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"Electronic Tools For Enhanced Development and Procurement by Integrated Teams"

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Integrated Product and Process Development

The Crusader is the Army's next generation cannon artillery system. The Crusader consists of two vehicles, the self-propelled howitzer, and the resupply vehicle. The system was developed to replace the current self-propelled howitzer fleet, which was designed in the 1950's. The Crusader will deliver several important technical advances over its predecessor. The Crusader will provide much better maneuverability, keeping pace with other weapons including the Abrams tank and Bradley Fighting Vehicle. The system will also totally automate the ammunition handling, loading, and firing functions. The automation will relieve the crew of manual duties, and permit them to focus on the battle. The Crusader is capable of carrying 60 rounds of projectiles, and firing at a rate of 11 rounds per minute. The resupply vehicle can carry an additional 120 projectiles, and automates the reloading function by connecting an external docking boom to the self-propelled howitzer. The process is completely automated, and the crews do not have to leave either of the vehicles.

The Crusader program began in 1996, and is currently in the program definition and risk reduction phase. The first mobility test prototypes will be delivered in June 1999, and the first vehicles to be delivered to the field are scheduled for late 2005. The Crusader team members are spread across the entire United States. The three major team segments are the Army's Office of Project Manager - Crusader, United Defense in Minneapolis, and the System Manager representing the user in the field. General Dynamics is also a major sub-contractor with the program.

Integrated Process and Product Development (IPPD) integrates all the activities of a project from product concept through post-production field support. Multifunction teams are utilized to optimize the process to meet cost, schedule, and performance objectives. The engineering process is integrated with sound business practices and common sense decision-making. Some of the more important concepts of IPPD are concurrent development of products and processes, maximum flexibility and use of industrial approaches, broad performance specifications to encourage robust industry design, multi-disciplinary teamwork, proactive risk management, and integrated management tools. IPPD has been extended to include the government as part of the team. Cross

participation in project contributions and problem-solving are utilized within a set of guiding principles. In addition, the organizational structures within the government and United Defense were structured similarly to clearly identify roles and facilitate communications.

The IPPD concept was also extended to the headquarters staff of the Department of the Army and the Department of Defense. This initiative was implemented to streamline the program and thereby shorten decision time. Key players were brought together to focus on the success of the program, while reporting to the program manager. Four focus areas were established: (1) Acquisition. (2) Cost Management. (3) Testing. (4) Requirements. There were several factors that enabled the Crusader program to implement IPPD. The program incorporated Integrated Data Environment, e-mail, Video Conferencing, Frequent Travel, and on-site representatives in the plant at United Defense.

The IPPD approach to project management has been in practice for almost five years, during which time there have been many learning experiences. Leadership requires having the right people to be at the top of the management structure. The leadership must have the competency to lead the program, while delegating and empowering the people below them. There is also a great deal of commitment required from all team members. There must be forward planning for both the project commitments and potential consequences. The organization must have clear lines of responsibility and authority, with the empowerment and flexibility to adapt through the life-cycle stages of the project. A multi-functional team approach requires a great deal of manpower up-front at the beginning of the project. Training is also very important for understanding IPPD and team building. And finally, it is important to integrate the government and contractor people into one group, while managing their very different cultures and objectives.

Steve Untz
Integrated Data Environment, and Common Development Environment (CDE) in an Information Data Environment (IDE)

Modeling and simulation were used to shorten the product development time of the Crusader. Several driving factors forced the necessity to shorten the development time as compared to existing standards. There were congressional funding cuts early in the program, limiting weight restrictions, technologically advanced vehicle systems, high firing rate requirement, advanced cannon cooling system, fully digitized crew cockpit, and a need for improved reliability and maintainability over the current Paladin system.

The traditional Department of Defense time-line for development of a system similar to the Crusader would take 12 to 15 years from requirement analysis through the testing of the first product. This project structure is very rigid and thoroughly documented. A test-fix-test approach is used where the prototype would be built, tested, fixed, and retested again until the system was ready for the end-user. The actual end-user would only be involved at the very end of the process. The new development method involves the developer and end-user at the beginning of the project. The test-fix-test process is completed through a virtual environment without the necessity of a full-scale prototype being built. Some of the key benefits of the new method are a shorter cycle-time, and the establishment of a high level of confidence early in the design that the system under development will meet the needs of the user. The entire process has been reduced to eight or nine years.

The Crusader development process utilized both modeling and simulation. The design process established and defined system behavior for hardware, software, and human involvement. These systems were permitted to evolve with the design. Continuous integration and validations of the interfaces with actual end-users were performed while working with simulators. This enables the refinement of models and designs before the actual hardware is constructed. Incremental testing and evaluation of subcomponents is conducted as pieces of the project are completed. These models provide a means to integrate all of the disciplines together enabling each group to see how their piece of the project will interact with others. The simulation-based development continuously verifies and optimizes the design of the Crusader.

The modeling and simulation development begins with a high level analysis of system models.

Several factors are explored including scenarios, time-lines, functional models, software architecture, and vehicle structure. The development then moves on to rapid prototyping models. The prototyping consists of dynamic object modeling, solid model simulation, visual prototypes, and low fidelity models. Integration support models simulate the environment, emulate software and hardware components, and stimulate the hardware before use of models is initiated. The modeling follows three basic processes. First, both software and hardware components are modeled in workstation computers. Second, tactical software is tested using hardware emulators to verify the interactions and compatibility of the components. Third, the actual hardware is then put into place for the integration of the subsystems.

Concurrent design verification and integration is a vital process to the development of the Crusader program. Modeling and simulation concurrently bring together hardware, software, and human interactions continuously throughout the entire development process. The simulations fine-tune and validate the models, and ensure that the production of actual components will proceed as smoothly as possible. The tested and verified models provide reference tools that help developers understand the Crusader system interactions. In addition, the verified models provide place-holders that can be used to continue the design and development process when actual hardware or software systems are not yet available.

A Common Development Environment (CDE) for all of the contractors, subcontractors, and government agencies reduced the development risk and mitigated the need for complex data exchange standards for communications. At the beginning of the project, the major development tools were selected. Project management required that all groups involved with the Crusader program use the selected tools. The development tools were assimilated into the Integrated Data Environment (IDE). This system is the repository for all the information on the project. All of the data is in one location, and is accessible by the personnel that need it. The tools used in this system start with the Metaphase Product Data Management (PDM) engine, which provides a common structure to house all of the project data. The PDM engine performs the functions of client server, workflow manager, encrypted data transmission, data management, wide area network support, and product structuring. Peripheral software systems integrated into the PDM engine include office automation, mechanical engineering, software engineering, business management, systems engineering, web/Internet browser, reference library, and configuration management.

The hardware and software systems are linked together in a hierarchical manner to permit easy direct access to required information. Two major structures are used, a work structure and a product structure. Within the work structure, all of the information is organized into a format that describes the type of work that needs to be accomplished. Scheduling and cost parameters are then linked to the system. Product structures are also integrated into the system and are organized by type of product that needs to be designed, built, and managed. The product structure includes items such as bill of materials. The two types of structures permit large amounts of data to be organized into a meaningful, useful, and accessible format.

There have been lessons learned throughout the course of the project. Technical learning experiences include relying on vendors that have technical expertise, the need to standardize desktop and LAN environments to reduce the variables of the project, and benefitting from utilizing a client server approach to offload the large amounts of computational functions. In addition, individual teams were made responsible for managing their own information. There were also cultural lessons learned. There was a major cultural change in the way business was conducted. People are resistant to change and need help to maneuver through the new methods of working together. People also needed to become accustomed to sharing information quicker, and permitting access to everyone's work.

Steve Flach
Best Value Source Selection

The Crusader program was awarded to United Defense as a sole source contract with a total value of $1.2 billion. The program included a requirement for $450 to $600 million of the contract to be sub-contracted in order to maintain the industrial base. The quantity and diversification of the sub-contractors required the program to develop an integrated communications system.

The best value source selection method was used tor select sub-contractors, and has been utilized by the Army for the past five years. Previous business practices involved the best price selection method, which awarded a contract to the lowest bidder that met the minimum requirements. A transition then began that involved purchasing as many commercial products as possible in order to save money. The best value source selection method combines these two methods. The requirements are established and put out for industry to respond with the best product they can deliver and its price. The selection team then decides whether the price, reliability, quality, or performance parameter is the most important, and makes its selection accordingly.

The typical sub-contracting process involves multiple steps. The requirements and sources are first identified then a make or buy decision is made. If buying, requisitions are signed, a kick off meeting is held, and final specifications, selection plans, and requests for proposals are written. Reviews and approvals are conducted, then the actual requests for proposals are made. After the proposals are received, technical evaluations and cost analysis are performed, followed by negotiations and awarding of the contracts. The entire process used to take a very long time. The Crusader program time-frame was substantially shorter, and required a different approach.

A matrix was developed to identify the functional areas of responsibilities. Each team was assigned requirements along with a time-line that met program requirements. This approach was completely new to the Armament Systems Division of United Defense, and was developed specifically for this program. The responsibilities were identified for the processes of Sub-Contract Management, PDT Management, Technical Lead Engineering, Product Assurance, Finance, and Design to Cost.

In the best value source selection process developed by United Defense, the requirements are first identified including written requests for additional information. Potential sources are selected by determining companies that either have products, or can develop products to meet the required specifications. United Defense has an internal make or buy decision policy that was developed and used for this program. The requisition is the formal process of review and approval that must be signed by the PDT Manager. The official start of the sub-contracting process begins with the kick-off meeting. This meeting is very beneficial in getting everyone involved up-front, and establishing ownership and buy-in of the project. The kick-off meeting determines each team member's responsibilities, cost requirements, program schedules, and other associated factors of the project.

In the next phase of the source selection process, a Statement of Work (SOW) / Specifications is written to indicate the project requirements. A source selection plan is then developed to identify responsibilities and authorities of the personnel involved in the source selection process. The Request For Proposal (RFP) is then written which specifies the total package requirements for the sub-contractor. All documentation is reviewed and approved by the appropriate personnel. After approvals are complete, requests for proposals are sent to all sources previously identified.

In the final phase of the selection process the proposals are received by a predetermined due date. The proposals proceed through a specific evaluation process including technical and cost analysis. The system's requirements are ranked and weighted. Proposals are rated using these categories, and the best product is determined. In a typical sub-contractor selection, technical capability consists of 45% of the total score, cost/price consists of 35% of the total score, and management capability-based past performance consists of 20% of the total score. The results of the evaluation are compiled, and a sub-contractor recommendation is made. The Source Selection Authority reviews the recommendation and accepts or rejects the selection. After the final decision has been made, all sub-contractors that have submitted proposals are notified of the results.

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