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REPORT OF SURVEY CONDUCTED AT

DAYTON PARTS, INC.

HARRISBURG, PA

JUNE 1995

BEST MANUFACTURING PRACTICES



Center of Excellence for Best Manufacturing Practices

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P R E F A C E



During the week of 26 June 1995, a Best Manufacturing Practices (BMP) survey was conducted at Dayton Parts, Inc. (DPI) in Harrisburg, Pennsylvania. Originally founded as Stanley Springs in 1921, its original product line of heavy-duty leaf springs used on tractors, trailers and other heavy equipment remains the core of the company's business. DPI manufactures and/or distributes truck and automotive components for the original equipment market and aftermarket with sales to heavy-, medium-, and light-duty truck and trailer independent companies. Supporting a work force of approximately 120 nonunion employees, DPI can produce more than 17,000 spring types and typically manufactures over 5000 spring part numbers per year. Company net sales in 1994 were approximately \$57M.

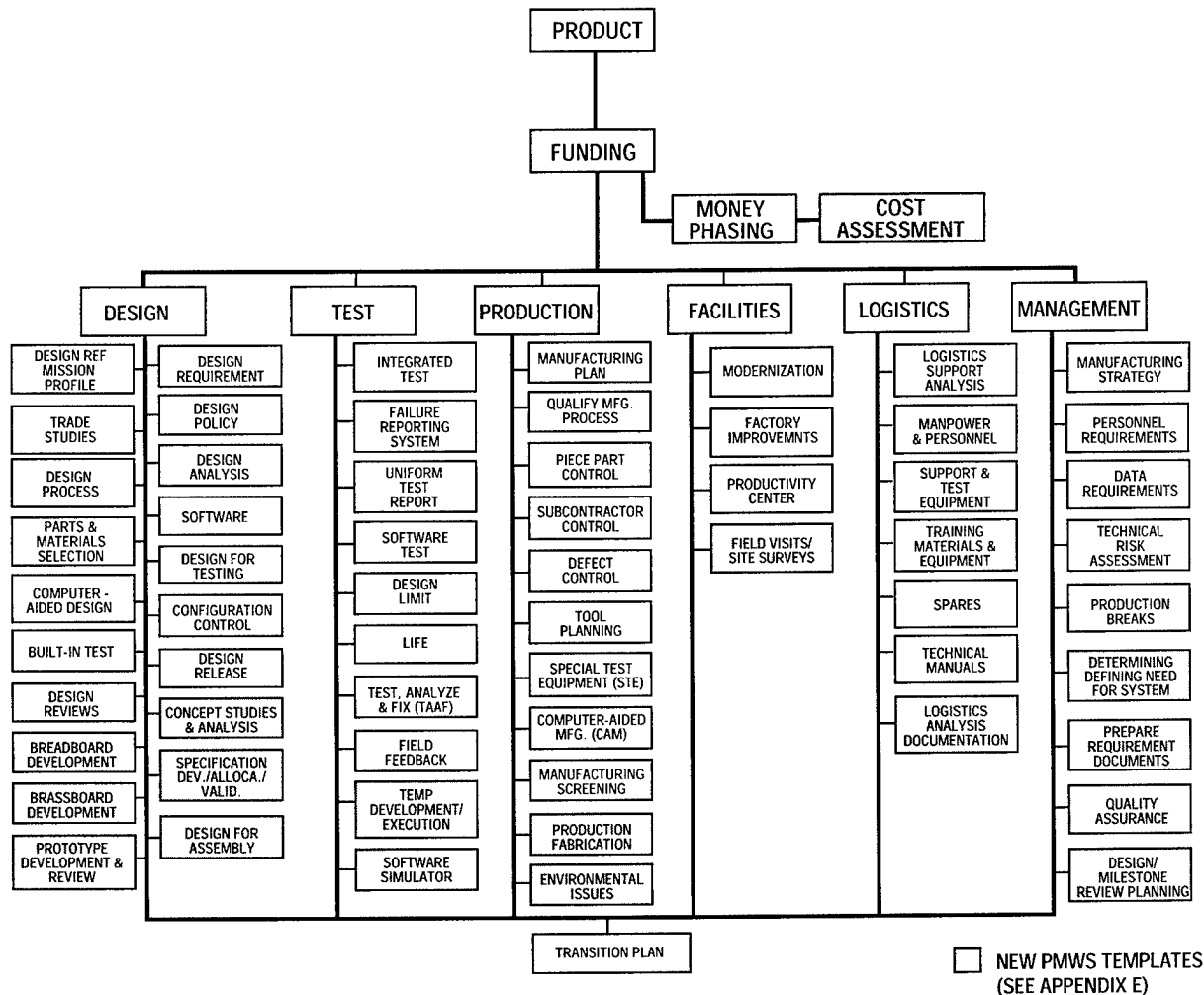
The BMP program has recognized – and documented information from – many small and mid-sized companies with substantial experience and expertise in the Department of Defense (DoD) 4245-7.M templates. The survey at DPI also identified several best practices which could prove beneficial to larger companies seeking improvement. One example is DPI's synchronous manufacturing concept which highlights continuous improvement through employee involvement. DPI encourages workers to examine and research new ways to streamline and enhance work efforts. Top management continually demonstrates its commitment to these changes through actions in response to team suggestions. Employees are actively involved in continuous improvement teams, and their inputs are making a difference.

BMP surveys are conducted to identify best practices in the critical path templates of the DoD 4245.7-M, "Transition from Development to Production." This document provides the basis for BMP surveys that concentrate on areas of design, test, production, facilities, logistics, and management. Practices in these areas and other areas of interest are presented, discussed, reviewed, and documented by a team of government engineers who are invited by the company to evaluate the company's policies, practices, and strategies. Only non-proprietary practices selected by the company are reviewed. In addition to the company's best practices, the BMP survey team also reviews potential industry-wide problems that can be referred to one of the Navy's Manufacturing Technology Centers of Excellence. The results of the BMP surveys are entered into a database for dissemination through a central computer network. Any actual exchange of detailed data is between companies at their discretion.

The Best Manufacturing Practices program is committed to strengthening the U.S. industrial base. Improving the use of existing technology, promoting the introduction of enhanced technologies, and providing a noncompetitive means to address common problems are critical elements in achieving that goal. This report on Dayton Parts, Inc. will provide information that can be used for benchmarking and is part of a national technology transfer effort to enhance the competitiveness of the U.S. industrial base.



“CRITICAL PATH TEMPLATES FOR TRANSITION FROM DEVELOPMENT TO PRODUCTION”



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SECTION 1

EXECUTIVE SUMMARY

1.1 BACKGROUND

Dayton Parts Inc. (DPI), located in Harrisburg, PA, was originally founded as Stanley Springs in 1921, and its original product line of heavy-duty leaf springs used on tractors, trailers and other heavy equipment has remained central to the company's business. The company became Dayton Parts in 1988 and kept the Stanley Springs name for its spring line and its repair facility. Acquired by JPE, Inc. in 1992, DPI manufactures and/or distributes truck and automotive components for the original equipment market and aftermarket and sells to heavy-, medium-, and light-duty truck and trailer independent companies. Its primary customers are independent warehouse distributors, mega distributors, wheel and rim distributors, and spring service outlets for heavy duty and medium duty commercial vehicles and related equipment. DPI has expanded on its original spring line to include the suspension, steering, and wheel end products to encompass a "one-stop" shopping concept. Products other than the springs are purchased for distribution.

The spring manufacturing plant is well-equipped and features state-of-the-art taper spring manufacturing equipment. Supporting a work force of approximately 120 non-union employees, the plant is capable of producing more than 17,000 spring types and typically manufactures over 5000 spring part numbers per year with 60% of these in lot sizes ranging from 1 to 40. Typical big lots average between 100 and 200. Leaf spring products currently represent approximately 80% of the manufactured product with the tapered spring line expected to grow from its current 20% share. Company net sales in 1994 were approximately \$57M from all sources – 46.5 % from springs.

Although the Best Manufacturing Practices (BMP) program has traditionally focused survey efforts on large manufacturing firms, it has long recognized – and documented information from – many small and mid-sized companies with substantial experience and expertise in the Department of Defense document 4245.7-M templates. As with companies that preceded it in this category, DPI presented several best practices which could prove beneficial to larger companies seeking improvement.

One of these practices is DPI's synchronous manufacturing concept which highlights continuous improvement through employee involvement. The manufacturing philosophy is based on the theory of constraints as presented in the book *The Goal* by Eliah Goldratt in which every action

is focused on the common goal of making money now and in the future. This program represents a substantial change in management philosophy – not unlike many large corporations – and has effected a real cultural change throughout the company. The new philosophy commands considerable management commitment to safety, customer service, quality, and cost reduction. These focal points are reinforced through various instituted programs such as safety and wellness programs, and have already significantly contributed to reduced worker compensation and lost time injuries. DPI management is serious about the new changes and has charged workers to always examine and research new ways to make their jobs easier. Top management continually demonstrates its commitment to these changes through actions in response to team suggestions. Shop floor supervisors now function more as coaches in the continuous improvement process as the workcells are becoming self-managed. Employees are actively involved in continuous improvement teams, and their input is making a difference.

The results of this new management change can be measured in increased sales and reduced cost and represent areas of interest for other companies – both large and small. The BMP survey team considered the following practices to be among the best in government and industry.

1.2 BEST PRACTICES

The BMP survey team documented the following best practices at DPI.

Item	Page
Inventory Control	5
DPI instituted a two-phase inventory control process in response to a large physical inventory write-off in manufacturing at the end of 1992.	
Full Taper Clip Development and Implementation	5
DPI replaced an outdated, time-consuming banding process by developing full taper clips and a specialized machine to bend the clips during installation. This was a product quality enhancement coupled with a significant cost reduction.	
Spring Coating Environmental Requirements	5
DPI determined that two different coatings used on assembled springs were non-compliant with	

Item	Page	Item	Page
new state environmental regulations. Faced with the expensive options of either purchasing equipment to remove Volatile Organic Compounds or incurring progressive fines, DPI took steps to identify, test, and utilize new coating materials that would fully meet the new environmental standards. It found excellent substitutes without significant capital investment.		Worker Safety Improvement Program	9
Hille Task Team	6	The primary goal of DPI's safety program is to increase safety awareness at DPI. Several initiatives, designed to help DPI meet its goal, are supported by a strong company commitment to safety, and an executive safety committee that meets quarterly to address current safety issues and make plans for the future.	
DPI assembled a team to investigate problems with and initiate continuous improvements to its Hille Computerized Hot Rolling Taper Mill. A new flexible setup system was developed and installed at a reasonable cost, avoiding the anticipated purchase of a new machine to meet expected capacity demands. A 50% productivity gain has been accomplished.		Synchronous Manufacturing	9
Distribution Program	7	DPI applies a manufacturing philosophy based on synchronous manufacturing where production flow – not capacity – is balanced to meet customer demands. Changes are measured by impact on the overall system throughput.	
DPI's warehousing and distribution center is a well-organized, well-controlled facility of approximately 150,000 square feet that maintains an inventory accuracy of over 99%. It has implemented a unique customer order and delivery system.		Continuous Improvement	10
Pre-Shift Stretching for Injury Prevention	7	Because DPI firmly believes that employee involvement and continuous improvement are essential for the future growth and well-being of the company, focus is maintained on systematic small improvements in company operating policies, management, and personnel involvement in the plants's daily operation.	
DPI established a successful injury prevention program through pre-shift stretching that has produced significant savings in dollars and employee injuries.		Communications	10
Injury Prevention Through Upper/Lower Extremity Screening	8	Developing and maintaining open communication between management, staff, and employees of DPI have contributed significantly to its success.	
DPI implemented Upper and Lower Extremity Screening Programs for manufacturing employees in response to information from its insurance carrier that manufacturing plant activities made the company potentially subject to significant numbers of carpal tunnel syndrome and other repetitive motion disorders if action was not taken. This prevention program identified and addressed several potential problems before they became costly.		1.3 INFORMATION	
Flexible Weekend Shift Work	8	The BMP survey team highlighted these information items at DPI.	
Rather than hiring part-time employees to staff the plant on weekends or working full-time employees overtime, the company used a creative employee scheduling technique similar to one used by hospitals to staff nurses on weekends. This increased throughput and capacity.		Item	Page
		Material Utilization	11
		DPI realized that the quantity of steel sold as scrap was excessive relative to the total raw steel consumed, but that it could be a controllable cost. To investigate the problem and develop solutions, a Material Utilization Task Team developed an information base to direct raw steel length purchasing decisions.	
		Wellness Program	11
		In 1994, DPI instituted a Wellness Program for all employees as an outgrowth of its aggressive safety program.	

1.4 ACKNOWLEDGMENTS

The BMP program wishes to extend its appreciation to the Pennsylvania Manufacturing Industrial Resource Center for arranging this survey, and to Mr. George Meyer at Dayton Parts, Inc. for making it possible.

1.5 ACTIVITY POINT OF CONTACT

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SECTION 2

BEST PRACTICES

2.1 PRODUCTION

PIECE PART CONTROL

Inventory Control

DPI instituted a two-phase inventory control process in response to a large physical inventory write-off in manufacturing at the end of 1992. The first phase centered on efforts of a task force comprised of personnel from management, scheduling, accounting, and warehousing that was established to solve the inventory control problem. By late January 1993, this group had removed all inventory from the assembly area, taken a physical count of all material and organized it into an expense warehouse. The system was also converted from a Simultaneous Issue and Receipt process to a requisition process, including pre-kitting jobs for assembly operations using BOMs and the schedule needs of the assembly area. By strengthening communications between all departments and adjusting the scheduling of work, DPI reduced throughput time and alleviated bottlenecks.

The second phase of the project included reorganizing part of the factory floor layout, initiating daily cycle count spot inventories in the warehouse, and bar coding accessory parts in the warehouse.

Benefits from this two-phase inventory control process initiation include:

- Downtime resulting from out-of-stock conditions for accessory parts has been eliminated
- Throughput time of finished goods has been reduced
- The yearly physical inventory has been abolished
- A \$46K yearly savings in material handling cost has been realized – this is in addition to a \$199K reduction in inventory variance between 1992 and 1994.

PRODUCTION FABRICATION

Full Taper Clip Development and Implementation

DPI established a purchasing task team in January 1993 to research the cost of purchased items and their related processes and determine if there were ways to reduce that cost. One significant example was the Signode process, which includes wrapping a band of steel with a rubber liner

around spring leaves to keep them from spreading. DPI's Signode installation table dated to the 1930s, and frequently broke down; in addition, repair parts were hard to find. Therefore, the task team examined various hand-held banders, and also attempted to improve the Signode table, but neither presented a viable solution.

One team member noticed that clips on sample springs from other manufacturers looked different than the DPI clips. With the cooperation of another team at DPI, the purchasing task team developed new clips called Full Taper Clips. These clips could be used in many applications in place of the old Signode banding. After developing the clips, the team member from engineering – with input from other members – developed a machine to bend the clips during installation.

With the use of the clip bending machine, an air cylinder now presses the clip into place around the spring, rather than an assembly operator hammering the clip around the spring. This new process is faster and reduces the operator's risk of a repetitive motion injury from constant hammering. Initially this process was only used on full taper springs. However, it was so successful that DPI is now implementing the full taper clips on multileaf designs.

As a result of implementing the full taper clips, the use of the Signode machine has been drastically reduced. The machine has now been moved out of the main manufacturing area, leaving space for other operations. Also, the waiting time before the Signode process was eliminated, reducing throughput time by an average of three days per spring since full taper clips did not add material handling or waiting to the manufacturing process. The new clips are installed as part of the final assembly process. The risk of injury from repetitive motion and heavy lifting has been reduced. The product quality was increased which can provide a competitive advantage. And finally, product cost has been reduced. Although the material cost for the clips is higher than the bands, this cost is offset by reduced labor costs.

ENVIRONMENTAL ISSUES

Spring Coating Environmental Requirements

As the result of the Pennsylvania Department of Environmental Regulations (PaDER) provisions of the Federal Clean Air Act Standards, DPI determined that two different coatings used on assembled springs were non-compliant.

The coatings – one a black, tar-based coating for multi-leaf springs and the other, a zinc-based coating for tapered springs – contained excessive Volatile Organic Compounds (VOCs) for meeting the new PaDER requirements. Faced with the expensive options of either purchasing equipment to capture VOCs or incurring progressive fines, DPI took steps to identify, test, and utilize new coating materials that would fully meet the new environmental standards. This requirement for identifying new coating materials with acceptable levels of VOCs was complicated by additional needs to meet salt spray tests, application-ease requirements, and simple part preparation, in addition to presenting a satisfactory finished appearance. The time available to find a solution was also limited by the regulating agency.

To meet these requirements, DPI formed a Project Task Team with representation from the plant's production, manufacturing engineering, maintenance, purchasing and product engineering elements. The team developed solution parameters which included the range of environmental concerns (PaDER regulations, employee exposure, and waste disposal issues), quality issues, process capacity, and projected costs in addition to the time deadlines. Discussions were held with numerous paint manufacturers regarding the coating needs and revealed a concurrent requirement that thorough pre-application cleaning was a specification included with many of the suggested materials. After investigating cleaning methods, the team determined it should avoid selecting coatings with pre-cleaning requirements if possible because of potentially high added costs and the environmental/safety problem associated with many cleaning methods.

A number of sample products were obtained from paint manufacturers and all were submitted to salt spray testing durations compatible with the quality requirements of DPI. Paints passing the first salt spray tests were subjected to additional similar tests as well as ASTM-specified tests (hardness, chip resistance, and adhesion) where applicable. The results of these tests – together with application methodologies and costs considerations – prompted the team to recommend a water soluble alkyd-based paint as a replacement for the black coating and a water-based, high performance vinyl coating as a replacement for the zinc-based coating. Neither required a pre-application cleaning of spring assemblies.

DPI, through successful team investigation, has found replacement coatings for both product lines that exceed environmental VOC requirements and require no pre-application cleaning. Implementation is ahead of the PaDER required timetable. Tests prove that both replacement coatings may be applied using the cost-effective method of dipping, and then air drying. This application method will eliminate over 90% of the labor required for the replaced zinc-based coating. Implementing the replacement coat-

ings saved over \$500K compared to adding environmental control equipment to original processes.

2.2 FACILITIES

MODERNIZATION

Hille Task Team

DPI assembled a team to investigate problems with and initiate continuous improvements to its Hille Computerized Hot Rolling Taper Mill. Used in the production of tapered spring products, the Hille machine represented a production bottleneck, while business projections in 1992 indicated significant growth would occur in the tapered spring market. Because between \$1.5M and \$2.0M was projected to be required to purchase additional taper rolling capacity, DPI management decided to assemble a continuous improvement team to investigate problems with the existing machine.

The team was initially led by the Director of Manufacturing and included members from engineering, maintenance, and the Hille operators' group. The team's stated mission was to continuously improve the machine availability and production output. Data was collected and charted to show key factors such as average ends per shift, setup hours, downtime hours, material handling hours, and maintenance by operators. A Pareto analysis was performed looking at every element contributing to downtime on the machine. Problems contributing most to the bottleneck problem were addressed first. For example, the initial analysis highlighted a major problem with hydraulic leaks. These were corrected by designing and installing two new seamless piping lines. The leak correction also reduced the disposal of used oil by six to eight drums per quarter.

Another major contributor to the reduced production capacity of the Hille machine was in setup time requirements. Major line setup changes required four hours, and average setup across the entire spectrum was 30 minutes. The team investigated quick-die change systems and worked with vendors to develop a system for the Hille. A new system was developed and installed at a total cost of \$149.1K. Installation of the system was projected at two weeks but only required four days from transport arrival to full production running. This was attributed to team familiarity with the new system. Since its implementation, overall average setup has dropped to as low as 18 minutes, and the 4-hour major setup has been reduced to 30 minutes. As a result of these improvements, the Hille is no longer a bottleneck and now contributes to the overall throughput improvement that the company is experiencing. Improvements to the machine and its operations have increased capacity to meet an even larger growth than anticipated, and it is expected to meet additional future requirements.

The team continues to monitor data and implement changes that impact the operational capability of the Hille machine. The results achieved by this team not only allowed the company to avoid a major capital equipment investment, but also provided the opportunity to demonstrate how employee involvement in continuous improvement activities can have a major impact on the company's overall business outlook.

Distribution Program

DPI maintains a warehousing and distribution center in Harrisburg, PA that stocks and distributes over 20,000 different items at any given time. The warehousing and distribution center is a well-organized, well-controlled facility of approximately 150,000 square feet and maintains an inventory accuracy of over 99%.

The method of distribution of inventoried goods is unique. Prior to recent changes in the process, customers could submit orders to DPI before the last three days of the months. If the order met certain minimum dollar amounts, the customer could take until the 15th of the next billing month to pay for the order. This process created large amounts of overtime for personnel at the end of each month, and customers had to spend extra dollars in inventory to be eligible for the delayed billing.

To alleviate both problems, DPI created a system called the Inventory Management Plan that encourages customers to place regular weekly orders and receive their products with guaranteed delivery dates and prepaid freight charges. In establishing this system, agreements were reached with small trucking companies that guaranteed them full loads

on specific days. Because the trucking company was paid by mileage, no funds were lost if a full truckload was not available. Delivery zones were established within the U.S. and Canada, and order days, shipping days, and receipt days were defined (Figure 2-1).

This change allowed DPI to reduce shipping costs by approximately 2%, significantly reduce overtime by company personnel, guarantee customer delivery dates, and allow customers to reduce the amount of inventory they must carry because of uncertain delivery and minimum order requirements. The average time of shipment from order placement is now 1.3 days.

2.3 LOGISTICS

MANPOWER AND PERSONNEL

Pre-Shift Stretching for Injury Prevention

DPI established a successful injury prevention program that has produced significant savings in dollars and employee injuries. DPI experienced high injury rates and consequent workers compensation costs in the late 1980s. To combat these problems, the company analyzed injury data to determine these problems, that led to injuries. This analysis revealed that approximately 80% of all manufacturing injuries occurred within the first two hours of each shift.

DPI requested production workers to perform stretching exercises prior to beginning their work. DPI's initial stretching program was implemented in 1990 and included classroom training and two weeks of mandatory stretching. After the two-week period, employees could voluntarily continue

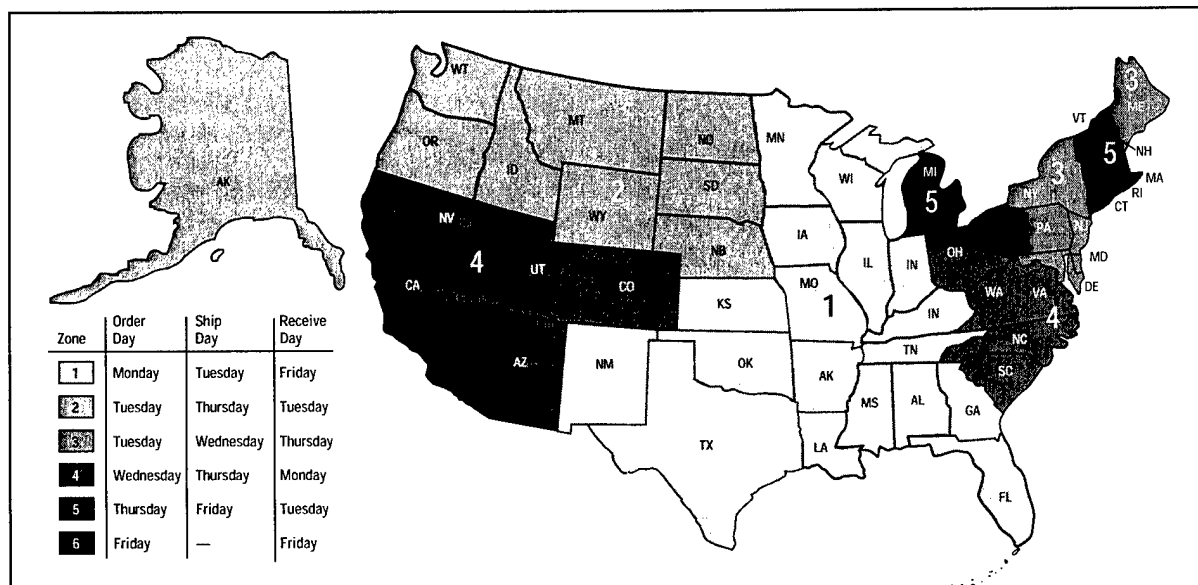


FIGURE 2-1. DELIVERY ZONE EXAMPLE

stretching each day, and a core group continued with the program for a year.

At the end of the year, none of the employees in the stretching group had been injured. This result influenced DPI to make stretching exercises mandatory again in 1992. All employees are now required to stretch for 10 to 15 minutes before starting production work. This time is included within the normal work shift.

This stretching program costs about \$75K per year to operate. However, in conjunction with other safety initiatives, it has returned significant savings to DPI. For example, the annual cost of workers compensation at DPI has decreased from \$700K to \$200K per year. In 1994, \$500K of the workers compensation premium was refunded to the company. This money was included in the quarterly profit and contributed to employee bonuses that quarter.

Injury Prevention Through Upper/Lower Extremity Screening

In 1993, DPI implemented an Upper Extremity Screening Program for all manufacturing employees. The insurance carrier for DPI indicated that its manufacturing plant activities made the company potentially subject to significant numbers of carpal tunnel syndrome and other repetitive motion disorders if action was not taken. Subsequently, a Lower Extremity Screening Program was added to the prevention program to address back and leg pain.

Work on the manufacturing plant floor at Dayton Parts, Inc. requires repetitive positioning of individual steel spring leafs for the various stages of machine forming and assembly of the completed spring set. Most workstations necessitate hand manipulation of the pieces, while stations handling hot leafs require manual tong use. Based on the insurance carrier's information, DPI management began to address these problems to prevent excessive workman's compensation costs and injury-related production interruptions.

The company's management team drafted an action plan with the development of an upper extremity screening program as the key thrust. With support from an occupational therapist, a registered nurse, and the company doctor, a pilot program was developed to educate workers regarding basic anatomy and physiology of the upper extremities, screen production-floor workers, and present a treatment recommendation program for symptomatic workers.

To help launch the program, an employee with severe existing symptoms was asked to participate. He was tested, and treatment was initiated to include wrist splints and hand tool modification. Because DPI's culture already acknowledged management's high concern for safety, the results

with this pilot employee sold the program to the rest of the manufacturing employees.

Individual upper extremity screening elements included the individual employee's history (including past work and hobbies), a physical assessment, a questionnaire regarding symptoms, and a series of tests that assessed dexterity, feeling sensitivity, and grip strength. Employees with indicated upper extremity problems were identified and recommendations developed for individual treatment including modification of the worksite and tools, fitting for splints, job rotation – and in severe cases, referral to a physician.

The success of this upper extremity screening program led to the development of a lower extremity screening program as an additional part of the injury prevention program. As before, a pilot program was initiated by working with a single employee with clear symptoms.

The upper and lower extremity screening programs have provided substantial benefits. The upper extremity screening program identified 28 employees with various levels of problems and all have been offered an appropriate level of treatment. The screening program also identified work elements most prone to result in identified problems so they can be examined.

Flexible Weekend Shift Work

DPI needed additional plant capacity on critical manufacturing processes. Already operating at almost full capacity, DPI would have to add more workers to weekend shifts. Rather than hiring part-time employees to staff the plant on weekends or working full-time employees overtime, the company used a creative employee scheduling technique similar to one used by hospitals to staff nurses on weekends.

Under this plan, full-time employees work a 12-hour shift on Saturday, a 12-hour shift on Sunday and two, eight-hour shifts on flexible weekdays. As an incentive to work this nontraditional work schedule, employees are paid for 45 hours per week while actually working 40.

DPI currently has five employees on this schedule, and both the employees and the company have realized many benefits, some of which were not envisioned when the program was established. Employees now have three days off from work each week, and the non-weekend days are flexible. This flexibility allows management to give employees off days to suit individual needs. In other weeks, these employees work certain days to cover for other workers on vacation. The weekend workers are cross-trained to operate many different machines in the plant and have become competent at maintaining and repairing the equipment they use since the maintenance staff does not normally work weekends. This allows the weekend workers to produce whatever parts are most needed to meet production schedules.

Worker Safety Improvement Program

Prior to the 1990s, DPI had no worker safety program, and injuries were viewed as a natural part of manufacturing. In the early 1990s, new DPI management and staggering worker's compensation costs prompted the company to aggressively pursue and manage worker safety. Many initiatives were implemented to reduce injuries and resultant costs.

The primary goal of the safety program is to increase safety awareness at DPI. The following initiatives, designed to help DPI meet its goal, are supported by a strong company commitment to safety, and an executive safety committee that meets quarterly to address current safety issues and make plans for the future.

- An employee safety committee has been established with representatives from across the company. This group tours the plant, lists safety problems, and works with maintenance personnel to have those problems repaired.
- A "stretching" program is required for all manufacturing distribution and service employees to stretch prior to starting work each day to help avoid work-related injuries.
- A "Working Safe" Incentive Program rewards safe workers. After one year without a lost-time accident, workers become eligible to win a "Safety Day" off from work in a monthly lottery, or a \$100 bonus at the end of the year.
- A housekeeping committee monitors the cleanliness of the manufacturing plant. This program has evolved into a competition for the cleanest department in the plant.
- A formal safety training program includes monthly meetings where short safety videos are shown and safety issues are discussed. Longer training classes have been established for topics such as forklift operation, personal protective equipment, and back injury avoidance.
- A wellness program is used to conduct activities such as carpal tunnel syndrome screening, and cholesterol and blood pressure monitoring.

When injuries occur, DPI now works closely with the injured employee to be sure he receives the necessary medical attention and returns to work when able. A case manager ensures that the injured employee sees a doctor on the approved list and accompanies the employee to the doctor's office. DPI makes weekly phone contact with the employee when he is not able to work. In addition, light duty jobs are created to provide productive work while employees are under injury restrictions.

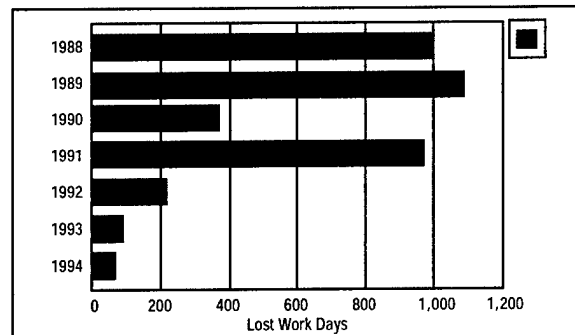


FIGURE 2-2. SAFETY HISTORY OF DAYTON PARTS, INC.

In 1988, DPI had 1000 days of lost work due to injuries. After the safety program took effect, the number of lost days dropped substantially, to 91 days in 1993 and 69 days in 1994 (Figure 2-2).

2.4 MANAGEMENT

MANUFACTURING STRATEGY

Synchronous Manufacturing

DPI has implemented a manufacturing philosophy based on synchronous manufacturing where production flow – not capacity – is balanced to meet customer demands. Under this system, typical measurements such as efficiencies of individual operations or operators are not used. Instead, changes are measured by impact on the overall system throughput. These concepts have been developed based on the book *The Goal* by Eliah Goldratt and is required reading in all plant departments.

DPI uses selected measurements to guide the focus of continuous improvement projects aimed at improving overall throughput, while reducing operating expense and WIP inventory. The process first identifies system bottlenecks which are the controlling resources of the system, and then tries to exploit those bottleneck functions. Under the throughput system, an hour wasted at a system constraint or bottleneck is equal to an hour on the complete system, and the use of a non-bottleneck resource is controlled by the constraints of the system.

Since the implementation of this concept in 1992, DPI has developed an employee involvement continuous improvement program to help identify and correct bottleneck problems. As a result, average order fill across all product lines rose from 84.2% in 1992 to 98% in 1995. This was accomplished while experiencing an increase in business from \$17M in 1992 to \$27M in 1994. During this same period, WIP was reduced through the continuous improvement program by almost 50%, and throughput measurements

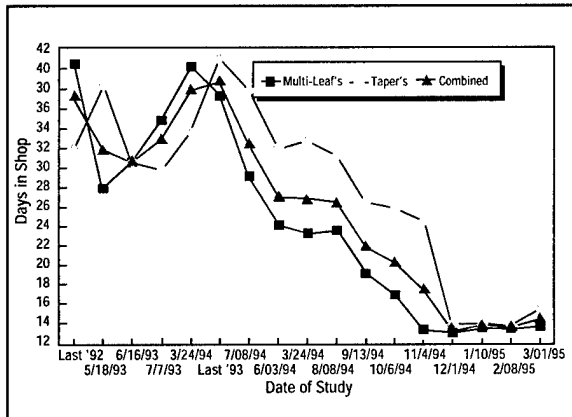


FIGURE 2-3. THROUGHPUT IMPROVEMENT (AVERAGE DAYS IN THE SHOP)

showed average days in the shop decreasing from 42 in 1992 to a low of 14 in 1995 (Figure 2-3). The productivity indicator that plots sales value per labor hour also indicated a rise from \$77 in January of 1994 to \$98 in May of 1995.

QUALITY ASSURANCE

Continuous Improvement

Because DPI firmly believes that employee involvement and continuous improvement are essential for the future growth and well-being of the company, focus is maintained on systematic small improvements in company operating policies, management, and personnel involvement in the plants' daily operation. The manufacturing continuous improvement focus goals (Figure 2-4) are centered on improved throughput, reduced operating expenses, reduced WIP inventory and improved raw material utilization. DPI management maintains that the success of the company is based on communicating with the employees, involving the work force in decision making, providing personnel with leadership, fair compensation, and providing monetary incentives.

DPI is adamant in its belief that no one knows more about a job than the person performing it. In keeping with the continuous improvement focus goals, volunteer cross-functional work teams have been established to develop and implement systematic improvements that help make the company successful. These teams, initially led by a member of management, evolve into self-directed work teams that are focused on specific improvement projects. Guidelines, not rules, for team operation have been established and are followed. These guidelines help the team to keep focused on the task at hand. When a specific project has reached completion, the team is either dissolved or addresses another effort that needs improvement.

Although there can be many problems in establishing and developing teams, the rewards are substantial. By empow-

ering and involving the employees in planning their work and making decisions, DPI acknowledges that talents are emerging and developing that previously were neither recognized or utilized. Productivity has increased and cost has decreased at DPI. Consequently, it has gained market shares in a fairly mature business. Growth from a \$17M to a \$27M business over the past two years is largely attributable to the company's commitment to the continuous improvement through employee involvement activities.

Communications

Developing and maintaining open communication between management, staff, and employees of DPI have contributed significantly to its success. The company wants employees to be aware of what is happening in the corporation and how changing events will affect them. In an effort to ensure that all personnel are aware of these events and have the opportunity to provide inputs to them, DPI has instituted several communications tools. The goal of this effort is to ensure that DPI maintains a well-informed work force and uses its most valuable asset – its personnel – wisely.

Some communication tools used by DPI include bi-weekly newsletters that are mailed to the employee's home; monthly meetings with the company president's birthday club; monthly supervisor-department meetings; monthly employee relations committee meetings; monthly safety committee meetings; quarterly business review meetings with all employees; an open-door policy; regular bulletin board notices; and an active management on the production floor.

The relationships between management and employees through this open communication allow DPI management to openly discuss business and the employee effect such as reducing accidents and workers compensation costs, reducing health care costs, initiating personal wellness programs at work, and avoiding reactionary decisions by management and personnel.

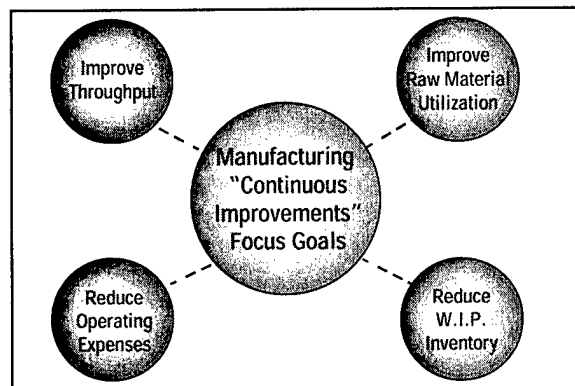


FIGURE 2-4. CONTINUOUS IMPROVEMENT FOCUS GOALS

SECTION 3

INFORMATION

3.1 MANAGEMENT

QUALITY ASSURANCE

Material Utilization

DPI realized in 1993 that the quantity of steel sold as scrap was excessive relative to the total raw steel consumed, but that it could be a controllable cost. To investigate the problem and develop solutions, a Material Utilization Task Team was formed with membership drawn from both shop floor and management departments. To minimize scrap, the team developed an information base to direct raw steel length purchasing decisions.

While the team knew the total scrap sold, it initially only had assumptions regarding the relative amounts of scrap steel (off fall) produced by the two major lines – multi-leaf springs and taper springs. To correct this lack of accurate information, the team spent its first three months gathering data relative to the off fall that resulted from the production of each part number and the length of the raw steel from which each part was produced. The result of the data analysis indicated that while the overall off fall was approximately 3%, the total for taper spring operations was over 6% (Figure 3-1). This data also revealed that 51% of the total off fall was from 21% of the production. The data indicated that the majority of the off fall resulted from less than optimum raw steel lengths, usually 22 feet for all cross sections.

DPI may produce as many as 5000 different spring designs in a year, mostly in relatively small batches, and it is therefore not feasible to buy pre-cut spring blanks direct from steel mills since the quantity of each length required is well below the minimum for such special cuts. The mills can supply stock cut to any length if at least five tons are requested in each length (for a given cross section) at no extra cost. Since the team's analysis indicated that off fall can be minimized by optimizing the purchased lengths, the decision was made to base purchase lengths on part number requirements. This optimization resulted in specifying two purchased lengths for a number of cross sections, and three for a few. To ensure these changes were understood by manufacturing personnel, the BOMs were changed to reflect the new (and additional) steel lengths. Likewise, the routing instructions were amended to provide shearing instructions for optimal steel utilization.

Modification of its raw steel purchasing procedures to optimize utilization has resulted in over \$42K in savings for

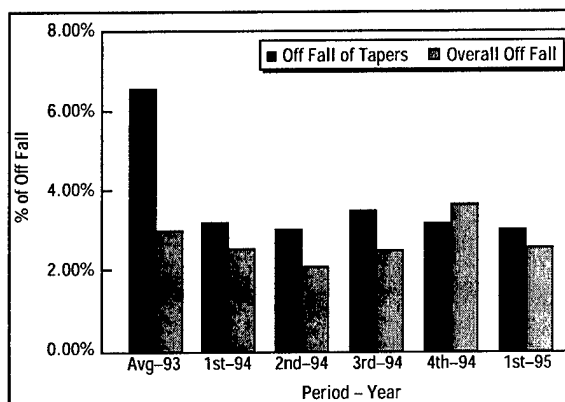


FIGURE 3-1. PERCENTAGE OF TAPERS OFF FALL VS. PERCENTAGE OF OVERALL OFF FALL

the company since the team was formed and has brought the off fall from taper spring production to well below 3%. This is doubly important since the taper spring line represents the growth market for Dayton Parts.

Wellness Program

In 1994 DPI instituted a Wellness Program for all employees as an outgrowth of its aggressive safety program. The company recognizes that one of its most important resources is its well-trained and motivated work force. Consequently, the health of its employees is important to the company's business health and success. Therefore, DPI joined forces with a local health care provider, Polyclinic Corporate Health, and developed a Wellness Program that is available to all employees at no cost. The objective of this plan is to reduce the costs of unknown health risks on the DPI work force.

Under this plan, the employee meets with a member of the health care provider and undergoes an initial screening process to develop a patient health history. Blood glucose and cholesterol screening, body flexibility testing, and blood pressure baselines are established, and weight and body fat measurements are taken. A written report of the general health condition is given to the employee only. Employees in high risk groups meet individually with a member of the care provider, and individual case management is offered. During this case management process, the screening results are reviewed and health suggestions are provided. Education and specific physicians referrals are also provided as part of the service.

At the beginning of the Wellness Program, DPI anticipated 10 to 15 volunteers to participate. Within the first six months, 60 employees participated in the initial screening, and presently 135 employees (or over one-half of the work force) are participating. Results to date have identified one employee with previously unknown minor heart attack discovered, two employees with previously unknown

elevated cholesterol identified, two employees with previously unknown elevated blood pressure identified, and one angina sufferer identified. By enabling its employees to have access to this program and receive needed medical assistance DPI is able to help its personnel hold down health care insurance cost and maintain a healthy work force.

APPENDIX A

TABLE OF ACRONYMS

ACRONYM	DEFINITION
BMP	Best Manufacturing Practices
DPI	Dayton Parts, Inc.
PaDER	Pennsylvania Department of Environmental Regulations
VOC	Volatile Organic Compound

APPENDIX B

BMP SURVEY TEAM

TEAM MEMBER	ACTIVITY	FUNCTION
Bob Jenkins (703) 602-3003	Naval Sea Systems Command Washington, DC	Team Chairman
John Carney (703) 602-3005	Naval Surface Warfare Center Carderock Division Washington, DC	
Don Hill (317) 306-3781	Naval Air Warfare Center Aircraft Division - Indianapolis Indianapolis, IN	
Travis Walton (403) 405-3883	University of Maryland College Park Engineering Research Center College Park, MD	

APPENDIX C

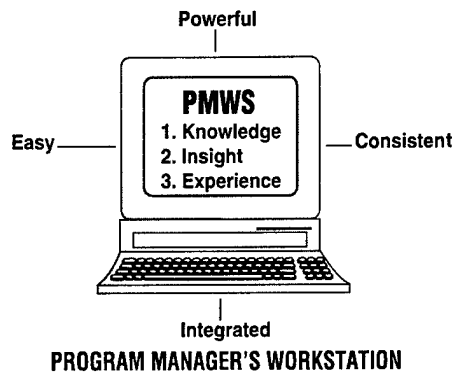
PROGRAM MANAGER'S WORKSTATION

The Program Manager's Workstation (PMWS) is a series of expert systems that provides the user with knowledge, insight, and experience on how to manage a program, address technical risk management, and find solutions that industry leaders are using to reduce technical risk and improve quality and productivity. This system is divided into four main components; KNOW-HOW, Technical Risk Identification and Mitigation System (TRIMS), BMP Database, and Best Manufacturing Practices Network (BMPnet).

- **KNOW-HOW** is an intelligent, automated method that turns "Handbooks" into expert systems, or digitized text. It provides rapid access to information in existing handbooks including Acquisition Streamlining, Non-Development Items, Value Engineering, NAVSO P-6071 (Best Practices Manual), MIL-STD-2167/2168, SecNav 5000.2A and the DoD 5000 series documents.
- **TRIMS** is based on DoD 4245.7-M (the transition templates), NAVSO P-6071 and DoD 5000 event oriented acquisition. It identifies and ranks the high risk areas in a program. TRIMS conducts a full range of risk assessments throughout the acquisition process so corrective action can be initiated before risks develop into problems. It also tracks key project documentation from concept through production including goals, responsible personnel, and next action dates for future activities in the development and acquisition process.
- The **BMP Database** draws information from industry, government, and the academic communities to include documented and proven best practices in design, test, production, facilities, management, and logistics.

Each practice in the database has been observed and verified by a team of experienced government engineers. All information gathered from BMP surveys is included in the BMP Database, including this survey report.

- **BMPnet** provides communication between all PMWS users. Features include downloading of all programs, E-mail, file transfer, help "lines", Special Interest Groups (SIGs), electronic conference rooms and much more. Through BMPnet, IBM or compatible PC's and Macintosh computers can run all PMWS programs.



- To access **BMPnet** efficiently, users need a special modem program. This program can be obtained by calling the BMPnet using a VT-100/200 terminal emulator set to 8,N,1. Dial (703) 538-7697 for 2400 baud modems and (703) 538-7267 for 9600 baud and 14.4 kb. When asked for a

user profile, type: DOWNPC or DOWNMAC <return> as appropriate. This will automatically start the Download of our special modem program. You can then call back using this program and access all BMPnet functions. The General User account is:

USER PROFILE: BMPNET

USER I.D.: BMP

Password: BMPNET

If you desire your own personal account (so that you may receive E-Mail), just E-Mail a request to either Ernie Renner (BMP Director) or Brian Willoughby (CSC Program Manager). If you encounter problems please call (703) 538-7253.

APPENDIX D

NAVY CENTERS OF EXCELLENCE

Automated Manufacturing Research Facility (301) 975-3414

The Automated Manufacturing Research Facility (AMRF) – a National Center of Excellence – is a research test bed at the National Institute of Standards and Technology located in Gaithersburg, Maryland. The AMRF produces technical results and transfers them to the Navy and industry to solve problems of automated manufacturing. The AMRF supports the technical work required for developing industry standards for automated manufacturing. It is a common ground where industry, academia, and government work together to address pressing national needs for increased quality, greater flexibility, reduced costs, and shorter manufacturing cycle times. These needs drive the adoption of new computer-integrated manufacturing technology in both civilian and defense sectors. The AMRF is meeting the challenge of integrating these technologies into practical, working manufacturing systems.

Electronics Manufacturing Productivity Facility (317) 226-5607

Located in Indianapolis, Indiana, the Electronics Manufacturing Productivity Facility (EMPF) is a National Center of Excellence established to advance state-of-the-art electronics and to increase productivity in electronics manufacturing. The EMPF works with industry, academia, and government to identify, develop, transfer, and implement innovative electronics manufacturing technologies, processes, and practices. The EMPF conducts applied research, development, and proof-of-concept electronics manufacturing and design technologies, processes, and practices. It also seeks to improve education and training curricula, instruction, and necessary delivery methods. In addition, the EMPF is striving to identify, implement, and promote new electronics manufacturing technologies, processes, materials, and practices that will eliminate or reduce damage to the environment.

National Center for Excellence in Metalworking Technology (814) 269-2420

The National Center for Excellence in Metalworking Technology (NCEMT) is located in Johnstown, Pennsylvania and is operated by Concurrent Technologies Corporation (CTC), a subsidiary of the University of Pittsburgh Trust. In support of the NCEMT mission, CTC's primary focus includes working with government and industry to develop improved manufacturing technologies including advanced methods, materials, and processes, and transfer-

ring those technologies into industrial applications. CTC maintains capabilities in discrete part design, computerized process analysis and modeling, environmentally compliant manufacturing processes, and the application of advanced information science technologies to product and process integration.

Center of Excellence for Composites Manufacturing Technology (414) 947-8900

The Center of Excellence for Composites Manufacturing Technology (CECMT), a national resource, is located in Kenosha, Wisconsin. Established as a cooperative effort between government and industry to develop and disseminate this technology, CECMT ensures that robust processes and products using new composites are available to manufacturers. CECMT is operated by the Great Lakes Composites Consortium. It represents a collaborative approach to provide effective advanced composites technology that can be introduced into industrial processes in a timely manner. Fostering manufacturing capabilities for composites manufacturing will enable the U.S. to achieve worldwide prominence in this critical technology.

Navy Joining Center (614) 486-9423

The Navy Joining Center (NJC) is a Center of Excellence established to provide a national resource for the development of materials joining expertise, deployment of emerging manufacturing technologies, and dissemination of information to Navy contractors, subcontractors, Navy activities, and U.S. industry.

The NJC is located in Columbus, Ohio, and is operated by Edison Welding Institute (EWI), the nation's largest industrial consortium dedicated to materials joining. The NJC combines these resources with an assortment of facilities and demonstrated capabilities from a team of industrial and academic partners. NJC technical activities are divided into three categories - Technology Development, Technology Deployment, and Technology Transfer. Technology Development maintains a goal to complete development quickly to initiate deployment activities in a timely manner. Technology Deployment includes projects for rapid deployment teaming and commercialization of specific technologies. The Technology Transfer department works to disseminate pertinent information on past and current joining technologies both at and above the shop floor.

APPENDIX E

NEW BEST MANUFACTURING PRACTICES PROGRAM TEMPLATES

Since 1985, the BMP Program has applied the templates philosophy with well-documented benefits. Aside from the value of the templates, the templates methodology has proven successful in presenting and organizing technical information. Therefore, the BMP program is continuing this existing “knowledge” base by developing 17 new templates that complement the existing DoD 4245.7-M or Transition from Design to Production templates.

The development of these new templates was based in part on Defense Science Board studies that have identified new technologies and processes that have proven successful in the last few years. Increased benefits could be realized if these activities were made subsets of the existing, compatible templates.

Also, the BMP Survey teams have become experienced in classifying Best Practices and in technology transfer.

The Survey team members, experts in each of their individual fields, determined that data collected, while related to one or more template areas, was not entirely applicable. Therefore, if additional categories were available for Best Practices “mapping,” technology transfer would be enhanced.

Finally, users of the Technical Risk Identification and Mitigation System (TRIMS) found that the program performed extremely well in tracking most key program documentation. However, additional categories – or templates – would allow the system to track all key documentation.

Based on the above identified areas, a core group of activities was identified and added to the “templates baseline.” In addition, TRIMS was modified to allow individual users to add an unlimited number of user-specific categories, templates, and knowledge-based questions.

APPENDIX F

COMPLETED SURVEYS

BMP surveys have been conducted at the companies listed below. Copies of older survey reports may be obtained through DTIC or by accessing the BMPNET. Requests for copies of recent survey reports or inquiries regarding the BMPNET may be directed to:

Best Manufacturing Practices Program
4321 Hartwick Rd., Suite 308
College Park, MD 20740
Attn: Mr. Ernie Renner, Director
Telephone: 1-800-789-4267
FAX: (301) 403-8180
ernie@bmpcoe.org

COMPANIES SURVEYED

Litton
Guidance & Control Systems Division
Woodland Hills, CA
October 1985 and February 1991

Texas Instruments
Defense Systems & Electronics Group
Lewisville, TX
May 1986 and November 1991

Harris Corporation
Government Support Systems Division
Syosset, NY
September 1986

Control Data Corporation
Government Systems Division
(Computing Devices International)
Minneapolis, MN
December 1986 and October 1992

ITT
Avionics Division
Clifton, NJ
September 1987

UNISYS
Computer Systems Division
(Paramax)
St. Paul, MN
November 1987

Honeywell, Incorporated
Undersea Systems Division
(Alliant Tech Systems, Inc.)
Hopkins, MN
January 1986

General Dynamics
Pomona Division
Pomona, CA
August 1986

IBM Corporation
Federal Systems Division
Owego, NY
October 1986

Hughes Aircraft Company
Radar Systems Group
Los Angeles, CA
January 1987

Rockwell International Corporation
Collins Defense Communications
(Rockwell Defense Electronics
Collins Avionics and
Communications Division)
October 1987 and March 1995

Motorola
Government Electronics Group
Scottsdale, AZ
March 1988

General Dynamics
Fort Worth Division
Fort Worth, TX
May 1988

Hughes Aircraft Company
Missile Systems Group
Tucson, AZ
August 1988

Litton
Data Systems Division
Van Nuys, CA
October 1988

McDonnell-Douglas Corporation
McDonnell Aircraft Company
St. Louis, MO
January 1989

Litton
Applied Technology Division
San Jose, CA
April 1989

Standard Industries
LaMirada, CA
June 1989

Teledyne Industries Incorporated
Electronics Division
Newbury Park, CA
July 1989

Lockheed Corporation
Missile Systems Division
Sunnyvale, CA
August 1989

General Electric
Naval & Drive Turbine Systems
Fitchburg, MA
October 1989

TRICOR Systems, Incorporated
Elgin, IL
November 1989

TRW
Military Electronics and Avionics Division
San Diego, CA
March 1990

Texas Instruments
Defense Systems & Electronics Group
Dallas, TX
June 1988

Bell Helicopter
Textron, Inc.
Fort Worth, TX
October 1988

GTE
C³ Systems Sector
Needham Heights, MA
November 1988

Northrop Corporation
Aircraft Division
Hawthorne, CA
March 1989

Litton
Amecom Division
College Park, MD
June 1989

Engineered Circuit Research, Incorporated
Milpitas, CA
July 1989

Lockheed Aeronautical Systems Company
Marietta, GA
August 1989

Westinghouse
Electronic Systems Group
Baltimore, MD
September 1989

Rockwell International Corporation
Autonetics Electronics Systems
Anaheim, CA
November 1989

Hughes Aircraft Company
Ground Systems Group
Fullerton, CA
January 1990

MechTronics of Arizona, Inc.
Phoenix, AZ
April 1990

Boeing Aerospace & Electronics
Corinth, TX
May 1990

Textron Lycoming
Stratford, CT
November 1990

Naval Avionics Center
Indianapolis, IN
June 1991

Kurt Manufacturing Co.
Minneapolis, MN
July 1991

Raytheon Missile Systems Division
Andover, MA
August 1991

Tandem Computers
Cupertino, CA
January 1992

Conax Florida Corporation
St. Petersburg, FL
May 1992

Hewlett-Packard
Palo Alto Fabrication Center
Palo Alto, CA
June 1992

Digital Equipment Company
Enclosures Business
Westfield, MA and
Maynard, MA
August 1992

NASA Marshall Space Flight Center
Huntsville, AL
January 1993

Department of Energy-
Oak Ridge Facilities
Operated by Martin Marietta Energy Systems, Inc.
Oak Ridge, TN
March 1993

Technology Matrix Consortium
Traverse City, MI
August 1990

Norden Systems, Inc.
Norwalk, CT
May 1991

United Electric Controls
Watertown, MA
June 1991

MagneTek Defense Systems
Anaheim, CA
August 1991

AT&T Federal Systems Advanced
Technologies and AT&T Bell Laboratories
Greensboro, NC and Whippany, NJ
September 1991

Charleston Naval Shipyard
Charleston, SC
April 1992

Texas Instruments
Semiconductor Group
Military Products
Midland, TX
June 1992

Watervliet U.S. Army Arsenal
Watervliet, NY
July 1992

Naval Aviation Depot
Naval Air Station
Pensacola, FL
November 1992

Naval Aviation Depot
Naval Air Station
Jacksonville, FL
March 1993

McDonnell Douglas Aerospace
Huntington Beach, CA
April 1993

Crane Division
Naval Surface Warfare Center
Crane, IN and Louisville, KY
May 1993

Philadelphia Naval Shipyard
Philadelphia, PA
June 1993

R. J. Reynolds Tobacco Company
Winston-Salem, NC
July 1993

Crystal Gateway Marriott Hotel
Arlington, VA
August 1993

Hamilton Standard
Electronic Manufacturing Facility
Farmington, CT
October 1993

Alpha Industries, Inc
Methuen, MA
November 1993

Harris Semiconductor
Melbourne, FL
January 1994

United Defense, L.P.
Ground Systems Division
San Jose, CA
March 1994

Naval Undersea Warfare Center
Division Keyport
Keyport, WA
May 1994

Mason & Hanger
Silas Mason Co., Inc.
Middletown, IA
July 1994

Kaiser Electronics
San Jose, CA
July 1994

U.S. Army
Combat Systems Test Activity
Aberdeen, MD
August 1994

Stafford County Public Schools
Stafford County, VA
July 1994

Sandia National Laboratories
Albuquerque, NM
January 1995

Lockheed Martin
Electronics & Missiles
Orlando, FL
April 1995

McDonnell Douglas
Aerospace (St. Louis)
St. Louis, MO
May 1995

Dayton Parts, Inc.
Harrisburg, PA
June 1995

Wainwright Industries
St. Peters, MO
June 1995
