief coverage of Integrated Product and Process Management (IPPM). A subsequent contract modification included additional provisions for IPPM and funds for IPPM training. IPPM provisions flow down to major subcontractors, including Hercules and Lockheed.

Four functional development teams manage the program. The personnel we interviewed are Government members of the Composite Structures Development Team (CSDT). The other three teams are the Armor, the Signature Management, and the System Integration Teams.

The CSDT is a true Integrated Product Team (IPT), as it includes representatives from three ARL directorates, the Training and Doctrine Command (TRADOC), the Defense Contract Management Command (DCMC), the test and evaluation community, and UDLP. At this early point of its life cycle, the CAV does not have a Project Manager. Instead, the TARDEC Development Business Group heads the program. The UDLP efforts dovetail with those of TARDEC. They have established subteams for the upper hull, the lower hull, the crew compartment, and for ramps and joints.

The CAV ATD is TARDEC's first implementation of the IPPM methodology. The IPT started in August 1993. The team wrote the Request for Proposal (RFP) and staffed it within TARDEC. They asked industry for comments. Members representing IPPM interests participated on the Source Selection Evaluation Board (SSEB).

A Texas Instruments (TI) system, known as the Integrated Product Development Process (IPDP), was the model for the IPPM methodology now in use. First, top TARDEC and UDLP management tailored the TI package to the CAV. Next, intermediate managers tailored it and followed up by being hosts to a two day IPPM workshop led by TI in January 1995. The workshop paved the way for a detailed tailoring of the package and implementation.

Army interaction with UDLP is frequent. Daily phone calls, monthly co-chaired meetings, quarterly In-process Reviews (IPR's), and e-mail keep both parties in touch. The e-mail system has extra features making it possible to transfer engineering drawings and various reports, manipulate them, and approve their status. Its virtual workplace capabilities are especially important in view of the three hour time separation between TARDEC and UDLP Team members.

- The ground rules are consistent with those in the TI IPDP package, tailored to CAV. Both parties observe the rules and so far there has been no need to modify them.

- Cost and schedule impacts are considerations of every team decision. An advantage of the extensive teaming is that the Government Team can get a good handle on overfunded, underfunded, or previously unforseen needs. Familiarity with contract provisions is essential.

- Thus far, there has been no conflict over proprietary information transfer and intellectual property protection.

- A small barrier to Government-Contractor teaming has been UDLP's unfamiliarity in working with Government personnel in such a close manner. The personnel we interviewed believe that both parties will overcome this barrier as they become more familiar and confident with the terms of the contract.

- Easier prevention and elimination of misconceptions through teamwork is one big benefit of IPPM.

- The Army provided a prioritized list of Government expectations in the contract and intends to update the list as the program evolves. This aids the Contractor in understanding the Government's needs and guides programmatic and technical trade-offs. The list helps reduce controversy in decision making.

IPPM is working in this acquistion program because:

- Dissemination of the updated prioritized list of Government expectations keeps all team members current.

- Tailoring sessions included all stake holders. Everyone participated to clarify misconceptions and correct flawed expectations.

- Tailoring sessions identified proposed scope of work and contract deficiencies or mismatches.

- The TI methodology is comprehensive (from start of work to contract closeout).

Persons Interviewed:	MAJ R. Brynswold, AMSTA-TR-P, DSN 786-8718 Mr. Don Ostberg, AMSTA-TR-P, DSN 786-6133 Mr. Jeff Carie, AMSTA-TR-P, DSN 786-7715
Interviewed By:	Mr. Ferenc Beiwel, AXMIB-P, DSN 793-7816

ACRONYM LISTING

ACAT	Acquisition Category
AMSAA	Army Materiel Systems Analysis Activity
ARL	Army Research Laboratory
ATCOM	Aviation and Troop Support Command
ATD	Advanced Technology Demonstrator
CAD	computer aided design
CALS	Continuous Acquisition and Life-Cycle Support
CAV	Composite Armored Vehicle
CCAWS	Close Combat Anti-armor Weapons Systems
CCTT	Close Combat Tactical Trainer
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CE	Concurrent Engineering
CFV	Cavalry Fighting Vehicle
CITIS	Contractor Integrated Technical Information Service
CPFF	cost plus fixed fee
CSDT	Composite Structures Development Team
CSSR	Cost and Schedule Status Report
DARPA	Defense Advanced Research Projects Agency
DCAS	Defense Contract Administration Service
DCMC	Defense Contract Management Command
DIS	Distributed Interactive Simulations
DPRO	Defense Plant Representative Office
DSREDS	Digital Storage and Retrieval Engineering Data System
DTUPC	design to unit production cost
EMD	Engineering and Manufacturing Development
ERDEC	Edgewood Research, Development and Engineering Center
ESG	Executive Steering Group
FEE	Functional Execution Element
FLIR	forward looking infrared
GDLS	General Dynamics Land Systems
HAB	Heavy Assault Bridge

ACRONYM LISTING

IDF	Integrated Development Facility
IDT	Integrated Development Team
IFV	Infantry Fighting Vehicle
IGES	Initial Graphics Exchange Standard
IOT	Initial Operational Tests
IPDP	Integrated Product Development Process
IPPM	Integrated Product and Process Management
IPR	In-process Review
IPT	Integrated Product Team
ITAS	Improved Target Acquisition System
JCALS	Joint Computer-aided Acquisition and Logistics Support
LRIP	Low Rate Initial Production
MDHS	McDonnell Douglas Helicopter Systems
MICOM	Missile Command
MTMC	Military Traffic Management Command
MWG	Management Working Group
NDI	Nondevelopmental Item
NVESD	Night Vision and Electronic Sensors Directorate
OPTEC	Operational Test and Evaluation Command
PAT	Process Action Team
PDR	Preliminary Design Review
PDT	Product Development Team
PM CATT	Program Manager for Combined Arms Tactical Trainers
PMO	Product Management Office or Project Management Office or Program Management Office
PQT	Production Qualification Tests
QA	Quality Assurance
RFP	Request for Proposal
SAF	Semi-Automated Forces
SEIT	System Engineering and Integration Team
SIMNET	Simulations Network

ACRONYM LISTING

SSEB	Source Selection Evaluation Board
SOW	Statement of Work
STRICOM	Simulation, Training and Instrumentation Command
TARDEC	Tank-Automotive Research, Development and Engineering Center
TDP	Technical Data Package
TECOM	Test and Evaluation Command
TI	Texas Instruments
TIWG	Test and Integration Working Group
TOW	Tube launched Optically tracked Wire guided
TRADOC	Training and Doctrine Command
UDLP	United Defense Limited Partnership
USAIS	United States Army Infantry School
WBS	Work Breakdown Structure