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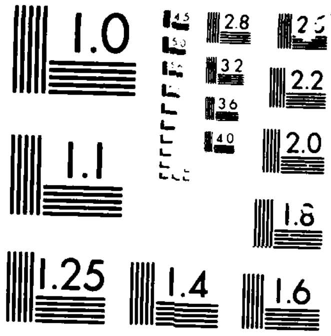
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MANAGEMENT METHODS FOR QUALITY IMPROVEMENT BASED ON STATISTICAL PROCESS CONTROL: A LITERATURE AND FIELD SURVEY

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This report presents the findings of a study on statistical process control (SPC) management approaches. SPC management approaches are intended to improve an organization's productivity and product or service quality by reducing variation in the work process. The study was conducted to identify similarities and distinctions among SPC management approaches, evaluate the use of commercial SPC training packages in normal industrial facilities, and attempt to identify requirements and barriers to implementing SPC management systems in naval industrial facilities.

Information for this study was obtained through reviews of SPC management literature and visits to private businesses and naval industrial facilities that use SPC management approaches.

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Results of the study indicate that SPC management approaches emphasize the use of elementary statistics to monitor and analyze process performance by managers and workers, long-term orientation toward quality improvement, and increased intraorganizational communication and cooperation. The SPC management approaches differed with regard to implementation strategies, assignment of responsibility for quality improvement efforts, and consideration of individual behavior. The review of training packages failed to identify a sole source capable of meeting the requirements of naval industrial facilities for SPC instruction.

Analysis indicated that development of a sound implementation rationale, top management commitment, and long-term resource allocation were some of the critical requirements for implementation of SPC management approaches in naval industrial facilities. The selection of vendors on the basis of lowest price and emphasis on appraising short-term, individual performance were identified as some of the barriers to implementation of SPC management approaches in naval industrial facilities.

FOREWORD

This report presents the findings of a study on statistical process control (SPC) management practices. It was sponsored by the Chief of Naval Material (NAVMAT-01M) and funded by Work Request No. 45L36, entitled Management Methods for Quality Improvement Based on Process Analysis and Control.

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Technical Director

SUMMARY

Problem

The Navy is currently working to increase the size of the Fleet without corresponding increases in the maintenance budget. In light of that situation, it is critical that the Navy adopt management systems such as statistical process control (SPC) to achieve and maintain quality (Taft, 1985). SPC management approaches are intended to improve an organization's productivity and product or service quality by reducing variation in the work process. These approaches have been found to improve performance in a variety of industrial settings. The requirements in order to implement SPC management approaches in naval repair and maintenance organizations, however, still must be determined.

Purpose

The purposes of this research were to: (1) identify the basic characteristics of SPC management approaches, (2) distinguish among the major SPC management approaches, (3) determine the suitability of commercial SPC training programs for use in naval facilities, (4) identify those conditions within naval repair and maintenance organizations necessary for the development of SPC management approaches, and (5) begin to identify policies and practices in naval repair and maintenance facilities that inhibit use of SPC management approaches.

Approach

Several sources of information were used during this study and included: (1) site visits to private sector organizations and naval activities using SPC management approaches, (2) review of 56 SPC training course descriptions and 10 computer software packages, and (3) perusal of various journal articles and books.

Results

It was found that the three major SPC management approaches investigated had 12 characteristics in common. The characteristics included increased management involvement in process improvement, long-term efforts to remove defect-producing factors in a process, improved organizational communications and coordination, and the use of statistical analysis.

Based on visits to six Navy facilities and nine private sector sites, the researchers determined that the principles of W. E. Deming, J. M. Juran, and P. B. Crosby represented three major approaches to SPC. The core of Deming's approach is a set of 14 management principles which emphasize the critical role of top management in process control. Juran's approach is based on an 8-step problem-solving "breakthrough sequence." Crosby's approach is built on 4 quality principles and a 14-step quality improvement plan.

Seven conditions were identified as being necessary for the effective development of SPC in naval repair and maintenance activities: (1) a clear and sound rationale for adopting an SPC approach, (2) understanding and acceptance by the organization's top management of SPC methods as an effective means to improve quality, (3) commitment of personnel, funds, and time to develop an SPC approach, (4) establishment of policies and practices which support and institutionalize the SPC approach, (5) integration of the SPC approach with the existing quality assurance program, (6) a high level quality control

advocate, and (7) some short-term quality improvements to mitigate the effects of military turnover and encourage continued use of the SPC approach.

Training packages for organizations that intend to use SPC methods were found to fall into one of three categories: (1) material developed by Deming, Juran, and Crosby, (2) material on SPC philosophies and principles developed by organizations independent of Deming, Juran, and Crosby, and (3) material that emphasizes the statistical methods used in SPC management approaches. At most of the sites visited a combination of training materials was used, the particular combination dependent on the initial SPC approach adopted, the skills and abilities of the people to be trained, and the length and extent of the SPC implementation.

Through interviews at naval repair and maintenance activities six practices that could work against the successful use of an SPC approach were identified: (1) the perception that quality is the concern and sole responsibility of the quality assurance department, (2) quality assurance and management policies and practices that overemphasize individual accountability for quality, (3) the scheduled rotation of top military management that could make it difficult to develop the consistent support required for an SPC approach, (4) the practice of evaluating managers on short-term accomplishments rather than contributions to the long-term improvement of quality, (5) appraisal and incentive systems that emphasize schedule and quantity instead of quality, and (6) procurement regulations and guidelines that emphasize awarding contracts to the lowest bidder instead of requiring statistical evidence of quality.

Conclusions

Based on site visits to naval and private facilities, it was concluded that:

1. SPC is a feasible approach to quality improvement in naval shipyards and air rework facilities.

2. SPC management methods are useful when applied to both production and non-production functions of organizations.

3. The participation of top management is critical to implementation and institutionalization of SPC. Participation can take the form of attendance at SPC courses, work on steering or other executive committees for process control, and allotment of time and personnel for SPC efforts.

4. Regardless of the soundness of the specific approach, it will not be effectively used if the necessary resources, such as time, money, and personnel, are not made available.

5. The value of any of these approaches cannot be judged without considering the nature of the organization that intends to use it. The choice of an approach, thus, should not be based solely on the characteristics of that approach but also on its compatibility with the adopting organization. It is possible, and in some cases advisable, to combine elements of different SPC approaches and training packages. By doing so, an organization can develop an SPC system tailored to its particular needs.

6. Organizational changes must be made to accommodate and sustain the program. Examples include: vendor selection policies, departmental restructuring, quality assurance activities, interdepartmental quality improvement efforts, and quality measurement

systems. Such changes can reduce some of the potential problems that may arise from the limited tenure of military managers.

7. A quality improvement program will not be effectively used if it is not accompanied by a shift in the perception of how work is accomplished. That is, the organization should be geared toward practices that emphasize defect prevention rather than defect detection and rework.

Recommendations

1. SPC management approaches should be used as a means of improving quality and productivity in naval repair and maintenance activities.

2. For successful implementation and institutionalization of SPC approaches, top management support must be obtained.

3. Use of SPC methods should be introduced through a systematic, phased approach.

4. SPC training programs specific to Navy shipyards and Naval Air Rework Facilities should be developed and supplemented with commercial training materials.

5. Training should be ongoing within each organization to encourage continuous use of SPC methods.

6. Pilot projects should be used to introduce SPC to the organization. Information from the pilot projects will be useful in tailoring the SPC management approach to the particular needs of the organization. The selection of the projects should strike a balance between problem magnitude, estimated time for its solution, and probability of success.

Future Research Considerations

The following two research objectives are important to any future investigation of SPC implementation within a naval repair or maintenance organization: (1) continuing examination of policies and practices that could impede the use of SPC in the Navy, and (2) identification of the organizational and management resources needed to support its use.

The first research objective can be addressed by examining present attempts to use SPC diagnostic and problem-solving techniques in naval organizations. Both objectives can be met by developing a pilot project in a large organization that offers a full range of opportunities for developing SPC as a management approach.

CONTENTS

INTRODUCTION

Background and Problem

Statistical process control (SPC) techniques were developed by Walter Shewhart at Bell Labs in the U.S. in the 1920s. These techniques were used in the defense industries during World War II to maximize product quality. Decreases in the demand for products from the military industries after the war led to diminished requirements for the use of SPC techniques in U.S. industry. At the same time that the use of SPC in the U.S. was waning, it was gaining acceptance in Japan. U.S. experts in SPC were sent to Japan to work with industrial leaders to help them reestablish their industrial base (Holland, 1983). The extensive use of SPC and supporting management techniques by the Japanese is credited with their current reputation as world leaders in quality control.

SPC is used to maximize product quality through control of work processes rather than through postproduction inspection. In general, SPC involves the analysis of such critical process components as materials, equipment, and procedures used to create products or services. The seven basic analytic techniques associated with SPC quality efforts are: flowcharts, cause-and-effect diagrams, Pareto diagrams, histograms, scatter diagrams, run charts, and control charts (Ishikawa, 1983).

These graphic tools are used in combination with group problem-solving methods, such as brainstorming and nominal group interview techniques, to "control" process. Statistical process "control" consists of the identification and removal of systemic causes of defects and reduction of variation in the critical process components. Once a process has attained a state of statistical control, it is expected to consistently create defect-free products or services. Products and services without defects eliminate waste and rework costs, minimize inspection costs, and lead to increased productivity (Garvin, 1983).

In order to obtain full benefits from the SPC techniques, major proponents of quality improvement (Crosby, 1979, 1984; Deming, 1982; Juran, 1981b) have identified management practices that enhance their use. These management practices coupled with SPC techniques are expected to lead to a sustained, organization-wide total quality control effort (Ishikawa & Lu, 1985).

The Navy is currently working to increase the size of the Fleet while minimizing any corresponding increases in the maintenance budget. In their effort to minimize maintenance costs and meet new quality requirements (Taft, 1985), naval industrial facilities are implementing SPC management approaches.

Purpose

The purposes of this study were to determine the following: (1) characteristics of major SPC management approaches, (2) distinctions between the major approaches, (3) suitability of commercial SPC training programs for the Navy, (4) conditions necessary for the development of SPC management approaches in Navy maintenance organizations, and (5) policies and practices that could inhibit use of SPC in Navy maintenance organizations. The last two topics were of such magnitude that this research represents only the beginning of an on-going effort to address them.

APPROACH

Information for this study was obtained through site visits, attendance at SPC management courses, and review of SPC materials. A brief description of these data collection methods follows.

Site visits to nine private businesses and six naval industrial facilities were made. The private businesses were selected on the basis of three criteria: (1) they used recognized SPC management approaches, (2) the SPC management approaches were well-established in the organizations (i.e., enduring and multidepartmental), and (3) major SPC management approaches (i.e., Deming, Juran, and Crosby) were represented in the sample. To maintain the confidentiality promised during interviews, the names of the companies visited have not been disclosed. It should be noted, however, that the sample consisted of major U.S. corporations from a variety of manufacturing areas. The naval industrial facilities visited consisted of five shipyards and one Naval Air Rework Facility (NAVAIREWORKFAC). These organizations were in the initial stages of implementing SPC management approaches. They were selected to provide preliminary information on any unique requirements of and barriers to SPC management approaches in naval industrial facilities. It should be noted that the SPC management approaches identified during the visits to private business also were being considered for use by the naval industrial facilities (see Table 1).

Forty-four interviews were conducted during the study. The interviewees included private consultants, managers, general foremen, workers, and quality assurance inspectors. A semi-structured format was used during the interviews. General questions such as the following were used to direct discussion:

- How would you characterize your approach to SPC?
- Why was the approach initiated?
- How long has the approach been used?
- How is the approach managed?
- Have you used consultants?
- Describe your training program.
- What SPC analytic methods are being used?
- What has been the reaction to the approach?
- Has using the approach helped?
- Do you have any recommendations on implementing an SPC management approach?

Additional questions were asked concerning potential barriers to implementing SPC management approaches in naval industrial facilities.

The information on commercial SPC training was obtained from the following sources: Deming's videotape training program Quality, Productivity and Competitive Position (1981); Juran on Quality Improvement Workbook, (1981b) and selected videotapes from the Juran on Quality Improvement series (1981a); attendance at a 4-day Deming seminar, QUALPRO's 5-day seminar on techniques of statistical quality control, and a 4-day seminar on teaching statistical methods to production workers.

Information also was collected on 10 statistical computer software packages that were designed to support an SPC management approach.

Table 1

Information on Private and Public Organizations Visited During the Study

Name of Company/ Organization	Products	Major SPC Approach	Approximate Length of Use (Years)
Company A	Computer magnetic storage material	Crosby	1.5
Company B	Automobiles	Deming	4.0
Company C	Lasers, CRTs	In-house	1.5
Company D	Automobile parts	Deming	3.5
Company E	Toys	Crosby	2.5
Company F	Computers	Juran	3.0
Company G	Cameras, film	In-house	2.5
Company H	Automobiles	Deming	4.0
Company I	Oscilloscopes, microcircuits	Juran	4.0
Shipyard A	Ship overhaul	In-house/ Juran	0.5
Shipyard B	Ship overhaul	In-house/ Crosby	0.5
Shipyard C	Ship overhaul	Juran	pre-implementation
Shipyard D	Ship overhaul	In-house/ Deming	2.0
Shipyard E	Ship overhaul	In-house/ Juran	0.3
NAVAIREWORKFAC	Aircraft repair	Deming	pre-implementation

Among the literature reviewed were Deming's Quality, Productivity, and Competitive Position (1981); Juran's Quality Control Handbook (1974); The Juran Report (1983); Crosby's Quality is Free (1979); and Quality Without Tears (1984). Other articles, books, and videotapes relating to SPC management were reviewed (see Bibliography).

RESULTS AND DISCUSSION

Basic Characteristics of SPC Management Approaches

It was clear from the literature review and site visits that SPC management approaches are applied to more than manufacturing functions. The involvement of staff functions such as product design, planning, and purchasing was perceived as critical to achieving maximum benefits in quality and productivity (Tribus, 1983). Regardless of the type of business, adopted approach, or specific organization, the following characteristics were found to be common to all.

1. The active involvement of top management in SPC management was reported as a critical requirement for success. Involvement of top management included: (a) training in SPC methods; (b) forming and participating in SPC executive and steering committees; (c) developing a greater understanding of work processes; (d) developing a long-term quality improvement orientation through planning and budgeting activities; (e) providing workers with the appropriate training, equipment, support, and organizational climate needed for quality work; and (f) selecting vendors based on statistical evidence of quality (Gitlow & Hertz, 1983).

2. Statistical evidence was used as the basis for developing actions to improve quality.

3. Organizations emphasized attention to system functioning rather than to individual behavior.

4. Emphasis was placed on the need to identify and work on causes of poor quality that were systemic in nature rather than those that were tied to individual performance.

5. Emphasis was on removing defect-producing factors in a process rather than using inspection to filter out defective products.

6. Programs dealt with quality improvement in a systematic rather than piecemeal fashion that considered long-term rather than short-term goals.

7. The need for increased inter- and intradepartmental communication to solve problems was recognized.

8. Use was made of simple data collection methods to study processes, identify areas for improvement, and evaluate prescribed actions.

9. The need was recognized for training in quality management, measurement, and analysis.

10. It was also recognized that different levels in the organization required different types of training.

11. Alterations in organization structure were required. The alterations took such forms as reducing levels of management, creating a vice-presidency position for quality, and developing a statistician position that reported directly to the chief executive officer.

12. The success of these programs depended, in part, on the presence of a high level quality improvement advocate.

Major SPC Management Approaches

The approaches of W. Edwards Deming, Joseph M. Juran, and Philip B. Crosby were identified through interviews and literature reviews as the major SPC management approaches (Smith, 1982). Information on these approaches is presented in two sections. The first section presents brief biographical sketches of each SPC management proponent, followed by a description of his specific approach. The second section describes major distinctions between the approaches.

Description of Approaches

Deming. Dr. W. Edwards Deming is a statistician who has received a great deal of credit for Japan's quality revolution (Ringle, 1981). The prestigious Japanese Deming Prize, awarded to companies and individuals for outstanding accomplishments in quality improvement and management, was named in his honor. Deming is a university professor and consultant who lectures extensively throughout the United States and abroad.

Deming initially emphasized the use of statistical techniques, particularly control charting, to analyze and control process quality. Experience with organizations trying to improve quality led Deming to realize the key role of management attitudes and behaviors in a total quality effort. Although the statistical techniques are of no less importance, his major emphasis is now on management and its duties and responsibilities. Deming maintains that the cause of 85 percent of process problems and product errors are correctable only through managerial action and not through improved workers' attitudes or inspection. Such critical factors as vendor quality, training, intra-organization communication, and condition of equipment are the responsibility of management. Management must develop a full understanding of the processes within the organization and continuously work to remove defect-producing factors in the system (Main, 1984). The core of the approach is Deming's 14 points for management (Process Management Institute, undated):

1. Create constancy of purpose towards improving products and services, allocating resources to provide for long-range needs rather than short-term profitability.

2. Adopt the new philosophy for economic stability by refusing to allow commonly accepted levels of delays, mistakes, defective materials, and defective workmanship.

3. Cease dependence on mass inspection by requiring statistical evidence of built-in quality in both manufacturing and purchasing functions.

4. Reduce the number of suppliers for the same item by eliminating those that do not qualify with statistical evidence of quality; end the practice of awarding business solely on the basis of price.

5. Search continually for problems in the system to constantly improve processes.

6. Institute modern methods of training to make better use of all employees.

7. Focus supervision on helping people do a better job; ensure that immediate action is taken on reports of defects, maintenance requirements, poor tools, inadequate operating definitions, or other conditions detrimental to quality.

8. Encourage effective, two-way communication and other means to drive out fear throughout the organization and help people work more productively.

9. Break down barriers between departments by encouraging problem solving through teamwork, combining the efforts of people from different areas such as research, design, sales, and production.

10. Eliminate use of numerical goals, posters, and slogans for the workforce that ask for new levels of productivity without providing methods.

11. Use statistical methods for continuing improvement of quality and productivity, and eliminate work standards that prescribe numerical quotas.

12. Remove all barriers that inhibit the worker's right to pride of workmanship.

13. Institute a vigorous program of education and retraining to keep up with changes in materials, methods, product design, and machinery.

14. Clearly define top management's permanent commitment to quality and productivity and its obligation to implement all of these principles.

Juran. Dr. J. M. Juran holds degrees in engineering and law and has been an executive in industry, a government administrator, and a university professor. Juran is internationally known for his work on statistical quality control. He is the editor of the Quality Control Handbook (1974) as well as the author of 12 books and over 200 published papers. Juran is head of the Juran Institute, an institution dedicated to quality improvement and management, and also lectures and consults extensively.

Juran's operational approach is represented by his "breakthrough sequence" (Juran, 1981a). The breakthrough sequence is the structure through which annual improvements in quality are achieved. Juran defines breakthrough as "the organized creation of beneficial change" and suggests that all breakthroughs follow the same sequence. The breakthrough sequence is:

1. Proof of the need.
2. Project identification.

3. Organization to guide each project.
4. Organization for diagnosis and for analysis of projects.
5. Diagnosis--breakthrough in knowledge.
6. Remedial action on the findings.
7. Breakthrough in cultural resistance to change.
8. Control at the new level.

For breakthrough to occur, all employees need to participate in improvement and have the skills needed to make the improvements. A committee of managers is formed to solicit project nominations from all employees, screen nominations, select the year's projects, and appoint teams to address each one. Each project team studies the problem's symptoms, formulates and tests hypotheses, identifies causes, and stimulates remedial actions. Project outcomes are documented and presented in the annual audit.

Crosby. Philip B. Crosby was trained in engineering and worked for many years in private industry. He was the corporate vice-president of quality for International Telephone and Telegraph before he founded Philip Crosby Associates, Inc., a quality management training and consulting enterprise. Crosby is also an internationally known consultant, lecturer, and author. He is the author of Quality is Free (1979) and Quality Without Tears (1984).

"Four absolutes" form the foundation of Crosby's approach (1979). They are:

1. Definition: Quality is defined as conformance to requirements.

2. Performance standard: The performance standard is zero defects or "do it right the first time" (i.e., meet the requirements the first time).

3. System: To obtain quality, a system of prevention rather than appraisal is required.

4. Measurement: The cost of quality (COQ) is measured. It is the cost of nonconformance or the expense of doing things wrong and includes the costs of scrap, rework, inspection, etc.

To achieve the four absolutes, Crosby advocates a 14-step program:

1. Management commitment to quality: Quality is defined as conformance to requirements and a company quality policy is prepared.

2. Establish a quality improvement team: The team guides the quality improvement program and is comprised of representatives of all departments, preferably department heads.

3. Determine measures of quality: The measures are indicative of the status of quality and are determined for all departments.

4. Evaluate COQ: The COQ indicates where corrective action is profitable and includes all prevention, appraisal, and failure costs.

5. Create awareness of quality: Inform everyone of the need for improvement and the cost of nonconformance, discuss and display quality measurements and identify nonconformance problems.

6. Take corrective action: Identify and resolve problems.

7. Establish zero defects program committee: The committee plans the zero defects program and informs everyone of the zero defects concept and program.

8. Train supervisors for their role in the quality management program: Supervisors are trained and then they train their employees.

9. Establish a zero defects day: All employees are given an orientation to the new philosophy and zero defects is established as the performance standard of the company.

10. Establish measurable quality improvement goals: Individual goals are determined by employees in meetings with supervisors.

11. Implement procedures for removing causes of errors: Employees describe barriers that keep them from attaining zero defects. There is immediate follow-up by the appropriate functional areas.

12. Give recognition for achievement: Recognize (not financially) those employees who meet goals or perform outstanding acts.

13. Establish a quality council: The council is comprised of quality professionals and team chairpersons and meets regularly to discuss quality-related matters.

14. Do it over again: A typical program takes 12-18 months.

Distinctions Between Approaches

All three quality consultants advocate the same basic philosophy. Elements of this philosophy include management's responsibility for most quality problems (80-90%), the need to provide workers the means to do a good job, and the need to minimize the use of postproduction inspection. Although their quality improvement approaches converge on these points, the approaches seem to differ in three areas. The following major distinctions were found:

Implementation strategy: Both Juran and Crosby provide systematic and clearly defined implementation plans for their SPC management approaches. Juran proposes team problem-solving projects organized around an eight-step "breakthrough sequence." Crosby advocates a 14-step company-wide quality awareness and improvement approach. Deming stresses the adoption of his 14 management principles but does not provide a specific implementation plan. He feels that each organization must identify and address its own unique requirements in adopting his principles.

Quality improvement responsibility: The Deming approach places its greatest emphasis on the requirement that managers continually improve work processes through the statistical monitoring of those processes. The Juran approach assigns the major responsibility for quality improvement to problem-solving teams. Juran teams are expected to find solutions to specific problems selected by top management on a yearly basis. The Juran approach places greater emphasis on specific problem removal than on general continuous process improvement. The Crosby approach attempts to systematically develop an individual commitment to quality improvement within each level of an organization. Although management is perceived as having the greatest impact on quality improvement, the attitudes and contributions of workers are specifically addressed in the Crosby approach.

Worker accountability: The Deming approach does not deal directly with the issue of worker-produced errors. Deming states that such errors can be resolved by the first-level supervisor. Under the Juran approach, training is provided that directly addresses the issue of worker-caused problems. Crosby places greater emphasis on worker accountability than either Juran or Deming. Under the Crosby approach, attempts to encourage worker commitment to quality improvement take the form of individual quality pledge cards, individual goal setting, and nonmonetary rewards for individual performance. Differences in the training approaches and materials also were noted. These differences will be discussed in the next section.

Suitability of Commercial SPC Training Programs for Navy Applications

Training packages for organizations that are using SPC or wish to begin its use fall into three general categories: (1) training material provided by Deming, Juran, and Crosby; (2) material from organizations independent of Deming, Juran, and Crosby that presents the general principles of SPC; and (3) material that emphasizes statistical methods.

Deming Training

Dr. Deming presents his approach through a 4-day seminar. Through the Center for Advanced Engineering Study, Massachusetts Institute of Technology, Dr. Deming has videotaped a condensed version of his 4-day seminar that is available for purchase and use in-house (Deming, 1981). The series of videotapes, entitled Quality, Productivity, and Competitive Position, consists of 16 one-hour tapes and is supplemented by a book of the same title. In comparison to the training materials of the other two approaches, that provided by Deming was found to be the most limited in terms of portability and documentation. The book and tapes emphasize Dr. Deming's management philosophy and present examples of its successful use. They do not specify any implementation plan, but rather the theoretical basis and value of the use of the Deming principles. Users reported that the Deming approach fell short in the actual use of the SPC analytic techniques and required supplemental training and consultation.

Juran Training

Training in the Juran SPC approach is achieved through the use of Juran on Quality Improvement videotapes and workbooks. The training package includes 16 half-hour videotapes, participants' workbooks, leaders' manuals, and a reference library of Juran's writings. To start the training process, an organization sends personnel who will serve as facilitators to a one-day leader training seminar. Following the seminar, the facilitators return to the organization to train selected teams of managers. The in-house training consists of 16 one-hour sessions. During each session, the participants view a 30-minute videotape, discuss the material covered in the tapes, and apply the Juran SPC techniques to a demonstration project. Reported strengths of the Juran training were its portability, focus on application and extensive documentation including a handbook, workbooks, and numerous published articles. Organizations using the Juran training found it useful on a project level. The project team approach provided a structured method to implement Juran's approach and was successful in addressing and solving problems. Some users felt the team problem-solving approach was too detailed to address larger organizational quality concerns; it emphasized the "how" but not the "why."

Crosby Training

The Crosby SPC approach involves an extensive series of training programs intended to instruct all levels of an organization. There are six basic courses associated with the Crosby approach: (1) Executive College, (2) Quality Improvement Process Management College, (3) Workshops, (4) Quality Education System Instructor's Course, (5) Quality Education System, and (6) Quality Awareness Experience. Some of these courses are for management and require attendance at Crosby College in Florida; others are conducted in-house using videotapes and workbooks for lower level employees. Books that describe the quality philosophy and implementation strategy of the Crosby approach are available (Crosby, 1979, 1984). A Crosby consultant is assigned to each participating organization and makes periodic visits to provide assistance during implementation and use. Of the three SPC training packages, the Crosby program provides the most extensive implementation support. Some users mentioned the desire for additional training in statistics and problem solving.

Training packages from the three major quality consultants were helpful to organizations implementing quality programs. They have various strengths and weaknesses; no one package is consistently superior to another. It should be emphasized that the degree to which any of these programs works depends on the willingness of the people to make it work.

Combined Use of Commercially Available Training

In most of the sites visited, more than one package was used for training. Some organizations used more than one of the major approaches, some used courses offered by other organizations, and some developed in-house courses. The need for supplemental courses and selection of the appropriate ones depended on the initial approach taken, the skills and abilities of the people to be trained, and the length and extent of involvement in the program. In most organizations, no one training package was found to address all needs over time, but many commercial training aids exist from which to fashion a total training program. Appendix A lists the SPC courses identified during the study.

Other aids to training are statistical software packages. Many organizations use multiple approaches to data collection, analysis, and graphic presentation. Examples included calculations by hand, use of computer software for analysis and graphic presentation, and barcode data entry systems. While statistical software is used in many organizations to analyze and chart process control data, it also may be useful for training. The appropriateness of packages is dependent on the organization's computer hardware and its need for specific statistics. Appendix B presents a description of SPC software reviewed during the study.

No single commercial training program was found to be superior for use by the Navy. Despite the fact that the Navy organizations visited had training programs that were not developed to the point that their full adequacy could be determined, it was anticipated that they would face the same issues as private organizations. These issues included the acceptance of the quality approaches and associated training packages by the organization and the need to modify or supplement the commercial training packages.

Conditions for the Development of SPC Systems in Naval Repair and Maintenance Activities

Based on an overview of the results of this investigation, a list of requirements for the development of SPC systems in naval repair and maintenance activities was generated.

1. A clear and sound rationale for the adoption of a quality program must be developed.

2. Top management must understand and accept SPC as a viable approach for quality improvement in their organization. This commitment may require support at the headquarters level.

3. Concrete organizational commitments (i.e., time, money) to carry out the SPC effort must be made. These resource commitments are needed for such necessary program components as training, forming steering committees or project teams, and redefining the jobs of managers and workers.

4. Mechanisms must be put in place that allow the SPC systems to continue to operate and become institutionalized. This process may require organizational changes in structure, policies, and practices to support the continuing use of the system.

5. Coordination must be established between SPC activities and the existing quality assurance program.

6. A high-level quality control advocate is needed to maintain visibility of process improvement issues.

7. Although adoption of an SPC approach is a long-term enterprise, frequent military command changeovers necessitate some early successes. Initial applications of SPC should maximize the possibility of such successes (e.g., projects of limited scope, information feedback within short time frame).

For information on the conditions present in the private businesses that were visited, see Appendix C.

Navy Policies and Practices That Could Inhibit Use of SPC in Naval Repair and Maintenance Activities

Since shipyards and NAVAIREWORKFACs are in the early stages of implementing SPC management approaches, all of the potential conflicts between Navy policies and these approaches probably were not addressed in the interviews. Those that were stated were often based on speculation rather than extensive experience. Further investigation of how SPC is implemented in naval industrial facilities will be needed to fully address this question.

Although the list is not complete, several potential impediments to implementation of SPC were identified during the site visits.

1. In naval repair and maintenance activities, quality is often perceived as the concern of the quality assurance department only. SPC management approaches

emphasize that quality is everyone's concern. The need for all departments, especially the production department, to have ownership of quality was noted in the interviews.

2. The individual appraisal system as currently used in shipyards and NAVAIREWORKFACs fails to encourage cooperation within and between functional areas, cooperation essential to the successful use of SPC.

3. The Navy uses cost as a major factor in selecting vendor services rather than statistical evidence of quality.

4. Legislation requires an "arm's length" relationship with vendors rather than a cooperative one.

5. The scheduled rotation of top military managers could make it difficult to develop consistent management support for an SPC approach. It is possible that the turnover of top military managers could lead to hesitancy on the part of civilian managers and workers to adopt such an approach. (Although SPC users in private industries considered management turnover to be a critical feature in SPC implementation success, it was their perception that the turnover rate between Navy military and private managers was not significantly different.)

6. The evaluation by headquarters of top military managers on short-term accomplishments could encourage them to use "quick fix" methods at the expense of long-term, sustained gains in quality.

7. The introduction of SPC in the nuclear shipyards might be difficult and politically sensitive due to the "hands off" policy at nuclear sites.

Navy policies and practices are changing to support the use of SPC in shipyards and NAVAIREWORKFACs. Examples include: (1) shipyard directives prescribing achievement of quality through process control rather than through inspection; (2) the purchase of the Juran videotapes by shipyards, indicating at least initial support for an effort to adopt SPC; and (3) establishment of a program in the NAVAIREWORKFACs in which artisans inspect and certify their own work. In conjunction with the artisans' certification, quality assurance specialists verify the quality of the work on a sampling basis. This program is compatible with SPC concepts.

CONCLUSIONS

1. The use of an SPC management approach to improve quality and productivity in naval repair and maintenance activities is feasible.

2. SPC management methods are useful when applied to both production and non-production functions of organizations.

3. The participation of top management is critical to implementation and institutionalization of SPC. Participation can take the form of attendance at SPC courses, work on steering or other executive committees for process control, and allotment of time and personnel for SPC efforts.

4. Regardless of the soundness of the specific approach, it will not be effectively used if the necessary resources, such as time, money, and personnel, are not made available.

5. The value of any of these approaches cannot be judged without considering the nature of the organization that intends to use it. The choice of an approach, thus, should not be based solely on the characteristics of that approach but also on its compatibility with the adopting organization. It is possible, and in some cases advisable, to combine elements of different SPC approaches and training packages. By doing so, an organization can develop an SPC system tailored to its particular needs (King & Brassard, 1984).

6. Organizational changes must be made to accommodate and sustain the program. Examples include: vendor selection policies, departmental restructuring, quality assurance activities, interdepartmental quality improvement efforts, and quality measurement systems. Such changes can reduce some of the potential problems that may arise from the limited tenure of military managers.

7. A quality improvement program will not be effectively used if it is not accompanied by a shift in the perception of how work is accomplished. That is, the organization should be geared toward practices that emphasize defect prevention rather than defect detection and rework.

RECOMMENDATIONS

1. SPC management approaches should be used as a means of improving quality and productivity in naval repair and maintenance activities.

2. For successful implementation and institutionalization of SPC approaches, top management support must be obtained.

3. Use of SPC methods should be introduced through a systematic, phased approach.

4. SPC training programs specific to Navy shipyards and NAVAIREWORKFACs should be developed and supplemented with commercial training materials.

5. Training should be ongoing within each organization to encourage continuous use of SPC methods.

6. Pilot projects should be used to introduce SPC to the organization. Information from the pilot projects will be useful in tailoring the SPC management approach to the particular needs of the organization. The selection of the projects should strike a balance between problem magnitude, estimated time for its solution, and probability of success.

FUTURE RESEARCH CONSIDERATIONS

The following two research objectives are important to any future investigation of SPC implementation within a naval repair or maintenance organization: (1) continuing examination of policies and practices that impede the use of SPC in the Navy, and (2) identification of the organizational and management structures needed to support its use.

The first research objective can be addressed by examining present attempts to use SPC in naval organizations. Both objectives could be met by developing a pilot project in a large organization that offers a full range of opportunities for developing an SPC management approach.

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APPENDIX A

COMMERCIAL SPC TRAINING PROGRAMS

COMMERCIAL SPC TRAINING PROGRAMS

Center for Advanced Engineering Study, Massachusetts Institute of Technology, 105 Massachusets Avenue, Cambridge, MA 02139.

Managing Systems of People and Machines for Quality and Productivity (seminar: 2 days). Instructors: W. Edwards Deming and M. Tribus.

Philip Crosby Associates, Inc., 807 West Morse Boulevard, P. O. Box 2369, Winter Park, FL 32790.

1. Executive College (course: 2.5 days).
2. Quality Improvement Process Management College (course: 5 days).
3. Workshops (course: 2.5 days).
4. Quality Education System Instructor's Course (course: 7 days).
5. Quality Education System (videotape/workshop: 15 2-hour sessions).
6. Quality Awareness Experience (seminar: 5 sessions).

The Deming Institute, 5735 San Vicente Street, Coral Gables, FL 33146.

1. The Deming Philosophy (seminar: 1 day).
2. Understanding the Deming Philosophy (seminar: 4 days).
3. Tools and Techniques of the Deming Philosophy (seminar: 4 days).
4. Company Applications: Discussion and Feedback (seminar: 2 days).
5. The Union's Role in the Deming Philosophy (seminar: 2 days).

Growth Opportunity Alliance of Greater Lawrence (GOAL), 28 Stafford Street, P. O. Box 1465, Lawrence, MA 01842.

1. Quality Function Deployment (course no: JA031, 1 day).
2. Introduction to Seven New Quality Planning Tools (course no: JA032, 1 day).
3. Self-inspection (course no: JA033, 1 day).
4. Better Control of Quality of Purchased Material (course no: ST021, 1 day).
5. Improving Quality and Productivity Through Marketing Research (course no: MA010, 1 day).
6. Management Methods for Quality and Productivity (course no: DE040, 4 days).
7. Implementing Deming's Fourteen Points (course no: DE042, 2 days).
8. Overview of the U.S. Quality Revolution (course no: DE041, 1 day).
9. Managing a Business Using Statistical Methods (course no: ST022, 4 days).
10. Case Study Seminar (course nos: CS060 and CS061, 1 day).
11. Seven Quality Planning Tools (course no: JA030, 2 days).
12. Improving Quality and Productivity During Manufacture Using Statistical Analysis (course no: ST020, 2 days).
13. Quality and Productivity in the Office (course no: QP070, 3 days).
14. Unions' Role in Quality and Productivity Improvement (course no: SP002, 1 day).
15. Area-wide Efforts (course no: SP003, 1 day).
16. In-depth Look at Japanese TQC (course no: JA034, 2 days).
17. Decision Theory and Bayesian Inference (course no: ST023, 2 days).

Institute for Quality and Productivity, University of New Hampshire and the Portsmouth Naval Shipyard, Kingsbury Hall, University of New Hampshire, Durham, NH 03824.

Implementing Company-wide Quality Improvement Programs (conference: 1 day).

Juran Institute Inc., 88 Danbury Road, Wilton, CT 06897.

1. Management of Quality (course: 4 days).
2. Upper Management and Quality (seminar: 1 day).
3. Juran on Quality Improvement (16 videotapes).

Management Development Programs. The College of Business Administration, University of Tennessee, Knoxville, TN.

Managing with Statistical Process Control to Achieve Productivity Through Quality. An intensive 1-week course designed for and limited to senior executives or a 3-week management development program.

Process Management Institute, One Paramount Plaza, Suite 360, 7801 East Bush Lake Road, Bloomington, MN 55435.

1. Executive Training (course no: 201, 2 days).
2. Manager Training (course no. 301, 5 days).
3. Employee Training (course no. 401, 2 days).
4. Descriptive Statistics (course no. 501, 5 days).
5. Statistical Process Control I (course no. 502, 5 days).
6. Statistical Process Control II (course no. 503, 5 days).
7. Statistical Inference (course no. 504, 5 days).
8. Professional Training (course no. 601, 10 days).

Quality Enhancement Seminars (QES), 1015 Gayley Avenue, Suite #275, Los Angeles, CA 90024.
Quality, Productivity, and Competitive Position (seminar: 4 days).

QUALPRO, 200 DeBush Lane, Powell, TN 37849.
1984 seminars: Japanese Methods for Quality and Productivity Improvement.

1. Techniques of Statistical Quality Control (seminar one: 5 days).
2. On-line Statistical Process Control (seminar two: 4 days).
3. Experimental Design Techniques for Upgrading Existing Production Processes (seminar three: 4 days).
4. Experimental Design Techniques for Designing and Developing Processes (seminar four: 4 days).
5. Statistical Methods for Improving Marketing and Sales Performance (seminar five: 4 days).
6. Development of a Company-wide Quality and Productivity Improvement Program (seminar six: 4 days).
7. Teaching Statistical Methods to Production Workers and Quality Circle Members (seminar seven: 4 days).

George Washington University. Continuing Engineering Education Program, Washington, D.C. 20052.

1. Operating a Business Using Statistical Methods (course no: 1130DC, 4 days).
2. Effective Management Through Statistical Process Control: Applying Proven Methods for Improving Productivity and Quality to Stay Cost-competitive (course no: 1126DC, 5 days).

3. Implementing Control Methods for Productivity and Quality (course no: 981DC, 4 days).
4. Managing Quality Improvement: Statistical Methods for Process Control and Breakthrough (course no: 1060, 4 days).
5. Bottom-line Benefits of Quality: In Nonmanufacturing Operations and Service Industries (course no: 1106DC, 3 days).
6. Quality Engineering: Establishing and Maintaining Control of Quality (course no: 598DC, 3 days).

APPENDIX B

CHARACTERISTICS OF SPC SOFTWARE PACKAGES

Characteristics of SPC Software Packages

Company, Package Title	Cost	Compatible Machines	Available on	Features
Perry Johnson Analysts - SPC Analyst	$1,135	IBM-PC, Apple I, II, IIe, Hewlett-Packard, Radio Shack, Victor 9000, Columbia 1600, Burroughs B20, Dec Rainbow, others	disks, tapes, cassette	$\bar{X}$, R $\bar{X}$ & variance charts. Outlines probable causes of out-of-control processes. Designs experiments. Helps determine eingineering tolerances. Evaluates inspection costs. Moving range, $\bar{p}$, X, N, Np charts. Periodic small sampling.
Software by the Pierson Co.; 3 programs: (1) SPC 1-Variable data	$195 $ 25 for 30-day trial	IBM PC, 2 drives, printer, printer interface, 48K Apple II, 1 drive, IBM color monitor, HP 7470A plotter	disks	(1) 250 data groups, 2-9 samples/group control limits, runs tests, determines process capability, histograms (IBM only) - stores up to 3 past control limits, produces summary tables, some interpretation.
(2) SPC 2-Attribute	$175	"	disks	(2) 250 data groups, some interpretation, np, p, u, c charts (IBM only), runs test. p charts into np charts np charts into p charts c charts into n charts n charts into c charts
(3) SPC 3-Moving average & range charts	$175	"	disks	(3) 250 data groups, 2 to 10 groups, moving R and average table. Some interpretation. Summary table (IBM only), 15 to 20 data groups. Number of groups may be changed.
(4) SPC - Versions 1 & 2	(a) $350 (b) $400	"	disks	Version 2 is larger (250 vs 300 data groups). X, R, moving average & range, attribute charts. Summary table. Some intrepretation. Mean, range, max, min, variance, standard deviation, skew, kurtosis.
(5) SPC - Version 3	$1,000	"	disks	Like 1 & 2 but comes with SPC manual, plotting package & up to 500 defined data groups.
Culvern-SQC Pack	$495	Apple 48K, IBM PC 64K, TI professional 128K, Victor 9000 with graphics	disks	$\bar{X}$, R, median, frequencies, histograms, p-charts, c, u, Pareto, Fishbone, X, median, moving average, variance. Used at Uniroyal, PET, Donnelly, Michael J. Cleary.
GTC Microstat Ltd. QC-Pro. IBM PC-2	(1) $600 (2) $300 (3) $375	Apple II, II+, IIe, 2 drives, Microtek, Epson printer drives display, Hercules text, IBM dot matrix IBM PC-two drives IBM dot matrix	disks	(1) Variable data analysis charts, frequencies, histograms, skew, kurtosis, moving average, variance, standard deviation, capability index/ratio. % out of specs, normal curve overlay. (2) Attribute data. P, c, u charts. (3) Reliable analysis (Weibull), plots on Weibull probability paper, regression, correlation, plots.
Penton Quality Alert	$795	Apple II, II+, IIe, IBM PC or PCXT, or "compatibles"; printer for IBM, Epson MX, FX with Graftnax graphics card	disks	Tutorials data, variable and attribute, histograms, descriptive stats, defect counts, charts, normal curves, some interpretation. Revisions free of charge.
Crosby Co. Stat Pack		IBM PC & XT, TI Professional Victor 9000, TRS 80 I, III, X, Campaq, Dot Corona, Chameleon, Columbia, Eagle, Wang, Zenith PC, Burroughs ET 200, Tandy 2000, TRS Model 100, 2 disk	disks	Charts. Problem paper Q COSTIV. Some interpretation. Technical support. Descriptive. Statistics.

APPENDIX C

SUMMARY OF INTERVIEWS WITH PRIVATE BUSINESSES THAT USE SPC

COMPANY BACKGROUND

1.	Company/Type of Business	2. Name of Program	3. Reason for Quality Improvement Program
A.	Computer magnetic storage material	Quality improvement process	Concern with profit margin, Japanese threat, customer request
B.	Automobiles	Statistical thinking, statistical methods, Deming process	NBC white paper, Japanese competition
C.	Lasers, CRTs, electro-optics	Total quality program	Mandate from higher level
D.	Automobile parts	-[a]	NBC white paper
E.	Toys	Quality improvement process	Product complaint and return rates
F.	Computers	Juran on quality improvement program	Japanese challenge, corporate decision
G.	Cameras, film	-	Threat for market share, decline in stock
H.	Automobiles	-	NBC white paper
I.	Oscilloscopes, microcircuits	Corporate quality assurance	High cost of quality

[a]No information obtained.

COMPANY BACKGROUND

4. Major Approach and Reason for it	5. Length of Program	6. Extent of Program
A. Crosby: polished package, easily used and modified, good follow-up support from Crosby consultant	1 and 1/2 years	Corporate-wide
B. Deming: NBC white paper	4 years	Corporate-wide, international, all functions
C. Mandatory quality circles and statistical process control: To involve everyone, to improve communication	1 and 1/2 years	Division-wide
D. Deming: NBC white paper	3 and 1/2 years	Division-wide
E. Crosby organization will outlive the person; Crosby approach more marketable than Juran and Deming	2 and 1/2 years	Corporate-wide, international, all functions
F. Juran: Corporate decision	3 years	Plant-wide
G. SPC analysis: to reduce rework and waste	2 and 1/2 years	Engineers and managers in manufacturing
H. Deming: NBC white paper	4 years	Plant-wide, many staffs of corporation
I. Juran, although all three used: Juran for problem solving, Crosby for top management support, Deming for statistics	4 years	Corporate-wide, on project basis

STRUCTURE

7. Quality Champion(s)	8. Steering Committee (SC) Objective	9. Steering Committee Composition
A. Director of Corporate QA and Administrator of Quality College	Determine corporate-wide quality goals and problem identification	All top officers of company
B. President of Corporation and Director of Statistical Methods	Coordinate Deming process and develop implementation strategy	VPs and GMs from every organization worldwide
C. Division Manager, Branch Manager, and Trend Analyst	No SC (quality circle coordinator monitors and coordinates circles; managers responsible for circles in their areas)	No SC
D. Director of QA	No SC (top management identifies problem areas)	No SC
E. Director, Requirement and Conformance	Show that top management is committed, provide direction, provide money	Major function heads
F. Plant General Manager and Manager of Quality Programs	Quality Advisory Board: Selects problems and teams	General Manager and immediate staff
G. Vice-President for Quality	No SC (matrix organization)	No SC
H. Director of Statistical Methods	No SC (Central reliability quality systems groups work on system improvements. Quality of Worklife coordinator establishes problem-solving teams for special problems)	No SC
I. Corporate QA	Corporate Quality Management Council oversees implementation	Corporate QA and top managers

OTHER COMMITTEES/TEAMS

	NAME	PURPOSE	MEMBERSHIP	DURATION
A.				
	1. Quality Improvement Teams (QITs)	Identify and prioritize problems at division level	Each division has QIT	8-10 members; six-month appointments
	2. Ad Hoc Committees	Action teams solve particular problems	Members assigned by QIT for particular problem	-
	3. Tiger Team	Aid steering committee and improve interdivision communication	10 members	-
	4. Tiger Assistance Group (TAG Team)	Aid ailing QITs	Subgroup of Tiger Team, ad hoc	-
B.				
	1. Floor teams	Monitor line process	All members of a line	Permanent
	2. Statistical Methods Council	Consult with floor teams	40 statisticians from all branches; meet regularly	Permanent
	3. Quality Plus	Quality improvement and communication; mandatory quality circles	About 10 members	Teams may disband, members may switch teams

C. Top management identifies problem areas. Staff statistical consultant establishes what is to be measured and charted. Shop volunteer assists consultant and becomes key player. Consultant then assumes advisory role.

OTHER COMMITTEES/TEAMS

	NAME	PURPOSE	MEMBERSHIP	DURATION
D.				
	1. QITs	Show that top management is committed, provide direction and money	Members are from plant or division. There are 38 QITs worldwide; all functions	-
	2. Quality Council	Determines corporate quality issues and policy	All QIT chairpersons are members; 38 members; semi-annual	-
E.	QITs	A QIT is akin to the quality improvement steering committee (QISC) except that it is for a plant or division. QITs do much the same things as the QISC, and they report to the QISC	There are 38 worldwide. The first QIT was formed 14 months before the last one	It took 6-7 months before the first improvements were reported
F.				
	1. Juran project teams	Solve specific problems and implement solutions	8-10 professionals	Weekly; 1 hour plus extra work; ad hoc, assigned by General Manager
	2. Quality circles	Work on problems within a work area	Voluntary	Permanent

OTHER COMMITTEES/TEAMS

	NAME	PURPOSE	MEMBERSHIP	DURATION
G.				
	Ad hoc problem-solving groups	Deal with problems as they occur	Composed of trained manufacturing engineers and managers	Number varies
H.				
	1. Managers' Council (administration teams)	Solves organization-wide problems	Top level managers	Permanent
	2. Plant Councils (business teams)	Solve plant problems	Superintendents	Permanent
	3. Core Groups (resource teams)	Solve work group and departmental problems	Professionals	Permanent
	4. Employee Participation Groups (operating teams)	Solve problems related to specific work area	Floor employees	One-half hour per week (production shuts down); permanent
I.				
	Pilot programs/sociotechnical analysis groups	Increase quality, decrease scrap, initial quick returns and continuous improvement	Composed of workers, foremen, department manager; corporate QA is statistical consultant	Number varies, weekly/daily, permanent (sociotechnical analysis groups are ad hoc)

TRAINING

11.	Consultant	12. Role/Function of Consultant	13. Direction of Training
A.	Philip Crosby Associates	Trainer, educator, consultant	Top-down
B.	W. Edwards Deming	Trains statisticians, some presentations, uses videotapes, feels consultant teaching a waste	Top-down
C.	In-house consultant	SPC trainer/consultant	-
D.	Dave Chambers and Don Wheeler	In-house statistical trainers and consultants	Top-down
E.	Philip Crosby Associates	Trainer and consultant	Top-down
F.	None	None	Top-down
G.	Outside consultant	Trouble-shooter/consultant	Top-down
H.	Two statisticians and Deming	Statisticians consult with teams, external evaluation by Deming	Top-down
I.	Two PhD statisticians from QA	Training/consultants	Top-down

TRAINING

14.	Courses - Title	15. Length - Description	16. Instructor
A.			
	1. Executive College	2 and 1/2 days; help executives understand role in quality improvement; emphasis on concepts of QI	Crosby Quality College and in-house consultants
	2. Quality Improvement Process Management College	5 days; instruct QIP panel on its role, emphasis on the techniques of QI	
	3. Quality Education System Instructor's Course	15 2-hour sessions; aimed at helping the individual understand his/her role in improving quality	
	4. Quality Awareness Experience	Focus on specific company problems with quality	
B.			
	1. Early Awareness	1 day	In-house consultants
	2. Applications of Statistical Methods	40 hours	
	3. Designed Experiments	-	
C.	-	4 hours over 4 days, basic charting	In-house consultants
D.	George Washington University (4-day course)	4 days; implementation of statistical quality control methods	In-house consultants

TRAINING

14.	Courses - Title	15. Length - Description	16. Instructor
E.			
	1. Executive College	2 and 1/2 days; help executives understand role in quality improvement; emphasis on concepts of QI	Crosby Quality College and in-house consultants
	2. Quality Improvement Process Management College	5 days; instruct QIP panel on its role; emphasis on the techniques of QI	
	3. In-house Quality Improvement Process Management	As B, modified by organization	
	4. Quality Education System Instructor's Course	15 2-hour sessions; aimed at helping the individual understand his/her role in improving quality	
	5. Quality Awareness Experience (under review)	Focus on specific company problems with quality	
F.	Juran on Quality Improvement Course	8 weeks; group problem-solving	In-house consultants
G.	Comprehensive, From Introduction to Statistics to Experimental Design	22 days, 1 day/week	In-house consultants--about 40 employees

TRAINING

14.	Courses - Title	15. Length - Description	16. Instructor
H.			
	1. Basic Course	Deming philosophy, statistics problem-solving	In-house consultants
	2. Basic Course (for specific plant)	40 hours of workshops	
	3. Team Skills Workshops		
I.			
	1. Fundamentals of Statistical Quality Control (SQC)	Basic tools of SQC, applications, total approach to quality management, work area applications	In-house consultants
	2. Applied Statistics for Engineers	Statistical principles and experimental design	
	3. Production Process Control	-	
	4. Designing for Reliability		

TRAINING

17.	Location of Training	18. Participants	19. Materials
A.	Winter Park, Florida and in-house		Provided by consultant
		1. Top executives	
		2. Managers of quality improvement programs (QIPs), QIT members	
		3. Management, supervisors, and professionals	
		4. Hourly workers	
B.	In-House	1. All employees	In-house consultants
		2. All employees	In-house consultants
		3. Supervisors, engineers	In-house consultants
C.	In-house	Personnel from all functional areas	In-house consultants
D.	In-house	Top managers	Commercial

TRAINING

17. Location of Training	18. Participants	19. Materials
E. Winter Park, Florida and in-house	1. Top executives 2. Managers of QIP, QIT members 3. Managers, QIT members 4. Management, supervisors, and professionals 5. Hourly workers	Provided by Philip Crosby
F. In-house	1. Top managers 2. Each project team	Juran videotapes, workbooks, General Electric quality circle materials
G. In-house	Quality Vice-President on down, by volunteers	Siegel's nonparametric statistics, Grant & Leavenworth, Ishikawa, Schaum's outline by Siegel

TRAINING

17. Location of Training	18. Participants	19. Materials
H. In-house	1. Manufacturing and engineering	In-house
	2. All employees	In-house
I. In-house	1. Managers, foremen, and line workers	In-house
	2. Engineers	In-house

SPC MATERIALS

	20. Spc Methods Used	21. Relationship of Quality Assurance (QA) to the Quality Improvement Program (QIP)
A.	Some charting and trend analysis taught in measurement section of the Crosby course	The Quality College is under both QA and training
B.	Control charts, problem-solving, designed experiments	QA now emphasizes managing processes
C.	Basic charting, Latin square/factoral design	Independent
D.	Control charting primarily by hourly workers	Director of QA is champion of program
E.	Using material covered in Crosby material	Champion is part of QA
F.	Some teams use statistics, some not taught in Juran course; mostly using basic techniques (1-7)	Better agreement on quality emphasis
G.	Advanced--almost all are beyond the first six basic methods	Reorganization of the company, decentralized; QA has stopped inspection in some areas
H.	From basics (1-7) to experimental design, Weibull plots	QA people now work on process improvement
I.	From basics (1-7) to experimental design, sociotechnical systems analysis groups, computer-assisted data gathering/analysis	Good results; corporation's QA has initiated current quality program

SPC MATERIALS

	22. Relationship of QA to Production	23. Quality Inspection
A.	-	-
B.	Some of the former QA functions now performed by engineers	Some have been eliminated
C.	Same as before	No change
D.	QA staff is aware of SPC, but have not implemented it because they did not feel line management would be supportive	-
E.	There is now a preventive engineering group	-
F.	Production now thinks of quality rather than just quantity; a lot more cooperation	No change
G.	-	Inspection decreased, eliminated in some areas, greatly decreased in others
H.	QA decentralized; as of April 1982, quality is production's responsibility	Uses no separate QA inspection--production officers are responsible
I.	Quality program deals specifically with selected production managers and their departments	Inspection decreased and decentralized

24. **Suppliers—Any Relationship Changes**

A. Using special workshop developed by Crosby College for those who deal with suppliers.

B. Establishment of long-term relationships with vendors has resulted in higher quality of supplies.

C. -

D. Have made some progress in requiring SPC data from vendors. Reduced number of vendors and require vendors to attend seminars.

E. Crosby approach has helped with supplier problems.

F. No change.

G. Has not been fully implemented. Some suppliers are being required to show SPC data, others have not.

H. Inspection has decreased; increased communication of needs between suppliers and workers. Supervisors working with suppliers to improve suppliers' products.

I. More aware of vendor defects. More apt to reject inferior supplies. No statistical data are required at present time.

25. **Acceptance by all Levels of the Organization**

A. -

B. Some rejection, but moving toward acceptance. Unions either neglect issue or show mild acceptance.

C. Vertical and horizontal communication has increased. Management is more receptive. QC circles more accepted by hourly workers, resulting in increased communication.

D. -

E. No decrease in customer complaints yet.

F. Good results. Works better with participatory style of management. Harder to use in areas without criterion measures (software development).

G. General and widespread acceptance.

H. Some initial problems with QA. Problems with top and middle management recognizing their own need of training; line workers reluctant to record errors due to previous repercussions.

I. Acceptance good within individual departments using SPC. Workers in affected areas were pleased.

26. **Monetary Savings**

A. Some examples given. $250,000 savings by making production of diskette more efficient.

B. Improvements in quality, grievances down, absenteeism down, and suggestions up. Can't show causal link with Deming process.

C. End of 1983 showed a $2.3 million savings, on-time delivery increased from 90 to 95 percent, product yield on 4 tubes has increased 10 percent.

D. Customer complaints dropped 66 percent. Quality index increased from 81 to 129 (145 = no defects).

E. Cost of quality has decreased over time.

F. Have increased amount of defect-free material shipped. One Juran team developed test equipment resulting in a first-year savings alone of over $1 million.

G. Large savings reported in camera division, less reprocessing and inspection.

H. Emphasis is on problems solved. Grievances down in one manufacturing area. Reported best safety record.

I. Scrap decreased from 15 to 4 percent. Realized savings roughly $240 million for fiscal 1983 with reported gross of $1.2 billion.

27. **Critical Components**

A. Commitment by management is the key. They must develop and sustain the new system. Cost of quality will get management's attention.

B. Top management commitment, need to train VPs on statistics. Need personnel evaluation changes. Have system reward teamwork and cooperation. Identify what causes management resistance and provide motivation to change.

C. Increased communication--supervisors/managers should not be group leaders. Training should emphasize how the individual and company can benefit. Mandatory quality circles were more productive. Familiarize everyone with problem-solving process. Top management must form quality circles from beginning.

D. Outside consultant very important to supplement training and teach how to collect and arrange data. Top management must be committed. The way to sell SPC to management is to show proven results of process control.

E. Top management must understand the SPC program and consider it a top priority. Define company quality policy. Must demonstrate to management and workers that time and money are committed.

F. Top management support. Must reevaluate present workload of supervisors and managers to allow time for implementing new system. Worker accountability, reports of findings, attendance of training seminars, etc. Use the approach most appropriate for the situation.

G. Quality leader, organizational structure, good in-house training capability.

H. Appoint top person in organization the quality leader. Understand principles and develop statement of philosophy. Use flow-charting and get a good understanding of the problem. Emphasize teamwork, training.

I. Top management must provide support and the necessary resources. Emphasis on training. Start with projects that show short-term results (60-90 days). Select process measures that are helpful to management.

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