REPORT OF SURVEY CONDUCTED AT

UNITED DEFENSE, L.P.
GROUND SYSTEMS DIVISION
AIKEN, SC

SEPTEMBER 2003

Best Manufacturing Practices

1998 Award Winner

INNOVATIONS IN AMERICAN GOVERNMENT

BEST MANUFACTURING PRACTICES CENTER OF EXCELLENCE
College Park, Maryland
www.bmpcoe.org

Foreword

This report was produced by the Office of Naval Research's Best Manufacturing Practices (BMP) Program, a unique industry and government cooperative technology transfer effort that improves the competitiveness of America's industrial base both here and abroad. Our main goal at BMP is to increase the quality, reliability, and maintainability of goods produced by American firms. The primary objective toward this goal is simple: to identify best practices, document them, and then encourage industry and government to share information about them.

The BMP Program set out in 1985 to help businesses by identifying, researching, and promoting exceptional manufacturing practices, methods, and procedures in design, test, production, facilities, logistics, and management – all areas which are highlighted in the Department of Defense's 4245.7-M, *Transition from Development to Production* manual. By fostering the sharing of information across industry lines, BMP has become a resource in helping companies identify their weak areas and examine how other companies have improved similar situations. This sharing of ideas allows companies to learn from others' attempts and to avoid costly and time-consuming duplication.

BMP identifies and documents best practices by conducting in-depth, voluntary surveys such as this one at United Defense, L.P. Ground Systems Division, Aiken, South Carolina conducted during the week of September 15, 2003. Teams of BMP experts work hand-in-hand on-site with the company to examine existing practices, uncover best practices, and identify areas for even better practices.

The final survey report, which details the findings, is distributed electronically and in hard copy to thousands of representatives from industry, government, and academia throughout the U.S. and Canada – *so the knowledge can be shared*. BMP also distributes this information through several interactive services which include CD-ROMs and a World Wide Web Home Page located on the Internet at http://www.bmpcoe.org. The actual exchange of detailed data is between companies at their discretion.

United Defense, L.P. Ground Systems Division Aiken is a leader in manufactured components for multiple military tracked vehicles. The company has established standards of excellence in fabrication, welding, laser cutting, and subassembly of aluminum, steel, and stainless steel components. The company demonstrated its experience and technical expertise, clearly indicating continuous process improvements in safety and recognition and development of its employees. Among the best examples were United Defense, L.P. Ground Systems Division Aiken's Ball Lock Fixturing, Production Planning, System Lean Manufacturing, High Performance Work System, and Safety Operations.

The BMP Program is committed to strengthening the U.S. industrial base. Survey findings in reports such as this one on United Defense, L.P. Ground Systems Division Aiken expand BMP's contribution toward its goal of a stronger, more competitive, globally-minded, and environmentally-conscious American industrial program.

I encourage your participation and use of this unique resource.

Anne Marie T. SuPrise, Ph.D.
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Report Summary

Background

United Defense, Limited Partnership (UDLP) can trace its history back to two companies — the Food Machinery Corporation (FMC) and the Harrisburg Steel Company (Harsco). FMC began in 1884 when inventor John Bean developed a new type of spray pump to combat San Jose scale in California's orchards. Realizing there was a great demand for the spray pump, he formed the Bean Spray Pump Company which concentrated its manufacturing efforts on agricultural equipment. In the late 1920s, the company merged with makers of food processing equipment and cannery machinery for vegetables, and created a larger company with a new name — FMC. By the mid-1930s, FMC was the world's largest manufacturer of machinery and equipment for handling fruits, vegetables, milk, fish, and meat products. As World War II began, FMC entered the defense business, manufacturing amphibious tractors and tanks for the U.S. Military.

Harsco began in 1742 and established itself as an internationally recognized leader in the production of America's first seamless gas cylinder. Later, the company began producing a range of specialty steel products, and expanded into new products and markets as a diversified industrial organization. During World War II, Bowen McLaughlin York, a division of Harsco, began building tanks. For the next 50 years, FMC and Harsco achieved recognition for producing quality combat vehicles and Navy guns. One of the most noteworthy vehicles developed and produced was the Bradley Fighting Vehicle, which was hailed as the "most magnificent fighting machine ever." In 1974, FMC opened a 220,000 square foot factory and office facility in Aiken, South Carolina for commercial products. In 1982, the facility was rededicated as a state-of-the-art manufacturing plant for the manufacture of parts for the Bradley Fighting Vehicle. With the downsizing of the U.S. Military, the facility was restructured and now manufactures components for multiple military tracked vehicles, the Navy's MK45 Gun System, and the Vertical Launching System. In 1994, FMC and Harsco merged their defense units to form UDLP.

The Aiken facility is one of five UDLP Ground Systems Divisions (GSDs), and has the proud distinction of having the best safety record in its industry. Embedded into the facility's walkway are concrete blocks that make visitors aware of the plant's safety record, publicizing major milestones of the millions of hours its employees have worked without a lost-time accident. UDLP GSD Aiken's safety record earned the facility the Palmetto Star Award, the highest award presented by the State of South Carolina, and the National Safety Council Award of Honor, the highest level of achievement attainable. UDLP GSD Aiken has also been noted in the U.S. Congressional Record for safety performance.

UDLP GSD Aiken is a leader in the research, design, and development of technologies necessary for the manufacture of advanced armored combat vehicles, artillery, naval guns, missile launchers, and precision munitions. The facility is the prime developer, system integrator, and producer of critical combat systems, and is equipped for advanced fabrication, welding, machining, laser cutting, and subassembly of aluminum, steel, titanium, copper alloy, and stainless steel components. In the face of an ever-changing defense environment, UDLP GSD Aiken reacted quickly and appropriately with the implementation of production planning to cut costs and deliver technologically advanced systems on time, on budget, and on specifications. The facility produces quality components to military specifications with an acceptance rate of 99.9% of total parts shipped.

UDLP GSD Aiken continues to be a leader of manufactured components for multiple military tracked vehicles and has established standards of excellence in manufacturing. The facility's excellent safety record, the recognition and development of its employees, technical expertise, and the establishment of its Skip Lot Process, System Lean Manufacturing Practices, High Performance Work System, and Weld Code Procedure have provided the U.S. Military with combat vehicles and components that are second to none. The BMP survey team considers the following practices to be among the best in industry and government.

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Section 2

Best Practices

Production

Ball Lock Fixturing

Ball Lock fixturing has helped United Defense, L.P. Ground Systems Division Aiken reduce the average machine set-up time from 43 minutes per set-up to 16 minutes per set-up. Over time, this simple mounting system has allowed fixture changes to be reduced by approximately 300 percent.

United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken operates as a business unit or commodity center within United Defense Corporation. The company is responsible for the machining, welding, and assembly of a variety of mechanical parts and assemblies for other United Defense divisions, facilities, and outside customers.

As a supplier of high mix/low quantity component parts, UDLP GSD Aiken constantly strives to implement Lean Manufacturing practices in all of its processes. In the high mix/low quantity environment, a company cannot set-up a machine once and leave it set-up to manufacture large quantities of parts. Instead, many set-ups must be performed over a short period of time, and each time it must be set-up to manufacture a low quantity of parts to be used or shipped within a short time period. The intent is to deliver to the customer what is needed, when it is needed, and in the quantity it is needed.

In order to minimize the non-value-added process of setting up machines for the manufacture of component parts, UDLP GSD Aiken is changing the manner in which vises and fixtures are located on the machine tables. Traditionally, the fixtures and vises were located on the machine tables using dowel pins or sine keys. The fixtures were then clamped to the machine tables using various clamping components such as threaded studs, tee nuts, bolts, or strap clamps.

Fixtures are now being located and clamped to the machine tables using ball lock shanks, normally four for each fixture. With the ball lock shank mounting process, a steel sub-plate is semi-permanently mounted to the machine using the existing tee slots and ways. The sub-plate is drilled and reamed to accept receiver bushings for the ball lock shanks and hold down bolts. The receiver bushing holes are located within the same hole pattern and spacing for all sub-plates. Aluminum fixture plates are then manufactured or purchased to mount the vises or holding fixtures. These plates contain the same hole pattern and spacing which match the sub-plates (Figure 2-1). Fixtures or vises are then mounted

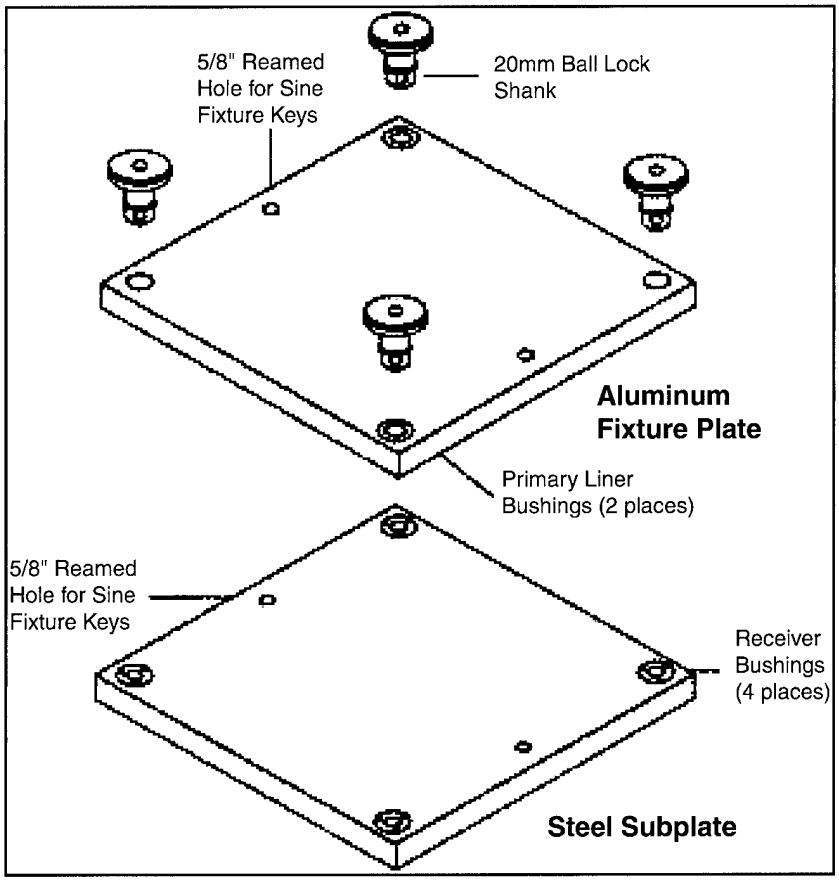


Figure 2-1. Ball Lock Sub-plate and Fixture Plate

to the fixture plate using a variety of accessories, dowel pins, bolts, toe clamps, strap clamps, etc. When the machinist or operator wants to change a set-up for another job, the right fixture plate is obtained with the holding fixture or vise already mounted for the job; it is then mounted to the pre-drilled machine sub-plate. The mounting of the fixture plate is accomplished using two ball lock shanks and normally two hold down bolts. Figure 2-2 shows a ball lock fixture mounted on a machine table.

The use of ball lock fixturing provided UDLP GSD Aiken with many benefits including:

- Simplified set-ups with the reduction of clamping components needed in stock to attach fixtures to a machine table
- Minimized set-up time (typically 15 to 30 minute set-up time has been reduced to three to five minutes)
- Increased process capability through the repeatability of fixture location
- Increased machine availability time
- Eased set-up change-over
- Reduced accident exposure
- Reduced work instruction complexity

UDLP GSD Aiken's use of ball lock fixturing and change-over procedures, along with other Lean Manufacturing practices, have reduced machine set-up and pre-set times from an average of 43 minutes per set-up to 16 minutes per set-up.

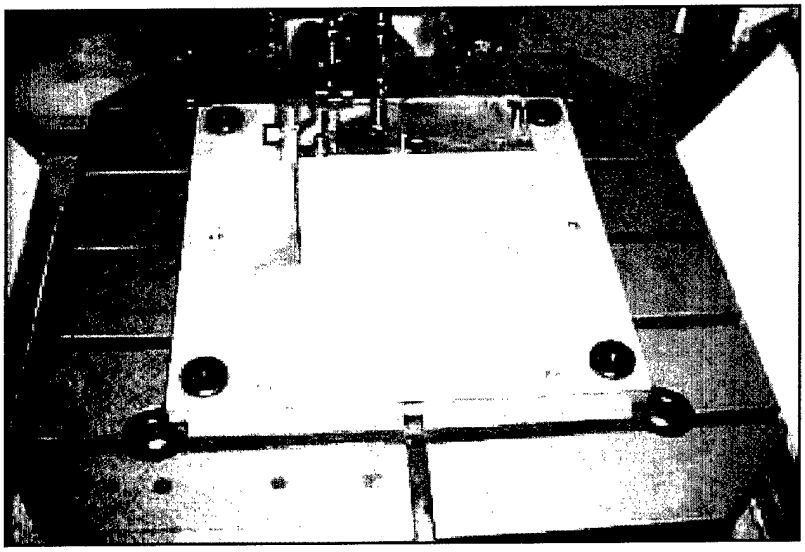


Figure 2-2. Mounted Ball Lock Fixture

Component Lean Implementation

Lean Manufacturing initiatives at United Defense, L.P. Ground Systems Division Aiken has allowed the company to realize significant savings in material, time, cost, inventory, and work in process, and ensured continued competitive advantage for many of its products.

In 1996, United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken began machining gun shields for one of the U.S. Navy's large gun programs. The gun shields consist of outer plates and inner skins. The outer plates are approximately three inches thick and of various complexities in shapes. The inner skins are generally thinner than the outer plates, and consist of several flat plates machined to different contours and sizes.

Originally, large plates of material were ordered and transported to a saw where the plates were cut into large, individual blanks of material. The many different pieces required to build a complete gun shield were machined on different machines. While effective, this process of manufacturing the different pieces required for one gun shield assembly created numerous opportunities for improvement. As the first step in implementing a Lean Manufacturing philosophy to the manufacture of gun shields, a nesting program was developed. The nesting program minimizes material usage, allows the use of smaller blanks of material, and allows material vendors to hold raw material to a tighter flatness tolerance with smaller plates. This process improvement allowed UDLP GSD Aiken to eliminate 17 set-up and run operations on its sawing operations.

Further Lean initiatives included value stream mapping of various parts required for a gun shield set, moving incoming materials to the "point of use," machining only the parts needed for one set instead of machining a complete order of individual parts at one time, eliminating hold down fixturing by moving the machining to machine tools that have vacuum clamping capabilities, and moving the packaging of the completed sets of parts to the machine where the parts are manufactured. The Lean Manufacturing initiatives taken on this one product line demonstrated dramatic results in sav-

ing time and money for the company. An example of this saving is demonstrated with the outer plates, where part travel distance has been reduced by 75%, floor space requirements reduced from 428 square feet to 81 square feet, and machining operations reduced by 72%. Similar savings were generated on the manufacture of the inner skins.

UDLP GSD Aiken demonstrated and realized the many benefits of a strong Lean Manufacturing philosophy. These initiatives allowed the facility to reduce scrap and rework and process cycle time from receipt of order to final payment, remove wasteful tasks/processes, reduce inventory and work in process, provide quicker customer response times, and add value for the customer.

Production Planning

Traditionally done departmentally, United Defense, L.P. Ground Systems Division Aiken implemented Production Planning as a team approach that ties plant loads and capabilities into a central system where each area projects 50% into the future, goes paperless, and integrates shop area leaders into higher management and analyst decisions. Numerous calculations are automatically generated, thus reducing error, and charts are instantly updated with more useful graphics that accurately depict daily, monthly, and yearly projections.

To supply United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken's management with up-to-date load and capacity information based on current and future customer requirements, a software-based Access Production Plan System was introduced. In addition to infrastructure savings, the database allows central information access, facilitating team organizational structure, lean processes, continuous improvement strategy, statistical data requiring robust analysis, and presentation capabilities to ensure positive business and staffing decisions.

UDLP GSD Aiken's original process relied on monthly, manually-generated business charts. Issues and actions were manually calculated daily based on load, people, and days per month. The presentations consisted of overhead transparencies and paper reports in various formats local to each business center. Many extrapolations and projections were not created due to time and calculation constraints. Production and load information was only available for 12 months and limited the accessibility of information during a given month. Area and team members were not included in the process and could not contribute to goal-oriented planning or reorganization. Information concerning excess capacity was not communicated from one center to the next, and was therefore poorly utilized.

Under the current central database system, production load information is electronically imported and projected out 18 months. All current load data and manufacturing capabilities are programmed into the system to identify the part and contract information. The Production Plan System reviews the total load requirements based on capability (generated by a run standard hours system), and calculates the number of people and output hours required to meet the monthly load specification. Area Managers review and confirm the data and make minor adjustments for absenteeism and other work area specifics. The system recalculates the expected output hours required per day, and updates the charts and tallies projected backlogs. By fine-tuning backlogs, Area Managers plan to exceed projected output and receive Performance Sharing Plan Awards. Additionally, area data can be accessed so that personnel can be moved to where they are most needed. This strengthens team results by placing the team members most responsible for those results close to the process.

Each month, the Area Managers, Area Business Managers, and Materials personnel meet before the Production Plan Meeting with UDLP GSD Aiken's Leadership Team. This closes the circle from production floor to upper management. Having accurate data and 18-month projections of backlogs allow top-level production restructuring to meet future contract impacts before the on-set of the backlog. Using the load versus output chart, backlog hot spots can be shown and researched to determine root causes or bottlenecks. Moving less time critical orders, modernizing or purchasing capital equipment, or adjusting schedules are supported in simulation runs with the Access Production Plan System. In addition, the production plan can be quickly adjusted to accommodate emergency requests, thereby enhancing customer support.

In pursuing ISO certification, investigators were pleased to see production line comments drawn from production metrics highlighting risk areas. By tracking mitigation efforts, ISO representatives tracked historical quality changes that were supported with real data. UDLP GSD Aiken realized a 25% reduction in direct labor staffing and a 60% reduction in support infrastructure.

System Lean Manufacturing

To improve performance on a U.S. Navy contract for missile Vertical Launching System components, United Defense, L.P. Ground Systems Division Aiken developed a System Lean Manufacturing process that significantly reduced production cost. As more process features are included in the lean implementation, the company anticipates additional savings.

System Lean Manufacturing implementation provides substantial benefits for the manufacture of major machined and welded components for defense systems. These benefits are derived from process changes in material management to minimize inventory and manufacturing operations, reducing the distance parts travel on the factory floor and relocating machinery to improve production performance. To improve performance on a U.S. Navy contract for missile Vertical Launching System components, United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken developed a System Lean Manufacturing process and significantly reduced production costs.

UDLP GSD Aiken's previous process focused on work orders to manufacture individual components in production lots that corresponded to two to three months of inventory. These components were produced at multiple work centers throughout the facility, and organized around the technical manufacturing disciplines. Inventory was stored at various locations around the plant, typically near the last manufacturing operation. Deliverable item assembly focused on assembly in the best order from component inventory. For example, one system included six weldments built up from 86 components, 82 of which were manufactured at UDLP GSD Aiken at 19 work centers in 311 manufacturing operations. Each weldment had its own work order, generated for one month's production, and was delivered to final assembly where finished units including the other weldments were shipped weekly and not necessarily as a complete shipset. This process was accomplished after completing a 12-mile journey across the factory floor.

By contrast, the Lean Manufacturing implementation process treats the finished assembly as the principal focus of the manufacturing process, organizing manufacturing to minimize both direct and indirect costs. The review included evaluating individual machining operations, changing metal ordering to reduce the size and increase frequency of deliveries, generating kits to move the developing structure between work centers, reorganizing the process and eliminating work orders in favor of work instructions related to the kit components, consolidating the work centers, and minimizing component travel time on the shop floor by relocating machinery where necessary.

The System Lean Manufacturing process yielded impressive results. Process certification of all components contributes to variance elimination, thereby improving quality. Workstation involvement was reduced from 19 to 10, and manufacturing operations for the 82 manufactured components were reduced from 317 to 225. The average travel distance for all 86 components was reduced from 12 miles to 5.5 miles. Inventory was reduced from three months of production to one week of production, costs were reduced, and quality was increased, thereby increasing customer satisfaction.

UDLP/TACOM Weld Code Procedure

United Defense, L.P. Ground Systems Division Aiken developed the Ground Systems Division / Tank-Automotive and Armament Command Weld Code, resulting in significant savings to the government and overall improvement in weld quality.

Prior to 1996, all ground combat vehicles that were fabricated to Military Standard requirements affixed significant non-value-added costs to the contract price. Redundant workmanship samples were often required, and weld procedure books had to be prepared specifically for each program. The qualification requirements for welders were program-driven with each program having different inspection requirements. Many times the visual criteria for acceptance did not exist in the specification.

Acquisition Reform was a military initiative designed to align requirements more closely with commercial procurement. By using commercial standards, many of the costly military requirements that did not add value could be eliminated. When many of the military specifications were canceled without replacement, a void was left because no commercial equivalent specification existed. To fill the void, United Defense, L.P. Ground Systems Divisions (UDLP GSDs) in Santa Clara, York, and Aiken, the Tank-Automotive and Armament Command (TACOM), the Tank Automotive

Research Development and Engineer Center, and the Armament Research Development and Engineering Center teamed to develop steel and aluminum weld codes for use in the manufacture of ground combat vehicles for the Army. The Weld Code maintained the integrity of process control and delivery of a quality product while reducing cost by deleting non-value-added requirements. The Weld Procedure Manuals were applicable to all UDLP GSDs' Army ground combat vehicle programs. The manuals were process-based (position, material, etc.), removing artificial cost drivers and eliminating vague and ambiguous verbiage and redundant workmanship sample requirements. Welder certification was standardized enabling welders to be transferred to other GSD sites. Procedures and inspection criteria were posted on the floor in the welding areas and made available via the company's Intranet. The Weld Code also provided an alternative process of radiographic surveillance where sampling could be applied if the process was under control. Through this single process initiative (from 1997 to 2000), the government saved more than $5.2 Million. Under certain conditions, the Weld Codes enabled the sharing of procedures and best practices with suppliers to dramatically aid them in reducing their process development costs and improving lead times for purchased components.

Standard Repair Procedures were developed to accommodate repairs typically encountered, and accomplished without excessive input or approvals. The repairs are to be performed only under certain controlled conditions. UDLP GSD Aiken standardized the Standard Repair Procedures for all GSD sites and reduced the number of procedures from 51 to 21. The government received $50 Thousand through this single process initiative.

The UDLP/TACOM Weld Code was initially developed for use by the company in the manufacture of ground combat vehicles for the Army; however, the Army has adopted the Weld Code for use by all contractors for the procurement of tracked vehicles. The document has been converted to the government-owned Cage Code 19207. The Weld Code reduced overall tracked vehicle cost, simplified the manufacturing process, provided manufacturing flexibility through use across programs, reduced supplier lead time, and improved the overall weld quality.

Vacuum Clamping

United Defense, L.P. Ground Systems Division Aiken introduced Vacuum Clamping as an alternate method in securing plates to machine tables. This process eliminated the need for mechanical clamping, reduced set-up times, and decreased the average time required to complete a single job.

Previously, United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken used a hard line clamp process that secured plates to the machine tables by using countless numbers of clamping components. As a result, set-up times were lengthy, frequent program stops occurred, workers' errors increased, and the potential for operator injury existed. All areas were manually labeled indicating to the operator where to clamp, thus making the process tedious and complex, and contributing to increased process variables, accident exposure, high machine time, and manual set-up.

UDLP GSD Aiken introduced Vacuum Clamping as an alternate method to secure plates to machine tables. This process involved constructing fixture plates with air entry ports. A vacuum pump and piping system sucked air through the ports and clamped the parts to the fixture. Three types of fixtures are used in this process:

- Dedicated — clamps a specific part of a group of parts to the machine table
- Universal — clamps parts of different sizes and shapes to the machine table
- Button — clamps parts that must be elevated to provide a clearance below a specific part and provides a better seal of all parts

All fixtures are vacuum operated with automated electronics, thereby reducing set-up time. The dedicated fixtures can be built at minimal cost. Universal fixtures encompass multiple parts, and can be readily produced. Both the dedicated and universal fixtures are significant cost reducing factors.

By using the vacuum clamping process, UDLP GSD Aiken has minimized set-up time, increased machine availability and capability, and reduced accident exposure to operators since it is no longer necessary to physically clamp plates to the tables. The electronic verification process performs all commands, decreasing the work instruction complexity and optimally fitting more parts on the three fixtures. The vacuum clamping process decreased the average time required to complete a single job,

yielded cost-effective results, and fostered a more productive environment with better manufacturing capability, thereby enabling UDLP GSD Aiken to be more competitive.

Facilities

Optimation Nesting Process

For small- or medium-sized companies to modernize, existing capital equipment must often be upgraded rather than replaced. United Defense, L.P. Ground Systems Division Aiken upgraded its cutting and punching operations by engineering modern efficiencies into existing machines with the implementation of its Optimation Nesting Process.

Streamlining the movement of fabrication from the drawing to the actual part has been a goal of United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken. Previously, programming numerical control (NC) machines for repetitive cutting and stamping operations required tedious steps. G code had to be created detailing x and y-axis positioning, and after they were created, the procedure for input required NC tape production and storage of paper copies in shop books. In many cases, the set-up for a run could take many hours to configure, and complex geometry was not always feasible. Upgrading to a costly "turn key" solution could not be supported due to the business plan cost structure. UDLP GSD Aiken chose to upgrade its existing machines with Optimation Nesting Software.

Interfacing the Optimation Nesting Software to cutting and punching machines made a significant impact on productivity and efficiency. Operations have been reduced by 50%, with an 80% set-up time reduction. Optimation software personnel supported the interface to UDLP GSD Aiken's Alabama 3000 Watt Laser and the Whitney Punch/Plasma machine, accomplishing the goal of streamlining. The Whitney Punch/Plasma machine was once an Optimation-capable machine. Reconverting the interface to Optimation generated the idea that similar efficiencies could be realized if the Alabama Laser machine was also be converted. Although the Whitney machine proved to be a straightforward conversion, the configuration of the Alabama laser machine required a six-week trial-and-error period to attain satisfaction with the output. The experience gained through the Whitney Punch/Plasma machine's transition facilitated the process. Key to the success of the Optimation Nesting Process was the teaming, where vendors were available 24 hours a day and project engineers were assigned for direct support including travel to the site.

UDLP GSD Aiken realized many efficiencies by implementing the Optimation Nesting Process including:

- Run files are workstation-created via CADDS files or MasterCam import
- Parts library or nest files are supported
- Run files are directly downloaded from the network simplifying reuse of recurring nests
- Remnants are automatically recorded and catalogued for future needs
- Numerical file call-up errors are low
- Entire week of nested runs can be programmed in10 to12 hours per week
- Tolerance errors are limited to and identified at the workstation
- One-day turnaround on prototypes and special orders
- Up to five programs can be queued at a time eliminating programming stoppage
- 99% accuracies on the first part run; 80% reduction in set-up time
- Operator process simplification
- Low software/interface downtime

Management

High Performance Work System

United Defense, L.P. Ground Systems Division Aiken implemented a High Performance Work System that allowed the facility to remain competitive in a decreasing market.

In 1992, United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken implemented a High Performance Work System. The prior management structure was a team concept with a traditional management structure. Whenever possible, employees were involved in decisions that affected their work. With regular, one-hour, weekly team meetings, group problem solving sessions began

to occur as the teams matured. UDLP GSD Aiken recognized that the defense industry was changing and shrinking. The Bradley Fighting Vehicle was maturing, and past successes could not be counted on for the future. To survive, UDLP GSD Aiken took a proactive approach to changing the way it did business.

UDLP GSD Aiken implemented the High Performance Work System with the development of organizational beliefs and principles used for planning, leading, and managing the business. Operating principles were established to guide the day-to-day interactions of employees. The employees were given the autonomy and freedom to use their capabilities and creativity to operate, maintain, and improve the way things were done. Principles defined the desired culture and provided the boundaries for employees' performance.

In developing the High Performance Work System, UDLP GSD Aiken defined the beliefs that the survival of business and job security depended on how well customers were satisfied, and the understanding that customers were the only sources of income. The perfection of the material and information flow needed to be the focus of all efforts, and success would occur with everyone striving for excellence and continuous improvement. The company understood that employees wanted to contribute to the success of the business and maximize their contribution if it was perceived to be in their best interest. To be successful, employees must have the right knowledge, the right skill, the will, mutual respect, trust, and support. It was understood that all employees bring a unique value to the business and the teams, and are entitled to a safe and healthy working environment. To accomplish its goals, UDLP GSD Aiken established the following principles:

- Decision Making: Accommodate team members' needs when making business decisions, and support those decisions in accordance with the company's beliefs and principles.
- Teamwork: Most work would be done in multi-skilled teams, and employees were encouraged to participate on these teams and support each other.
- Skill Application: Work in a flexible manner in the improvement of the business, self, and other employees.
- Problem Solving: Problems would be solved as close to the source as possible, allowing for an individual's direct involvement in business successes.
- Meaningful Work: Strive to have jobs which use a variety of employees' skills, and provide the freedom for employees to work within defined boundaries.
- Capability Development (Training): Continuously improve skills and quality of thinking.
- Performance Feedback: Preferably, to collect from the job by the individual/team; however, feedback from other sources will provide a help-to-improve purpose.
- Information Sharing/Communication: Sharing appropriate information in a timely manner will enable improvement of individuals, teams, and the business.
- Reward/Recognition: Recognize and reward employees for continuous demonstration and applications of skills that improve the effectiveness of the organization.
- Organizational Contributions: All levels and functions of the organization will provide a distinctive and value-added contribution to the perfection of the material flow and business performance.

The organizational structure was changed to Cell Family Teams (CFTs) with a cell family technician who is responsible for and has the authority to operate, maintain, and improve material flow, manage customer/supplier relationships, communicate and collaborate to solve problems, and establish and achieve team goals. The CFTs have five functional specialists coordinating activities across each shift. The coordinators represent the areas of manufacturing, process improvement, administrative, human resources, and quality. The coordinators' role is to communicate with their CFTs and the "outside world" in issues involving their functional area. The coordinators are managers of the CFTs' compliance with the site and teams' policies, procedures, principles and systems in their functional areas. The coordinators are the champions for the CFTs' continuous improvement, and the focal point within the CFT for ideas, problems, and issues involving their functional areas.

A resource team consisting of Engineering, First Line Supervisor, and Materials Analyst was established to provide strong "coaching" for the CFTs, build the capability of team members, lead improvements within the CFT, provide equal support to all

shifts, and provide technical and functional expertise. Seven business managers were established to lead the implementation of UDLP GSD Aiken's new work system. The business managers provide strong leadership for the CFTs, facilitate interaction of team members, provide technical/functional expertise and proven "big-picture" business understanding. Through downsizing and attrition, the number of business unit managers eventually decreased to one.

The measures of success defined were:

- Cost: Operating cost per standard hour shipped; material cost per standard hour shipped
- Delivery: Based on the on-time delivery to the customer of 95% on time and the throughput (days per work order)
- Quality: Total cost of quality per standard hour shipped, and the pieces accepted by the customer divided by the pieces shipped to the customer.
- Other: Safety, health, environmental, and financial

In 2000, the High Performance Work System underwent a renewal process. It was known from the beginning that renewal would be needed on a periodic basis. UDLP GSD Aiken recognized that the shop leadership role needed to be stronger, and Kaizen confirmed the need. The site's excellence had diminished over the years, and the organization had become reactive rather than proactive.

The leadership of manufacturing was combined into one position, and a stronger leadership presence was established on the shop floor. The shop floor leadership consisted of three Area Leaders on day shift, one Area Leader on second shift, and Team Leaders by each department. The Team Leaders are shop technicians who apply for the job and receive an additional $1.25 per hour, and are closest to the material flow where variables to the process can be quickly corrected. Engineering staff was also moved closer to the work to provide better support. The engineering role includes leadership for capability improvement through Kaizen, Business Process Reengineering, and Process Certification. Area Managers provide the focus and leadership to ensure each team and business area are functioning effectively to meet business and plant requirements and results. Team Leaders provide the focus and leadership to ensure that the team functions in a cost effective and competitive manner. Team building exercises were scheduled to help develop team concepts. UDLP GSD Aiken's High Performance Work System allowed the company to remain competitive in a decreasing market, and continues to evolve and improve operations.

Long Term Agreement Process

United Defense, L.P. Ground Systems Division Aiken implemented a Long Term Agreement process for the procurement of materials. By taking advantage of the needs across United Defense and its second-tier suppliers, better pricing, delivery, service, and quality have been achieved for both United Defense and its second-tier suppliers.

United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken implemented a Long Term Agreement (LTA) process for the procurement of materials used by the company and its second-tier suppliers. The LTA enabled the company to save money and ensure that the supply of regularly needed materials was readily available.

Previously, the company put purchases out for bid, but realized that by combining the purchases from all its facilities and second-tier suppliers, better pricing, response, quality, and delivery could be attained by using an LTA with its suppliers. United Defense established a "Commodity Team" of buyers/purchasers to develop an LTA with its commodity suppliers. The goals of the LTA were to guarantee high quality, reduce cost, improve delivery, and provide service flexibility. Initially, an LTA was used to procure aluminum sheets and plates. This product line was selected because of the opportunity for a quick return, and all United Defense sites used the material. Five mills and nine distributors were considered for the LTA. A consolidated forecast of the needs of UDLP GSD Aiken and its second-tier suppliers was created and resulted in a survey of suppliers where six were solicited. After a request for quote and a statement of work were generated, the quotes were evaluated and an LTA was awarded.

UDLP GSD Aiken realized many benefits from this process. Purchasing lead-time has been reduced by 20 days due to the elimination of bids, proposals, and the quote process. Supplier lead-time was reduced, and a more consistent quality of material is received from the supplier. Deliveries are 100%, and 99.4% of the deliveries meet the requirements. Should problems arise, only one sup-

plier needs to be contacted. A reduced price, with a maximum escalation clause, was obtained by giving the supplier exclusive rights to the procurements from UDLP GSD Aiken, unless the supplier cannot supply the needed material or the quality deteriorates. The supplier can lock in mill forecasts in advance and maintain inventory and remnant stock, which has improved R&D and prototype lead times.

Performance Sharing Plan

United Defense, L.P. Ground Systems Division Aiken developed a Performance Sharing Plan that rewards its employees with the company's business performance. It also fosters teamwork and employee development, and creates a focus on key performance parameters.

United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken implemented a Performance Sharing Plan that rewards its employees with the company's business performance. The purpose of the Plan is to share gains from improved performance with the employees. The Plan is measured and pays an incentive directly to the employee on a quarterly basis. A booklet describing the Plan is distributed at an all-employee meeting at the beginning of each year.

UDLP GSD Aiken's Performance Sharing Plan is based on the employees becoming shareholders in the performance of the organization, where both the employee and the organization benefit. The Plan uses cost-per-run standard hour as a key measure. A run standard hour is an engineer's estimation of the set-up time, run-time, and inspection time required to manufacture a particular part. To ensure accuracy and fairness of the estimation, one part is run and compared to the estimated time. If needed, an adjustment to the estimate is made, and the run standard hour is locked in. The Plan also uses safety, environmental, quality performance, and average time required for set-up as measurements. The plant manager has the authority to suspend the Plan for a quarter if safety, the environment, or quality deteriorate, which ensures that cost-per-run standard hour does not become the only priority. All plant employees who are not participating in another performance incentive plan are included, with the exception of the plant manager, ensuring that everyone is a stakeholder. Additionally, team members with long-term disability and those who leave or join the company during a quarter have their payout based on quarterly earnings. If a team member dies during the year, the pay-out goes to a designated beneficiary and is also based on quarterly earnings.

The Performance Sharing Plan is run by a Performance Sharing Committee, consisting of 13 people from the UDLP GSD Aiken Plant Leadership Team and other select, non-exempt team members. The committee currently has nine employees from the shop, which is approximately one from each major area. Participation in the committee is voluntary. The committee makes suggestions, reviews the current year's plan, and communicates the information, including current monthly status. The committee also makes recommendations and sets objectives for future Plan years. Monthly results are posted on a special Performance Sharing Plan board in the plant cafeteria and in the company's newsletter, Communicator. The quarterly results are reviewed by the Plant Manager at the plant's quarterly meeting.

Payout from the Performance Sharing Plan is not guaranteed. Occasions have occurred where the payout improvement requirement was not achieved or was very low. The Performance Sharing Plan is self-funding from savings, and uses a two-tiered system with two levels of payout to drive breakthrough performance. The higher payout tier is purposely set at a level that, while achievable, is difficult to achieve without "breakout" performance. The higher level of payout is unique to UDLP GSD Aiken, and has the potential of paying out a reward of 10%. From 2000 to 2002, the Performance Sharing Plan resulted in savings of more than $3 Million, with an average payout of approximately $1,800 per employee, resulting in a return on payout of approximately $2 per $1 paid out.

Process Certification

To provide the tight control needed to minimize direct and indirect manufacturing costs, United Defense, L.P. Ground Systems Division Aiken implemented Process Certification to assure manufacturing repeatability and component uniformity. The process recognizes the key roles of operator skills, material properties, tooling, safety, inspection, process, numerical controls, and the machine tool in manufacturing quality.

Previously, United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken used a traditional

manufacturing process focusing on competency for machine operation and execution of work orders to produce economic quantities of individual parts in a high-volume/low-mix environment. Dispersed responsibility for certain functions intrinsic to the manufacturing operation (i.e., quality assurance) led to large numbers of operations that reduced machine availability, and other operations that did not add value to the product. With other process changes being undertaken at UDLP GSD Aiken to better support other internal processes and improve performance, it was essential to better control workstation operation.

As part of the strategic plan, top management established Process Certification as a goal, and formed a Process Certification Team. The Team included a leader/champion, process owners, process stakeholders, and, where appropriate, customer representation. The Team comprehensively reviewed the manufacturing process at each workstation, and developed a draft charter for review and approval by the Site Steering Committee. The charter includes identifying behavioral norms and utilizing continuous improvement tools. On acceptance of the charter, the Site Steering Committee ensured that necessary resource requirements were adequately staffed.

With the charter in hand, the Committee analyzed the broad scope of workstation operations. Key inputs included equipment, skills, materials, morale, engineering processes, product design, tooling, safety, and behavior. Typical outputs were quality improvements to improve customer satisfaction, increase throughput, cost reduction, and establishment of a process ownership culture. The Team then established metrics and key process characteristics that can be measured and reported to monitor process implementation and identify subsequent improvement opportunities. After suitable review, the plan was approved and participants in the process were trained for their roles and conformance with the plan or work instruction requirements. The training included behavioral requirements, process analysis methodologies, auditing, and preventive maintenance requirements. The process was implemented, tested, updated and refined. Additional training was, and is provided as required based on demonstrated process performance and process owner/stakeholder understanding.

To achieve process certification, ongoing internal reviews have several key criteria that include:

- Audits and key process indicators must exhibit acceptable results
- Complete requirements are understood and followed
- Complete process owners/stakeholders are trained for the initial cycle
- Acceptable team behavior
- Team understanding that certification is only the initial step for improvement
- Team understanding that personnel will be measured from this point on for continuous improvement in the process
- Celebrating the success

Direct benefits of Process Certification include continuous process monitoring via artifact and probe checks and reduced product inspection time, with concurrent increased machine efficiency and utilization. Indirect benefits include management using these controlled, certified processes to implement other, enterprise-wide processes important to meeting corporate financial goals and increasing customer satisfaction.

Quality Partnership Council

United Defense, L.P. Ground Systems Division Aiken's Quality Partnership Council is improving the business acquisition process by eliminating the need for unnecessary planning and increasing the opportunity to acquire new business.

United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken examined its business operations in acquisition management and is acquiring new customers by activating conventional business contacts. While each customer representative expressed interest and intent, the internal procedures of the customer would consistently change the operating structure, making it difficult for customers' representatives to adapt and keep up. UDLP GSD Aiken tried several ways to minimize the effects of its customers' dynamic structure in transacting new business.

Previously, UDLP GSD Aiken's new business acquisition methodology had become redundant and inefficient in the use of time, manpower, and resources. The process jeopardized UDLP GSD Aiken's status to compete and grow in a long-term business environment. In its original business operations strategy, the company was accustomed to manufacturing large amounts of big budget defense items monthly. Acquiring new business was becom-

ing more difficult because the relationship between the contractor and the customer did not allow for quick resolutions of problems. Each time a business matter was handled, UDLP GSD Aiken dealt with different customer representatives who did not communicate with their predecessors. This tied up money and resources that were needed for equipment modernization. When new business was obtained, the products were inspected and reviewed by the contractor and the customers' representatives. As a result, unnecessary redundancy, increased overhead costs, wasted production time and manpower indicated a need for change.

UDLP GSD Aiken formed the Quality Partnership Council (QPC) made up of representatives from various areas of contracting to handle this process and resolve the issues. The QPC meets quarterly to identify roles and responsibilities, set schedules, and make recommendations for the best way to achieve new business in acquisition, engineering, quality, production, logistics, and finance. It then empowered representatives (known as czars) of both the customer and contractor to negotiate these policies and agree to final terms regarding business ventures. This new process yielded tremendous benefits. The QPC incorporated 22 standard Quality Assurance (QA) clauses across several programs. The clauses have been modified into six contracts, resulting in enormous cost savings since 1995. It developed and adopted steel and aluminum weld codes patterned after American Welding Society standards, and defined a way for both the customer and contractor to have equal representation and control over all business matters.

Since UDLP GSD formed the QPC, cost savings have increased and waste has greatly decreased, enabling the company to achieve a long-term business strategy that previously did not exist.

Safety Operations

United Defense, L.P. Ground Systems Division Aiken has an outstanding and proactive health and safety program. The effectiveness of this program is evidenced by its safety record of 13 consecutive years and more than seven million work hours without a lost-time accident. The company has also been accepted into the OSHA Voluntary Protection Program, which allowed it to develop a closer working relationship with OSHA.

Safety is a number one priority at United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken. This philosophy is firmly ingrained into the culture of the organization and encompasses everything done at the facility. The facility's mission statement is "To SAFELY Produce A Quality Product On Time At A Competitive Cost." Safety awareness is prominent as it greets visitors to the facility as they walk up to the door. Embedded into the facility's walkway are concrete blocks making visitors aware of the plant's outstanding safety record, publicizing major milestones of the millions of hours its employees have worked without a lost-time accident. The company has had only two lost-time accidents since the facility began operations in 1982. In 2003, this record stands at seven million accident-free hours spanning a period of 13 years.

Management and resource teams at UDLP GSD Aiken take ownership and are held responsible for improving the level of safety performance in numerous areas of the facility that concern the safety and health of employees. Strong leadership, direction, and technical expertise are provided to all employees to ensure that safe work practices are followed both on-the-job and off-the-job, and that physical hazards within the facility are eliminated or minimized. The leadership ensures that the latest local, state, and federal safety regulations are not only followed but exceeded. The responsibility for working safely is passed down to all employees and contractors — working safely is a condition of employment at UDLP GSD Aiken. It is believed that both employees and contract workers must assume a 100% level of responsibility for working safely and striving for an injury-free work place. Worker participation in plant safety is not only encouraged and rewarded, it is also expected. All employees are involved in the day-to-day management of safety processes through their involvement in the plant safety committee, office safety committee, safety resource network, management safety, or weekly safety meetings.

The plant safety committee is made up of 11 employees, one from each of the different areas of the shop floor, and meets monthly to review issues, concerns, trends, and actual performance, and makes recommendations for improvement. Chaired by the Safety Engineer, the committee's main purpose is to provide a focal point for team and employee involvement in plant safety initiatives. The committee's duties are varied and include communicating the information received at plant safety com-

mittee meetings to all shifts in the respective cell family. The office safety committee is made up of four representatives from different office areas, and meets quarterly to review issues, concerns, trends, and performances, and makes recommendations for health or safety improvements. The office safety committee is chaired by the Human Resources Administrator and provides a focal point for team and employee involvement in office health and safety issues. UDLP GSD Aiken's plant manager and staff are proactive in plant safety and meet monthly to review the overall safety program at the facility. This helps provide management direction and ensures that continuous improvement is achieved.

UDLP GSD Aiken has been a member of OSHA's Voluntary Protection Program (VPP) since 1994, and has been re-certified twice as a VPP site since original certification. The VPP promotes effective worksite-based safety and health where management, labor, and OSHA establish cooperative relationships at workplaces that have implemented a comprehensive safety and health management system. Acceptance into VPP is OSHA's official recognition of employers' and employees' outstanding efforts of exemplary occupational safety and health.

Skip Lot Process

United Defense, L.P. Ground Systems Division Aiken implemented the Skip Lot Process to support its complementary goals of high quality levels, reduced cost, and process ownership by the operators.

With successful implementation of continuous work inspection processes at United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken, traditional quality assurance (QA) sampling techniques based on part cost became redundant and superfluous and did not promote the process ownership goals important to the implementation of modern lean fabrication processes. The company developed the Skip Lot Process to support its complementary goals for high quality levels, reduced cost, and process ownership by the operators. UDLP GSD Aiken benefited from this process by reducing cost/run standard hour, eliminating redundant administrative requirements, reducing inspection time, improving material flow, and maintaining high quality, as measured by scrap and rework performance.

The Skip Lot Process is based on eliminating redundant inspections and unnecessary handling time for work orders on a production lot basis while retaining corrective procedures where needed in the Quality Assurance (QA) process. With final inspection occurring at the workstations, it was possible to ensure quality by periodically auditing the workstation-based process. Workstation audits include monthly verification of the first piece qualification (for each production lot), the calibration of in-use gages, and the drawings and specifications with mil-standards and weld specifications. To qualify for inclusion in the Skip Lot Process, the production process and operator must be certified, and at least two production lots must be accepted by QA before subsequent production lots become a candidate for the process. When accepted, work orders carry the note "Job on Skip Lot" on the front page. Parts produced under the Skip Lot Process go directly from the workstation to shipping, bypassing the QA laydown area and improving material flow. Documentation bears the marks of the certified process, operator, and the operator's inspection sign-off which must be complete before the parts are authorized for shipment. Parts can be removed from the process at any time by quality/manufacturing engineering if the production process is changed or if engineering changes to the part are required. Rejection of any part, by QA or the customer, will automatically cause all such parts to be removed from the Skip Lot Process until three production lots have been accepted by QA.

UDLP GSD Aiken realized many benefits from its Skip Lot process, including:

- Reduced cost/run standard hour (the standard metric for all manufacturing operations)
- Reduced direct inspection costs (with up to a 38% reduction in inspection/manufacturing cost ratio)
- Elimination of redundant administrative requirements
- Improved material flow
- Maintenance of high quality parts (as measured by scrap and rework performance)
- Reduced inspection time

Section 3

Information

Production

Machine Tool Probing

Machine part touch probing has significantly contributed to the set-up reduction and Lean Manufacturing efforts at United Defense, L.P. Ground Systems Division Aiken. This process allowed the company to utilize its numerical control machines with a higher degree of efficiency and accuracy.

Machine part probing is one means of establishing a relationship between the material clamped to a machine table or located on a fixture and the numerical control (NC) part program. It is necessary to know the X, Y and Z zero-points on the table for the NC machine to move the machine spindle to the proper position on the part for machining.

Prior to establishing part probing capability on its NC machines, United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken's operators would locate the material or fixture by using an edge finder or dial indicator and manually jog the machine tool or move the part on the table. This process was time consuming and dependent on the skill of the operator. Other problems associated with this method included requiring the operator to climb onto a slippery machine table (on large machines) to view a dial indicator or edge finder, creating an unsafe condition. Occasionally, the operator would jog the machine in the wrong direction or at rapid travel and cause the machine to crash. Additionally, this process did not allow the operator or Quality Assurance (QA) personnel to easily verify machine accuracy on a regular basis.

Machine part probing uses touch probes and probe routines in part programs. Probes are spring-loaded devices that are loaded into a tool holder which are then loaded into the machine spindle. The machine program moves the spindle to an approximate location, and then the probe searches for part presence. Most NC programmers build their programs to begin this search within one-half inch of the anticipated part or part feature location. When the probe touches the part or desired feature, an electronic signal is sent to the machine controller telling the machine where that point is in relationship to the machine "home" zero point. Numerous touch points are used to further define the true location of part features (e.g., edges, holes, bosses, slots, webs). Probing allows a part or fixture to be mounted onto a table, not mounted to a locating fixture that is precisely located on the machine each time. Once the machine controller knows the location of the X, Y, and Z zero-points of the part, machining of the part can begin using the NC program.

Setting of the X, Y, and Z zero-points by the NC part program results in faster and more consistent set-up times. Touch probing also allows for irregular, varying, and inconsistent parts to be machined to the desired accuracy because the machine controller knows where each part is on the table, not where it should be. By using touch probing, the operators of large machines are no longer required to climb on the bed of the machine to accurately locate each part. This method of locating work pieces also allows the NC programmer to easily perform multiple work offsets which reduces programming time and allows for better automation of processes by testing for part presence. Another major advantage of touch probing is that simple and frequent monitoring of machine accuracy can be accomplished using a master artifact on a regular basis to check the machine. Machine part probing helps improve part quality and reduces total set-up and cycle times. With the use of touch probing and other initiatives, UDLP GSD Aiken reduced set-up times by more than 80% on three NC machines.

Model to Part

United Defense, L.P. Ground Systems Division Aiken implemented MasterCam software for model-to-part representation and improved the manufacturing process for probing and drilling in machining. This software eliminated the need for hard-copy maintenance manuals, reduced production costs, and eased programming updates.

Prior to implementation of MasterCam Software, United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken used a non-graphics, Unix-based process that electronically mapped the mechanical machining methods of its manufacturing. This process was used to prepare the probing and machining devices used in the facility's manufactured systems, which caused poor import/export capability, complicated post processing, and incorporated high maintenance fees. In addition, operator error was high because there was no accurate way of home zeroing the device on initial start up, no perishable tool library, and the process produced excessive hard copies.

UDLP GSD Aiken implemented MasterCam software as a new process. The software allows actual speed of the probing tools that are used in the manufacturing process to be accurately simulated, preventing costly mistakes and wasted products. The software provides accurate tooling files that are accessible when drilling becomes necessary, allowing the availability of an exact picture of the finished product before the physical set-up begins. This process enables product-finishing problem solutions to be predicted before they occur. Another addition to the software includes a function which verifies that cuts made by the machining tools are accurately represented, thereby eliminating material waste and decreasing material costs. This new software package provides a way to automatically zero the probing tools at a point of origin in a three-axis design.

The MasterCam software generates tool libraries that can be easily updated, eliminating unnecessary documentation. With on-line support of the system, maintenance costs have been eliminated, and the multi-software compatibility can be shared between this software and other packages. The major software packages used by UDLP GSD Aiken for manufacturing can be converted to MasterCam requirements and performance standards, which will translate into long-term supportability.

With UDLP GSD Aiken's implementation of MasterCam software, rejections of products that were attributed to programming/engineering issues have been significantly reduced, programming cycle times have been cut in half, non-recurring costs have been lowered, more accurate estimates in proposals are easier to generate, and customer lead-time has been improved.

Management

Employee Development

United Defense, L.P. Ground Systems Division Aiken implemented a successful employee development program that is employee driven, appraised and supported by supervision, and meets the needs of the company.

United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken provides its employees with the resources and management support needed to direct their own personal and professional development. Employees are responsible for their own improvement by developing the skills, knowledge, and abilities that result in high levels of achievement and satisfaction in their current positions, or by developing new skills, knowledge, and abilities to enable progression to other positions, not only at the Aiken facility, but elsewhere within UDLP.

Employees review their position description to ensure that the duties, responsibilities, and qualifications are accurately defined and understood. Employees and their managers discuss and reach agreement on the relative importance of the duties, and define individual objectives for the following year after reviewing the manager's objectives and business goals. The standard of performance that defines whether or not the objectives were accomplished is also defined. Non-exempt employees do not have formal objectives established, but have a performance appraisal to provide continuous communication and coaching. The appraisal provides feedback on how employees accomplish their objectives or perform position responsibilities. The appraisal provides the mechanism for the supervisor to guide the employee in achieving optimum results. Employees communicate their career aspirations to the managers, and the managers provide suggestions and encouragement regarding their growth. Employee development plans are applicable to all UDLP GSD Aiken's employees, and cover the upcoming twelve-month period. The categories of development covered in the plans are customer focus, interpersonal and technical skills, communication, motivation and commitment, planning and organization, problem solving and decision making, and leadership. Managers commit to providing sup-

port with budget, time away from other duties, and providing opportunities for employees to use their skills. Employees commit to fully execute planned activities. The development action plans include one to three focus areas, desired results, and activities. Several examples of development activities include acting as manager, advisor, or trainer for less experienced co-workers; attending relevant conferences or seminars; participating in audits; leading or facilitating conferences or meetings; attending college courses; making presentations; and participating in community or civic affairs.

UDLP GSD Aiken's employee development program increased employees' participation in managing their job performance, and improved communication between employees and managers. Employees can be appraised and rewarded since the establishment of a solid plan, which provides the platform to constructively discuss job performance, pay, and development. Employees are focused on the objectives of the organization, and the development activities are in line with the long- and short-term needs of the organization. Employees who are dedicated to completing the development plan have been very successful in their advancement as shown with the current Manufacturing Area Manager, who began as a shop welder.

Operator Certification/Verification

United Defense, L.P. Ground Systems Division Aiken is implementing an Operator Certification / Verification process that gives manufacturing technicians the empowerment to make product acceptance decisions and perform other inspection tasks through validated training. The process provides many benefits important at the workstation level and accomplishes enterprise goals to reduce costs and improve quality.

An important component of enterprise-wide processes to provide increased customer satisfaction, improved financial performance, and reduced cost is Operator Certification/Verification, a process by which manufacturing technicians are empowered to make product acceptance decisions and perform other inspection tasks with validated training. United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken is implementing this process to provide benefits important at the workstation level and to accomplish enterprise goals to reduce costs and improve quality.

Previously, all first piece inspections at UDLP GSD Aiken were performed by technicians and then verified by independent Quality Assurance (QA) personnel prior to continuing part production. When all manufacturing operations were completed, the manufacturing order of a part traveled to the quality lay-down area to await final inspection and buy-off. QA personnel performed final inspection, completed transactions, and tagged parts for shipment or storage by material handling. These operations caused redundant inspections and delayed completion of manufacturing orders by moving parts from production to QA and waiting in the lay-down area, particularly as the company moved from a low mix/high volume to a high mix/low volume manufacturing environment. The ability of UDLP GSD Aiken to implement enterprise-wide manufacturing processes that optimized the emerging high mix/low volume production capability was also impaired.

UDLP GSD Aiken recognized several imperatives that governed evolution of its work product:

- Inspection is not a value-added activity; quality cannot be inspected into a product, quality must be built into a product
- Customers continue to demand improved quality and competitive cost
- Operators need immediate feedback on their processes
- Focusing on continuous process improvement adds value for customers

UDLP GSD Aiken formed a team comprised of manufacturing area leaders, quality engineers, human resources, and technicians to address these imperatives. The team drafted a program of operator certification and "Self Inspection" that was presented to the customer for approval. Once the program was approved by the customer, it was written into the contract. The process focused on operator training, letting the operators know what was expected, and then empowering them to meet those expectations. Empowerment included their involvement in the evolution of standards, training, and certification of the facility in all key areas, specifically blueprint reading, hands-on inspection of parts, inspection techniques/instruments appropriate for that workstation, QA procedures and standards, and successful performance of five inspections with QA or an experienced, certified

technician. Optional training is also provided in several specialized areas such as geometric dimensioning and tolerancing, coordinate measuring machines, welding inspection, and any additional specialized training if needed.

The Operators Certification/Verification process is now universally used at UDLP GSD Aiken, providing the operators instant feedback, eliminating redundant inspections, reducing ratios of inspection time to manufacturing time, and increasing accountability, process ownership, and higher levels of responsibility.

Quality Recognition Program

United Defense, L.P. Ground Systems Division Aiken's Quality Recognition Program is designed to increase company-wide productivity and quality by encouraging and rewarding employees for their ideas, teamwork, and improvement efforts. All employees can participate, including part-time and temporary employees.

Previously, United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken had no formalized process to recognize personnel who made significant contributions to the organization. UDLP GSD Aiken implemented the Quality Recognition Program (QRP) to increase company-wide productivity and quality by encouraging and rewarding employees for their ideas, teamwork, and improvement efforts. Employees in all the UDLP GSD facilities can participate, including part-time and temporary employees. Through feedback and the result of participation metrics, the QRP is continuously improving.

The QRP was designed to be a formal process based on four categories — Labor Utilization and Development, Customer Focus, Outstanding Performance, and Outstanding Teamwork. Three levels of recognition (awards) were devised to address improvement in these fields. Two awards are dispensed quarterly for one-time performance and continuing process impact; the third award is given yearly for creating an environment/culture improvement.

Figure 3-1. Lapel Pin

Representatives from three UDLP GSD facilities perform formal reviews of the candidates while review of the attributes contained in particular submissions entails the written portion and a personal presentation from the candidate. This process ensures that ideas are effectively communicated across diverse backgrounds. Evaluation is based on productivity metrics, cost, schedule, performance, and other criteria expended to make the contribution. Documentation of lessons learned is contained in the QRP nomination form which requires presenters to detail the challenge and innovation of their new process and also translate the idea into quality techniques. Key segments include strategy highlighting, process mapping, brainstorming, cross-functional teaming, integrated product development, concurrent engineering, and conformance to continuous quality improve-

ment. Metrics must be employed to illustrate the QRP award success for schedule, cost, labor hours, and product or service quality, and division-wide and customer impact. Customer surveys are recommended as a measurement tool. Nomination forms are located in the cafeteria and available via the Division's Intranet, with quarterly deadlines for submission noted in the company's bulletins and memos.

For approved QRP awards, recognition includes a personal letter signed by the Division's General Manager, a lapel pin (Figure 3-1), and articles printed in the plant and division newspaper. The QRP award is also recorded in the employee's personal file. Award winners have, in some cases, moved to higher positions of management within UDLP, such as a welding trainee who became a Manufacturing Area Manager.

Technical Scholars Program

United Defense, L.P. Ground Systems Division Aiken's Technical Scholars Program provides students and the company the opportunity to join forces and create a strong labor force. Outstanding students bring discipline and aptitude to production processes while the company provides educational support and long-term opportunities for interns.

United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken implemented the Technical Scholars Program through Aiken Technical College (ATC), which prepares qualified students for careers as skilled technicians through a cooperative arrangement that combines classroom theory with practical on-the-job experience. Previously, UDLP GSD Aiken supported ATC by serving on advisory committees and contacting the college for referrals when openings became available for student post graduation enlistments at the facility. However, UDLP GSD Aiken wanted more formal process options.

Currently, qualified students can attain an Associate's Degree while working/interning for UDLP GSD Aiken up to 20 hours per week. The facility pays all tuition, book expenses, and provides a working wage to the student. Students are selected based on their ability to complete academic and experiential curriculums. Besides the monetary benefit, students secure a rewarding career with UDLP GSD Aiken, attain advanced technology and production experience, and aid in mastering the technical degree. The pay scale increases as students gain experience, ethics, and certifications. UDLP GSD Aiken benefits by having direct access to the most promising technical labor with proven learning capacity. Management evaluates the interns for future, full-time employment while they work part-time and acquire important production knowledge. UDLP GSD Aiken realizes that students capable of attaining an ATC Associate's Degree are well-rounded and likely to achieve further educational qualifications.

On UDLP GSD Aiken's shop floor, the latest academic processes and methods are openly discussed and compared to plant practices and production processes. The interns' knowledge of the learned technical efficiencies from their production experience are communicated to other ATC students. Annual and quarterly meetings are held with ATC and include an open dialogue. By teaming with ATC, UDLP GSD Aiken received the Silver Crescent Award, the State of South Carolina's prestigious manufacturing award.

Weld Cell

United Defense, L.P. Ground Systems Division Aiken is developing a Lean Manufacturing weld cell for high mix/low volume production lots. The new cell will include the items needed for the welder to receive raw material to the cell and output the finished product. When combined with reduced warehouse inventory, this process should result in significant savings in time and money.

United Defense, L.P. Ground Systems Division (UDLP GSD) Aiken is developing a Lean Manufacturing weld cell for high mix/low volume production steel weldments to reduce or eliminate part inventories. Previously, the company had a 60-day warehouse inventory located in various areas throughout the plant. A team consisting of the Area Lead, Engineer, Production Scheduler, Purchasing Agent, and Production Analyst was created to develop the project. To begin the project, the team selected 43 steel weldments to review and analyze.

To implement the process, UDLP GSD Aiken used a new, larger weld station layout which will house all required fixtures, sandblaster, and oven. Weld fixtures are currently stored in a central location, and must be pulled and taken to the weld booth. By locating the fixtures in the booth, the time re-

quired to get the fixtures and take them to the booth will be eliminated. The sandblaster and oven will allow the welder to clean, preheat, or stress relieve parts as necessary. The current process uses batch quantities of component inventories. The weldments are released and the components are picked up and delivered to the weld shop. The components are stored in a central location which will be further enhanced by the introduction of a two-bin pull system. Weldment kits, consisting of the components needed to complete the weldment, are being developed. The components will be grouped by weldment to enhance production flow.

As this process has not been fully implemented, data indicating savings are not yet available. However, UDLP GSD Aiken's goals are to reduce the hours required per set by 27% and warehouse inventory by 75%. Finished weldments will be packaged in the booth, allowing raw material to enter and the finished product to exit the booth.

Appendix A

Table of Acronyms

ACRONYM	DEFINITION
ATC	Aiken Technical College
CFT	Cell Family Team
FMC	Food Machinery Corporation
GSD	Ground Systems Division
Harsco	Harrisburg Steel Company
LTA	Long Term Agreement
NC	Numerical Control
QA	Quality Assurance
QPC	Quality Partnership Council
QRP	Quality Recognition Program
TACOM	Tank-Automotive and Armament
UDLP	United Defense, Limited Partnership
VPP	Voluntary Protection Program

Appendix B

BMP Survey Team

Team Member	Activity	Function
Larry Halbig 317-891-9901	**BMP Field Office-Indianapolis** Indianapolis, IN	**Team Chairman**
Victor Norris 301-405-9990	**BMP Center of Excellence** College Park, MD	**Technical Writer**
	TEAM A	
Don Hill 317-849-3202	**BMP Field Office-Indianapolis** Indianapolis, IN	**Team Leader**
Makin Hamzah 909-273-4950	**Naval Surface Warfare Center – Corona** Corona, CA	
Fred Perkins 301-405-9990	**BMP Center of Excellence** College Park, MD	
	TEAM B	
Larry Robertson 812-854-5336	**Naval Surface Warfare Center – Crane** Crane, IN	**Team Leader**
Peter Bissegger 909-273-5766	**Naval Surface Warfare Center – Corona** Corona, CA	
Tom Daniels 301-405-9990	**BMP Center of Excellence** College Park, MD	

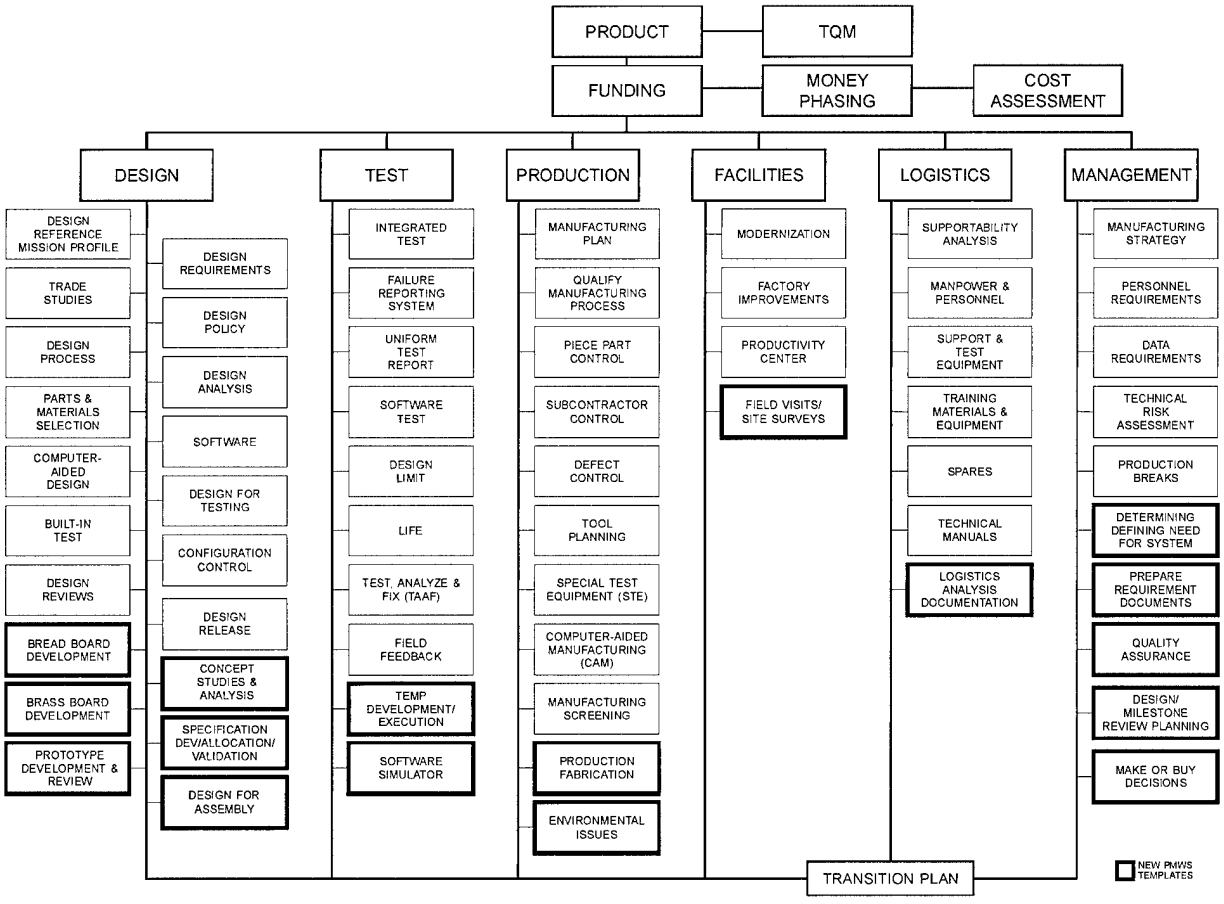
Appendix C

Critical Path Templates and BMP Templates

This survey was structured around and concentrated on the functional areas of design, test, production, facilities, logistics, and management as presented in the Department of Defense 4245.7-M, Transition from Development to Production document. This publication defines the proper tools or templates that constitute the critical path for a successful material acquisition program. It describes techniques for improving the acquisition process by addressing it as an industrial process that focuses on the product's design, test, and production phases which are interrelated and interdependent disciplines.

The BMP program has continued to build on this knowledge base by developing 17 new templates that complement the existing DOD 4245.7-M templates. These BMP templates address new or emerging technologies and processes.

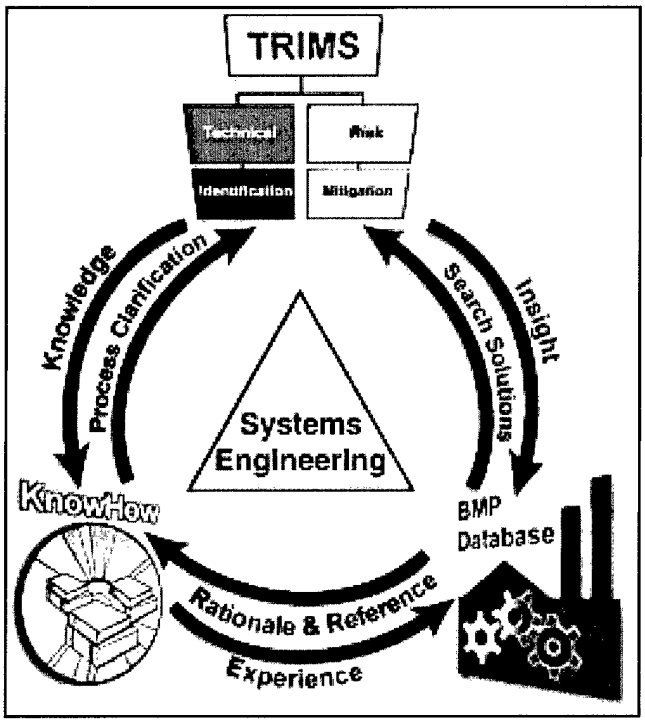
"CRITICAL PATH TEMPLATES FOR TRANSITION FROM DEVELOPMENT TO PRODUCTION"



Appendix D

The Program Manager's WorkStation

The Program Manager's WorkStation **(PMWS)** is an electronic suite of tools designed to provide timely acquisition and engineering information to the user. The main components of PMWS are KnowHow; the Technical Risk Identification and Mitigation System (TRIMS); and the BMP Database. These tools complement one another and provide users with the knowledge, insight, and experience to make informed decisions through all phases of product development, production, and beyond.



KnowHow provides knowledge as an electronic library of technical reference handbooks, guidelines, and acquisition publications which covers a variety of engineering topics including the DOD 5000 series. The electronic collection consists of expert systems and simple digital books. In expert systems, KnowHow prompts the user to answer a series of questions to determine where the user is within a program's development. Recommendations are provided based on the book being used. In simple digital books, KnowHow leads the user through the process via an electronic table of contents to determine which books in the library will be the most helpful. The program also features a fuzzy logic text search capability so users can locate specific information by typing in keywords. KnowHow can reduce document search times by up to 95%.

TRIMS provides insight as a knowledge based tool that manages technical risk rather than cost and schedule. Cost and schedule overruns are downstream indicators of technical problems. Programs generally have had process problems long before the technical problem is identified. To avoid this progression, TRIMS operates as a process-oriented tool based on a solid Systems Engineering approach. Process analysis and monitoring provide the earliest possible indication of potential problems. Early identification provides the time necessary to apply corrective actions, thereby preventing problems and mitigating their impact. TRIMS is extremely user-friendly and tailorable. This tool identifies areas of risk; tracks program goals and responsibilities; and can generate a variety of reports to meet the user's needs.

The **BMP Database** provides experience as a unique, one-of-a-kind resource. This database contains more than 2,500 best practices that have been verified and documented by an independent team of experts during BMP surveys. BMP publishes its findings in survey reports and provides the user with basic background, process descriptions, metrics and lessons learned, and a Point of Contact for further information. The BMP Database features a searching capability so users can locate specific topics by typing in keywords. Users can either view the results on screen or print them as individual abstracts, a single report, or a series of reports. The database can also be downloaded, run on-line, or purchased on CD-ROM from the BMP Center of Excellence. The BMP Database continues to grow as new surveys are completed. Additionally, the database is reviewed every other year by a BMP core team of experts to ensure the information remains current.

For additional information on PMWS, please contact the Help Desk at (301) 403-8179, or visit the BMP web site at http://www.bmpcoe.org.

Appendix E

Best Manufacturing Practices Satellite Centers

There are currently ten Best Manufacturing Practices (BMP) satellite centers that provide representation for and awareness of the BMP Program to regional industry, government and academic institutions. The centers also promote the use of BMP with regional Manufacturing Technology Centers. Regional manufacturers can take advantage of the BMP satellite centers to help resolve problems, as the centers host informative, one-day regional workshops that focus on specific technical issues.

Center representatives also conduct BMP lectures at regional colleges and universities; maintain lists of experts who are potential survey team members; provide team member training; and train regional personnel in the use of BMP resources.

The ten BMP satellite centers include:

California

Chris Matzke
BMP Satellite Center Manager
Naval Surface Warfare Center, Corona Division
Code QA-21, P.O. Box 5000
Corona, CA 92878-5000
(909) 273-4992
FAX: (909) 273-4123
matzkecj@corona.navy.mil

District of Columbia

Geoffrey Gauthier
BMP Satellite Center Manager
U.S. Department of Commerce
Bureau of Industry & Security
14th Street & Constitution Avenue, NW
H3876
Washington, DC 20230
(202) 482-9105
FAX: (202) 482-5650
ggauthie@bis.doc.gov

Illinois

Robert Lindstrom
BMP Satellite Center Manager
Rock Valley College
3301 North Mulford Road
Rockford, IL 61114-5699
(815) 921-2073
FAX: (815) 654-4343
r.lindstrom@rvc.cc.il.us

Iowa

Bruce Coney
BMP Satellite Center Manager
Iowa Procurement Outreach Center
2273 Howe Hall, Suite 2617
Ames, IA 50011
(515) 294-4461
FAX: (515) 294-4483
bruce.coney@ciras.iastate.edu

Louisiana

Alley Butler
BMP Satellite Center Manager
Maritime Environmental Resources & Information Center
Gulf Coast Region Maritime Technology Center
University of New Orleans
UAMTCE, Room 163-Station 122
5100 River Road
New Orleans, LA 70094-2706
(504) 458-6339
FAX: (504) 437-3880
alley.butler@gcrmtc.org

Ohio

Larry Brown
BMP Satellite Center Manager
Edison Welding Institiute
1250 Arthur E. Adams Drive
Columbus, Ohio 43221-3585
(614) 688-5080
FAX: (614) 688-5001
larry_brown@ewi.org

Pennsylvania

John W. Lloyd
BMP Satellite Center Manager
MANTEC, Inc.
P.O. Box 5046
York, PA 17405
(717) 843-5054
FAX: (717) 843-0087
lloydjw@mantec.org

South Carolina

Henry E. Watson
BMP Satellite Center Manager
South Carolina Research Authority - Applied Research and Development Institute
100 Fluor Daniel
Clemson, SC 29634
(864) 656-6566
FAX: (843) 767-3367
watson@scra.org

Tennessee

Danny M. White
BMP Satellite Center Manager
Oak Ridge Center for Manufacturing and Materials Science
BWXT Y-12, L.L.C.
P.O. Box 2009
Oak Ridge, TN 37831-8091
(865) 574-0822
FAX: (865) 574-2000
whitedm1@y12.doe.gov

Virginia

William Motley
BMP Satellite Center Manager
DAU Program Director, Manufacturing Manager
Defense Acquisition University
9820 Belvior Road, Suite G3
Ft. Belvior, VA 22060-5565
(703) 805-3763
FAX: (703) 805-3721
bill.motley@dau.mil

Appendix F

Navy Manufacturing Technology Centers of Excellence

The Navy Manufacturing Technology Program has established Centers of Excellence (COEs) to provide focal points for the development and technology transfer of new manufacturing processes and equipment in a cooperative environment with industry, academia, and the Navy industrial facilities and laboratories. These consortium-structured COEs serve as corporate residences of expertise in particular technological areas. The following list provides a description and point of contact for each COE.

Best Manufacturing Practices Center of Excellence

The Best Manufacturing Practices Center of Excellence (BMPCOE) provides a national resource to identify and share best manufacturing and business practices being used throughout government, industry, and academia. The BMPCOE was established by the Office of Naval Research's BMP Program, the Department of Commerce, and the University of Maryland at College Park. By improving the use of existing technology, promoting the introduction of improved technologies, and providing non-competitive means to address common problems, the BMPCOE has become a significant factor to counter foreign competition.

Point of Contact:
Dr. Anne Marie T. SuPrise
Best Manufacturing Practices Center of Excellence
4321 Hartwick Road
Suite 400
College Park, MD 20740
Phone: (301) 405-9990
FAX: (301) 403-8180
E-mail: annemari@bmpcoe.org

Institute for Manufacturing and Sustainment Technologies

The Institute for Manufacturing and Sustainment Technologies (iMAST) is located at the Pennsylvania State University's Applied Research Laboratory. iMAST's primary objective is to address challenges relative to Navy and Marine Corps weapon system platforms in the areas of mechanical drive transmission technologies, materials processing technologies, laser processing technologies, advanced composites technologies, and repair technologies.

Point of Contact:
Mr. Robert Cook
Institute for Manufacturing and Sustainment Technologies
ARL Penn State
P.O. Box 30
State College, PA 16804-0030
Phone: (814) 863-3880
FAX: (814) 863-1183
E-mail: rbc5@psu.edu

Composites Manufacturing Technology Center (Operated by South Carolina Research Authority)

The Composites Manufacturing Technology Center (CMTC) is a Center of Excellence for the Navy's Composites Manufacturing Technology Program. The South Carolina Research Authority (SCRA) operates the CMTC and The Composites Consortium (TCC) serves as the technology resource. The TCC has strong, in-depth knowledge and experience in composites manufacturing technology. The SCRA/CMTC provides a national resource for the development and dissemination of composites manufacturing technology to defense contractors and subcontractors.

Point of Contact:
Mr. Henry Watson
Applied Research and Development Institute
Composites Manufacturing Technology Center
934-D Old Clemson Highway
Eagles Landing Professional Park
Seneca, SC 29672
Phone: (864) 656-6566
FAX: (864) 653-7434
E-mail: watson@scra.org

Electronics Manufacturing Productivity Facility (Operated by American Competitiveness Institute)

The Electronics Manufacturing Productivity Facility (EMPF) identifies, develops, and transfers innovative electronics manufacturing processes to domestic firms in support of the manufacture of affordable military systems. The EMPF operates as a consortium comprised of government, industry, and academic participants led by the American Competitiveness Institute under a Cooperative Agreement with the Navy.

Point of Contact:
Mr. Michael Frederickson
Electronics Manufacturing Productivity Facility
One International Plaza, Suite 600
Philadelphia, PA 19113
Phone: (610) 362-1200, ext. 215
FAX: (610) 362-1288
E-mail: mfrederickson@aciusa.org

Electro-Optics Center (Operated by The Pennsylvania State University's Applied Research Laboratory)

The Electro-Optics Center (EOC) is a national consortium of electro-optics industrial companies, universities, and government research centers that share their electro-optics expertise and capabilities through project teams focused on Navy requirements. Through its capability for national electronic communication and rapid reaction and response, the EOC can address issues of immediate concern to the Navy Systems Commands. The EOC is managed by the Pennsylvania State University's Applied Research Laboratory.

Point of Contact:
Dr. Karl Harris
Electro-Optics Center
West Hills Industrial Park
77 Glade Drive
Kittanning, PA 16201
Phone: (724) 545-9700
FAX: (724) 545-9797
E-mail: kharris@psu.edu

Navy Joining Center (Operated by Edison Welding Institute)

The Navy Joining Center (NJC) provides a national resource for the development of materials joining expertise and the deployment of emerging manufacturing technologies to Navy contractors, subcontractors, and other activities. The NJC works with the Navy to determine and evaluate joining technology requirements and conduct technology development and deployment projects to address these issues. The NJC is operated by the Edison Welding Institute.

Point of Contact:
Mr. Harvey R. Castner
EWI/Navy Joining Center
1250 Arthur E. Adams Drive
Columbus, OH 43221-3585
Phone: (614) 688-5063
FAX: (614) 688-5001
E-mail: harvey_castner@ewi.org

National Center for Excellence in Metalworking Technology (Operated by Concurrent Technologies Corporation)

The National Center for Excellence in Metalworking Technology (NCEMT) provides a national center for the development, dissemination, and implementation of advanced technologies for metalworking products and processes. Operated by the Concurrent Technologies Corporation, the NCEMT helps the Navy and defense contractors improve manufacturing productivity and part reliability through development, deployment, training, and education for advanced metalworking technologies.

Point of Contact:
Dr. Daniel L. Winterscheidt
National Center for Excellence in Metalworking Technology
c/o Concurrent Technologies Corporation
100 CTC Drive
Johnstown, PA 15904-1935
Phone: (814) 269-6840
FAX: (814) 269-2501
E-mail: winter@ctcgsc.com

Energetics Manufacturing Technology Center

The Energetics Manufacturing Technology Center (EMTC) addresses unique manufacturing processes and problems of the energetics industrial base to ensure the availability of affordable, quality, and safe energetics. The EMTC's focus is on technologies to reduce manufacturing costs, improve product quality and reliability, and develop environmentally benign manufacturing processes. The EMTC is located at the Indian Head Division of the Naval Surface Warfare Center.

Point of Contact:
Mr. John Brough
Naval Surface Warfare Center
Indian Head Division
101 Strauss Avenue
Building D326, Room 227
Indian Head, MD 20640-5035
Phone: (301) 744-4417
DSN: 354-4417
FAX: (301) 744-4187
E-mail: broughja@ih.navy.mil

Center for Naval Shipbuilding Technology

The Center for Naval Shipbuilding Technology (CNST) supports the Navy's ongoing effort to identify, develop and deploy in U.S. shipyards, advanced manufacturing technologies that will reduce the cost and time to build and repair Navy ships. CNST provides a focal point for developing and transferring new manufacturing processes and technologies; benefits that will accrue not only to the Navy, but to industry as well. CNST is operated and managed by ATI in Charleston, South Carolina.

Point of Contact:
Mr. Ron Glover
Center for Naval Shipbuilding Technology
5300 International Blvd.
Charleston, SC 29418
Phone: (843)760-4606
FAX: (843)760-4098
E-mail: glover@aticorp.org

Gulf Coast Region Maritime Technology Center (Operated by University of New Orleans, College of Engineering)

The Gulf Coast Region Maritime Technology Center (GCRMTC) fosters competition in shipbuilding technology through cooperation with the U.S. Navy, representatives of the maritime industries, and various academic and private research centers throughout the country. Located at the University of New Orleans, the GCRMTC focuses on improving design and production technologies for shipbuilding, reducing material costs, reducing total ownership costs, providing education and training, and improving environmental engineering and management.

Point of Contact:
Mr. Frank Bordelon, New Orleans Site Director
Gulf Coast Region Maritime Technology Center
Research and Technology Park
CERM Building, Room 409
University of New Orleans
New Orleans, LA 70148-2200
Phone: (504) 280-5609
FAX: (504) 280-3898
E-mail: fbordelo@uno.edu

Appendix G

Completed Surveys

As of this publication, 136 surveys have been conducted and published by BMP at the companies listed below. Copies of older survey reports may be obtained through DTIC or by accessing the BMP web site. Requests for copies of recent survey reports or inquiries regarding BMP may be directed to:

Best Manufacturing Practices Program
4321 Hartwick Rd., Suite 400
College Park, MD 20740
Attn: Anne Marie T. SuPrise, Ph.D., Director
Telephone: 1-800-789-4267
FAX: (301) 403-8180
annemari@bmpcoe.org

1985	Litton Guidance & Control Systems Division - Woodland Hills, CA
1986	Honeywell, Incorporated Undersea Systems Division - Hopkins, MN (now Alliant TechSystems, Inc.) Texas Instruments Defense Systems & Electronics Group - Lewisville, TX General Dynamics Pomona Division - Pomona, CA Harris Corporation Government Support Systems Division - Syosset, NY IBM Corporation Federal Systems Division - Owego, NY Control Data Corporation Government Systems Division - Minneapolis, MN
1987	Hughes Aircraft Company Radar Systems Group - Los Angeles, CA ITT Avionics Division - Clifton, NJ Rockwell International Corporation Collins Defense Communications - Cedar Rapids, IA UNISYS Computer Systems Division - St. Paul, MN
1988	Motorola Government Electronics Group - Scottsdale, AZ General Dynamics Fort Worth Division - Fort Worth, TX Texas Instruments Defense Systems & Electronics Group - Dallas, TX Hughes Aircraft Company Missile Systems Group - Tucson, AZ Bell Helicopter Textron, Inc. - Fort Worth, TX Litton Data Systems Division - Van Nuys, CA GTE C^3 Systems Sector - Needham Heights, MA
1989	McDonnell-Douglas Corporation McDonnell Aircraft Company - St. Louis, MO Northrop Corporation Aircraft Division - Hawthorne, CA Litton Applied Technology Division - San Jose, CA Litton Amecom Division - College Park, MD (now Northrop Grumman Electronic Systems Division) Standard Industries - LaMirada, CA (now SI Manufacturing) Engineered Circuit Research, Incorporated - Milpitas, CA Teledyne Industries Incorporated Electronics Division - Newbury Park, CA Lockheed Aeronautical Systems Company - Marietta, GA Lockheed Missile Systems Division - Sunnyvale, CA (now Lockheed Martin Missiles and Space) Westinghouse Electronic Systems Group - Baltimore, MD (now Northrop Grumman Corporation) General Electric Naval & Drive Turbine Systems - Fitchburg, MA Rockwell Autonetics Electronics Systems - Anaheim, CA (now Boeing North American A&MSD) TRICOR Systems, Incorporated - Elgin, IL
1990	Hughes Aircraft Company Ground Systems Group - Fullerton, CA TRW Military Electronics and Avionics Division - San Diego, CA MechTronics of Arizona, Inc. - Phoenix, AZ Boeing Aerospace & Electronics - Corinth, TX Technology Matrix Consortium - Traverse City, MI Textron Lycoming - Stratford, CT

1991	Resurvey of Litton Guidance & Control Systems Division - Woodland Hills, CA Norden Systems, Inc. - Norwalk, CT (now Northrop Grumman Norden Systems) Naval Avionics Center - Indianapolis, IN United Electric Controls - Watertown, MA Kurt Manufacturing Co. - Minneapolis, MN MagneTek Defense Systems - Anaheim, CA (now Power Paragon, Inc.) Raytheon Missile Systems Division - Andover, MA AT&T Federal Systems Advanced Technologies and AT&T Bell Laboratories - Greensboro, NC and Whippany, NJ Resurvey of Texas Instruments Defense Systems & Electronics Group - Lewisville, TX
1992	Tandem Computers - Cupertino, CA Charleston Naval Shipyard - Charleston, SC Conax Florida Corporation - St. Petersburg, FL Texas Instruments Semiconductor Group Military Products - Midland, TX Hewlett-Packard Palo Alto Fabrication Center - Palo Alto, CA Watervliet U.S. Army Arsenal - Watervliet, NY Digital Equipment Company Enclosures Business - Westfield, MA and Maynard, MA Computing Devices International - Minneapolis, MN (now General Dynamics Information Systems) (Resurvey of Control Data Corporation Government Systems Division) Naval Aviation Depot Naval Air Station - Pensacola, FL
1993	NASA Marshall Space Flight Center - Huntsville, AL Naval Aviation Depot Naval Air Station - Jacksonville, FL Department of Energy Oak Ridge Facilities (Operated by Martin Marietta Energy Systems, Inc.) - Oak Ridge, TN McDonnell Douglas Aerospace - Huntington Beach, CA (now Boeing Space Systems) Crane Division Naval Surface Warfare Center - Crane, IN and Louisville, KY Philadelphia Naval Shipyard - Philadelphia, PA R. J. Reynolds Tobacco Company - Winston-Salem, NC Crystal Gateway Marriott Hotel - Arlington, VA Hamilton Standard Electronic Manufacturing Facility - Farmington, CT (now Hamilton Sundstrand) Alpha Industries, Inc. - Methuen, MA
1994	Harris Semiconductor - Palm Bay, FL (now Intersil Corporation) United Defense, L.P. Ground Systems Division - San Jose, CA Naval Undersea Warfare Center Division Keyport - Keyport, WA Mason & Hanger - Silas Mason Co., Inc. - Middletown, IA Kaiser Electronics - San Jose, CA U.S. Army Combat Systems Test Activity - Aberdeen, MD (now Aberdeen Test Center) Stafford County Public Schools - Stafford County, VA
1995	Sandia National Laboratories - Albuquerque, NM Rockwell Collins Avionics & Communications Division - Cedar Rapids, IA (now Rockwell Collins, Inc.) (Resurvey of Rockwell International Corporation Collins Defense Communications) Lockheed Martin Electronics & Missiles - Orlando, FL McDonnell Douglas Aerospace (St. Louis) - St. Louis, MO (now Boeing Aircraft and Missiles) (Resurvey of McDonnell-Douglas Corporation McDonnell Aircraft Company) Dayton Parts, Inc. - Harrisburg, PA Wainwright Industries - St. Peters, MO Lockheed Martin Tactical Aircraft Systems - Fort Worth, TX (Resurvey of General Dynamics Fort Worth Division) Lockheed Martin Government Electronic Systems - Moorestown, NJ Sacramento Manufacturing and Services Division - Sacramento, CA JLG Industries, Inc. - McConnellsburg, PA
1996	City of Chattanooga - Chattanooga, TN Mason & Hanger Corporation - Pantex Plant - Amarillo, TX Nascote Industries, Inc. - Nashville, IL Weirton Steel Corporation - Weirton, WV NASA Kennedy Space Center - Cape Canaveral, FL Resurvey of Department of Energy, Oak Ridge Operations - Oak Ridge, TN

1997	Headquarters, U.S. Army Industrial Operations Command - Rock Island, IL (now Operational Support Command)
	SAE International and Performance Review Institute - Warrendale, PA
	Polaroid Corporation - Waltham, MA
	Cincinnati Milacron, Inc. - Cincinnati, OH
	Lawrence Livermore National Laboratory - Livermore, CA
	Sharretts Plating Company, Inc. - Emigsville, PA
	Thermacore, Inc. - Lancaster, PA
	Rock Island Arsenal - Rock Island, IL
	Northrop Grumman Corporation - El Segundo, CA
	(Resurvey of Northrop Corporation Aircraft Division)
	Letterkenny Army Depot - Chambersburg, PA
	Elizabethtown College - Elizabethtown, PA
	Tooele Army Depot - Tooele, UT
1998	United Electric Controls - Watertown, MA
	Strite Industries Limited - Cambridge, Ontario, Canada
	Northrop Grumman Corporation - El Segundo, CA
	Corpus Christi Army Depot - Corpus Christi, TX
	Anniston Army Depot - Anniston, AL
	Naval Air Warfare Center, Lakehurst - Lakehurst, NJ
	Sierra Army Depot - Herlong, CA
	ITT Industries Aerospace/Communications Division - Fort Wayne, IN
	Raytheon Missile Systems Company - Tucson, AZ
	Naval Aviation Depot North Island - San Diego, CA
	U.S.S. Carl Vinson (CVN-70) - Commander Naval Air Force, U.S. Pacific Fleet
	Tobyhanna Army Depot - Tobyhanna, PA
1999	Wilton Armetale - Mount Joy, PA
	Applied Research Laboratory, Pennsylvania State University - State College, PA
	Electric Boat Corporation, Quonset Point Facility - North Kingstown, RI
	Resurvey of NASA Marshall Space Flight Center - Huntsville, AL
	Orenda Turbines, Division of Magellan Aerospace Corporation - Mississauga, Ontario, Canada
2000	Northrop Grumman, Defensive Systems Division - Rolling Meadows, IL
	Crane Army Ammunition Activity - Crane, IN
	Naval Sea Logistics Center, Detachment Protsmouth - Portsmouth, NH
	Stryker Howmedica Osteonics - Allendale, NJ
2001	The Tri-Cities Tennessee/Virginia Region - Johnson City, TN
	General Dynamics Armament Systems - Burlington, VT (now General Dynamics Armament and Technical Products)
	Lockheed Martin Naval Electronics & Surveillance Systems-Surface Systems - Moorestown, NJ
	Frontier Electronic Systems - Stillwater, OK
2002	U.S. Coast Guard, Maintenance and Logistics Command-Atlantic - Norfolk, VA
	U.S. Coast Guard, Maintenance and Logistics Command-Pacific - Alameda, CA
	Directorate for Missiles and Surface Launchers (PEO TSC-M/L) - Arlington, VA
	General Tool Company - Cincinnati, OH
2003	University of New Orleans, College of Engineering - New Orleans, LA
	Bender Shipbuilding and Repair Company, Inc. - Mobile, AL
	In Tolerance Contract Manufacturing, - Cedar Rapids, IA
	Resurvey of Electric Boat Corporation, Quonset Point Facility - North Kingstown, RI
	United Defense, L. P. Ground Systems Division - Aiken, SC