



*REPORT OF SURVEY CONDUCTED AT*

**ELIZABETHTOWN COLLEGE  
ELIZABETHTOWN, PA**

*NOVEMBER 1997*

## ***Best Manufacturing Practices***



**BEST MANUFACTURING PRACTICES CENTER OF EXCELLENCE  
College Park, Maryland  
[www.bmpcoe.org](http://www.bmpcoe.org)**

# Foreword

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This report was produced by the 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 Elizabethtown College, Elizabethtown, Pennsylvania conducted during the week of November 17, 1997. 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 government, industry, 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, BMPnet, 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.

Since 1992, Elizabethtown College's Department of Plant Operations has been evolving into a unique facilities management group built on trust, reliability, visibility, and credibility. Guided by its director's leadership, the Department developed a new attitude and outlook by creating a service-oriented ethic and team atmosphere; placing value on its employees; improving communications at all levels; and establishing itself as an integral part of Elizabethtown College's educational process. Among the best examples were Plant Operations' accomplishments in recycling; performance contract; and managing change through team environment.

The Best Manufacturing Practices program is committed to strengthening the U.S. industrial base. Survey findings in reports such as this one on Elizabethtown College 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.

A handwritten signature in cursive script that reads "Ernie Renner".

Ernie Renner

*Director, Best Manufacturing Practices*

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Elizabethtown College

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# Section 1

## Report Summary

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### Background

Elizabethtown College was founded in 1899 by the Reverend Jay G. Francis and members of the Church of the Brethren. During its first two decades, Elizabethtown College functioned as a college and as an academy for high school students to bolster its teacher training program. In 1921, the College became accredited by the State Council on Education, and bestowed its first baccalaureate degree. The success during the 1920s was soon replaced by the hardships of the 1930s. Despite calls to close down the facility, the spirit of perseverance at the College carried it through those trying times. After World War II, Elizabethtown College again saw prosperity, and became accredited by the Middle States Association in 1948 and the American Council of Education in 1949.

From its modest beginnings with three teachers and six students, Elizabethtown College grew in size and stature to become one of the most highly regarded, private, liberal arts colleges. Since 1994, the College has been consecutively ranked in the top five for Regional Liberal Arts Colleges (North) by *U.S. News & World Report*. Situated on a 185-acre campus in Elizabethtown, Pennsylvania, Elizabethtown College accommodates a student body of 1,550 full-time undergraduate students with 152 full-time and part-time professors. The College offers a comprehensive curriculum in liberal arts with major studies in the arts and sciences; pre-professional programs; and interdisciplinary programs. Its fiscal budget for 1997 was \$38.5 million.

The BMP survey focused on Elizabethtown College's Department of Plant Operations which is located on a peninsula at the north end of the campus; employs 55 personnel; and had a fiscal budget of \$3.2 million in 1997. The Department's responsibilities are divided into three groups: Environmental Services (e.g., administration, academia, residential); Maintenance (e.g., general repairs, grounds, safety); and Office Support (e.g., work orders, warehouse, delivery). In addition, Plant Operations uses a cross-functional team approach to support its groups, promote high quality delivery of services, and ensure consistency with the Department's mission, goals, and objectives. Among

the best practices documented were Plant Operations' recycling; performance contract; and managing change through a team environment.

Since 1992, Plant Operations has been evolving into a unique facilities management group built on trust, reliability, visibility, and credibility. Guided by its director's leadership, the Department created a service-oriented ethic and team atmosphere; placed value on its employees as well as their skills and knowledge; improved communication at all levels; strived for continuous improvement in work quality and customer satisfaction; and established itself as an integral part of Elizabethtown College's educational process. This new attitude and outlook boosted the Department's self-image, and established a working relationship with the campus community. Plant Operations soon began receiving praises and awards from faculty and students who consistently rate the Department among the top performing organizations on campus. In addition, Plant Operations' efforts provide valuable benefits and annual savings for Elizabethtown College through preventive maintenance, Green Lights programs, Habitat for Humanity, In-Service Day, and other projects.

Elizabethtown College's centennial will virtually coincide with the turning of the century. The College plans to build a celebration around three themes: lifting up the achievements and heritage of its first hundred years; envisioning new possibilities for the future; and repositioning itself in the context of history, society, and the educational marketplace. The Department of Plant Operations will likely be doing the same. The BMP survey team considers the following practices to be among the best in industry and government.

### Best Practices

The following best practices were documented at Elizabethtown College:

Item	Page
<b>Energy Management System</b>	<b>3</b>
In 1996, Elizabethtown College installed the state-of-the-art Landis & Staefa System 600 Energy Management System as part of the Performance Contract for energy management. This	

<b>Item</b>	<b>Page</b>	<b>Item</b>	<b>Page</b>
campus-wide management system provides comprehensive energy management; automatic temperature control strategies; facility management reports; and improved response times to facility problems.		<b>Communication — Spreading the Word</b>	<b>6</b>
<b>Lighting Efficiency</b>	<b>3</b>	Plant Operations initiated a Communication process to promote its mission, goals, objectives, and accomplishments throughout the campus community. The Department's dynamic approach champions reliable, efficient service and continuous improvement — internally within the Department; externally with customers and suppliers; vertically with top-down visions and bottom-up ideas; and horizontally with other departments.	
Through its participation in the Environmental Protection Agency's Green Lights program, Elizabethtown College conducts lighting surveys of its facilities, identifies areas where existing lighting can be upgraded, and completes all lighting upgrades that are financially advantageous. The College's lighting efficiency efforts reduced environmental pollutants released into the atmosphere and decreased its annual electricity consumption by 1,935,130 kilowatt hours per year.		<b>Managing Change through a Team Environment</b>	<b>8</b>
<b>Performance Contract</b>	<b>4</b>	Plant Operations established cross-functional teams to ensure high quality delivery of services and address issues associated with utility management, recycling, education, quality assurance, maintenance, and work orders. Teams are the essential ingredient for managing change throughout Plant Operations and ensuring consistency with the Department's mission, goals, and objectives.	
Elizabethtown College negotiated an energy-saving Performance Contract which enabled the College to complete \$1.8 million in energy efficiency improvements and maintenance projects, and receive a guaranteed energy cost savings of \$181,000 per year. Cash flows projected for the term of the Performance Contract have separate components, and are the responsibility of the contractor and Plant Operations respectively.		<b>Raising Staff Self-Esteem</b>	<b>8</b>
<b>Recycling</b>	<b>5</b>	As part of its total quality and continuous improvement process, Plant Operations initiated several practices to raise self-esteem within the Department. The objective was to develop a staff that believed in itself and its purpose, and was willing to put forth extra effort.	
The Recycling program saves Elizabethtown College approximately \$18,000 each year and provides a valuable link between Plant Operations and the student population. Through the program, Plant Operations educates and involves students in recycling responsibilities and operational issues which promote awareness, campus feedback, and continuous improvement. Profits from the program are split between the Residence Hall Association and the Plant Operations Scholarship Fund.		<b>Total Quality Service Program</b>	<b>9</b>
<b>Utility Management</b>	<b>6</b>	Based on six principles, Plant Operations structured and developed its Total Quality Service program to ensure continuous improvement. Changes in the Department were an evolutionary process, achieved through leadership, education, and communication. Through this program, Plant Operations has become one of the top performing organizations at Elizabethtown College.	
The utility management team uses an Energy Management System to monitor electricity use throughout the campus. The system regulates electricity consumption by centrally controlling the operational equipment through individual meters on the buildings. In addition, the team avoids high electricity demand charges by keeping peak demand low via load management.		<b>Point of Contact</b>	
		For further information on items in this report, please contact:	
		Mr. Larry Bekelja Elizabethtown College Department of Plant Operations One Alpha Drive Elizabethtown, Pennsylvania 17022-2298 (717) 361-1408 FAX: (717) 361-1431 E-mail: <a href="mailto:bekeljw@acad.etown.edu">bekeljw@acad.etown.edu</a>	

## Section 2

### *Best Practices*

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#### *Facilities*

##### Energy Management System

Prior to 1996, Elizabethtown College used an energy management system which featured early-1980 technology, energy management controls, and direct digital control in a few of the buildings. However, the outdated system lacked flexibility, was difficult to maintain, and could not provide the level of control required by the College. Repairs and replacement parts were also becoming expensive due to the system's age. A new system was required which could provide the flexibility to grow and expand with the constantly changing needs of the College. In 1996, Elizabethtown College installed the state-of-the-art Landis & Staefa System 600 Energy Management System (EMS).

Elizabethtown College chose the automated and centralized EMS as part of the Performance Contract for energy management. This campus-wide management system provides comprehensive energy management; automatic temperature control strategies; facility management reports; and improved response times to facility problems. The system is PC-based and runs in a Windows environment. Sensory and control system inputs are received by EMS from all over the campus. Energy use is monitored through individual meters in every building. Additional sensors monitor switches, pumps, water usage, valves, fans, building temperatures, and other key points throughout the campus. Most heating/cooling and critical energy management systems can be controlled centrally from Elizabethtown College's Department of Plant Operations.

The new EMS was funded as part of the \$1.8 million Performance Contract with Landis & Staefa which guarantees an annual savings of \$247,000. By utilizing this state-of-the-art technology, Elizabethtown College reduced energy costs substantially; decreased response times; increased comfort levels and customer satisfaction; and improved facility management reporting.

##### Lighting Efficiency

Elizabethtown College has been a participant in the Environmental Protection Agency's (EPA's) Green Lights program since 1993. Green Lights is a voluntary pollution prevention program that encourages participants to use energy efficient lighting technologies to improve lighting quality and reduce environmental emissions in their facilities. Partners in the Green Lights program sign a Memorandum of Understanding (MOU) whereby they agree to conduct lighting surveys of their facilities, identify areas where existing lighting can be upgraded, and complete all lighting upgrades that are financially advantageous to their organization.

Elizabethtown College's Department of Plant Operations conducted detailed lighting audits and/or surveys of 681,000 square feet of classroom, office, laboratory, assembly, and dining service space. As of April 1997, 554,000 square feet of this space (85% of the total campus) had been upgraded. These efforts included replacing mercury vapor lighting with metal halide; upgrading all indoor fluorescent fixtures to T-8 fluorescent lamps with electronic ballasts; and using high-pressure sodium fixtures for outdoor lighting. Plant Operations replaced 9,000 lighting fixtures across the entire campus, and installed motion sensors where applicable. The new fixtures last longer, conserve electricity, and improve the quality of light. In addition, Plant Operations converted 313 exit signs from 25-watt to one-watt fixtures. The longer life of these fixtures exemplifies the labor cost savings associated with lighting efficiency upgrades. Over the past three years, none of the bulbs in the exit signs have needed replacement. This upgrade saved Elizabethtown College approximately \$13,000 per year in labor and electricity costs. The College's lighting efficiency efforts also reduced environmental pollutants released into the atmosphere (Table 2-1) by decreasing electrical power requirements.

Through its participation in the Green Lights program, Elizabethtown College reduced its annual electricity consumption by 1,935,130 kilowatt hours per year. This reduction translated to an annual energy cost savings of \$82,000. In November 1996, the EPA awarded Elizabethtown College a Gold

**Table 2-1. Pollution Prevention Resulting from Lighting Efficiency Upgrades**

Atmospheric Pollutant	Pounds Prevented
CO <sub>2</sub>	3,096,208
SO <sub>2</sub>	34,983
NO <sub>x</sub>	11,092
Heavy Metals	4

Medal and a Dream Team Medal for its achievements in preventing environmental pollution through lighting efficiency upgrades. The College also received the EPA's Certificate of Achievement in April 1997 for its successful completion of all commitments made under the Green Lights program's MOU.

Plant Operations' ongoing Total Quality Service (TQS) program also influenced the success of the lighting efficiency efforts. Through its TQS program, Plant Operations built credibility at all levels of the campus, and developed an attitude of continuous improvement and customer service. Success was achieved by adopting simple, small, incremental changes which are implemented every day by an empowered workforce. This philosophy enables Plant Operations to develop a broad environmental commitment to the campus, and aids the Department in implementing other energy efficiency efforts.

### Performance Contract

Funded through the Department of Energy's Institutional Conservation program, Elizabethtown College conducted energy audits of all campus facilities. The audits identified potential improvements that could save the College up to \$300,000 annually in energy costs. However, capital investment to implement the projects was estimated at \$1.3 million. Since the Department of Plant Operations successfully demonstrated credibility and cost reductions through several small-scale energy projects, Elizabethtown College was confident that the additional \$300,000 in savings was attainable if sufficient resources could be allocated to the effort. As a result, Elizabethtown College negotiated an energy-saving Performance Contract which enabled the College to complete \$1.8 million in energy efficiency improvements and maintenance projects,

and receive a guaranteed energy cost savings of \$181,000 per year.

After six months of negotiations, Elizabethtown College narrowed down its contractor choices to two companies. Plant Operations held several meetings with each company, and questioned them on how they would meet the needs of the campus. A weighted scoring system aided the College in determining the final choice of contractor. However, the final proposal for the Performance Contract required an additional six months of discussion between the two parties. Several criteria were negotiated into the contract which was unusual for standard performance contract arrangements.

The Performance Contract is not a shared savings agreement. Instead, savings are guaranteed at a level substantiated by Elizabethtown College's energy audit reports. Financing for the project is provided through a bond issue with a 5% interest rate, and all savings are applied toward the debt. The College controls the selection of subcontractors; determines the energy management system installed under the contract; and defines the comfort levels of all buildings managed by the system. Plant Operations can add control points and adjust set points within the energy management system, and informs the contractor of any actions. Ongoing consulting services and incorporated fees were also negotiated to ensure that technical support from the contractor provided a meaningful impact on the effectiveness of operations.

The simple payback period for all energy cost saving measures performed under the Performance Contract was 5.8 years. However, Elizabethtown College elected to increase the payback period and the term of the contract to ten years. This strategy enabled the College to incorporate several deferred maintenance items and install energy efficiency measures which had payback periods that exceeded 5.8 years.

Cash flows projected for the term of the Performance Contract have separate components, and are the responsibility of the contractor and Plant Operations respectively. The contractor must meet the savings guarantee of \$181,000 per year. Any shortfalls in the amount must be covered by the contractor. Plant Operations must produce the savings in operational costs — annual savings are projected at \$41,000 in repair costs; \$35,000 in labor costs; and \$30,000 in natural gas costs. The overall savings totals \$287,000 per year. Each year, positive cash flows are also projected for the College. The accumulated cash flows over the ten-year term of the contract will be \$236,767.

Numerous projects have been completed under the Performance Contract. Plant Operations retrofitted 9,000 lighting fixtures — each tagged with color-coded dots that correspond to tags on replacement lamps. This project improved lighting quality, simplified maintenance, and reduced service costs. A state-of-the-art Energy Management System was installed to replace a ten-year old, outdated pneumatic control system. The new computerized system provides comprehensive energy management and control strategies, and the flexibility to expand with the needs of the College. Plant Operations also improved the mechanical systems in five buildings by installing a pool dehumidification system; replacing three 25-year old boilers and an outdated chiller; and changing out the fan coil units with heat pumps. These improvements reduced energy, service, and maintenance costs as well as increased the comfort and safety levels of the campus facilities.

Specific energy reduction retrofits were also completed. These projects included replacing the electric hot water heaters with energy efficient gas water heaters in two buildings; upgrading the rooftop heating, ventilating, and air conditioning units in the dining hall; using liquid line amplifications to increase the efficiency of large reciprocating refrigeration units; replacing six unit ventilators with two rooftop-mounted units that use gas heating and electric cooling; and installing variable frequency drives to control the speed of supply air fans. Plant Operations increased the comfort levels of the campus facilities; new electrical systems were added to all buildings, providing real-time power monitoring.

The Performance Contract enables Elizabethtown College to complete energy efficiency improvements and maintenance projects while reducing Plant Operations' budget. Figure 2-1 shows a comparison of the budget before and after establishing the contract. Energy, maintenance, and labor cost savings now sufficiently cover the capital investment of

improvements. Elizabethtown College achieves positive cash flows and improves overall operations and comfort of the campus.

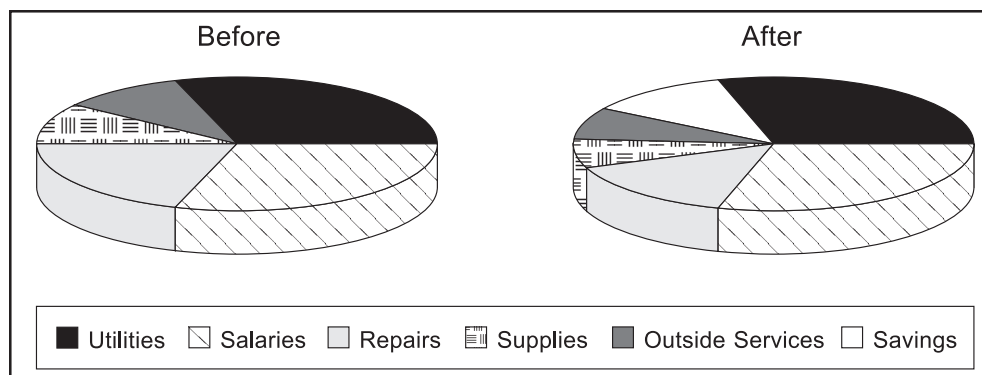
## Recycling

Elizabethtown College saves approximately \$18,000 each year through its Recycling program. The campus recycles various materials including paper, cardboard, cans, bottles, wood waste, dining hall scraps, paint, and asphalt paving. In addition, the program provides a valuable link between the Department of Plant Operations and the student population. Through the program, the Department educates and involves students in recycling responsibilities and operational issues which promote awareness, campus feedback, and continuous improvement. Plant Operations prides itself as an integral part of the learning community.

Students are strongly encouraged to recycle. Recycling centers are established in each residence hall so students can separate and dispose of recyclable material. Incoming freshmen receive written information describing the Recycling program and its various incentives. Plant Operations gives 50% of the profits from the Recycling program to the Residence Hall Association so students can purchase items (e.g., furniture, televisions, VCRs, ping-pong tables) for use in their common living areas. The remaining 50% is placed in the Plant Operations Scholarship Fund. Elizabethtown College's students and employees take pride in recycling, and continue to develop new ideas for the program.

Since initiating the Recycling program, Plant Operations no longer buys mulch from outside sources. Waste and appropriate wood waste are collected by ground maintenance crews and shredded in a tub grinder to produce high-quality garden mulch for the campus. In addition, dining hall scraps and yard waste are used for composting. A pulper located in

the dining hall grinds scraps into compost material which reduces water consumption and labor costs associated with handling this material. The processed scraps are combined with ground leaves and grass clippings, and then aged to produce a nutrient-rich compost for use on the campus grounds.



**Figure 2-1. Operating Budgets Before and After Performance Contract**

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Through its Recycling program, Elizabethtown College significantly reduced hauling and disposal costs, and generated revenue by selling recyclable material. Between 1994 and 1996, the College reduced its trash pick-ups by nearly half, and saved \$400 in hauling and disposal costs for each eliminated truckload. Revenue generated from the sale of recyclable material in 1996 included \$2,151 for aluminum, \$134 for paper, and \$195 for cardboard. The balance of the \$18,000 yearly savings results from reductions in hauling and disposal costs.

## Utility Management

Between 1992 and 1997, Elizabethtown College reduced Plant Operations' budget from \$4.2 million to \$3.2 million, and completed an expansion project to increase floor space by 13% (125,000 square feet) — all without reducing its operational staff. This feat was accomplished in many ways including energy efficiency improvement projects and a comprehensive quality program. The main focus was utility costs which represented approximately one-third of Plant Operations' budget.

The utility management team uses an Energy Management System to monitor electricity use throughout the campus. The system regulates electricity consumption by centrally controlling the operational equipment through individual meters on the buildings. Where appropriate, variable speed drives are installed on the electric motor driven systems. Since electricity demand (total kilowatt required at any moment) is recorded hourly, the team can determine and adjust for high loads of total energy use in any building. In addition, the team avoids high electricity demand charges by keeping peak demand low via load management (peak shaving). Demand charges are based on the 15-minute period when the College's power usage is at its highest during a month.

To track the College's natural gas consumption, the utility management team conducts biweekly meter readings. The team then calculates the gas consumption and cost for each building, and records the data in a spreadsheet. Water and sewer usage are also monitored and recorded on a biweekly basis. The monitoring system is so accurate that the team can identify a leaking toilet just by reviewing a meter's data. The team's energy efficiency improvement projects included placing separate water meters on the swimming pool and air-conditioning cooling towers which eliminated sewer charges

billed against these systems; maintaining flow rates in showers at 1.75 to 2.25 gallons per minute; and installing low volume per flush units whenever a toilet was replaced. Between 1991 and 1996, Plant Operations realized \$9,500 per year in cost savings by reducing water usage in the dining hall, gymnasium, and residence halls. Plant Operations also promotes water conservation awareness in the campus community through competitions. In 1996, the residence hall students who saved the highest percentage of water received a pizza party.

Through several small-scale energy projects, Plant Operations successfully demonstrated its credibility and cost reduction efforts. During a two-year period, Plant Operations received three matching grants (totaling \$110,000) under the Department of Energy's Institutional Conservation program. The grants helped finance the energy efficiency improvement costs (\$230,000) for converting the hot water heating systems from electricity to gas in two buildings; installing a pool dehumidifier; retrofitting exit lights; and changing the heating, ventilating, and air-conditioning system's piping between two buildings. Energy and maintenance cost savings totaled \$95,500 per year from these projects. The following year, Plant Operations received additional grants through the program to conduct energy audits in all remaining buildings. These audits revealed a potential cost savings of \$210,000 per year. Plant Operations' successful efforts persuaded the College's administration to implement the efficiency improvements and finance them through an energy-saving Performance Contract.

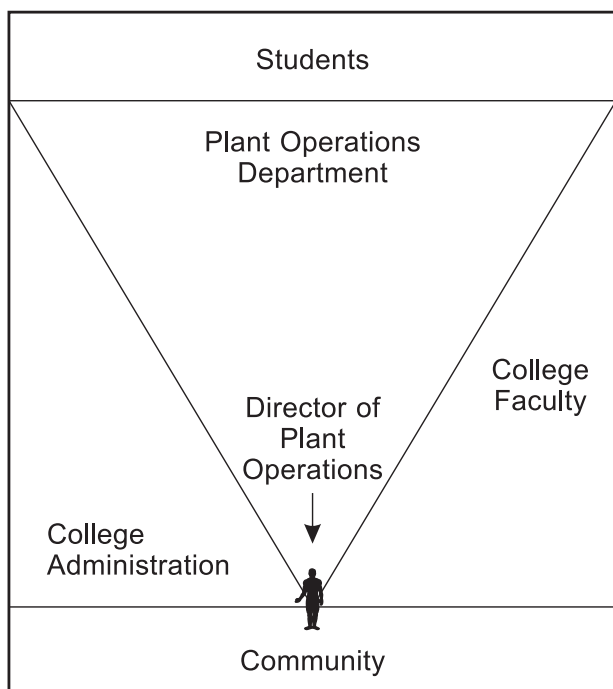
The utility management team continues to explore new methods for increasing energy efficiency. Through daily meetings, the team discusses energy issues and ideas as part of the continuous improvement process. Team management and employee empowerment are the keys to the success of Elizabethtown College's resource efficiency programs.

## *Management*

### Communication — Spreading the Word

The Department of Plant Operations initiated a Communication process to promote its mission, goals, objectives, and accomplishments throughout the campus community. Prior to this initiative, Plant Operations' quality services were overlooked by most of the campus, viewed as unessential to the educational process, and minimally supported by

top officials. Today, Plant Operations takes a dynamic approach to communicating — internally within the Department; externally with customers and suppliers; vertically with top-down visions and bottom-up ideas; and horizontally with other departments. This approach champions reliable, efficient service and continuous improvement. In addition, Plant Operations established itself as an integral part (Figure 2-2) of the educational process and conveys this message to students, faculty, and trustees through a variety of programs:



**Figure 2-2. Communications**

- **Plant Operations Scholarship Fund** — This fund gives \$1,000 annually to a needy student; awards \$1,000 to children of staff who attend Elizabethtown College; and helps finance staff who pursue undergraduate work and continuing education. Plant Operations raises all the money for the fund through employee contributions and various programs (e.g., Recycling Program).
- **Plant Operations Residence Life Management Team** — This team was organized to promote communication with the students. Ambitious efforts involved creating a student group with representatives from all college-owned housing on and off campus, and scheduling forums so issues and concerns (e.g., recycling, energy conservation, maintenance, safety) could be communicated between Plant Operations and students.

- **Recycling Program** — This program is linked to student groups who educate incoming freshmen on the practices and incentives of recycling. Recycling centers are established in each residence hall. Plant Operations gives 50% of the profits from the program to the Residence Hall Association so students can purchase items (e.g., furniture, televisions, VCRs, ping-pong tables) for use in their common living areas. The remaining 50% is placed in the Plant Operations Scholarship Fund.
- **Opportunities for Interaction** — Plant Operations' manager and staff regularly receive invitations to discuss their programs (e.g., total quality management, project management, performance contracting) with business classes at Elizabethtown College and other universities. Plant Operations also opens its facilities to tours and lectures.
- **Customer Satisfaction** — Work orders are personally handled by a Work Order Station Coordinator. The customer of every fifth work order receives a customer satisfaction card so feedback can be obtained. Any dissatisfaction issues are addressed immediately. Plant Operations summarizes customer feedback every semester to analyze performance levels and trends.
- **Self-evaluation** — Plant Operations performs self-evaluations at the completion of every calendar year. All staff members complete a questionnaire. In addition, 50 questionnaires are issued to faculty, administrators, and office staff for their evaluations of Plant Operations, and another 50 questionnaires are distributed to students. Plant Operations enters the assessment data into a database and compares the results against previous years' performance.

This added dimension of communication enables Plant Operations to partake in the mainstream of the campus life and become an integral part of the educational process. The Communication process helped Plant Operations improve its performance, credibility, student involvement, staff visibility, and services to the campus, as well as lay the groundwork to win support for programs that promote continuous improvement. In 1993, Plant Operations won the Key to the Campus Award and the Unsung Hero Award from the student chapter of Habitat for Humanity. One staff member also won the Excellence of Service Award. Since then, Plant Operations has won awards which, in most cases, had been previously given to faculty or administrators.

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## Managing Change through a Team Environment

Providing total quality service is a team effort at the Department of Plant Operations. The Department employs 55 people who are distributed throughout three functional organizations: the Environmental Services Group, the Maintenance Group, and the Office Support Group. The Environmental Services Group manages academic, administrative, and residential issues. The Maintenance Group handles heating, ventilating, and air-conditioning; groundskeeping; general repairs; auto/fleet; safety; plumbing; carpentry; electrical service; and general maintenance. The Office Support Group addresses work orders; warehousing and delivery; and maintenance assistance.

Plant Operations established cross-functional teams to ensure high quality delivery of services and address issues associated with utility management, recycling, education, quality assurance, maintenance, and work orders. Teams are the essential ingredient for managing change throughout Plant Operations and ensuring consistency with the Department's mission, goals, and objectives. To promote team participation, everyone from the functional groups must serve on at least one team. Each team establishes its goals for one year. The team leaders work together with the Director and Managers as the management team.

Developing teams at Plant Operations has been an evolutionary process. Most teams took two to three years to establish. Department staff receives basic training in teaming concepts and Total Quality Management prior to establishing a team. Team members are interviewed regarding their comfort level on a particular team and whether they feel that they are contributing. Teams are established to address pertinent issues. Some teams cease when an issue is resolved or a task no longer needs team guidance. Plant Operations uses Ad Hoc Groups to address hot topics. At one time, 12 teams existed—currently there are eight.

Team accomplishments include:

- Education — The team focuses on delivering education to Plant Operations' workforce. Projects include installing computer access to the Internet; reviewing new courses for employee learning; and setting up a library so employees have easy accessibility to "how to" books associated with their jobs. The team was also instrumental in acquiring a \$2,000 grant for

education from the President's Fund for Distinction. Most courses center around formal classes in mathematics, English, reading, writing, and physical and emotional wellness.

- Utility Management — The team focuses on tightening control of water, sewer, electricity, and gas usage on campus. Projects include setting up a computer monitoring system to track and control electrical usage in each building; implementing scheduled meter reading of gas and water usage for trend analysis; improving sewer fee calculations; installing motion sensors in lighting systems; participating in the Green Lights program, and using variable speed drives with motors. The team places great emphasis on energy conservation training and awareness throughout the campus. Utility Management initiatives produced an accumulated savings of more than \$300,000 in the first six years.
- Recycling — The team focuses on creative ways to recycle paper, cardboard, leaves, food scraps, and other waste normally sent to a landfill. Educating the campus and establishing incentives were the greatest challenges faced by this team. Projects include recycling leaves and trimmings into mulch; sorting and selling paper; and composting food waste. Profits from recycling are shared with the Residence Hall Association so students can purchase items for use in their common living areas. The team's initiatives saved approximately \$18,000 each year.
- Safety — The team focuses on safety issues, provides safety training to Plant Operations' workforce, increases safety awareness on the job, conducts periodic inspections, and tracks safety performance. These efforts reduced Plant Operations' insurance premium from \$131,000 in 1992 to \$81,000 in 1997, and produced a \$13,000 annual rebate.

Plant Operations' cross-functional teams successfully manage change and provide the best results for the Department. The teams have ownership of their projects, and can freely recommend and implement their solutions.

## Raising Staff Self-Esteem

As part of its total quality and continuous improvement process, Plant Operations initiated several practices to raise self-esteem within the Department. The objective was to develop a staff that

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believed in itself and its purpose, and was willing to put forth extra effort. Plant Operations' first step was the elimination of the night shift. By moving everyone to the day shift, students and faculty got to know the custodians. The general quality of life improved for the custodians, and they became more of an integral part of the educational process and community. Plant Operations also holds a kickoff breakfast at the start of every fall semester. Invited guests include Elizabethtown College's President and others from outside the Department who speak on the importance of Plant Operations and offer encouragement. This practice is very effective in motivating and recognizing the employees.

Plant Operations takes full advantage of its educational surroundings by providing training to its staff in reading, writing, mathematics, computers, and communication skills. A typical workshop syllabus offers courses in Study Strategies, Basic Computing, Total Quality Service, and Working with Others with Differing Styles. This successful program enabled Plant Operations to win a \$2,000 award from the President's Fund for Distinction. The Department's focus on education soon led to the establishment of the Plant Operations Scholarship Fund, which currently has more than \$22,000 in its account. All funds for this program are raised by the Department. The fund gives \$1,000 annually to a needy student; awards \$1,000 to children of staff who attend Elizabethtown College; and helps finance staff who pursue undergraduate work and continuing education. This practice represents another way Plant Operations' workforce has become an integral part of the educational process at Elizabethtown College.

Each year, the Department conducts a Plant Operations In-Service Day where cross-functional teams work on various activities, and speakers discuss such topics as depression, stress, physical well being, and out-of-the-box thinking. Other practices include an employee of the month and an employee of the year program where employees nominate their peers. In addition, Plant Operations gives all employees an annual cost of living raise. Two years ago, the highest paid employees voluntarily gave up a percentage of their raises and had it applied toward the raises of the lowest paid employees as a way of reducing the gap between the highest and lowest paid workers.

Plant Operations' initiatives have significantly improved the self-esteem and quality of work life for its staff. By enriching the workforce through educa-

tional investments and other self-improvement opportunities, Plant Operations successfully demonstrated that better people make a better environment.

## Total Quality Service Program

The process of developing a Total Quality Service (TQS) program for Plant Operations began with the arrival of a new Department director in 1992. Prior to this time, the Department performed well, but functioned as an isolated support unit. Most employees felt insignificant to the overall mission of Elizabethtown College. They were physically isolated on a peninsula at the north end of the campus, and half worked on the night shift without contact with the rest of the campus community.

The Department director immediately began a process to create a team atmosphere and develop a quality ethic. The process focused on building a continuously improving, service-oriented organization that would be accepted as an integral part of the College's educational mission. The first step was introspective — to develop credibility within the Department and then expand this outwardly to customers, students, and the entire campus community. The process required a major change in culture and attitude. Foundations for this change were rooted in the concepts of W.E. Deming and Total Quality Management. Plant Operations' management worked to create an environment which supported effective communication, an open flow of ideas, self-esteem enhancement for employees, customer satisfaction, and continuous improvement. Key changes included placing all employees on the day shift, and initiating measures that improved communication and integration within the campus community.

Plant Operations' TQS program consists of six fundamental principles:

- Customer Focus — Customers include both internal customers (e.g., department staff) and external customers (e.g., students, faculty). Service calls are treated as opportunities for improvements rather than complaints. The objective is to change the Department from a producer-centered to a customer-centered culture.
- Leadership — Leadership maintains the vision, defines the strategy, and provides the resources for continuous improvement.

- 
- Improved Communication — Quality service is attained by understanding what the customer wants, and involves effective internal as well as external communications.
  - Continuous Improvement — This principle represents the core of the TQS philosophy. Quality service is a direct result of continuous improvement. Even small, incremental improvements must have a well-defined direction stemming from the other fundamental principles.
  - Accountability — Management is responsible for the process of service delivery, but is dependent upon the staff to ensure that the process is efficient and meets the needs of the customer.
  - Quality of Work Life — Management must understand that staff satisfaction is a prerequisite to customer satisfaction. Therefore, they must work to enhance individual self-esteem and create an environment in which employees can become valued members of the team.

Based on these principles, Plant Operations structured and developed a new system to ensure continuous improvement. Changes in the Department were an evolutionary process, achieved through

leadership, education, and communication. The new attitude and outlook also brought about dramatic improvements. Between 1992 and 1997, Plant Operations reduced its budget by 20%, primarily due to cost savings and improved efficiencies, without reducing the number of employees. At the same time, campus facilities expanded by 13% and all employees received annual wage and salary increases. Most importantly, the students and faculty consistently rate Plant Operations among the top performing organizations on campus. The Department repeatedly receives awards and commendations from Elizabethtown College's administration and campus organizations for its excellence in customer service.

The development of Plant Operations' TQS program is significant because it has helped the Department become one of the top performing organizations at Elizabethtown College. Typically, the facilities management group is not often seen as a leader or trend setter in most organizations. Plant Operations has worked steadily over the past six years to build credibility at all levels and to develop an attitude of continuous improvement and customer service. Success is achieved by adopting simple, small, incremental changes and implementing them every day with an empowered workforce.

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# Appendix A

## *Table of Acronyms*

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<b>Acronym</b>	<b>Definition</b>
EMS	Energy Management System
EPA	Environmental Protection Agency
MOU	Memorandum of Understanding
TQS	Total Quality Service

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# Appendix B

## ***BMP Survey Team***

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<b>Team Member</b>	<b>Activity</b>	<b>Function</b>
<b>Larry Robertson</b> (812) 854-5336	<b>Crane Division</b> <b>Naval Surface Warfare Center</b> Crane, IN	<b>Team Chairman</b>
<b>Cheri Spencer</b> (301) 403-8100	<b>BMP Center of Excellence</b> College Park, MD	<b>Technical Writer</b>

### **Team**

<b>Rick Purcell</b> (301) 403-8100	<b>BMP Center of Excellence</b> College Park, MD	<b>Team Leader</b>
<b>Larry Halbig</b> (317) 306-3838	<b>Hughes Air Warfare Center</b> Indianapolis, IN	
<b>Ann Elsen</b> (301) 405-0221	<b>University of Maryland</b> College Park, MD	

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# Appendix C

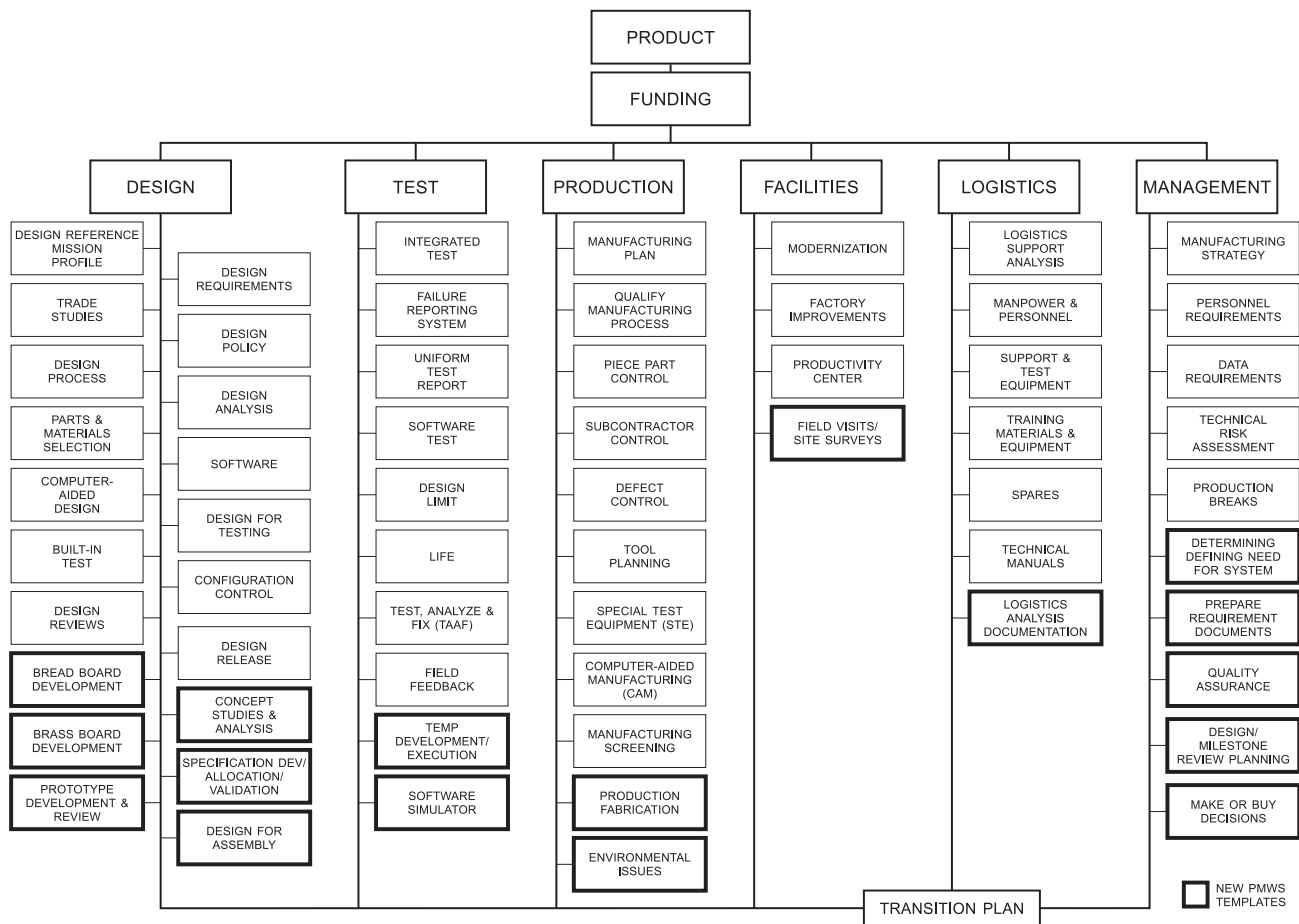
## Critical Path Templates and BMP Templates

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

## ***BMPnet and the Program Manager's WorkStation***

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The BMPnet, located at the Best Manufacturing Practices Center of Excellence (BMPCOE) in College Park, Maryland, supports several communication features. These features include the Program Manager's WorkStation (**PMWS**), electronic mail and file transfer capabilities, as well as access to Special Interest Groups (SIGs) for specific topic information and communication. The BMPnet can be accessed through the World Wide Web (at <http://www.bmpcoe.org>), through free software that connects directly over the Internet or through a modem. The PMWS software is also available on CD-ROM.

PMWS provides users with timely acquisition and engineering information through a series of interrelated software environments and knowledge-based packages. The main components of PMWS are KnowHow, SpecRite, the Technical Risk Identification and Mitigation System (TRIMS), and the BMP Database.

**KnowHow** is an intelligent, automated program that provides rapid access to information through an intelligent search capability. Information currently available in KnowHow handbooks includes Acquisition Streamlining, Non-Development Items, Value Engineering, NAVSO P-6071 (Best Practices Manual), MIL-STD-2167/2168 and the DoD 5000 series documents. KnowHow cuts document search time by 95%, providing critical, user-specific information in under three minutes.

**SpecRite** is a performance specification generator based on expert knowledge from all uniformed services. This program guides acquisition person-

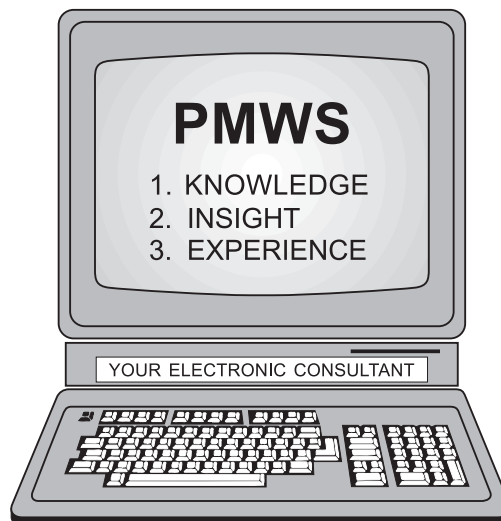
nel in creating specifications for their requirements, and is structured for the build/approval process. SpecRite's knowledge-based guidance and assistance structure is modular, flexible, and provides output in MIL-STD 961D format in the form of editable WordPerfect® files.

**TRIMS**, based on DoD 4245.7-M (the transition templates), NAVSO P-6071, and DoD 5000 event-oriented acquisition, helps the user identify and rank a program's high-risk areas. By helping the user conduct a full range of risk assessments throughout the acquisition process, TRIMS highlights areas where corrective action can be initiated before risks develop into problems. It also helps users track key project documentation from concept through production including goals, responsible personnel, and next action dates for future activities.

The **BMP Database** contains proven best practices from industry, government, and the academic communities. These best practices are in the areas of design, test, production, facilities, management, and logistics. Each practice has been

observed, verified, and documented by a team of government experts during BMP surveys.

Access to the BMPnet through dial-in or on Internet requires a special modem program. This program can be obtained by calling the BMPnet Help Desk at (301) 403-8179 or it can be downloaded from the World Wide Web at <http://www.bmpcoe.org>. To receive a user/e-mail account on the BMPnet, send a request to [helpdesk@bmpcoe.org](mailto:helpdesk@bmpcoe.org).



# Appendix E

## ***Best Manufacturing Practices Satellite Centers***

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There are currently seven 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; identify regional experts for inclusion in the BMPnet SIG e-mail; and train regional personnel in the use of BMP resources such as the BMPnet.

The seven BMP satellite centers include:

### **California**

#### **Chris Matzke**

BMP Satellite Center Manager  
Naval Warfare Assessment Division  
Code QA-21, P.O. Box 5000  
Corona, CA 91718-5000  
(909) 273-4992  
FAX: (909) 273-4123  
cmatzke@bmpcoe.org

#### **Jack Tamargo**

BMP Satellite Center Manager  
257 Cottonwood Drive  
Vallejo, CA 94591  
(707) 642-4267  
FAX: (707) 642-4267  
jtamargo@bmpcoe.org

### **District of Columbia**

#### **Margaret Cahill**

BMP Satellite Center Manager  
U.S. Department of Commerce  
14th Street & Constitution Avenue, NW  
Room 3876 BXA  
Washington, DC 20230  
(202) 482-8226/3795  
FAX: (202) 482-5650  
mcahill@bxa.doc.gov

### **Illinois**

#### **Thomas Clark**

BMP Satellite Center Manager  
Rock Valley College  
3301 North Mulford Road  
Rockford, IL 61114  
(815) 654-5515  
FAX: (815) 654-4459  
adme3tc@rvcux1.rvc.cc.il.us

### **Michigan**

#### **Maureen H. Reilly**

SAE/BMP Satellite Center Manager  
3001 W. Big Beaver Road, Suite 320  
Troy, MI 48084-3174  
(724) 772-8564  
FAX: (724) 776-0243  
reilly@sae.org

#### **Roy T. Trent**

SAE/BMP Automotive Manufacturing Initiative  
Manger  
3001 W. Big Beaver Road, Suite 320  
Troy, MI 48084-3174  
(248) 652-8461  
FAX: (248) 652-8662  
boulder@ees.eesc.com

### **Pennsylvania**

#### **Sherrie Snyder**

BMP Satellite Center Manager  
MANTEC, Inc.  
P.O. Box 5046  
York, PA 17405  
(717) 843-5054, ext. 225  
FAX: (717) 854-0087  
snyderss@mantec.org

### **Tennessee**

#### **Tammy Graham**

BMP Satellite Center Manager  
Lockheed Martin Energy Systems  
P.O. Box 2009, Bldg. 9737  
M/S 8091  
Oak Ridge, TN 37831-8091  
(423) 576-5532  
FAX: (423) 574-2000  
tgraham@bmpcoe.org

# Appendix F

## *Navy Manufacturing Technology Centers of Excellence*

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The Navy Manufacturing Sciences and Technology Program established the following 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 Navy centers and laboratories. These COEs are consortium-structured for industry, academia, and government involvement in developing and implementing technologies. Each COE has a designated point of contact listed below with the individual COE information.

### **Best Manufacturing Practices Center of Excellence**

The Best Manufacturing Practices Center of Excellence (BMPCOE) provides a national resource to identify and promote exemplary manufacturing and business practices and to disseminate this information to the U.S. Industrial Base. The BMPCOE was established by the Navy's BMP program, Department of Commerce's National Institute of Standards and Technology, and the University of Maryland at College Park, Maryland. The BMPCOE improves the use of existing technology, promotes the introduction of improved technologies, and provides non-competitive means to address common problems, and has become a significant factor in countering foreign competition.

Point of Contact:  
Mr. Ernie Renner  
Best Manufacturing Practices Center of Excellence  
4321 Hartwick Road  
Suite 400  
College Park, MD 20740  
(301) 403-8100  
FAX: (301) 403-8180  
ernie@bmpcoe.org

### **Center of Excellence for Composites Manufacturing Technology**

The Center of Excellence for Composites Manufacturing Technology (CECMT) provides a national resource for the development and dissemination of composites manufacturing technology to defense contractors and subcontractors. The CECMT is managed by the GreatLakes Composites Consortium and represents a collaborative effort among industry, academia, and government to develop, evaluate, demonstrate, and test composites manufacturing technologies. The technical work is problem-driven to reflect current and future Navy needs in the composites industrial community.

Point of Contact:  
Dr. Roger Fountain  
Center of Excellence for Composites Manufacturing Technology  
103 Trade Zone Drive  
Suite 26C  
West Columbia, SC 29170  
(803) 822-3705  
FAX: (803) 822-3730  
rfglcc@glcc.org

### **Electronics Manufacturing Productivity Facility**

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 industry, university, and government participants, led by the American Competitiveness Institute under a CRADA with the Navy.

Point of Contact:  
Mr. Alan Criswell  
Electronics Manufacturing Productivity Facility  
Plymouth Executive Campus  
Bldg 630, Suite 100  
630 West Germantown Pike  
Plymouth Meeting, PA 19462  
(610) 832-8800  
FAX: (610) 832-8810  
<http://www.engriupui.edu/empf/>

### **National Center for Excellence in Metalworking Technology**

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. The NCEMT, operated by Concurrent Technologies Corporation, helps the Navy and defense contractors improve

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manufacturing productivity and part reliability through development, deployment, training, and education for advanced metalworking technologies.

Point of Contact:

Mr. Richard Henry  
National Center for Excellence in Metalworking  
Technology  
1450 Scalp Avenue  
Johnstown, PA 15904-3374  
(814) 269-2532  
FAX: (814) 269-2799  
henry@ctc.com

### **Navy Joining Center**

The Navy Joining Center (NJC) is operated by the Edison Welding Institute and 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.

Point of Contact:

Mr. David P. Edmonds  
Navy Joining Center  
1100 Kinnear Road  
Columbus, OH 43212-1161  
(614) 487-5825  
FAX: (614) 486-9528  
dave\_edmonds@ewi.org

### **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 energetics. The focus of the EMTC is on process technology with a goal of reducing manufacturing costs while improving product quality and reliability. The COE also maintains a goal of development and implementation of environmentally benign energetics manufacturing processes.

Point of Contact:

Mr. John Brough  
Energetics Manufacturing Technology Center  
Indian Head Division  
Naval Surface Warfare Center  
Indian Head, MD 20640-5035  
(301) 743-4417  
DSN: 354-4417  
FAX: (301) 743-4187  
mt@command.nosih.sea06.navy.mil

### **Manufacturing Science and Advanced Materials Processing Institute**

The Manufacturing Science and Advanced Materials Processing Institute (MS&AMPI) is comprised of three centers including the National Center for Advanced Drivetrain Technologies (NCADT), The Surface Engineering Manufacturing Technology Center (SEMTC), and the Laser Applications Research Center (LaserARC). These centers are located at The Pennsylvania State University's Applied Research Laboratory. Each center is highlighted below.

Point of Contact for MS&AMPI:

Mr. Henry Watson  
Manufacturing Science and Advanced Materials  
Processing Institute  
ARL Penn State  
P.O. Box 30  
State College, PA 16804-0030  
(814) 865-6345  
FAX: (814) 863-1183  
hew2@psu.edu

- **National Center for Advanced Drivetrain Technologies**

The NCADT supports DoD by strengthening, revitalizing, and enhancing the technological capabilities of the U.S. gear and transmission industry. It provides a site for neutral testing to verify accuracy and performance of gear and transmission components.

Point of Contact for NCADT:

Dr. Suren Rao  
NCADT/Drivetrain Center  
ARL Penn State  
P.O. Box 30  
State College, PA 16804-0030  
(814) 865-3537  
FAX: (814) 863-6185  
[http://www.arl.psu.edu/drivetrain\\_center.html](http://www.arl.psu.edu/drivetrain_center.html)

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- **Surface Engineering Manufacturing Technology Center**

The SEMTC enables technology development in surface engineering—the systematic and rational modification of material surfaces to provide desirable material characteristics and performance. This can be implemented for complex optical, electrical, chemical, and mechanical functions or products that affect the cost, operation, maintainability, and reliability of weapon systems.

Point of Contact for SEMTC:  
Dr. Maurice F. Amateau  
SEMTC/Surface Engineering Center  
P.O. Box 30  
State College, PA 16804-0030  
(814) 863-4214  
FAX: (814) 863-0006  
[http://www.arl.psu.edu/divisions/arl\\_org.html](http://www.arl.psu.edu/divisions/arl_org.html)

- **Laser Applications Research Center**

The LaserARC is established to expand the technical capabilities of DOD by providing access to high-power industrial lasers for advanced material processing applications. LaserARC offers basic and applied research in laser-material interaction, process development, sensor technologies, and corresponding demonstrations of developed applications.

Point of Contact for LaserARC:  
Mr. Paul Denney  
Laser Center  
ARL Penn State  
P.O. Box 30  
State College, PA 16804-0030  
(814) 865-2934  
FAX: (814) 863-1183  
[http://www.arl.psu.edu/divisions/arl\\_org.html](http://www.arl.psu.edu/divisions/arl_org.html)

- **Gulf Coast Region Maritime Technology Center**

The Gulf Coast Region Maritime Technology Center (GCRMTC) is located at the University of New Orleans and will focus primarily on product developments in support of the U.S. shipbuilding industry. A sister site at Lamar University in Orange, Texas will focus on process improvements.

Point of Contact:  
Dr. John Crisp  
Gulf Coast Region Maritime Technology Center  
University of New Orleans  
Room N-212  
New Orleans, LA 70148  
(504) 286-3871  
FAX: (504) 286-3898

# Appendix G

## *Completed Surveys*

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As of this publication, 99 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 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 400  
College Park, MD 20740  
Attn: Mr. Ernie Renner, Director  
Telephone: 1-800-789-4267  
FAX: (301) 403-8180  
ernie@bmpcoe.org

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<b>1985</b>	Litton Guidance & Control Systems Division - Woodland Hills, CA
<b>1986</b>	Honeywell, Incorporated Undersea Systems Division - Hopkins, MN (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
<b>1987</b>	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 (Paramax)
<b>1988</b>	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 <sup>3</sup> Systems Sector - Needham Heights, MA
<b>1989</b>	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 Standard Industries - LaMirada, CA Engineered Circuit Research, Incorporated - Milpitas, CA Teledyne Industries Incorporated Electronics Division - Newbury Park, CA Lockheed Aeronautical Systems Company - Marietta, GA Lockheed Corporation Missile Systems Division - Sunnyvale, CA Westinghouse Electronic Systems Group - Baltimore, MD General Electric Naval & Drive Turbine Systems - Fitchburg, MA Rockwell International Corporation Autonetics Electronics Systems - Anaheim, CA TRICOR Systems, Incorporated - Elgin, IL
<b>1990</b>	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

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- 1991**      *Resurvey of Litton Guidance & Control Systems Division* - Woodland Hills, CA  
Norden Systems, Inc. - Norwalk, CT  
Naval Avionics Center - Indianapolis, IN  
United Electric Controls - Watertown, MA  
Kurt Manufacturing Co. - Minneapolis, MN  
MagneTek Defense Systems - Anaheim, CA  
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  
*(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  
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  
Alpha Industries, Inc. - Methuen, MA
- 
- 1994**      Harris Semiconductor - Melbourne, FL  
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  
Stafford County Public Schools - Stafford County, VA
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- 1995**      Sandia National Laboratories - Albuquerque, NM  
Rockwell Defense Electronics Collins Avionics & Communications Division - Cedar Rapids, IA  
*(Resurvey of Rockwell International Corporation Collins Defense Communications)*  
Lockheed Martin Electronics & Missiles - Orlando, FL  
McDonnell Douglas Aerospace (St. Louis) - St. Louis, MO  
*(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  
Department of Energy, Oak Ridge Operations - Oak Ridge, TN

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**1997**

Headquarters, U.S. Army Industrial Operations Command - Rock Island, IL

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

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