INTRODUCTION TO TOTAL QUALITY

Quality Management for Production, Processing, and Services

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CHAPTER TEN

Decision Making and Problem Solving

MAJOR TOPICS

- Decision Making for Total Quality
- Solving and Preventing Problems
- Problem-Solving and Decision-Making Tools
- The Decision-Making Process
- Objective versus Subjective Decision Making
- Scientific Decision Making and Problem Solving
- Employee Involvement in Decision Making
- Role of Information in Decision Making
- Management Information Systems
- Creativity in Decision Making

Decision making and problem solving are fundamental to total quality. On the one hand, good decisions will decrease the number of problems that occur. On the other hand, the workplace will never be completely problem-free. The purpose of this chapter is three-fold:

- To help readers become better decision makers
- To help readers learn how to solve problems effectively, positively, and in ways that don't create additional problems
- To help readers learn to make decisions and handle problems in ways that promote quality

DECISION MAKING FOR TOTAL QUALITY

All people make decisions. Some are minor (What should I wear to work today? What should I have for breakfast?). Some are major (Should I accept a job offer in another city? Should I buy a new house?). Regardless of the nature of the decision, decision making can be defined as follows:

> *Decision making is the process of selecting one course of action from among two or more alternatives.*

Decision making is a critical task in a total-quality setting. Decisions play the same role in an organization that fuel and oil play in an automobile engine: they keep it running. The work of an organization cannot proceed until decisions are made.

Consider the following example. Because a machine is down, the production department at DataTech, Inc. has fallen behind schedule. With this machine down, DataTech cannot complete an important contract on time without scheduling at least 75 hours of overtime. The production manager faces a dilemma. On the one hand, no overtime was budgeted for the project. On the other hand, there is substantial pressure to complete this contract on time because future contracts with this client may depend on completing this one on time. The manager must make a decision.

In this case, as in all such situations, it is important to make the right decision. But how do managers know when they have made the right decision? In most cases, there is no single right choice. If there were, decision making would be easy. Typically several alternatives exist, each with its own advantages and disadvantages.

For example, in the case of DataTech, Inc., the manager had two alternatives: authorize 75 hours of unbudgeted overtime or risk losing future contracts. If the manager authorizes the overtime, his or her company's profit for the project in question will suffer, but its relationship with a client may be protected. If the manager refuses to authorize the overtime, the company's profit on this project will be protected, but the relationship with this client may be damaged. These and other types of decisions must be made all the time in the modern workplace.

Managers should be prepared to have their decisions evaluated and even criticized after the fact. Although it may seem unfair to conduct a retrospective critique of decisions that were made during the heat of battle, having one's decisions evaluated is part of accountability and it can be an effective way to improve a manager's decision-making skills.

Evaluating Decisions

There are two ways to evaluate decisions. The first is to examine the results. In every case when a decision must be made, there is a corresponding result. That result should advance an organization toward the accomplishment of its goals. To the extent that it does, the decision is usually considered a good decision. Managers have traditionally had their decisions evaluated based on results. However, this is not the only way that decisions should be evaluated. Regardless of results, it is wise also to evaluate the process used in making a decision. Positive results can cause a manager to overlook the fact that a faulty process was used and, in the long run, a faulty process will lead to negative results more frequently than to positive.

For example, suppose a manager must choose from among five alternatives. Rather than collect as much information as possible about each, weigh the advantages and disadvantages of each, and solicit informed input, suppose the manager chooses randomly. He or she has one chance in five of choosing the best alternative. Such odds occasionally produce a positive result, but typically they don't. This is why it is important to examine the process as well as the result, not just when the result is negative, but also when it is positive.

TOTAL QUALITY TIP

Decisions Must Be Made Continually

"During conduct of operations certain cardinal decisions must be made, over and over again:

- *The process – Should it run or stop?*
- *The resulting product – Does it conform to goals?*
- *Nonconforming product – What disposition should be made?"*

J.M. Juran

SOLVING AND PREVENTING PROBLEMS

Even the best managed organizations have problems. A problem is any situation in which what exists does not match what is desired. The greater the disparity between the two, the greater the problem. Problem solving in a total-quality setting is not just putting out fires as they occur. Rather, it is one more way to make continual improvements in the workplace. This section contains two models for solving problems in ways that simultaneously lead to workplace improvements, These models are the Deming Cycle and the Perry Johnson method.

The Deming Cycle

The Deming Cycle is the name given by the Japanese to the continual improvement model developed by total-quality pioneer Dr. W. Edwards Deming. It consists of four major components, each of which can be subdivided into step-by-step activities. Deming disciple William W. Scherkenbach explains the model as follows:

- *Plan. Develop a plan to improve.* Even before problems occur, create a plan for improving your area of responsibility, particularly the processes in that area. Then, when problems occur, they can be handled within the context of Deming's model for continuous improvement. Developing such a plan involves completing the following four steps:
  1. Identify opportunities for improvement.
  2. Document the current process.
  3. Create a vision of the improved process.
  4. Define the scope of the improvement effort.

- *Do. Carry out the plan.* Implement the plan for improvement. The recommended approach is to first implement on a small scale over a specified period of time. This is the equivalent of developing and testing a prototype of a design before moving to full production.

- *Study. Examine the results.* Examine and record the results achieved by implementing the plan. The recorded results form the basis for carrying out the steps in the next component.

TOTAL QUALITY TIP

Don't Just Solve Problems, Make Improvements

"Over the years, various experts have proposed numbers of approaches to problem solving. You may recognize names such as Kepner-Trego, Alamo, Quality Improvement Process, Team-Oriented Problem Solving, Creative Problem Solving, Analytical Problem Solving, Breakthrough Process, QC Story, and the like. While each has particular strengths, each also has particular weaknesses. All of them have the shortcoming of needing a 'problem' to solve. Fortunately, for the problem solving industry, there is no shortage of problems! Unfortunately for the rest of us, just solving problems, or reducing waste, or eliminating defects will not make us competitive in this new economic age. We need to go beyond problems and look for opportunities for continual improvement."

William W. Scherkenbach

- *Act. Adjust as necessary.* Make adjustments as necessary based on what was learned in the previous component. Then repeat the cycle for the next planned improvement by returning to the first component of the model.

The Perry Johnson Method

Perry Johnson, Inc. of Southfield, Michigan, recommends an approach to problem solving that works well in a total-quality setting because of its three main characteristics:

1. It promotes teamwork in problem solving.
2. It leads to continual improvement rather than just putting out fires.
3. It approaches problems as normal by-products of change.

The Perry Johnson Method for problem solving is as follows:

- *Establish a problem-solving team.* The reason for using a team in solving problems is the same as that for using a team in any undertaking: no individual knows as much as a team. Team members have their own individual experiences, unique abilities and particular ways of looking at things. Consequently, the collective efforts of a team are typically more effective than the individual efforts of one person.

TOTAL QUALITY TIP

Problems Are Neither Good nor Bad

"Problems are not bad or good. They just are. They are normal, natural by-products of change. What we commonly think of as a problem is simply performance which varies from what is expected in an undesirable way."

Perry Johnson, Inc.

A problem-solving team can be a subset of one department or unit, or it can have members from two or more different departments. It can be convened solely for problem solving, or it can have other duties. Decisions about how to configure the team should be based on the needs, size, and circumstances of the organization.

- *Brainstorm the problem list.* It is important to get out in front of problems and deal with them systematically. For example, the military doesn't just sit back and wait for the next trouble spot on the world scene to boil over. Rather, potential trouble spots are identified and entered onto a problem list. The potential problems are then prioritized and plans are developed for handling them. The same approach can be used in any organization. The problem-solving team should brainstorm about problems that might occur and create a master list.

- *Narrow the problem list.* The first draft of the problem list should be narrowed down to the entries that are really problems. To accomplish this, evaluate each entry on the list by means of three criteria:
  - There is a standard to which the entry can be compared.
  - Actual performance varies from the standard in an undesirable way.
  - The variance is supported by facts.

Any entry that does not meet all three criteria should be dropped from the list.

- *Create problem definitions.* All problems remaining on the list should be clearly defined. A problem definition has two parts: a description of the circumstance and a description of the variance. Figure 10-1 contains sample problem definitions that have the desirable characteristics of being thorough, brief, and precise.

  A teamwork tool that can be helpful in clarifying the definition of a problem is *Why-Why*. This method involves asking why until the team runs out of answers. Figure 10-2 illustrates how Why-Why works. Going through this process can be an effective way to clearly define the real problem so that time and resources are not wasted working on symptoms.

- *Prioritizing and selecting problems.* With all problems on the list defined, the team can prioritize them and decide which one to pursue first, second, and so on.

> - Job 21A is over budget by 22 percent.
>   *Circumstance:*
>   Job 21A is over budget.
>   *Variance:*
>   By 22 percent
>
> - Reject rate of the machining department is too high by 12 percent.
>   *Circumstance:*
>   Reject rate of the machining department is too high.
>   *Variance:*
>   By 12 percent

Figure 10-1
Sample Problem Definitions

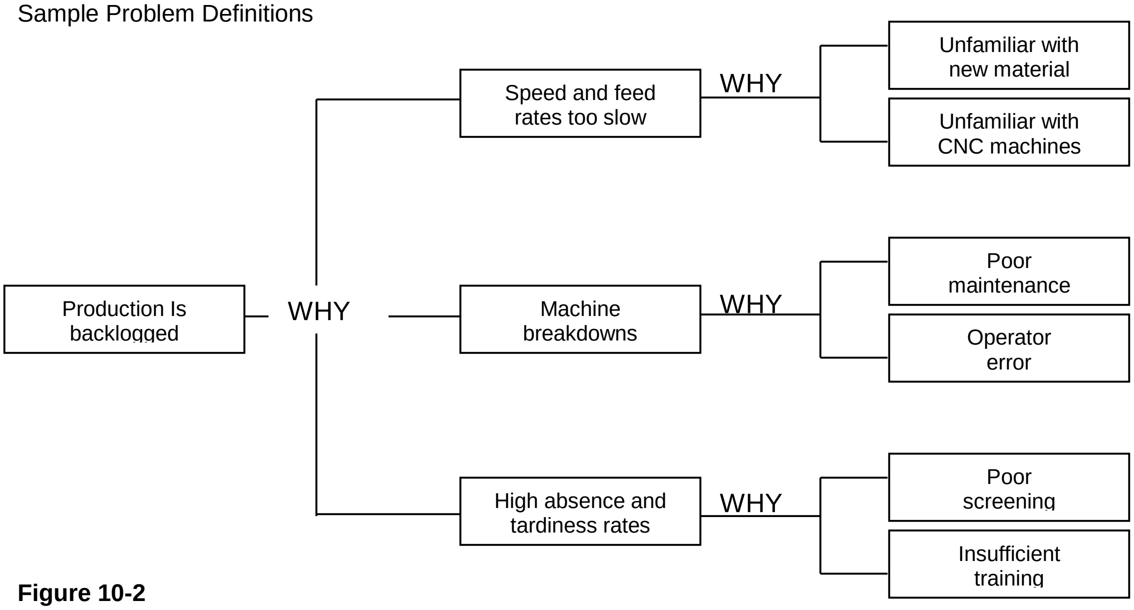


Figure 10-2
The Why-Why Method of Problem Definition

Perry Johnson recommends using a Problem Priority Matrix. The matrix is created as follows:

1. Divide the problem solving team into two groups and put them in separate rooms.
2. Have Group A rank the problem list in terms of benefit to the organization.
3. Have Group B rank the problems in terms of how much effort will be required to solve them.
4. Set up the Problem Priority Matrix as shown in Figure 10-3. The extended number is arrived at by multiplying the benefit ranking by the effort ranking for each problem. The lowest extended number is the problem that should be solved first. Solving it will yield the most benefit to the organization

with the least expenditure of effort. Other problems will yield more benefit or will require less effort. But when both benefit and effort required are taken into account, the lowest extended number would be the first to be solved.

Problem Number	Ranking by Benefit	Ranking by Effort	Extended Number (Multiplied)	Final Ranking
Problem 1	2	5	10	2
Problem 2	6	3	18	4
Problem 3	1	9	9	1
Problem 4	8	2	16	3
Problem 5	10	1	10	2
Problem 6	3	8	24	6
Problem 7	5	4	20	5
Problem 8	4	10	40	7
Problem 9	7	7	49	8
Problem 10	9	6	54	9

Figure 10-3
Problem Priority Matrix
Lowest number – Highest priority

- *Gather information about the problem.* When the problems have been prioritized, the temptation will be to jump right in ad begin solving them. This can be a mistake. The better approach is to collect all available information about a problem before pursuing solutions. Two kinds of information can be collected: objective and subjective. *Objective information* is factual. *Subjective information* is open to interpretation.

  Rarely will the information collected be only objective in nature. Nothing is wrong with collecting subjective information, as long as the following rules of thumb are adhered to for both objective and subjective information:
  1. Collect only information that pertains to the problem in question.
  2. Be thorough (it's better to have too much information than too little).
  3. Don't waste time recollecting information that is already on file.
  4. Allow sufficient time for thorough information collection, but set a definite time limit.
  5. Use systematic tools such as those explained in the Problem-Solving Tools section of this chapter.

Specifying the Problem

Specifying the problem means breaking it down into its component parts. All problems can be broken into five basic components as follows:

- Who is the problem affecting?
- What is the problem? This is a restatement of the final results of the Why-Why process.
- Where did the problem occur first, when did it occur first, and when did it occur last? How often is it occurring?

TOTAL QUALITY TIP

Separating Problems and Symptoms

"To narrow our problem list, the first thing we do is determine which items on our list are really problems and which are not. Sometimes, what we think at first glance to be problems are actually 'symptoms' or the causes of problems. Sometimes what we think are problems are actually causes of problems."

Perry Johnson, Inc.

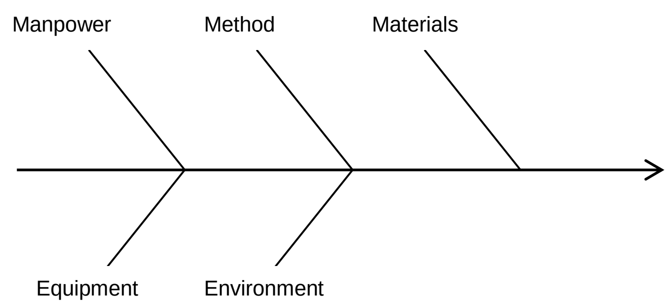
- Where does the problem occur? The answer to this question should be specific. If a machine in Department A is the problem, where should be specified not just as Department A, but also where in the machine the problem occurs (i.e., in the electrical system, in the hydraulic system, etc.).
- How much? What is the extent of the problem? Are there defective parts in every 50 produced? Are there two breakdowns per shift? This question should be answered in quantifiable terms whenever possible.

Identifying Causes

Identifying causes is a critical step in the process. It involves the pairing off of causes and effects. *Effects* are the problems that have already been identified. Say that one such problem has been targeted for solving. An effective tool for isolating the causes of this problem is the cause-and-effect diagram – also known as the fishbone diagram because of its appearance or the Ishikawa diagram after its inventor.

A fishbone diagram is illustrated in Figure 10-4. The five spines on this particular diagram represent the five major groupings of causes: personnel, method, materials, equipment, and environment. All causes of workplace problems fall into one of these major groupings. Using the diagram, team members brainstorm causes under each grouping. For example, under the equipment grouping, a cause might be insufficient maintenance. Under the personnel grouping, a cause might be insufficient training.

Figure 10-4
Sample Fishbone Diagram
(Cause-and-Effect)



Isolating the Most Probable Cause

The causes identified may or may not be the specific causes of the problem in question. To isolate the most probable cause or causes, each cause identified on the fishbone diagram is compared against the problem specifications developed earlier (i.e., who, what, when, where, how much).

When comparing potential causes and problem specifications for each cause there will be three possibilities: the cause will fully explain the specification, the cause will partially explain the specification, or the cause will not explain the specification. A cause that can fully explain the specifications is a likely candidate to be the most probable cause. If more than one cause fully explains the specifications, there may be more than one cause to the problem.

Finding the Optimum Solution

With the problem and its most probable cause identified, the next step is to find the optimum solution. The first task in this step is to develop a solution definition that clearly explains the effect the solution is to have. A solution definition should be the opposite of the problem definition. Figure 10-5 contains examples of problem definitions and their corresponding solution definitions.

With the definition in place, the team brainstorms possible solutions and creates a list. Perry Johnson, Inc. has developed a tool known as SCAMPER that can improve the team's effectiveness in building a solutions list. It is explained as follows:

- *Substituting.* Can the problem be solved by substitution? Can a new process be substituted for the old? Can one employee be substituted for another? Can a new material be substituted for the old?

- *Combining.* Can the problem be solved by combining two or more tasks, processes, activities, operations, or other elements?
- *Adapting.* Can the problem be solved by adapting an employee, a process, a product, or some other element to another purpose?
- *Modifying.* Can the problem be solved by modifying a process, job description, design, or something else?
- *Putting to other uses.* Can the problem be solved by putting a resource to other uses?

Problem Definition	Problem Solution
▪ Job 21A is over budget by 22 percent. ▪ Reject rate of the machining department is too high by 12 percent.	▪ Job 21A must be brought under budget by 2 percent. ▪ Reject rate of the machining department must be brought to 0 percent.

Figure 10-5
Problem Definitions and Problem Solutions

- *Eliminating.* Can the problem be solved by eliminating a position, part, process, machine, product, or something else?
- *Replacing.* Can the problem be solved by replacing an individual, part, process, machine, product, or something else?

With the solutions list developed, the next step is to identify the optimum entry on the list. One way to do this is by group consensus. A more objective approach is to undertake a cost-to-benefit analysis. This involves setting up a cost-benefit matrix. The matrix should contain cost categories and show the actual dollar costs in each category for each potential solution. The matrix is repeated from the perspective of benefits. Then, the total cost of each solution is compared against the total benefit to derive a cost-to-benefit ratio for each potential solution.

Figure 10-6 shows a cost-benefit matrix based on three proposed solutions to the following problem: the plastic coating unit is backlogged by two months. The three potential solutions are as follows:

- Purchase two additional plastic coating machines.
- Retrofit existing plastic coating machine with computer controls and automate the process.
- Add a second shift and run the plastic coating unit an additional eight-hour shift each day.

The cost-to-benefit matrix in Figure 10-6 shows the total cost for each potential solution. The costs range from a low of $60,2000 to a high of $196,300. The dollar value in benefits reveals that adding a second shift will produce costs that outweigh the benefits. The other two options are both feasible. However, the retrofit and automate option has a better cost-to-benefit ratio. With this option, every dollar spent will produce $2.23 in benefits. Based on the cost-to-benefit analysis the team would recommend retrofitting and automating the existing process.

Categories of Cost/Benefits	Purchase New Machines	Retrofit/ Automate	Add a Second Shift
COSTS			
Personnel Costs	$ -0-	$ -0-	$ 180,000
Equipment Costs	95,000	26,000	-0-
Down-Time Costs	-0-	11,400	-0-
Installation Costs	15,200	7,600	-0-
Training Costs	-0-	15,200	16,300
	$ 110,200	$ 60,200	$ 196,300
BENEFITS			
Reduced Overhead	$ 27,500	$ 27,500	$ 27,500
Elimination of Late Fees	32,000	32,000	32,000
Elimination of Cancelled Orders	75,000	75,000	75,000
	$ 135,500	$ 134,500	$ 134,500

COST-TO-BENEFIT RATIO	1 to 1.2	1 to 2.23	1.46 to 1

Figure 10-6
Cost-to-Benefit Matrix

Implementing the Optimum Solution

The implementation phase of the process is critical. If handled properly, the problem will be solved in a way that results in an improvement to the process in question. However, if implementation is not handled properly, new and even more serious problems can be created.

The key to effective implementation of a solution is to take a systematic approach. Perry Johnson recommends developing an action plan with the following components:

- Actions to be taken
- Methods for taking each action
- Resources needed for each action
- Special needs for each action
- Person responsible for each action
- Deadline for each action

Ease of implementation can be enhanced by building an Action Plan Matrix that commits the plan to one single sheet of paper whenever possible (see Figure 10-7). Before implementing the action plan, it is important to gain the support of any individual or group that might be affected by implementation. For example, the action plan in Figure 10-7 requires the expenditure of $1,500 for replacement parts and the time of maintenance personnel.

Unless the team leader has the authority to spend $1,500, he or she will need to gain the support of someone who does. In addition, the maintenance manager should be consulted to ensure that his or her crew is available when needed. Any other individual or department that will be affected in any way by action taken to implement the solution should be brought into the loop before the plan is implemented. Finally, after the solution has been implemented, the results should be monitored and adjustments made as necessary.

TOTAL QUALITY TIP

Solve Problems Without Creating New Ones

"Finding the solution is terrific. But if we implement it haphazardly, we could get into bigger trouble than we were in before. The solution may only partially solve the problem. Even worse, if poorly implemented, it may trigger all kinds of new problems."

Perry Johnson, Inc.

Action to be Taken	Method	Resources Required	Special Needs	Person Responsible	Deadline
Order replacement parts	Go to Purchasing Office and work with L. Smith	Approximately $1,500	None	Bao Du Vo	Tuesday the 8th
Prepare machine for repair	Remove old part and clean up	Basic tool box	None	Louise Crockett	Wednesday the 9th
Schedule repair personnel	Call Maintenance Supervisor, M. Washington	None	None	Jose Ortega	Tuesday the 8th

Figure 10-7

Action Plan Matrix

PROBLEM SOLVING AND DECISION-MAKING TOOLS

The models presented in the previous section can help problem-solving teams make better decisions provided that the decisions are based on facts. However, decisions based on information that is tainted by personal opinions, exaggeration, or personal agendas are not likely to be good decisions regardless of the problem-solving model used. The information collection step of the Perry Johnson model can be made more effective through the use of several quality tools.

Quality pioneer W. Edwards Deming recommends seven charts that can be used as tools to help secure objective information on which to base decisions: cause-and-effect diagram, flow chart, Pareto chart, run (trend) chart, histogram, control chart, and scatter diagram.

Cause-and-Effect Diagrams

Cause-and-effect diagrams were explained briefly in the previous section. They are also known as Ishikawa diagrams after the inventor Dr. Kaoru Ishikawa, or fishbone diagrams because of their appearance. To understand how a fishbone diagram is developed, consider the example in Figure 10-8. The four broad categories of potential causes for this particular problem are personnel, methods, equipment, and environment. The diagram in Figure 10-8 has no material branch, indicating that material plays no role in this particular problem.

Although personnel, methods, equipment, materials, and environment are the most common categories, they are not the only categories. Other categories, such as policy, procedures, and finances might also be used depending on the problem in question.

In his book *Guide to Quality Control*, Dr. Kaoru Ishikawa explains the benefits of using cause-and-effect diagrams as follows:

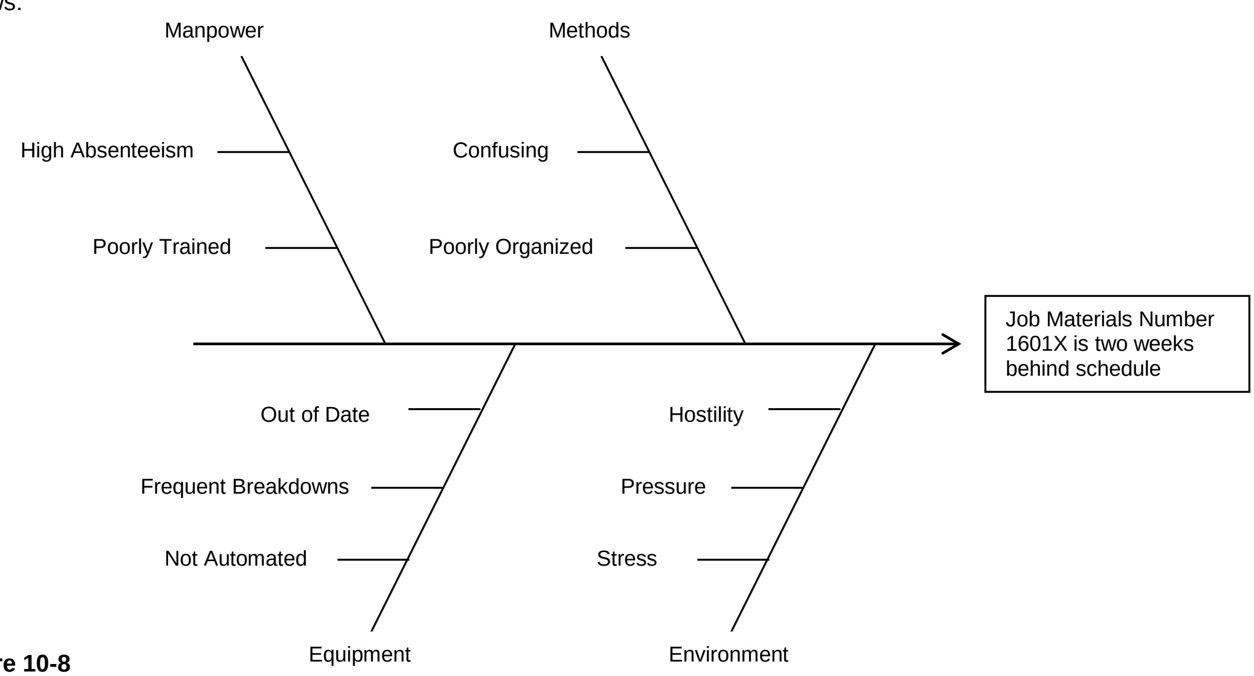
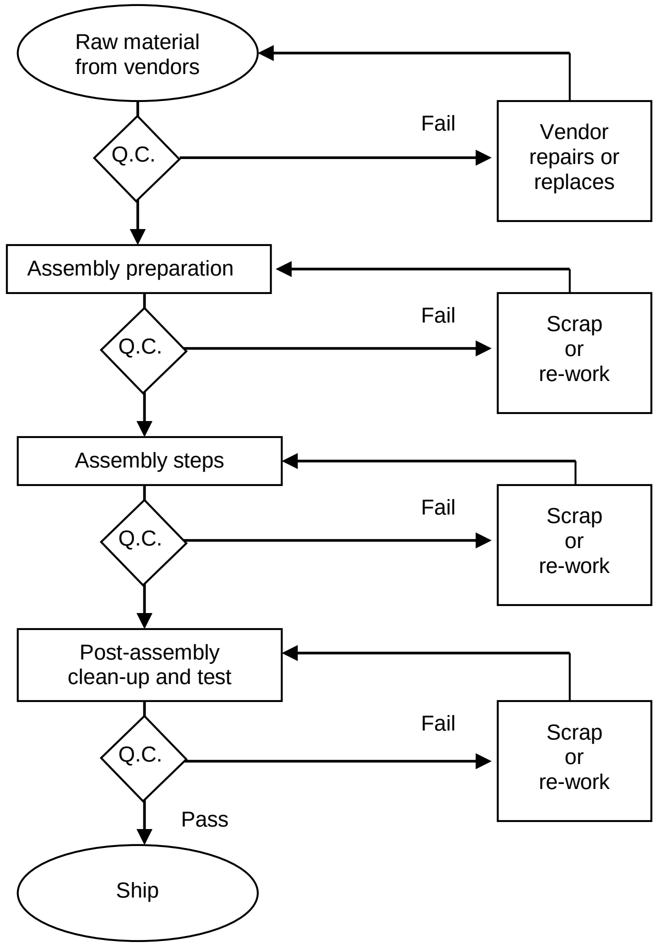


Figure 10-8
Fishbone Diagram

- Creating the diagram itself is an enlightening, instructive process.
- Such diagrams focus a group, thereby reducing irrelevant discussion.
- Such diagrams separate causes from symptoms and force the issue of data collection.
- Such diagrams can be used with any problem.

Figure 10-9
Low-Voltage Power Supply

Flow



Flow Charts

A *flow chart* is a graphic representation of a process. A necessary step in improving a process is to chart it. In this way, all parties involved can begin with the same understanding of the process. A good way to start is to ask several different team members who know the process to chart it independently. If their charts are not the same, one problem is revealed at the outset.

Another strategy is to ask team members to chart how the process actually works and then chart how they think it should work. Comparing the two versions can be an effective way to identify causes of problems.

After a process has been charted, it can be studied to determine what aspects of it are problematic and where improvements can be made. Figure 10-9 is a flow chart for the production of low-voltage power supplies for military aircraft.

Four major activities are shown on the chart, each with its own built-in quality check and feedback loop. The final and fifth step is shipping the product. If a problem is occurring in the production of low-voltage power supplies, the problem-solving team can use this flow chart to isolate the source.

Pareto Charts

A *Pareto (pay-ray-toe) chart* is used to establish priorities. It is particularly effective in helping sort out what problems or causes of problems to pursue first. For example, suppose the problem being discussed is a large increase in the organization's workers' compensation rate as a result of an increased number of accidents.

Before pursuing the problem further, the team decides to construct a Pareto chart to determine what types of injuries are having the greatest impact on rate increases. The chart in Figure 10-10 is an example of how the team's chart might turn out. From the information displayed on this Pareto chart, it is clear that back injuries represent the largest part of this company's accident/injury problem. In prioritizing the team's problem list, back injuries should come first.

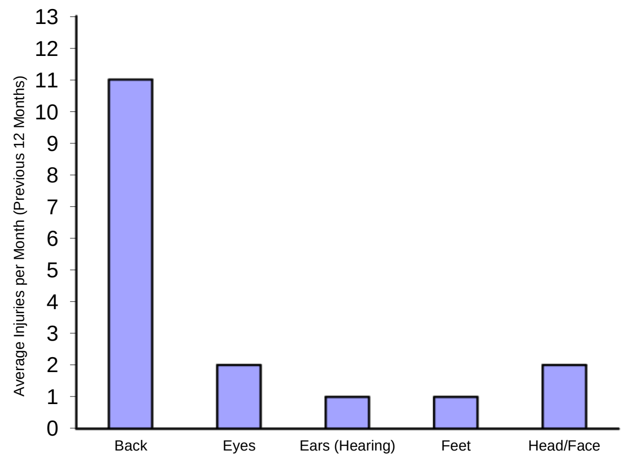


Figure 10-10
Pareto Chart: Frequency of Injury by Type

Run Charts

Run charts are used to identify trends by charting data over a specified period of time. For example, if absenteeism is thought to be a problem, it might be plotted for a specified period of time to determine if there are trends. Trends can be very helpful in separating causes from symptoms.

Figure 10-11 is a run chart that plots the average instances of absenteeism over a twelve-month period by workday. The problem days are Monday and Friday. In other words, this organization doesn't have an absenteeism problem, it has an absenteeism problem on Mondays and Fridays. Knowing this, the problem team can focus its efforts on getting people to come to work on these two problem days.

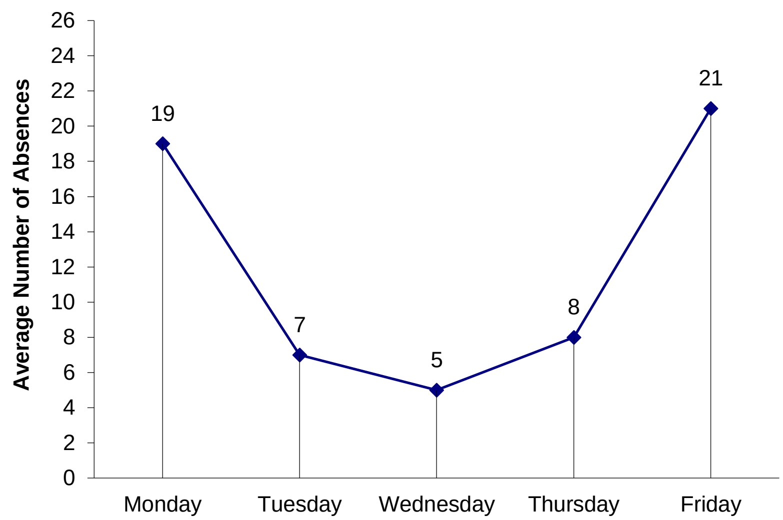


Figure 10-11
Run Chart

Histograms

Histograms are used to chart frequency of occurrence. How often does something happen? For example, suppose a great deal of variance exists in the amount of time it takes a manufacturer to produce a given printed circuit board. The production manager would like to settle on a reasonable amount of time that it should take to produce this product so that a company-wide standard can be established.

The immediate temptation is to compute the average time. However, the average time may not be a realistic time. The most frequent time may be more realistic. Figure 10-12 is a histogram showing the frequencies of production times for the printed circuit board in question.

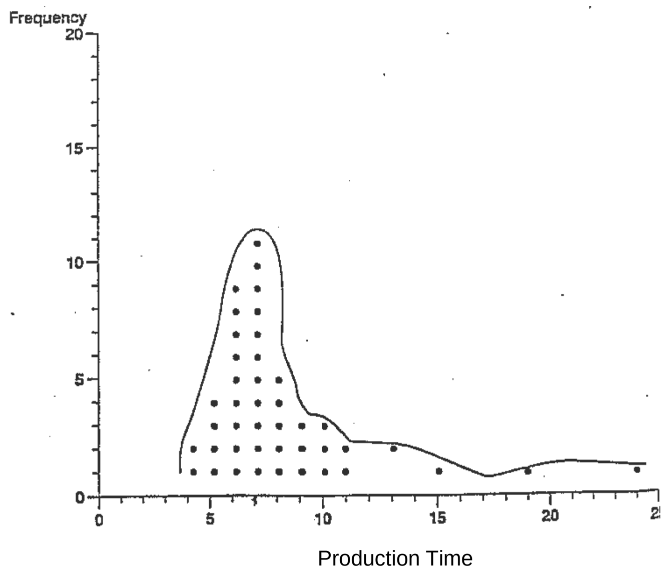


Figure 10-12
Histogram: Production Times for Printed Circuit Board

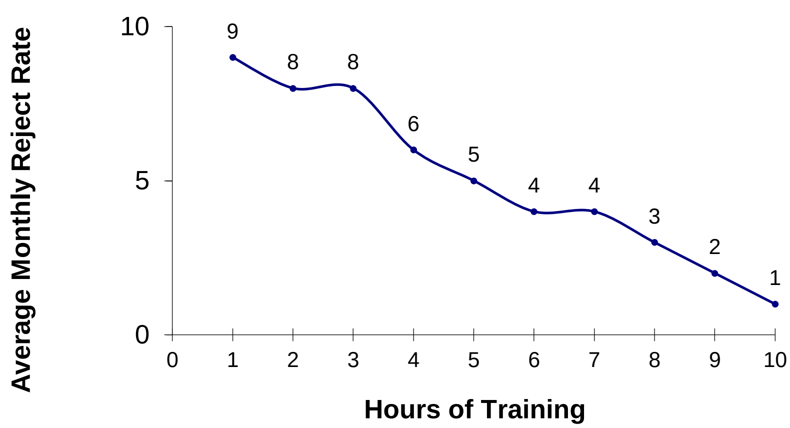
Twice, the board has been produced in just 4 hours. Once, it took 24 hours to produce it. However, the greatest frequencies are found in the range from 5 to 8 hours with 7 hours being the most frequent time. One can surmise that the boards that took 13 to 24 hours to produce were exceptions. Perhaps some vital part was missing and this held up production. The boards that were produced in 4 hours are probably also exceptional cases. Based on this histogram, a realistic standard for producing the printed circuit boards is probably 6.5 to 7 hours.

Scatter Diagrams

Scatter diagrams are used to graphically represent the relationship between two variables. For example, suppose a manufacturer wants to chart the relationship between hours of specialized training for assembly workers and the average reject rate for those workers. Figure 10-13 is a scatter diagram that charts such a relationship.

From this diagram, it appears that a relationship exists between the specialized training offered to employees and their respective reject rates. The more hours of training completed, the lower the average monthly reject rate. From this diagram, the problem-solving team can conclude that one way to decrease the reject rate is to increase the amount of training provided.

Figure 10-13
Scatter Diagram:
Hours of Training
vs. Reject Rate



Control Charts

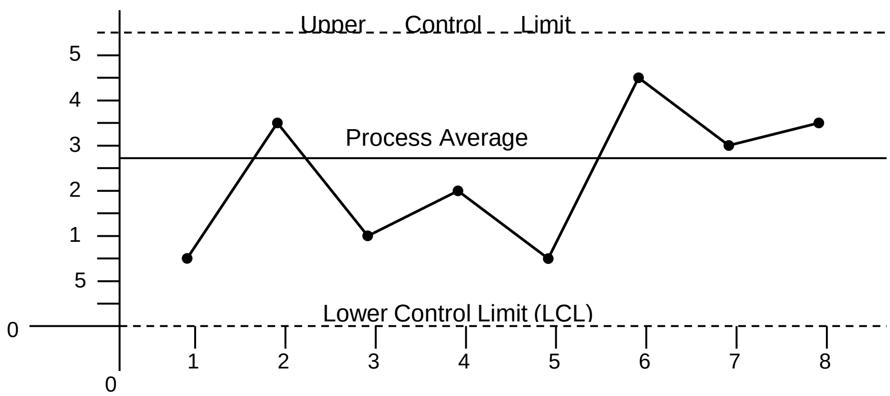
The type of chart for which quality pioneer W. Edwards Deming is most noted is the control chart. Control chars are used to analyze processes for the purpose of continually improving them. Such a chart has an upper control limit, an average, and a lower control limit (see Figure 10-14).

The idea is to let a process work in the normal manner for a specified period of time during which the behavior of the process is recorded. What constitutes behavior is defined locally. It might be defects, time errors, temperature, or any other factor that is a critical aspect of the process.

At the end of the limit-setting period, the behavior of the process is analyzed mathematically to establish upper and lower limits. After the limits have been established, the process is said to be in control. From this point forward, the behavior of the process is plotted on a control chart such as the one shown in Figure 10-14. As long as the points plotted fall within the upper and lower limits on the chart, the system is in control. A plot that falls outside of one of the limits indicates a problem that should be corrected immediately. Even when the process is in control, its performance will vary, as shown in Figure 10-14. In her book *The Deming Management Method*, Mary Walton explains the variations in process performance as follows:

There are two kinds of variation. The first is that which results from many small causes; minor variations in the worker's ability, the clarity of procedures, the capability of the machinery and equipment, and so forth. These are "common cause" and can often only be changed by management. The other form of variation is usually easier to eliminate. A machine malfunctions; an untrained worker is put on the job; defective material arrives from a vendor. Dr. Deming calls these "special causes." They show up on control charts as points outside the limits.

Figure 10-14
Control Chart



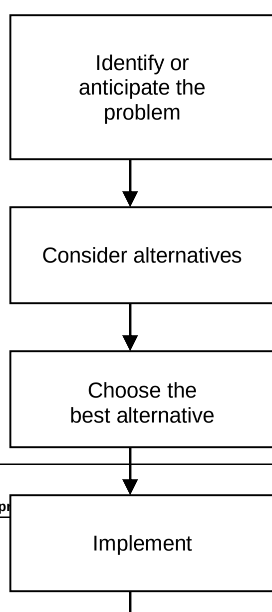
THE DECISION-MAKING PROCESS

Decision making is a process. For the purpose of this textbook, the decision-making process is defined as follows:

The decision-making process is a logically sequenced series of activities through which decisions are made.

Numerous decision-making models exist. Although they appear to have major differences, all involve the various steps shown in Figure 10-15. These steps will now be discussed.

Figure 10-15
Decision-Making Model



Identify or Anticipate the Problem

If managers can anticipate problems, they may be able to prevent them. Anticipating problems is like driving defensively; never assume anything. Look, listen, ask, and sense. For example, if you hear through the grapevine that a team member's child has been severely injured and hospitalized, you can anticipate the problems that may occur. She is likely to be absent, or if she odes come to work, her pace may be slowed. The better managers know their employees, technological systems, products, and processes, the better able they will be to anticipate problems.

However, even the most perceptive managers will be unable to anticipate all problems. For example, suppose a manager notices a "Who cares?" attitude among team members. This manager might identify the problem as poor morale and begin trying to improve it. However, he or she would do well to identify what is behind the negative attitudes. Perhaps they are the result of an unpopular management policy. Using the methods and tools described earlier in this chapter, the manager should separate causes from symptoms.

The factors that might be at the heart of the problem include those for which a manager is responsible (such as scheduling and work processes) as well as others over which managers have no control (such as the family problems of employees).

Consider Alternatives

This involves two steps. The first step is to list all of the various alternatives available. The second step is to evaluate each alternative. The number of alternatives identified in the first step will be limited by several factors. Practical considerations, the manager's range of authority, and the cause of the problem will all limit a manager's list of alternatives. After the list has been developed, each entry on it is evaluated. The main criteria against which alternatives are evaluated is the desired outcome. Will the alternative being considered solve the problem? If so, at what cost?

Cost is another criteria used in evaluating alternatives. There are always cost associated with alternatives. The costs might be expr4essed in financial terms, in terms of employee morale, in terms of the organization's image, or in terms of a client's good will. Such costs should be considered when evaluating alternatives. In addition to applying objective criteria, managers will also need to apply their judgment and experience when considering alternatives.

Choose the Best Alternative, Implement, Monitor, and Adjust

After all alternatives have been considered, one must be selected and implemented, and after an alternative has been implemented, managers monitor progress and adjust appropriately. Is the alternative having the desired effect? If not, what adjustments should be made? Selecting the best alternative is never a completely objective process. It requires logic, reason, intuition, and experience. Occasionally, the alternative chosen for implementation will not produce the desired results. When this happens and adjustments are not sufficient, it is important for managers to cut their losses and move on to another alternative.

Managers should avoid falling into the ownership trap. This happens when they invest so much ownership is given alternative that they refuse to change even when it becomes clear the idea is not working. This can happen at any time, but is more likely to happen when a manager selects an alternative that runs counter to the advice he or she has received, is unconventional, or is unpopular. The manager's job is to solve the problem. Showing too much ownership in a given alternative can impede one's ability to do so.

OBJECTIVE VERSUS SUBJECTIVE DECISION MAKING

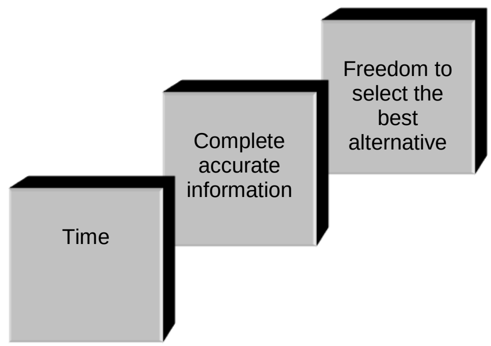
All approaches to decision-making fall into one of two categories: objective or subjective. Although the approach used by managers in a total-quality setting may have characteristics of both, the goal is to minimize subjectivity and maximize objectivity. The approach most likely to result in a quality decision is the objective approach.

Objective Decision Making

The objective approach is logical and orderly. It proceeds in a step-by-step manner and assumes that managers have the time to systematically pursue all steps in the decision making process (see Figure 10-16). It also assumes that complete and accurate information is available and that managers are free to select what they feel is the best alternative.

Measured against these assumptions, it can be difficult to be completely objective when making decisions. Managers don't always have the luxury of time and complete information. This does not mean that objectivity in decision-making should be considered impossible. Mangers should be as objective as possible. However, it is important to understand that the day-to-day realities of the workplace may limit the amount of time and information available. When this is the case, objectivity can be affected.

Figure 10-16
Factors that Contribute to Objective Decision Making



Subjective Decision Making

Whereas objective decision-making is based on logic and complete, accurate information, subjective decision-making is based on intuition, experience, and incomplete information. This approach assumes decision makers will be under pressure, short on time, and operating with only limited information. The goal of subjective decision-making is to make the best decision possible under the circumstances. In using this approach, the danger always exists that managers might make quick, knee-jerk decisions based on no information and no input from other sources. The subjective approach does not give managers license to make sloppy decisions. If time is short, the little time available should be used to list and evaluate alternatives. If information is incomplete, use as much information as is available.

SCIENTIFIC DECISION MAKING AND PROBLEM SOLVING

As explained in the previous section, there will be times when decisions must be made subjectively. However, through good management and leadership, such instances should and can be held to a minimum. One of the keys to success in a total-quality setting is using a scientific approach in making decisions and solving problems. The Total Quality Tip on the next page explains Joseph M. Juran's 85/15 rule. Decision makers in a total-quality setting should understand this rule. It is one of the fundamental premises underlying the need for scientific decision making.

Peter R. Scholtes explains the rationale for scientific decision making as follows:

> The core of quality improvement methods is summed up in two words: scientific approach. Though this may sound complicated, a scientific approach is really just a systematic way for individuals and teams to learn about processes. It means agreeing to make decisions based on data rather than hunches, to look for root causes of problems rather than react to superficial symptoms, to seek permanent solutions rather than rely on quick fixes. A scientific approach can, but does not always, involve using sophisticated statistics, formulas, and experiments. These tools enable us to go beyond band-aid methods that merely cover up problems to find permanent, upstream improvements.

Complexity and the Scientific Approach

In the language of scientific decision making, complexity means nonproductive, unnecessary work that results when organizations try to improve their processes without first developing a systematic plan. Several different types of complexity exist, including the following: errors and defects, breakdowns and delays, inefficiencies, and variation. The next Total Quality Tip explains the Pareto Principle. Decision-makers should keep this principle in mind when attempting to apply the scientific approach.

Errors and Defects

Errors cause defects and defects reduce competitiveness. When a defect occurs, one of two things must happen: the part or product must be scrapped altogether, or extra work must be done to correct the defect. Work that results from errors and defects adds cost to the product without adding value.

TOTAL QUALITY TIP

The Pareto Principle

"This principle is sometimes called the 80/20 rule: 80% of the trouble comes from 20% of the problems. Though named for turn-of-the-century economist Vilfredo Pareto, it was Dr. Juran who applied the idea to management. Dr. Juran advises us to concentrate on the 'vital few' sources of problems and not be distracted by those of lesser importance."

Peter R. Scholtes

Breakdowns and Delays

Equipment breakdowns delay work, causing production personnel either to work overtime or to work faster to catch up. Overtime adds cost to the product without adding value. When this happens, the organization's competitors gain an unearned competitive advantage. When attempts are made to run a process faster than its optimum rate, an increase in errors is inevitable.

Inefficiency

Inefficiency means using more resources (time, material, movement, or something else) than necessary to accomplish a task. Inefficiency often occurs because organizations fall into the habit of doing things the way they have always been done without ever asking why (see Case Study 10-1).

Variation

In a total-quality setting, consistency and predictability are important. When a process runs consistently, efforts can begin to improve it by reducing process variations of which there are two kinds:

- *Common variation* is the result of the sum of numerous small sources of variation that are always part of the process, such as the varying skills of workers.
- *Special variation* is the result of factors that are not part of the process and that occur only in special circumstances, such as a shipment of faulty raw material.

The performance of a process that operates consistently can be recorded and plotted on a control chart such as the one in Figure 10-17. The sources of the variation in this figure that fall within the control limits are likely to be common sources. The sources of variation in this figure that fall outside of the control limits are likely to be special sources. In making decisions about the process in question, it is important to separate common and special sources of variation.

Commenting on variation, Peter Scholtes says:

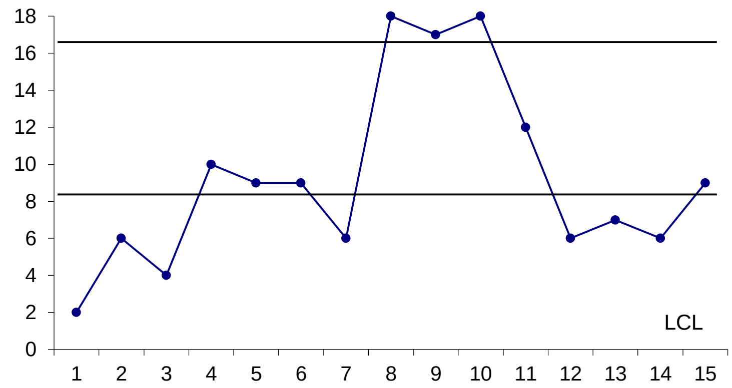
> If you react to common-cause variation as if it were due to special causes, you will only make matters worse and increase variation, defects, and mistakes. If you fail to notice the appearance of a special cause, you will miss an opportunity to search out and eliminate a source of problems.

CASE STUDY 10-1

The Utility Company That Forgot to Ask Why

"Many years ago a utility company installed a vent in a power plant to comply with an environmental regulation. Later, the need for the vent, which allowed steam and heat to escape, disappeared when the company changed fuels and equipment. By then, no one bothered to question having a vent. Recently, a project team in one plant discovered that the vent had outlived its usefulness and could be closed. The company estimates the savings in heat and efficiency to be over $100,000 a year.

Figure 10-17
Control Chart



The concept of using control charts and statistical data in decision making is discussed in greater depth in Chapter 17.

EMPLOYEE INVOLVEMENT IN DECISION MAKING

Chapter 8 showed how employee involvement and empowerment can improve decision making. Employees are more likely to show ownership in a decision they had a part in making. Correspondingly, they are more likely to support a decision for which they feel ownership. There are many advantages to be gained from involving employees in decision making, as was shown in Chapter 8. There are also factors that, if not understood and properly handled, can lead to problems.

Advantages of Employee Involvement

Involving employees in decision making can have a number of advantages. It can result in a more accurate picture of what the problem really is and a more comprehensive list of potential solutions. It can help managers do a better job of evaluating alternatives and selecting the best one to implement.

Perhaps the most important advantages are gained after the decision is made. Employees who participate in the decision making process are more likely to understand and accept the decision and have a personal stake in making sure the alternative selected succeeds.

Potential Problems with Employee Involvement

Involving employees in decision making can lead to problems. The major potential problem is that it takes time, and managers do not always have time. Other potential problems are that it takes employees away from their jobs and that it can result in conflict among team members. Next to time, the most significant potential problem is that employee involvement can lead to democratic compromises that do not necessarily represent the best decision. In addition, disharmony can result when a decision maker rejects the advice of the group.

Nevertheless, if care is taken, managers can gain all of the advantages while avoiding the potential disadvantages associated with employee involvement in decision making. Several techniques are available to help increase the effectiveness of group involvement. Prominent among these are brainstorming, the Nominal Group Technique (NGT), and quality circles. For details on how to implement these techniques, see Chapter 8 (pp. 188-189). Be particularly wary of the dangers of *groupthink* and *groupshift* in group decision making, as these phenomena were outlined in that chapter.

ROLE OF INFORMATION IN DECISION MAKING

Information is a critical element in decision making. Although having accurate, up-to-date, comprehensive information does not guarantee a good decision, lacking such information can guarantee a bad one. The old saying that knowledge is power applies in decision making – particularly in a competitive situation. In order to make decisions that will help their organizations be competitive, managers need timely, accurate information.

> *Information can be defined as data that have been converted into a useable format that is relevant to the decision making process.*

Data that are relevant to decision making are those that might have an impact on the decision. Communication is a process that requires a sender, a medium, and a receiver. In this process, information is what is provided by the sender, transmitted by the medium, and received by the receiver. For the purpose of this chapter, decision makers are receivers of information who have base decisions at least in part on what they receive.

Advances in technology have ensured that the modern manager can have instant access to information. Computers and telecommunications technology give decision makers a mechanism for collecting, storing, processing and communicating information quickly and easily. The quality of the information depends on people (or machines) receiving accurate data, entering it into technological systems, and updating it continually. This dependence on accurate information gave rise to the expression "garbage-in/garbage-out" that is now associated with computer-based information systems. The saying means that information provided by a computer-based system can be no better than the data put into the system.

Data versus Information

Data for one person may be information for another. The difference is in the needs of the individual. A manager's needs are dictated by the types of decisions he or she makes. For example, a computer printout listing speed and feed rates for a company's machine tools would contain valuable information for the production manager; the same printout would be just data to the warehouse manager. In deciding on the type of information they need, decision makers should ask themselves these questions:

- What are my responsibilities?
- What are my organizational goals?
- What types of decisions do I have to make relative to these responsibilities and goals?

Value of Information

Information is a useful commodity. As such it has value. Its value is determined by the needs of the people who will use it and the extent to which the information will help them meet their needs. Information also has a cost. Because it must be collected, stored, processed, continually updated, and presented in a useable format when needed, information can be expensive. This fact requires managers to weigh the value of information against its cost when deciding what information they need to make decisions. It makes no sense to spend $100 on information to help make a $10 decision.

Amount of Information

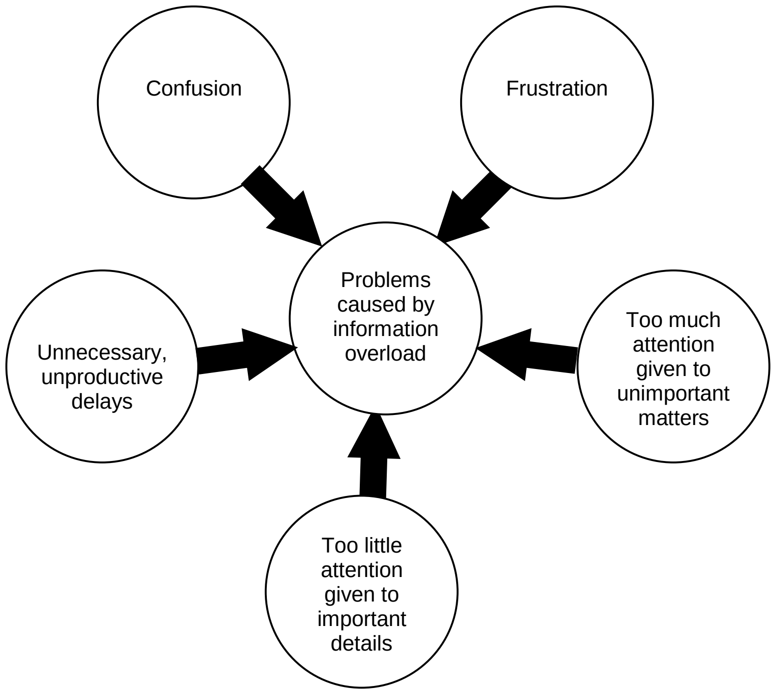
An old saying holds that a manager can't have too much information. This is no longer true. With advances in information technologies, not only can managers have too much information, they frequently do. This phenomenon has come to be known as *information overload*, the condition that exists when people receive more information than they can process in a timely manner. The phrase "in a timely manner" means in time to be useful in decision making (see Figure 10-18).

To avoid information overload, managers can apply a few simple strategies. First, examine all regular reports received. Are they really necessary? Do you receive daily or weekly reports that would meet your needs just as well if provided on a monthly basis? Do you receive regular reports that would meet your needs better as exception reports? In other words, would you rather receive reports every day that say everything is all right, or occasional reports when there is a problem? The latter approach is reporting by exception and can cut down significantly on the amount of information that managers must absorb.

Another strategy for avoiding information overload is formatting for efficiency. This involves working with personnel who provide information, such as management information systems (MIS) personnel, to ensure that reports are formatted for your convenience rather than theirs. Decision makers should not have to wade through reams of computer printouts to locate the information they need. Nor should they have to become bleary-eyed reading rows and columns of tiny figures. Talk with MIS personnel and recommend an efficient report form that meets your needs. Also, ask that information be presented graphically whenever possible.

Finally, make use of on-line, on-demand information retrieval. In the modern workplace, most reports are computer-generated. Rather than relying on periodic printed reports, learn to retrieve information from the MIS database when you need it (on demand) using a computer terminal or a networked personal computer (on-line).

Figure 10-18
Information Overload



USING MANAGEMENT INFORMATION SYSTEMS (MIS)

The previous section contained references to management information systems (MIS) and MIS personnel.

> *A management information system (MIS) is a system used to collect, store, process, and present information used by managers in decision making.*

In the modern workplace, a management information system is typically a computer-based system. A management information system has three major components: hardware, software, and people. *Hardware* consists of the computer – be it a mainframe, mini, or microcomputer – all of the peripheral devices for interaction with the computer, and output devices such as printers and plotters.

Software is the component that allows the computer to perform specific operations and process data. It consists primarily of computer programs but also includes the database, files, and manuals that explain operating procedures. *Systems software* controls the basic operation of the system. *Applications software* controls the processing of data for specific computer applications (word processing, CAD/CAM, computer-assisted process planning, spreadsheets, and so on).

A *database* is a broad collection of data from which specific information can be drawn. For example, a company might have a personnel database in which many different items of information about its employees are stored. From this database can be drawn a variety of different reports – such as printouts of all employees in order of age, by race, or by zip code. Files are kept on computer disks or tapes on which data are stored under specific groupings or file names.

The most important component is the people component, or users. It consists of the people who manage, operate, maintain, and use the system. Managers who depend on a management information system for part of the information needed to make decisions are users.

Managers should not view a management information system as the final word in information. Such systems can do an outstanding job of providing information about predictable matters that are routine in nature. However, many of the decisions managers have to make concern problems that are not predictable. For this reason, it is important to have sources other than the management information system from which to draw information.

CREATIVITY IN DECISION MAKING

The increasing pressures of a competitive marketplace are making it more and more important for organizations to be flexible, innovative, and creative in decision making. In order to survive in an unsure, rapidly changing marketplace, organizations must be able to adjust rapidly and change directions quickly. To do so requires creativity at all levels of the organization.

Creativity Defined

Like leadership, creativity has many definitions, and viewpoints vary about whether creative people are born or made. For the purposes of modern organizations, creativity can be viewed as an approach to problem solving and decision making that is imaginative, original and innovative. Developing such perspectives requires that decision makers have knowledge and experience regarding the issue in question.

Creative Process
According to Van Oech, the creative process proceeds in four stages: preparation, incubation, insight, and verification. What takes place in each of these stages is summarized as follows:

- *Preparation* involves learning, gaining experience, and collecting/storing information in a given area. Creative decision making requires that the people involved be prepared.
- *Incubation* involves giving ideas time to develop, change, grow, and solidify. Ideas incubate while decision makers get away from the issue in question and give the mind time to sort things out. Incubation is often a function of the subconscious mind.
- *Insight* follows incubation. It is the point in time when a potential solution falls in place and becomes clear to decision makers. This point is sometimes seen as a moment of inspiration. However, inspiration rarely occurs without having been preceded by perspiration, preparation, and incubation.
- *Verification* involves reviewing the decision to determine whether it will actually work. At this point, traditional processes such as feasibility studies and cost-benefit analyses are used.

Factors That Inhibit Creativity

A number of factors can inhibit creativity. Some of the more prominent of these are as follows:

- *Looking for just one right answer.* Seldom is there just one right solution to a problem.
- *Focusing too intently on being logical.* Creative solutions sometimes defy logic and conventional wisdom.
- *Avoiding ambiguity.* Ambiguity is a normal part of the creative process. This is why the incubation step is so important.
- *Avoiding risk.* When organizations don't seem to be able to find a solution to a problem, it often means decision makers are not willing to give an idea a chance.
- *Forgetting how to play.* Adults sometimes become so serious they forget how to play. Playful activity can stimulate creative ideas.
- *Fear of rejection or looking foolish.* Nobody likes to look foolish or feel rejection. This fear can cause people to hold back what might be creative solutions.
- *Saying "I'm not creative."* People who decide they are not creative won't be. Any person can think creatively and can learn to be even more creative.

Helping People Think Creatively

In the age of high technology and global competition, creativity in decision making and problem solving is critical. While it is true that some people are naturally more creative than others, it is also true that any person can learn to think creatively. In the modern workplace, the more people who think creatively, the better. Case Study 10-2 demonstrates what can happen when just one employee thinks creatively. Darrell W. Ray and Barbara L. Wiley recommend the following strategies for helping employees think creatively.

- *Idea vending.* This is a facilitation strategy. It involves reviewing literature in the field in question and compiling files of ideas contained in the literature. Periodically, circulate these ideas among employees as a way to get people thinking. This will facilitate the development of new ideas by the employees. Such an approach is sometimes called stirring the pot.

- *Listening.* One of the factors that causes good ideas to fall by the wayside is poor listening. Managers who are perpetually too hurried to listen to the ideas of employees do not promote creative thinking. On the contrary, such managers stifle creativity. In addition to listening to the ideas, good and bad, of employees, managers should listen to the problems employees discuss in the workplace. Each problem is grist for the creativity mill.
- *Idea attribution.* A manager can promote creative thinking by subtly feeding pieces of ideas to employees and encouraging them to develop the idea fully.

CASE STUDY 10-2

Soliciting Creative Ideas from Employees

"At an electric motor manufacturing plant, a crew ran out of wax in which to dip armatures. In the past its supervisor, Brad, had shown an openness to new ideas from his subordinates so they frequently made suggestions about how to increase productivity. As a result, he was always ahead of schedule. This time Brad was faced with having his full second shift sit idle while falling far behind quota. Then one of his employees asked, "Why couldn't we use the old wax? It doesn't get dirty, and all we do is throw it away." It was a great idea and only required scraping out the vats and recycling the wax. The crew got through the shift with only an hour of downtime and actually exceeded its quota that evening. The net result was a savings of thousands of dollars in resources and productivity over the next few months."