Part 1: Management's Responsibility

1

Management's Role

THE PRIMARY ROLE OF MANAGEMENT is to provide employees with the leadership necessary to meet the goals of the organization. This leadership must reflect the principles of total quality management. These principles were presented in the Introduction: *leadership commitment, customer focus, training, empowerment and involvement, measurement, recognition and rewards, and communication.*

LEADERSHIP COMMITMENT

Management must first examine how they manage. Is their style tailored to encourage input from other managers and departments? Or is their style that of not allowing other departments or disciplines to influence their decisions? In other words, do they operate as team leaders or as *silos?* When I refer to managers operating as silos, I mean that they stand alone within the organizational structure by excluding input from other managers or departments. This concept is explained further below.

Silos

Management in the past relied on experts in given disciplines to develop systems and procedures to guide the organization. These experts headed up their own departments (silos) and had specialists working for them who created the culture and systems for the *silo master.*

The silo master made it clear to all other silo masters in the organization how his department functioned and that there would be no interference from other groups or departments. This allowed the silo master to keep control of his territory. This also assured that the other department managers did not fully understand the requirements for positive interaction between groups or departments within the organizational structure.

Here's a classic example of how silos can thwart satisfying customer requirements. The marketing group receives an order from a customer and tells the design group what the customer wants. The design group gives their interpretation of the customer's needs to the manufacturing engineering group. Manufacturing engineering tells manufacturing what process to use to create the product that will satisfy the needs of the customer. Manufacturing does their very best to manufacture the part according to criteria supplied by manufacturing engineering. The quality department inspects the final product and decides it is manufactured incorrectly. Rework is performed and the part is shipped to the customer. The customer rejects the part because it does not meet his requirements! (See Fig. 1-1.)

Management needs to break down silos in their organizations because they create waste, redundancy, and poor quality. We are getting better today at breaking down silos and allowing interaction through cross-functional team management. Management should evaluate themselves to determine if their management style is autocratic or team oriented.

Autocratic Management

I remember when I first started working. I was told that in order to succeed and to keep my job, I had to remember two rules. Rule 1: The boss is always right. Rule 2: When the boss is wrong, remember Rule 1. Those were the days when systems were more important than people. Employee involvement consisted of doing only what the boss told you to do, whether it made sense or not. Management felt that empowering the worker took control away from management.

Switching to a management style that encourages employee involvement and empowerment is a tough transition for many. Unless special training is provided for middle and first-line management, the transition may never take place. And, unless upper management invests and participates in this training, the organization is bound to fail. It will be overtaken by other organizations who have invested in their most valuable resource, their employees, and are cashing in on that investment. Employees of an enlightened organization contribute every day to improved operations and systems.

Once management has committed itself to breaking down silos, it must embrace the concept of *Team Management.*

Team Management

Gone are the days when managers are expected to be proficient in only one discipline. Today managers must be part of a management team, and they must have a working knowledge of their peers' responsibilities. For example, the quality manager needs to understand how design engineering, manufacturing engineering, purchasing, sales, production control, customer service, and every other department functions. And every other manager should know the roles of the others.

This is not to say that they need to be as well trained in the other disciplines as their peers, but they must understand how the entire organization functions. We want to break down silos so we can move freely throughout the or-

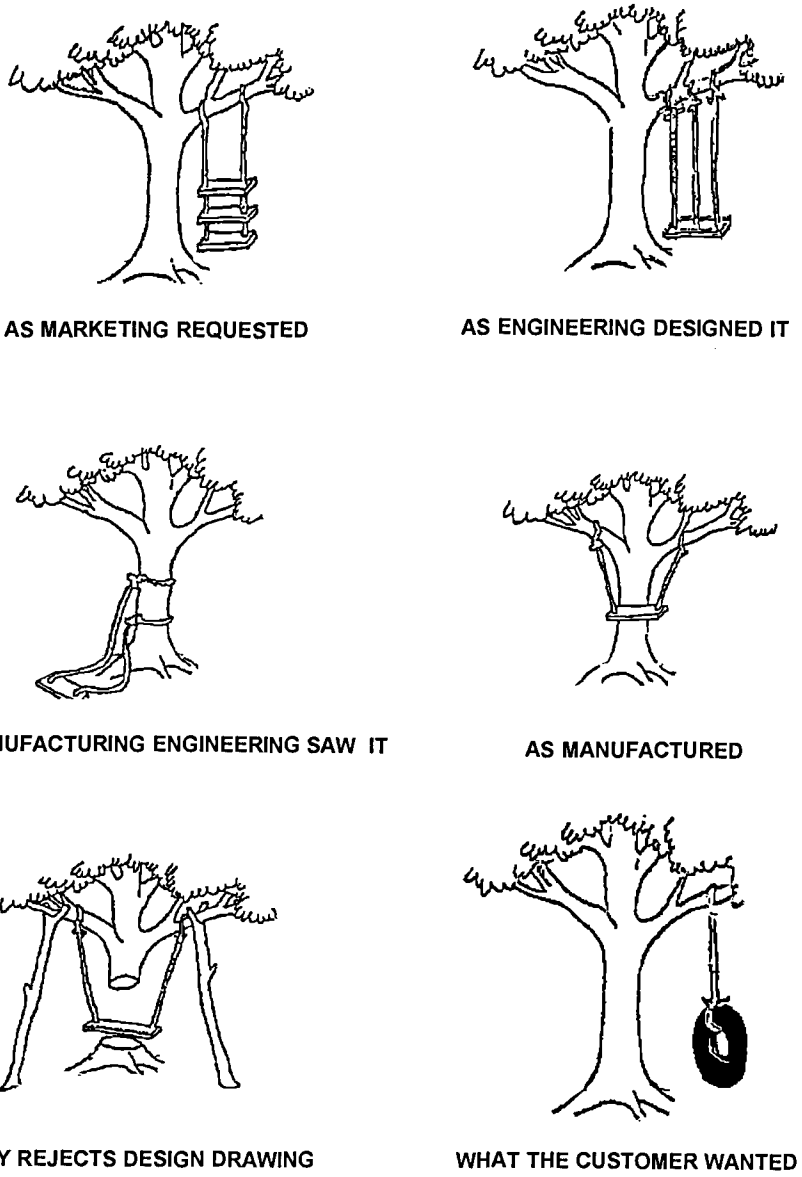

Figure 1-1—Customer requirements.

ganization. This creates another dilemma because now we need to allow managers who are outside our responsibility to be permitted, even welcomed, to handle situations that structurally may belong to us.

It's time for the goose story. We as managers should take a lesson from the goose. I'm sure you have observed geese in flight. They fly in a pattern that forms a horizontal V. There is a good reason why geese fly in a V pattern. The lead goose breaks the air current and creates an uplift behind him that the other geese can take advantage of. The second tier of geese likewise does the same for the third tier and so on and so forth for the entire flock.

The lead goose eventually tires of butting his head against the wind, so he drops back in the formation. Here's when something interesting takes place. Another goose from the flock moves to the front to assume the lead. This goose does so until he tires. Then he drops back and another goose moves in to lead. Geese in a flock are willing to follow the lead of whoever is leading at the time because they all have a common goal.

We can learn a lot from the goose! Geese have learned how to work as a team. All in the flock are willing and able to lead when necessary. The leader who drops back is not intimidated by another taking his place. He understands that for now it is best that someone else assumes leadership.

CUSTOMER FOCUS

Management must develop an attitude that puts the customer in every decision made. The customer is the reason we are in business. Without customers there would be no

job to perform, no requirements to be met, and no reason anyone would wish to purchase your company's stock.

As explained in the Introduction, there are two kinds of customers: *internal* and *external*. External customers provide income for the organization through purchasing goods or services. Internal customers (employees) satisfy the requirements of the external customers and the requirements of others in their own organization. Both are important and need to be understood for an organization to succeed and prosper.

External Customers

The expression "The customer is always right" is not always true; however, one right of the customer is always true: "The customer has the right to purchase from whomever he wants." With this in mind, we should make every attempt to make sure the customer wants to buy from us.

To assess the needs of your customers, utilize input from all customer contact personnel. In an organization that follows TQM principles, input can come from the sales representative, your marketing group, the quality department, manufacturing, customer service, and engineering. The method in which the input is provided can be *reactive* or *proactive*. Both sources should be looked upon as opportunities for satisfying your customers' needs.

Reactive input is in the form of customer complaints or from interpreting customer purchase orders or sales inquiries. When customer complaints are received, either as written complaints or in the form of returned goods, most organizations react as fire fighters and focus on the hot spot. We sometimes ignore the system that created the problem in the first place. When a purchase order or sales inquiry is received, most organizations interpret their customer's requirements through the mirror of their own paradigms.

Proactive input is solicited through visits to the customer's place of business, visits to your facility by your customer, customer satisfaction surveys, and by cross-functional teams consisting of employees from customer and supplier facilities. All these activities should be part of management's strategic business plan. The strategic business plan will be discussed further in Chapter 3.

Internal Customers

In a TQM environment, the attention paid to employees is as important as, if not more important than, attention paid to the customer. The employee is the internal customer of the organization, the individual who can make things happen. His or her understanding of the organization's goals and commitment to the customer must be complete. This can be assured by following a three-step process that includes (1) an employee survey, (2) an employee training program, and (3) regular communication sessions to continually reinforce the organization's goals.

Employee Survey

The employee survey should be designed to provide an assessment of how the employee feels about the company and how he perceives his role to the customer. An example of a survey I used successfully is provided in Fig. 1-2.

The TQM steering committee (discussed in Chapter 3) should review and analyze employee survey results and determine the training program required to bring employees up to speed on company goals. Training can be conducted by inside experts or by using outside resources. There are advantages and disadvantages to both approaches.

The advantages to using inside experts are cash flow containment and assuring that the training is tailored to existing company paradigms. The disadvantages of using in-house experts are having to overcome existing negative perceptions of the expert, if there are any, and removing the expert from his duties to provide preparation and training.

The advantages of using outside sources for training are many. Among them is the natural perception that an outside consultant knows more about a subject than inside people. This advantage can create a more receptive learning environment for the employee. Another advantage is that no time is taken from anyone's schedule for preparation of lesson plans. Two major disadvantages are expense and the fact that the outside resource is not familiar with your company culture.

Both options of training must be evaluated by the TQM steering committee, and selection of training resources should be made on the best fit analysis. The key is to assure that whatever training source is utilized that the source emulates the goals of the organization.

Activities concerning customers need to be communicated to everyone in the organization in a timely manner. Most information can be distributed on a monthly basis, but special news should be disseminated as required. An ideal method of sharing news is through a company newsletter that contains information on employees, customers, and continuous improvement activities.

TRAINING

Continuous improvement cannot occur within an organization unless training is part of management's agenda. Leaders in respective departments should take the initiative to conduct an analysis of each employee's ability to perform his or her job. This is often referred to as a *needs assessment analysis*.

The needs assessment analysis should be performed on the job function, not the individual performing the job. For example, suppose the job is to prepare an accurate product certification document. A flow diagram on completing a product certification is shown in Fig. 1-3.

The focus should be on preparing an accurate product certification, not on the skills of the final product auditor, the material handler, or the typist. Study each step in the flow diagram for the job and determine exactly what is required for that step to be successful. For example, let's look at the step: Inspect All Critical Characteristics Per Sample Plan.

To be successful at this step, every step preceding must have been performed correctly and accurately. All critical characteristics must be identified on the inspection plan or engineering drawing. The sample plan should be available and germane to the product being inspected. The test equipment and inspection equipment should be in full calibration and acceptable for the tolerances being examined. The individual conducting the task must be qualified for the task.

IN PLANT "ASK ME" BOX

(1) How do you perceive your role in service for customers?

_____ Directly Involved
_____ Indirectly Involved
_____ Not Involved

(2) How do feel about service you receive from related departments?

_____ Satisfied
_____ Not Satisfied
_____ No Opinion

(3) Do you have enough authority to make improvements to better serve our customers?

If No, Suggestions: _____

(4) Do you receive everything you need from the previous operation or department to do your job well?

Yes No (circle one)

If no suggestions: _____

(5) If you could make one change in either your department or the company as a whole, what would you change to improve service for our customers?

(6) If you could rate overall the products and services provided to our customers, what would that rating be?

_____ Superior _____ Good _____ Average _____ Poor _____ Other

Please explain: _____

Figure 1-2—Employee survey.

Any deficiency found in any of the subgroups contributing to the successful completion of the main task of *inspecting all critical characteristics per sample plan* may require training for the individual doing the inspection or correcting some upstream activities.

EMPOWERMENT AND INVOLVEMENT

One of the more responsible acts management can perform is recognizing that their employees can make significant contributions to the success of the organization. If management provides the tools and training, a great deal can be accomplished through employee empowerment and involvement (E & I). However, the employee must be properly prepared for such responsibilities.

The first employees that should be prepared for Employee E & I are managers and supervisors. The concepts of TQM must be provided through several training sessions and should be reinforced through appropriate actions from senior management. One of the better methods of demonstrating senior management's commitment to Employee E & I is by forming management teams and allowing these teams to evaluate and suggest how to improve current systems. It is through these management teams that lower-level employee teams are created.

The teams formed at all levels will concentrate on improving the organizations critical performance indicators (CPIs). CPIs are tracked and evaluated through measurement parameters established by management E & I teams.

MEASUREMENT

Management should establish measurements to track progress on CPIs. The unit of measurement should fit the indicator being evaluated and should be understood by those who contribute to the improvement process for that indicator. For instance, the cost of quality CPI should be measured in dollars and compared to several key values, such as cost of sales or cost of manufacturing. Another example is on time performance. This CPI can be measured in several ways, which should all relate directly to customer requirements. For example, this CPI can track orders shipped to customer-required dates (external customer measure), or it could track design engineering input to manufacturing en-

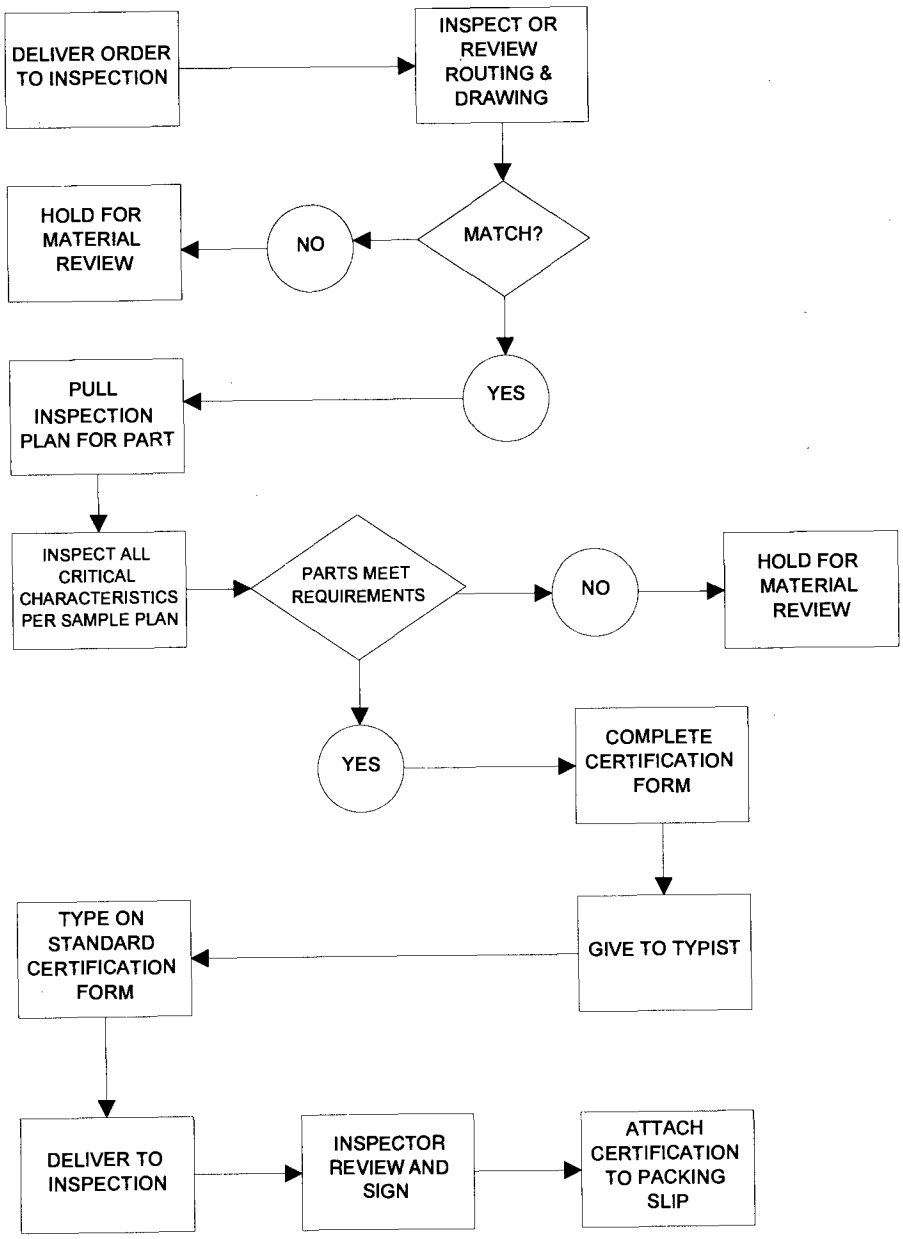

Figure 1-3—Product certification flow chart.

gineering (internal customer measure), or it could track quote turn around from your suppliers (a measure of your needs as a customer of your supplier).

CPIs will be discussed further in Chapter 2 when methods of continuous improvement are explored.

RECOGNITION AND REWARDS

Management has the responsibility to provide an environment for the work force that is safe and environmentally clean. This environment should also lay the foundation for supporting the employees' quality of work life. Once this foundation has been established, management must develop a recognition and rewards program designed to improve and maintain employee job satisfaction.

A three-tiered system should be developed that includes: (1) day-to-day recognition, (2) informal recognition, and (3) formal recognition programs. The best way to get started is to create a steering committee made up of staff management. This committee can define the scope of the program and establish guidelines to be followed by employee teams established to implement the program. Employee teams should include participants from all levels of the organization.

The steering committee can set the scope of the program to include as many systems as they feel the company can support and effectively manage, but some systems should always be included because of their proven effectiveness.

The following systems, when properly structured and administered, are very cost effective and contribute directly to a company's profitability through various improvements. In no particular order, these proven systems are: *pay-for-performance, perfect attendance, service awards*, and *continuous improvement programs*. Pay-for-performance recognizes employees for their performance on the job and should include such criteria as quality of work produced, productivity, attendance, initiative, job knowledge, and safety. An attendance policy should establish rules to define when employees are to be on the job and when they are excused from their job. This may seem like a basic idea, but it is surprising how many companies do not have an established and documented policy on absence from the job. When there is no written policy, there is no consistency, and this leads to dissatisfied employees who see management as untrustworthy or at the very least prone to favoritism. A service awards policy recognizes employees for their length of service with the company and can be very rewarding in enhancing employee esteem and fostering employee loyalty.

COMMUNICATION

This guideline is one of the more important for both management and employees. It is a two-way street, and both should strive to keep the airwaves open. Even though communication is a two-way street, it must start with management. Management should set the standard by creating an environment conducive to openness without fear of reprisal or ridicule. At all times communication must be polite and conducive to enhancing self-esteem. The best way to get started is as with all the other guidelines: establish a steering committee to set the policy and the guidelines for implementation. Then create the opportunity for employee involvement teams to get the program underway.

Some of the more common and effective programs include: company newsletters, staff and employee meetings, and an open invitation from management to allow employees at all levels to hold informal conversations or brainstorming sessions in employee lounges during breaks.

2

Strategic Planning

ONCE MANAGEMENT'S ROLE AND commitment are defined and established, the top executives of the organization should establish a *quality policy*. The quality policy should state the organization's commitment to: (1) continuous improvement and (2) customer satisfaction. These seem like basic organizational goals, but, unless stated, the rest of the organization will not be aware of them or will not have a clearly stated policy from which to develop their own planning for improvement.

Quality policies can be from one paragraph to a full page. The policy's length is not as important as its contents. For lasting impact on employees and customers, it is best to keep them short. After all, it is easier to recall one paragraph than an entire page. An example of a quality policy could be:

> (*insert company name here*) is committed to continuous improvement and providing products and services that are of the highest quality. At (*insert company name here*), we believe customer satisfaction is the most important service our employees can provide.

Although short, this policy is very much to the point. It says a lot about the philosophy of the company's top executives. It says, "The most important goal of this organization is to satisfy the customer and to find better ways to manufacture products and/or provide services." I do not want to become too involved with what *quality* means in this quality policy statement. There are as many definitions of this word as there are words on this page. The following are a few definitions of the word *quality* that should provide a basis for developing many more.

Quality is:

1. When a product is consistently represented.
2. An attitude of excellence with an objective of error-free performance shared by all employees.
3. Achieved through dedicated and skilled employees, modern facilities, controlled manufacturing processes, continuing education, and a positive work environment.
4. Directly related to superior value and performance and is provided to customers in terms of productivity improvements, reduced operating costs, and outstanding service.

For the rest of this book, *quality* is simply defined as: providing goods and services that meet or exceed customer requirements.

To provide goods and services that meet this definition, the executives of the organization must have a strategic plan to lead the company along this path. The plan should contain both long-term and short-term objectives. The window for long-term objectives should be no more than four years and preferably three years. The world changes so fast that planning more than four years ahead is not practical. Markets change at almost a constant pace. Customers' requirements do the same.

A long-term strategic plan should consist of four main programs. There should be: (1) a program for futuristic quality planning, (2) a program for service and product improvement, (3) a program for employee involvement and education, and (4) a program for business systems. These programs require a mission statement so that the goals of the program are understood. As with the quality policy statement, the mission statements for these programs should be short and to the point. This gives precise direction to steering committees implementing these programs. Mission statements for the programs I recommend are:

1. *Futuristic quality planning*—Develop and drive business decisions that utilize quality tools and concepts to assure the successful introduction and implementation of new products, processes, and services to our customers.
2. *Service and product improvement*—Develop and implement programs to improve office and manufacturing operations, processes, and systems leading to improvements and consistency in service and products, and reductions in internal waste.
3. *Employee involvement and education*—Utilize the inherent knowledge and expertise of our employees to identify and participate in opportunities for improvement, and provide appropriate education as needed in support of these goals.
4. *Business systems*—Develop and manage the business systems required to assure quality, improve operations, and support our internal and external customers.

These programs require further definition to understand how they are applied to effect continuous improvement.

FUTURISTIC QUALITY PLANNING

Futuristic quality planning is necessary to assure successful applications of new systems, processes, and products. Futuristic quality planning applies equally well to existing processes or products because it perpetuates continuous improvement. This planning program almost always requires the use of cross-functional teams. The core members of this team should consist of people who have the necessary authority to make decisions that support the program. During the course of planning activities, it will often be necessary to recruit employees who have special insight or knowledge of the process being evaluated.

It is best to use a structured approach for this planning process. This will assure consistency of purpose and allow easy inclusion of participants who have had experience on other quality planning teams.

A method I have applied over the years fits the needs of both service and product manufacturing. Both activities require futuristic quality planning to assure efficiency of operations and customer satisfaction. Service/product quality planning (SPQP) is a structured approach that can be applied to any business activity. It does not matter if we are working in a manufacturing or service environment. It does not matter if we are looking to improve office systems or manufacturing processes. The principles are the same: (1) flow chart the process chain for the activity or product; (2) assess the current method and effectiveness of quality control; (3) do a failure mode and effects analysis of high-risk process steps; and (4) develop a control plan to assure quality.

The SPQP process is designed to improve the quality of current services and products. When new services or products are under consideration, another quality tool should be applied to achieve maximum customer satisfaction. This other tool is quality function deployment (QFD). QFD is a very structured and extensive analysis of customer requirements and needs. The study and application of QFD warrants a book of its own and will not be covered in this manual.

We can still develop a strategic plan for customer satisfaction using only the tools contained within SPQP when applied toward new services or products if the customer is permitted to participate. I feel that most readers of this book are more interested in finding methods to improve current services, processes, or products. The study of QFD is recommended for marketing functions and design engineers.

The steps and tools required to prepare an SPQP are as follows:

Phase 1: Flow Chart

There are universal rules to follow when preparing a flow chart. A square box should be used to describe each major process step involved in creating the service or product. Arrows should be used to show the direction each process step takes as the total process evolves. Diamonds should indicate decision points along the process chain. Either inside or adjacent to the diamond is usually a question. Process flow lines (arrows) from the diamond points are used to act upon the answer and lead to the next process step. Other universal symbols are used to reduce the amount of text contained in a flow chart. One example is an inverted triangle to indicate that an evaluation or an inspection must take place at a particular process step.

An example of a flow chart using these symbols is shown in Fig. 2-1. This is a flow chart for heat treating a threaded bolt in a molten salt bath. This flow chart has ten process steps. Each individual process step could be expanded to describe the actions necessary to complete its task, but generally this is not necessary unless that particular step needs to be improved upon. This process has two decision points controlled by the furnace operator. A "yes" answer by the furnace operator allows the process to continue, but a "no" answer requires assistance from quality control.

Phase 2: Flow Chart Analysis

After the process is defined so that each major process step is identified, the next phase is to assess the contribution each step has in reaching the desired end result of the process. In this case, the end result is a bolt (or a processing lot of bolts) meeting all metallurgical and design requirements after the salt heat-treating process.

Let's review the process step LOAD PARTS IN BASKET (see Fig. 2-1). This step requires the furnace operator to verify several facts to assure compliance with meeting all quality requirements of his work order. These quality requirements are the contributions that this step has in satisfying the metallurgical and design requirements for salt heat treating.

The operator has to assure that all paperwork received with the product matches. This includes drawings, manufacturing routings, the heat treat process sheet, the quality assurance control plan, etc. The operator must assure that when the parts are loaded into the basket the parts are positioned so there will be an even transfer of heat during the heat-treating operation. The operator must assure that the parts are positioned to minimize distortion. And the operator must assure that if there are parts from other orders in the same basket, that these parts have weight and mass similar to the parts for the current order. All aspects of this one step, LOAD PARTS IN BASKET, can be evaluated as to its overall effectiveness.

In flow chart analysis, we evaluate each step in a process as to the severity of failing to perform the step correctly, the capability of the process itself to perform the step correctly, and the probability of knowing when the process is not performing as expected. We assign values to the severity, capability, and detection criteria to weigh the results so it is possible to prioritize required actions when the failure mode and effects analysis (FMEA) is prepared. The guideline values for severity, capability, and detection are presented in Tables 2-1, 2-2, and 2-3, respectively.

To see how these guidelines apply, let us continue to work with our example for heat treating. In Step three (see Fig. 2-1), LOAD PARTS IN BASKET, the SPQP team made the following decisions as shown in Table 2-4.

1. For "paper work matches," the team chose a severity rating of 3 because they felt that incorrect information as to material type, for instance, would prevent the product from responding as expected in the high-heat furnace. A capability of 3 was chosen because past experience has been positive with hardly any cases of mixed paperwork. For detection, the team chose "1," because mixed paperwork is very easy to detect when it occurs.
2. For "parts are positioned to assure even heat transfer," a 4 was chosen on severity because failure to satisfy this requirement could result in nonconformance to metallurgical properties. A 3 was chosen for capability because the baskets are designed with a partition that properly spaces the parts for even heat transfer. When it came to detection, the team picked "2" because if the operator put more than one part in a partition it would most likely be detected.

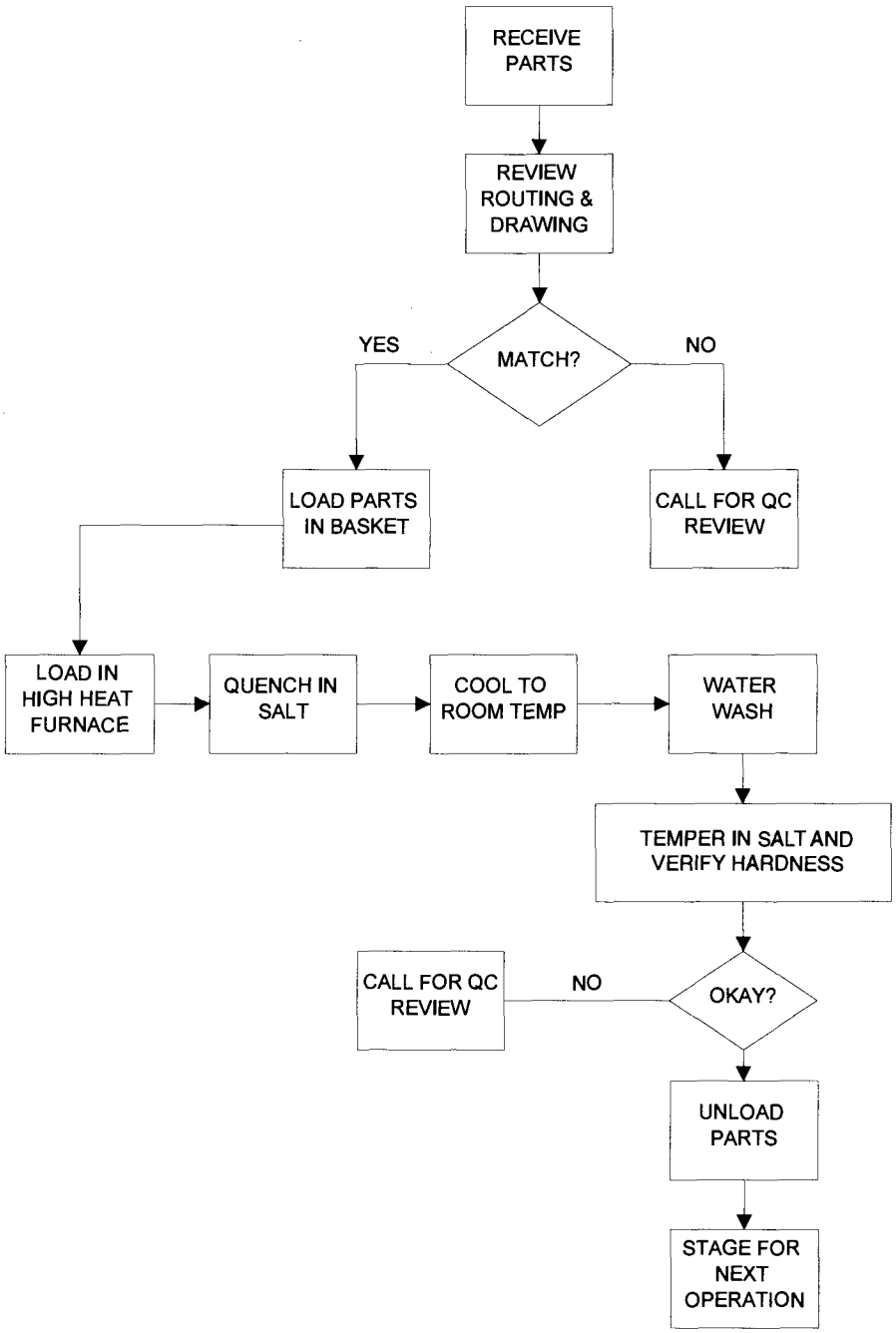

Figure 2-1—Basic salt bath heat treat process flow.

3. For "parts are positioned to minimize distortion," the team gave a severity rating of 4 because failure to satisfy this requirement could result in a dimensional defect. The capability was 3 because of operator experience with the effects of incorrect positioning. The selection of 2 for detection was assigned because a double check of position prior to moving the parts to the high-heat furnace is performed by another operator.
4. For "parts have similar mass and cross-sectional area," ratings of 4, 3, and 2 were assigned for severity, capability, and detection, respectively, based upon the quality history and experience of the operators involved.

This process is completed for each step in the process of salt heat treating. The end result is a compilation of values that allow's management to prioritize the analyses and improvements to be made by the SPQP team. An example of the completed process flow analysis for salt heat treating is provided in Fig. 2-2. In this example, one can see that the SCD values (severity rank times the capability rank times the detection rank equals the SCD value) vary from one step to the other and within each step depending on the controlled characteristic.

Management must decide which controlled characteristics require further evaluation through a FMEA. Companies usu-

TABLE 2-1—Service/product quality plan—severity assessment guidelines.

Severity Assessment	*The severity assessment* rates the overall importance of each potential product nonconformance to the process and final customer.
5	*Safety related characteristic.* Failure to satisfy this requirement could result in unexpected and/or catastrophic failure, leading to personal injury or property damage.
4	*Critical characteristic.* Failure to satisfy this requirement could either result in a significant loss in performance or cause the end user to produce a product that does not conform to his or her customer's requirements or would prevent or significantly hamper a following operation from performing its function.
3	*Functional characteristic.* Failure to satisfy this requirement could prevent the product from being assembled and used as intended, lead to more variability in performance than is normally anticipated, could be perceived as poor quality by the final customer, or a subsequent operation would have some difficulty in its process due to the nonconformance.
2	*Nonfunctional characteristic.* Failure to satisfy this requirement will not have any appreciable impact on performance. Most cosmetic requirements shall be considered nonfunctional characteristics unless there is a history of customer complaints. Cosmetic requirements that have resulted in complaints will be considered a functional characteristic. Subsequent operations would see no appreciable difference in performance.
1	*Process characteristic.* Failure to satisfy this requirement has no impact on the finished product or the manufacturing process.

TABLE 2-2—Service/product quality plan—capability assessment guidelines.

Capability Assessment	For Manufacturing Processes with Documented Process Capability Data	For Manufacturing Processes Without Documented Process Capability Data
1	$Cpk > 2.0$	N/A
2	$1.67 < Cpk < 2.0$ or $Ppk < 2.0$	N/A
3	$1.33 < Cpk < 1.67$ or $1.67 < PPK < 2.0$	Although documented process capability data are not available, past experience with this process on similar products has been very positive.
4	$1.00 < Cpk < 1.33$ or $1.33 < Ppk < 1.67$	Very few known problems have occurred when using this process on similar products in the past.
5	$Cpk < 1.0$	This process has been known to be a source of scrap and/or discrepant material when used on similar products or there are no historical data for this process.

NOTE: This assessment uses the formula $\min\left[\frac{\bar{x} - LSL}{3\sigma}, \frac{USL - \bar{x}}{3\sigma}\right]$ for both *Cpk* and *Ppk*.

TABLE 2-3—Service/product quality plan—detection assessment guidelines.

Detection Assessment	The detection assessment rates the probability that the current inspection and SPC system will find a nonconformance should it occur.
1	A nonconformance will almost always be detected. Either the process automatically detects a failure or a high capability has been established and SPC is appropriate, understood, and used to run the process.
2	There is a good chance of detecting a nonconformance. SPC is generally understood and usually reacted to in a capable process, or some form of 100% inspection is used.
3	The current system may detect a failure. SPC is in place, but not fully understood and or reacted to, or sample inspections are done throughout the run.
4	A nonconformance will probably not be detected. Control charts are done incorrectly or are incomplete, or inspections are limited, such as setup only.
5	There is absolute certainty that a nonconformance will not be detected. No inspection is done.

NOTE: "Detection" must take place before reaching the next applicable process/customer. Inspection by the next process or final inspection is not appropriate in determining this rating.

TABLE 2-4—Load parts in basket.

Process Step	Controlled Characteristic	SCD	Severity	Capability	Detection
Load parts in basket	Paper work matches	9	3	3	1
	Parts are positioned to assure even heat transfer	24	4	3	2
	Parts are positioned to minimize distortion	24	4	3	2
	Parts have similar mass and cross-sectional area	24	4	3	2

ally do not have unlimited resources and must limit the number of projects through the use of Pareto analysis.

Before going further, I feel it beneficial to provide definitions of *Pareto analysis* and *Pareto chart*.

Pareto analysis: Analyses of the frequency of events described on a Pareto chart that contribute to an outcome. In the quality profession, outcomes could be rejects, scrap, and other contributors to cost of quality such as incorrect invoices, purchase orders, missing information, etc.

Pareto chart: A simple statistical tool that ranks contributing factors to an outcome according to either cost or frequency of occurrence. This allows for easy prioritization of contributing factors for analysis, thereby keeping cost of analysis low by focusing on the *vital few* and temporarily not analyzing the *trivial many*.

In our example, management decided to perform a FMEA on all controlled characteristics that had an SCD value that exceeded 50. The candidates for FMEAs are shown in Table 2-5. In general, management would also consider any controlled characteristic that had a 5 for either capability or detection regardless of the SCD's value rank.

Phase 3: FMEA

The FMEA is a document designed to accept change. It acts as a futuristic planning tool by identifying potential causes of failure that should be considered in the development of control plans. As new controls are implemented, the FMEA is revisited and revised to reflect new process capabilities. FMEAs can be developed for processes or products. In our example, we are creating a Process FMEA for the salt heat treating process. A FMEA is an analytical technique utilized to assure to the best of its ability that all potential concerns (failures) are identified and addressed through some control mechanism. The group best suited to develop a FMEA is manufacturing engineering or a similar group or individual that understands the process (manufacturing or service). The Process FMEA identifies failure modes, explores the effects of the failure on customers, determines the potential causes of those failures, looks at current controls to avoid or identify the failure, and suggests actions to improve control.

The team assigned to complete the FMEA should consist of those close to the process being evaluated. As mentioned earlier, for a manufacturing operation such as heat treating, the best person to lead the team is a manufacturing engineer. For our example, other potential members are the plant metallurgist, laboratory technician, furnace operator, and supervisor of the heat treat department. An example of the FMEA format is shown in Fig. 2-3.

Let's work through an example of completing a FMEA. Each column contains information that leads to information/action for the subsequent column. Our team came up with the FMEA shown in Fig. 2-4 for Process Step 4: High Heat Furnace. The following logic is applied to fill the columns with information:

Process

In this column, list the process step that creates the controlled characteristic under analysis. For our example, the first entry in this column is High Heat Furnace. This process step is the first process step of the process flow analysis that had an SCD value that exceeded 50. To complete the FMEA, following in order, the next entries from Table 2-5 would be Cool, Temper, and Hardness Test.

Controlled Characteristics/Fail Mode

In this column, list the controlled characteristic and the anticipated failure mode. For the process step, High Heat Furnace, the controlled characteristic is Part Microstructure. The potential failure modes are: incorrect atmosphere, incorrect furnace temperature, and incorrect time at temperature.

Effects

In this column, list the effect the failure mode would have on the controlled characteristic. In the case of our example, all failure modes identified would cause the wrong microstructure, leading to product failure at a subsequent operation or in product application.

Likely Causes

At this juncture, we examine the likely cause(s) of the identified failure modes. The likely cause of incorrect atmosphere is contaminated salt. The likely cause for incorrect temperature is a defective furnace thermocouple. The likely cause of incorrect time at temperature is an incorrect setting of the furnace timer.

Current Control Methods

In this column, list the present method of controlling the likely cause(s) of the failure mode(s). In our example, the furnace salt is evaluated every six months by the chemical company the supplies the salt. The maintenance department changes the furnace thermocouples every two weeks. The removed thermocouples are returned to the thermocouple supplier to be calibrated and rebuilt as required for future

SERVICE / PRODUCT QUALITY PLAN

Phase I - Process Flow Analysis

Product Line: Salt Bath Heat Treat

Manufacturing Location: ABC Company

Original Issue Date: January 1994

Approved By:

Process Flow Diagram	Controlled Characteristics	Original				Revised (9/30/93)			
		Severity	Capability	Detection	SCD	Severity	Capability	Detection	SCD
1) Receive Parts	1) Parts are ready for Heat Treat.					4	3	1	12
2) Review Routings and Drawings	2) Parts match metallurgical requirements of the routing and drawing.	4	3	4	48	5	3	2	30
3) Load Parts Into Rack or on Wire and Match Paperwork.	3) - Paperwork for each load match.	3	3	1	9	3	3	1	9
	- Parts are positioned to ensure even heat transfer	3	3	3	27	4	3	2	24
	- Parts are positioned to minimize distortion.	4	3	4	48	4	3	2	24
	- Parts have similar mass and cross sectional area.	3	3	3	27	4	3	2	24
4) High Heat Furnace	4) Part microstructure					5	3	5	75
5) Quench	5) Part hardness					3	3	5	45
	Part microstructure.					5	3	5	75
6) Cool	6) Part microstructure.					5	3	5	75
7) Water Wash	7) Parts free of salt.	2	3	1	6	3	4	2	24
8) Temper	8) Part hardness					5	5	3	75
	Part microstructure.					5	3	5	75
9) Clean	9) Parts free of Heat Treat scale.	2	3	2	12	3	3	1	9
	Parts free of Heat Treat salts.					3	4	2	24
10) Hardness Test	10) Meet part hardness requirement.	4	3	2	24	5	5	3	75
11) Unload Parts From Rack or Wire and Match Paperwork.	11) Parts are free from:								
	- Damage					3	3	2	18
	- Distortion					3	4	4	48
	- Cracks					5	3	3	45
	- Salt					3	4	2	24
	- Paperwork matches parts in individual orders.					4	3	1	12
12) Stage For Subsequent Operations, Black Oxide or Further Processing.	12) Parts are as represented.					3	3	1	9

(Salt-fl1A)

Page 1 of 1

Figure 2-2—Process flow analysis.

TABLE 2-5—Salt Bath Heat Treat Phase 1 Results: operations in the process that exceed 50 in the SCD rating.

Operation	Characteristic	SCD Rating
Step 4: High heat furnace	Part microstructure	75
Step 6: Cool	Part microstructure	75
Step 8: Temper	Part hardness	75
	Part microstructure	75
Step 10: Hardness test	Meet part hardness requirement	75

use. The furnace operators monitor the time at heat as indicated on the electronic furnace controller.

Responsibility (Resp. and Date)

In this column, list the person(s) held accountable for applying the current controls. For our example, the heat treat supervisor is held accountable for having the furnace salts evaluated every six months, the maintenance department is accountable for changing the furnace thermocouples every two weeks, and the furnace operators are accountable for monitoring the time at heat.

Recommended Actions

This column is used when the team identifies an opportunity for improvement on one of the current methods of control. In our example, the team felt that the six-week interval was too arbitrary and not based on historical data. This meant that during some six-month periods, the salt bath was out of control or specification and not known except by sporadic metallurgical failures. So the team decided to apply statistical process control (SPC) to the salt bath analysis. A program was established to analyze the bath every week and chart the main variables of the bath on an individual's chart. The bath could then be rejuvenated/replaced based on out-of-control data. In the long run the team felt that money could be saved using this approach by eliminating metallurgical rejections necessitating rework or scrap. The chemical supplier was providing the bath analysis free of charge and was more than happy to acquire statistical data on the life cycle of his chemicals for marketing purposes.

Date

In this column list the name of the individual responsible for the recommended action(s) and the date the action(s) are expected to be implemented or completed.

All FMEAs should be put on a review program to evaluate and ascertain the currentness of the document. One of the better methods is to put document numbers on the SPQP and add them to the company calibration software system. This way, a one year "calibration" cycle can be programmed, and the review process cannot be overlooked. The review does not require a team; all that is required is that the individual making the review be knowledgeable of the process under review. The individual can always solicit, as necessary, the council of others in the organization for expert or specific assistance.

Phase 4: Control Plan

The final phase of an SPQP is the development of a control plan. As with the FMEA, a control plan can be designed for a process or for a product. The decision to make a process or product control plan is usually decided by the type of organization. An organization that provides a service, such as a machine shop manufacturing components for a larger manufacturer or a company that provides office cleaning services, would most likely employ a product control plan so that they are confident of satisfying all their customers' unique requirements. On the other hand, a manufacturer of standard ASTM A325M[1] structural bolts or a bank clearing customer checks would find the process control plan more apropos. In either case, the control plan format is the same and is shown in Fig. 2-5.

The control plan, as the FMEA, is divided into columns with headings to provide a natural sequence of events enabling users of the control plan a concise and clear guide for controlling the quality of the process or product. We will now work our way through a process control plan for heat treating an ASTM A325M structural bolt with a salt-bath furnace.

Process Point Control

This column contains the same information in the same sequence as the like column in the process flow analysis for the salt heat treat process. It is a listing of all steps required in the process of heat treating via this method in the exact order the steps are performed.

Controlled Characteristic

This column contains the same information in the same sequence as the like column in the process flow analysis for the salt heat treat process. All characteristics controlled at the process step in the same row must be listed in this column.

Control Methods/Sample Plan

In this column the method of controlling the characteristic along with the specified sampling method is detailed. Several methods of control are available including first article verification, in-process inspection to a sample plan based on lot size or production rate/hour, statistical process control, and 100% inspection. The method of control is based upon the capability of the process step to maintain design criteria.

Method of Evaluation

In this column we describe the process, equipment, or instrumentation used to evaluate each controlled characteristic. Methods may include visual inspection with or without a microscope, a metallograph, a pair of dial calipers, a scanning electron microscope (SEM), a hardness testing machine, etc. Of importance here is the requirement that for whatever method of evaluation we employ, an evaluation of the repeatability and reproducibility of that method be determined. One method of conducting an evaluation of the repeatability and reproducibility of an evaluation method is described in ASTM Guide for Conducting a Repeatability and Reproducibility Study on Test Equipment for Nondestructive Testing (F 1469).

[1]Specification for High-Strength Bolts for Structural Steel Joints [Metric].

SERVICE/PRODUCT QUALITY PLAN

Phase II - Failure Mode and Effects Analysis

Pg ___ of ___

Product Line: _____

Manufacturing Location: _____

Original Issue Date: _____

Current Revision/Date: _____

Approved By: _____

Process	Controlled Characteristics/Fail Mode	Effects	Likely Causes	Current Control Methods	Resp. and Date	Recommended Actions	Date

Figure 2-3—Failure mode and effects analysis.

SERVICE/PRODUCT QUALITY PLAN

Phase II - Failure Mode and Effects Anaysis

Pg 1 of 3

Product Line: Salt Heat Treat

Manufacturing Location: ABC Company

Original Issue Date: January 20,1994

Current Revision/Date: _____

Approved By: _____

Process	Controlled Characteristics/Fail Mode	Effects	Likely Causes	Current Control Methods	Resp. and Date	Recommended Actions	Date
High Heat Furnace	Part Microstructure 1) Atmosphere Wrong 2) Temperature Wrong 3) Time Wrong	Wrong Microstructure Leading to potential product failure	1) Salt contaminated 2)Wrong control settings 3)Thermocouples defective.	1) Salt evaluated every 6 mths. 2) Operator monitors temp. & time on controller instruments for each furnace. 3) Thermocouples are changed every 2 weeks.	Supervisor Operator Maintainance	1) Evaluate salt analysis to determine optimum frequency of evaluation. Use control chart method take data weekly.	Supervisor Begin 02/14/94

Figure 2-4—Failure mode and effects analysis.

SERVICE/PRODUCT QUALITY PLAN

Phase III - Control Plan

Pg ___ of ___

Product Line: _____

Date: _____

Manufacturing Location: _____

Process Point Control	Controlled Character.	Control Methods/Sample Plan	Method of Evaluation	Resp.	Reaction of Plan to Out of Control or Specifications.

Figure 2-5—Control plan.

SERVICE/PRODUCT QUALITY PLAN

Phase III - Control Plan

Pg___ of ___

Product Line: _____

Date: _____

Manufacturing Location: _____

Process Point Control	Controlled Character.	Control Methods/Sample Plan	Method of Evaluation	Resp.	Reaction of Plan to Out of Control Specifications.
Temper	Part Hardness	x + R Chart, 5 pieces per furnace load per order.	Newage Digital Hardness Machine.	Furnace Op.	Implement Procedure QA 017
	Part Microstructure	1 coupon per shift/furnace/material grade is submitted to the metallurgical laboratory for analysis.	metallograph	Laboratory Technicians	All parts processed after the last acceptable micro must be held for metallurgical evaluation. Any product found out of compliance is handled in accordance with procedure QA 017 and QA 018.

Figure 2-6—Control plan.

Responsibility

In this column, list the person(s) or department held accountable for evaluating the controlled characteristic. In the case of persons, avoid the use of personal names; instead, refer to the job title. This practice allows wider use of the control plan and eliminates the need for revisions when an individual is no longer performing the task detailed in the plan.

Reaction of Plan to Out of Control or Specifications

In this column we specify what to do if during the course of evaluation we find the characteristic either out of control or out of specification. This is an important consideration, and the team developing the control plan should be very specific so the person/department making the evaluation has clear instructions on how to handle the situation.

Failure to properly handle an out-of-control or out-of-specification characteristic could result in allowing the situation to continue or even permit a defective product to reach the customer. It is recommended that the team refer to standard operating procedures that describe in detail how to deal with these situations. Any referenced procedure should be available and completely understood by the individual/department that must act upon the problem.

A partially completed process control plan is shown in Fig. 2-6. So that we know how it is constructed, we will go through the process step, Temper.

The columns entitled Process Point Control and Controlled Character in the Phase III Control Plan shown in Fig. 2-6 list the process step and the controlled characteristics, respectively, for the temper operation. Two characteristics are affected by the temper operation: one is "part hardness," and the other is "part microstructure." A separate line is used for each of these characteristics.

In the Control Methods/Sample Plan column adjacent to Part Hardness, the team put the phase "X & R Chart, 5 pieces per furnace per order." This lets the furnace operator or anyone viewing the control plan know the statistical process control is to be applied to this characteristic at this process step. It also specifies the type of chart and the frequency and size of subgroup sampling.

In the Method of Evaluation column, the team inserted the name of the instrument required to check part hardness, in this case, a Newage digital hardness machine.

In the column entitled Responsibility, the team inserted the job title, Furnace Operator. In all cases, when assigning accountability for action, name the individual performing the task. With this directive comes responsibility from management. Management must assure that the person understands what is required and is properly trained to perform the task.

The column entitled Reaction of Plan to Out-of-Control Specification must provide enough information for the person named for responsibility to take appropriate action. In this case, the team chose to reference a procedure that details how to deal with nonconforming material.

The controlled characteristic, part microstructure, is addressed in similar manner. However, due to the time and cost involved in preparing metallurgical micromounts, the team decided to check this characteristic only once per shift/furnace/material grade. This action was made possible because the team earlier initiated more frequent check analyses of the salt bath when an opportunity for improvement was taken on the FMEA.

Although the SPQP program is very powerful, it does require a great deal of effort and resources to apply. This downside, however, is nothing compared to the business consequences of failing to plan for quality. Futuristic quality planning pays high dividends in terms of reduced scrap and rework. Other benefits include more satisfied customers both in terms of the shear number of customers and in the degree to which your customers are satisfied. This alone should be enough incentive for the top executives of an organization to fully support such a program.

Once the full support of top management is acquired, the staff management should review their operations and make recommendations for application of the SPQP process. It is best to choose a process or product fairly well understood by all involved in the process flow and one that shows promise for improvement. By starting with a process or product that is going to show success, confidence in the program is instilled in those who participate and in those who are on the sidelines watching to see how it goes. After two or three successes, you will find a grass roots movement by others to apply this new technique to their own areas of responsibility.

The other three programs mentioned earlier in this chapter are best covered under *continuous improvement*, the topic of Chapter 3. In Chapter 3, we will discuss critical performance indicators (CPIs), and the plan, initiate, evaluate (PIE) processes for continuous improvement. These two programs include strategic methods for service and product improvement, employee involvement and education, and business systems.

3

Continuous Improvement

IN THE FIRST CHAPTER we discussed management's role in providing the leadership necessary for the company to meet its business objectives. One business objective of primary importance is *continuous improvement.* If a company is dedicated to continuous improvement, it will constantly improve its internal performance, customer service, and quality. Such improvement automatically strengthens the company's competitive position and its ability to respond to customer needs.

Continuous improvement begins with an understanding of where you are and where you want to be. Everyone wants to be the best in their field; however, our ambitions should be realistic and in line with our resources. Goals should be obtainable while providing enough challenge to allow employees the opportunity to extend their current abilities.

While moving along the path of continuous improvement, keep in mind that the journey never ends! The present is now and the future is only the next step along the way. You cannot stop because, if you do, someone will pass you by. There is a saying from the Great North: "If you're not the lead dog, the scenery never changes." This saying applies to a company's journey along the path of continuous improvement. If you're not the leader in your industry, you won't see future opportunities until your competitor has passed that point, leaving only the spoils for you.

So, where do we begin to move along this path of continuous improvement? Like any journey, we have to determine where we are and where we want to go. Most companies have a pretty good idea of where they are through historical data that provide a measure of how well they are meeting the needs of their customers. These data include ratings on customer quality system surveys, customer returns, the number of service requests, employee absentee rates, efficiency ratios, the ratio of quotes accepted to those given, employee turnover, customer certification awards, cost of quality, JIT delivery performance, lost time injuries, and hundreds, even thousands more.

The data include information from internal as well as external customers. The two cannot be separated, as both contribute to the strength of the company. In the first chapter, we talked about utilizing surveys to assess the current pulse of the company. This is a good place to begin.

Top management should form a steering committee to evaluate all the summary information available from the data acquired from this historical data mentioned earlier. From that information, intelligent questions can be formed to ask employees, customers, and suppliers in the form of a survey. The purpose of this survey is to discover your strengths and weaknesses.

Analysis of the survey results should identify the critical performance indicators (CPIs) that drive your organization. If you recall, we earlier defined CPIs as those measures that contribute to customer (internal and external) satisfaction. It may not be surprising to find such factors as on-time delivery and cost of quality among the concerns of your customers and employees.

Once you have identified your CPIs, you need to know how to track and measure these indicators so that you may find out whether your efforts toward continuous improvement are effective. This requires a structured and systematic approach and a few tools of statistics.

Structured and systematic means that procedures are established to assure that everyone knows what is expected and that they do things the same way. It is important that everyone work with the same set of data and that these data be factual. The statistical tools are basic problem-solving techniques employing the use of brainstorming, flow chart analysis, and cause and effect analysis. These are simple yet powerful techniques that anyone can apply. A more detailed study of these techniques is discussed in Chapter 7, Statistical Quality Control.

The next step is to flow chart the process that affects the CPI. An example of a flow chart was presented in Chapter 1, Fig. 1-3. A flow chart is simple to construct and can be done by the employees who do the processes that lead to the final output of that process. For example, let's say that one of our company CPIs was to ship the customer order on time. If we examine the processes (steps) that affect shipping the customer's order on time, we may find, depending on the size of the organization, that as many as 30 processes contribute to that CPI. For the sake of simplicity, let's cut the number of processes to a more manageable level for this example.

The first step is to assemble representatives from each department that have an influence on shipping the customer's order on time. In our fictional company, these representatives will come from the customer service, design engineering, manufacturing engineering, production control, purchasing, manufacturing, quality, and the shipping departments. The entire process is represented in Fig. 3-1.

Each of the steps in this Ship Customer Order On Time flow chart has flow charts of its own. For instance, the last step, Shipping Packs & Ships Order, requires several steps before the customer order is actually shipped out the door. Documents must be assembled, packing and shipping instructions read, boxes selected and assembled, labels prepared, the product containerized, and the method of transportation scheduled.

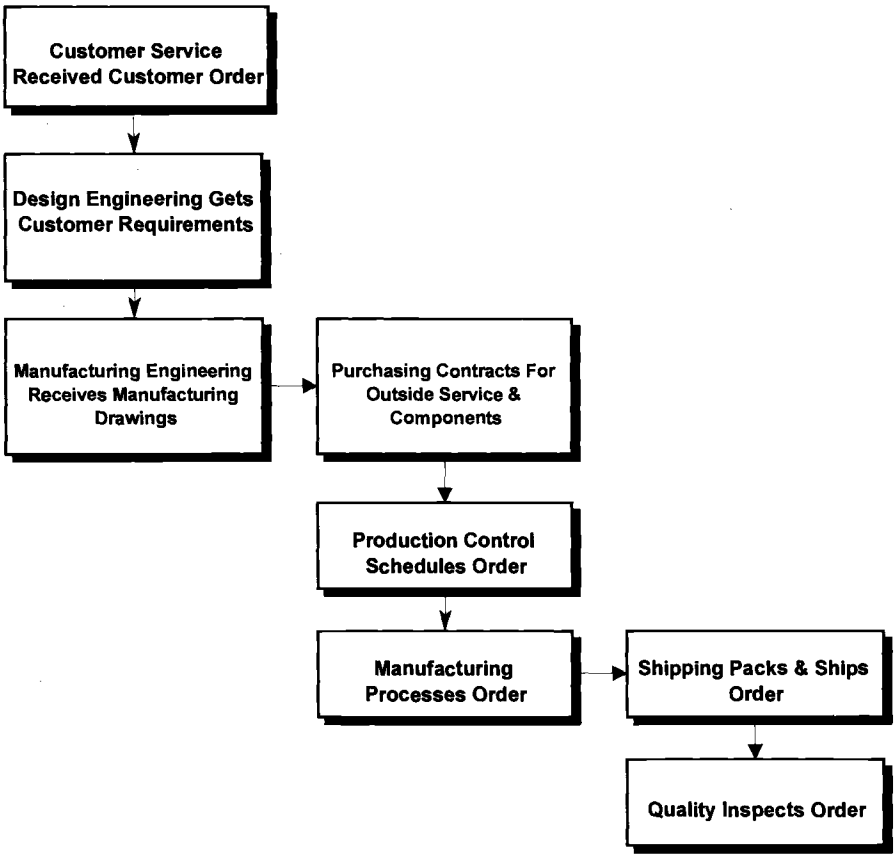

Figure 3-1—Flow chart for processing a customer order.

Every step requires time and employee input. Does each step contribute value to the product and is each step necessary? These basic questions must be answered by everyone along the process chain. If a step is required, the next questions center around the overall efficiency of that step. Throughout this analysis, the collection and evaluation of data should be observed by the employee team from the process. Some of the best methods of presenting data are the simplest. The run chart is very effective in tracking progress over time (Fig. 3-2).

The on time shipment chart in Fig. 3-2 shows improvement over a twelve-month period. The chart could very well have shown a downward or even a random pattern. It is important to know when to react to trends on run charts. It is a mistake to assign cause every time the chart makes a move in either the positive or negative direction. Normal forces of variation are ever present, and until a process is in control and control limits are calculated via statistical calculations of control chart data, reaction to movement should be with caution. More on control charts will be discussed in Chapter 7.

Through analysis of data collected, opportunities for improvement will become evident. Management must determine which opportunities to work toward first. These decisions are usually based upon cost effectiveness, quality improvement, or criticality of correcting an undesirable condition. Whatever the reasons for choosing a particular opportunity as a project for improvement, the process is the same.

The improvement process has been defined by more than one quality guru as the *plan, act, measure, and evaluate cycle.* I call the process PIE (plan, initiate, evaluate) (Fig. 3-3).

PLAN

The most important part of a project is the planning phase; this is certainly true for continuous improvement projects. The better the plan, the better the implementation and the results. When developing a plan, the team needs to consider all action steps in the process expected to lead to the improvement desired. Once all action steps are identified, the next step is to decide the sequence in which these steps should be implemented. After the sequence is determined, the time allotted to complete each step is calculated, and responsibility for each step is assigned.

This planning process can work only if a few basic guidelines are applied during this phase.

Planning Guidelines

- Obtain upper management commitment through sponsorship.
- Form the right combination for the team.