QUALITY ASSURANCE

Quality assurance (QA) describes and manages the activities of control, evaluation, audits, and regulatory aspects of a food processing system. A QA program consists of an in-house consulting organization; it evaluates the quality program and gives advice, suggestions, and instructions for its improvement.

QA is an advisory function, not a police function. It is not responsible for the quality program, it does not operate the system, and it does not do quality control. QA may audit the system and provide assistance in making improvements, but the planning, organizing, staffing, directing, and controlling of the quality program are in the hands of upper and production management.

Functions of a Quality Assurance Program

Information on food quality and food manufacturing is currently more readily available to consumers through the mass media. In many countries, the safety and quality of foods are becoming a matter of increasing concern and consumers are considerably more aware of existing and potential risks in their food from various sources: pesticides, food poisoning, and a poor diet. Demonstrating the impact of this greater awareness, consumers often prefer to buy foods that are made by larger, more recognizable manufacturers, because larger companies are supposed to have better quality products or manufacture their products under optimum conditions of quality, although many mid-size and small companies produce equally excellent quality foods.

Irrespective of the specific nature of the food-processing unit, food processors are responsible for the quality and safety of the food they produce. This obliges corporations to emphasize quality as the most important factor in their business, something they can only obtain through a well-established QA program.

What then are the functions of a QA department? QA functions involve establishing and managing the company's quality organizations, designing operating procedures, discussing the quality direction with top management, introducing them to the fundamentals of quality, and making certain there is consistency in management pronouncements.

The minimum requirement is for food processors to apply good sanitation practices, which include the design and layout of the premises, provision of adequate facilities, and programs for cleaning and sanitation (pest control), as set out in the Code of Federal Regulations 21 CFR Part 110 of the United States and in Codex General Principles of Food Hygiene of the United Nations. Additional QA programs, such as Hazard Analysis and Critical Control Point (HACCP), audits of several areas of manufacturing, of sanitation, and of the product in the market are also the responsibilities of a QA department. QA programs enable the application and verification of control measures intended to assure the quality and safety of food. They are required at each step in the food production chain to ensure safe food and to show compliance with regulatory and customer requirements.

The programs are a set of controls implemented and verified by the responsible person(s) at each step in the chain (e.g., producers, farmers, fishermen, food processors, retailers, distributors, storage and transport personnel, etc.). Governments have an important role in providing policy guidance on the most appropriate QA programs and verifying and auditing their implementation as a means of regulatory compliance. Selection and application of QA programs can vary depending on the step in the food production chain, size of the food business, type of product produced, etc., and may include Good Manufacturing Practices (GMPs), Good Agricultural Practices (GAPs), Good Laboratory Practices (GLPs), HACCP systems, and HACCP-based systems.

Regulatory agencies and food companies are improving QA programs to meet the demands for safe, high-quality foods. Successful management programs that enable food processors to address global marketplace opportunities while maintaining high quality and safety are more common.

The primary function of a QA department is to provide confidence for management and the consumer — the person a company must satisfy and who actually establishes the level of quality of the products a company manufactures. The function of QA in this sense is never ending. A company builds its product specifications and legal requirements around consumer preferences, and only by having an integrated and well-planned quality program can a food company succeed in supplying the customer with the desired products. The role of the QA department and the professional in this area is to guarantee that the consumer receives what he desires and that the company makes the profit it deserves. The QA department must also maintain monitoring activities on the available growing literature on concepts, techniques, and programs related to quality issues, to select the best ideas and bring them to management's attention.

Some companies assign the QA department additional functions in product development, plant sanitation, waste disposal, and research on processes, equipment, ingredients, etc. These are all specialized areas and require expertise for success.

Perhaps the most significant aspect of a QA program is the fact that through its functions, upper management is able to monitor, at all times and through all stages of manufacturing, the level of quality of its product, as well as keeping in line with industry trends.

By reporting directly to upper management, the QA professional is provided with the necessary independence to be effective in his or her functions. In turn, the QA professional needs to be competent and knowledgeable in the various aspects of the food industry, including regulatory, processing, sanitation, safety, and human relations. Thus, the selection, training, and respect given to QA professionals are very important factors of the company's quality program. The QA department's personnel should be considered as in-house consultants, advisors, and trainers for the company, to help the production of quality products through audits, to make recommendations for improvements, and to provide assistance in making such improvements.

To reach and maintain these goals, a QA program is built around three fundamental functions:

i. Quality Control

A program established around a processing operation to regulate a resulting product by some standard, the function of QC is associated with the production line, i.e., with specific processes and unit operations. QC activities are the operator's tools that help him to maintain a production line in accordance with predetermined parameters for a given quality level.

ii. Quality Evaluation

Describing or appraising the worth of a product, quality evaluation generally means taking a measurement of the product to the QC laboratory to evaluate the performance of incoming materials, products in process, or finished products. The finished product can be evaluated as offered in the market, ready for the consumer. This is carried out by product quality audits.

iii. Quality Audits

Quality audits are programs designed to verify or examine a product or manufacturing process over time. These can be classified as manufacturing quality audits, sanitation/GMPs audits, HACCP audits, product quality audits, and other special types of audits. A quality audit is a fundamental part of a QA program. It allows for quality verification of a product during manufacture, in the warehouse, in the distribution system, and in the market to assess performance over time or for comparison to competitor brands.

A quality audit is a planned, systematic examination of a manufacturing program and its implementation to determine its adequacy and the degree of conformance to it. It concentrates on quality-related aspects of production. A quality audit consists in examining a representative portion of the manufacturing program and drawing an inference about the total system based on this sample.

There are two types of quality audits: internal audits and third-party audits. An internal quality audit is a review conducted by employees of the organization. A third-party audit is conducted by an outside organization.

TOTAL QUALITY MANAGEMENT

Total Quality Management (TQM) is a theory of management based on the principles of quality assurance. It consists of the integration of all functions and processes within an organization in order to achieve continuous improvement of the quality of goods and services. As such, TQM is described as a process for managing quality; a philosophy of perpetual improvement. TQM relies on the fundamental principle that is the core of any business: maximize productivity while minimizing costs. Its goal is customer satisfaction.

The Concept of Total Quality Management

Total Quality Management (TQM) is based on a number of ideas. It means thinking about quality in terms of all functions of the enterprise, and it can be viewed as a management-led approach in which top management commitment is essential, a start-to-finish systems approach that integrates interrelated functions at all levels. TQM considers every interaction between the various elements of the organization. The emphasis is on quality in all aspects and functions of the company operation, companywide, not just the manufacturing function or provision of a major service to the external end-customer. Employee awareness and motivation are essential. All are responsible for ensuring quality in terms of satisfying the customer in all they do, and the approach is one of prevention of errors and faults rather than detection and correction. Thus, the overall effectiveness of the system is higher than the sum of the individual outputs from the subsystems.

The subsystems include all the organizational functions in the life cycle of a product, such as design, planning, production, distribution, and field service. Management subsystems also require integration, including strategy with a customer focus, the tools of quality, and employee involvement (an important linking process that integrates the whole). A corollary is that any product, process, or service can be improved, and a successful organization is one that consciously seeks and exploits opportunities for improvement at all levels. The load-bearing structure is customer satisfaction. The watchword is Continuous Improvement.

Following the Japanese, most TQM programs extensively employ teamwork to provide improved planning analysis and problem solving, communication, motivation, and collective responsibility. The 1990s were set to be the decade of quality. Preoccupation with quality improvement as a competitive force swept across North America and established bridgeheads in Europe in the 1980s. Some of the American quality gurus, such as Armand Feigenbaum, went as far as identifying quality as the single most important force in organizational success and growth for the 1990s and for the new millennium.

TQM and ISO 9000

The latest changes for the ISO 9001:2000 Standard's Process Model seem to complete the embodiment that TQM philosophy is that quality is a process that can be managed. In regard to ISO 9001, the following information gives an understanding of the elements of the TQM process.

TQM is a philosophy of perpetual improvement while ISO 9000 is a Quality System Management Standard. The ISO Quality Standard sets in place a system to deploy policy and verifiable objectives. As such, ISO implementation is a basis for TQM implementation. Where there is an ISO system, about 75% of the steps are in place for TQM. The requirements for TQM can be considered ISO plus. In short, implementing TQM is being proactive concerning quality rather than reactive.

The Structure of TQM

When all of its elements are implemented properly, TQM is like a well-built house: solid, strong, and cohesive. If TQM is not planned for and implemented correctly, it will be structurally weak and will probably fail. TQM is the foundation for activities such as meeting customer requirements, reducing development cycle times, Just in Time/Demand Flow Manufacturing, improvement teams, reducing product and service costs, and improving administrative systems training.

The Principles of TQM

TQM's primary objective is to achieve customer satisfaction by involving everybody dealing with product manufacturing, directly or indirectly. To do this, TQM operates on the basis of the following principles:

1. Involve and respect people: everyone associated with the organization, including personnel, customers, and suppliers. Management must be involved by providing leadership.
2. Processes, not people, are the problem.
3. Every employee is responsible for quality.
4. Everyone is a customer and a supplier.
5. Prevent problems. Do not wait for them to occur and then fix.
6. Involve the processes of preparing and delivering products and services to customers.
7. Quality improvements must be continuous.
8. Quality can and must be managed.
9. Plan and organize for quality improvement.
10. The quality standard is: defect free.
11. Goals are based on requirements, not negotiated.
12. Life cycle costs, not front end costs.

The 10 Steps to TQM

Maintenance of these principles is based in turn on 10 steps recognized as fundamental to a TQM program.

1. Pursue new strategic thinking
2. Know your customers
3. Set true customer requirements
4. Concentrate on prevention, not correction
5. Reduce chronic waste
6. Pursue a continuous improvement strategy
7. Use structured methodology for process improvement
8. Reduce variation
9. Use a balanced approach
10. Apply to all functions

Total Quality Management Tools

In the quality management field, there are statistical methods for analyzing numerical data focusing on results. However, in the world of business, it is also crucial to analyze language data such as customer requirements and ideas, and thus focus on processes. In both fields, the practice of TQM uses tools that help to reach the desired goals and results that characterize success. According to the experts, the seven statistical quality control tools for analyzing and interpreting numerical data include: (1) data sheet, (2) cause-and-effect diagram, (3) scatter diagram, (4) flowchart, (5) Pareto chart, (6) histogram, and (7) control chart.

When working with ideas, the seven management and planning tools used are: (1) affinity diagram, (2) interrelationship digraph, (3) tree diagram, (4) matrix diagram, (5) prioritization matrices, (6) process decision program chart, and (7) activity network diagram.

Regardless of the recommendations for the use of these techniques for quality control or as management tools, they can be used in either area, depending upon circumstances and needs. As an example, the cause-and-effect diagram (manufacturing) can be interrelated to the affinity diagram (administration). By understanding all of its processes, companies are able to define them, implement controls, monitor performance, and measure improvements by using these techniques. This is the fundamental basis of TQM.

Following is a general review of these management tools.

Statistical Analysis Tools

1. Data Sheet

Data from a table, form, query, view, or stored procedure displayed in a row-and-column format.

2. Cause-and-Effect Diagram

Kaoru Ishikawa, who pioneered quality management processes and in the process became one of the founding fathers of modern management, created the cause-and-effect diagram. Causes are arranged according to their level of importance or detail, resulting in a depiction of relationships and hierarchy of events. This helps to identify areas where there may be problems, and allows for comparison of their relative importance. Cause-and-effect diagrams are typically constructed through brainstorming techniques.

Causes in a cause-and-effect diagram are frequently arranged into the four most common major categories.

- Manpower, methods, materials, and machinery (for manufacturing)
- Equipment, policies, procedures, and people (for administration and planning)

The cause-and-effect diagram (Figure 1) is also known as “Ishikawa diagram” or “fishbone diagram” because it was drawn to resemble the skeleton of a fish, with the main causal categories drawn as bones attached to the spine of the fish.

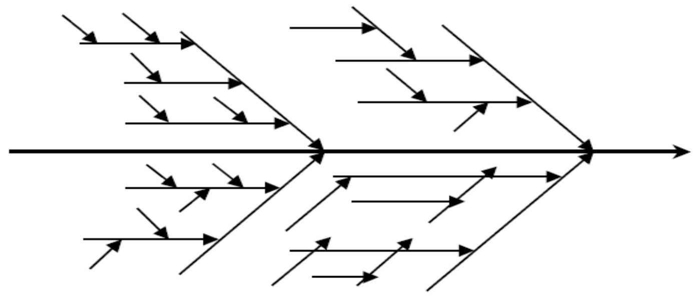

Figure 1. Cause-and-effect diagram

3. Scatter Diagram

A scatter diagram or scatter chart (Figure 2) is similar to a line graph, except that the data points are plotted without a connecting line drawn between them. Scatter charts are suitable for showing how data points compare to each other.

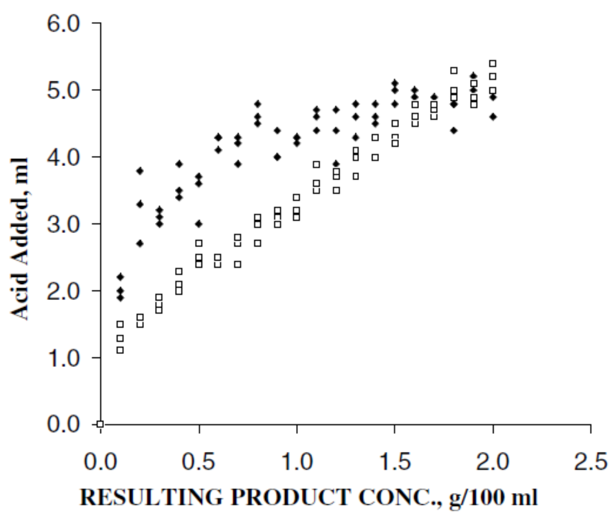

Figure 2. Scatter diagram

At least two measured objects are needed for the query (one for the *x*-axis and one for the *y*-axis).

Scatter diagrams are used to study possible relationships between two variables. Although these diagrams cannot prove that one variable causes the other, they do indicate the existence of a relationship, as well as the strength of that relationship. In a scatter diagram the horizontal axis contains the measured values of one variable and the vertical axis represents the measurements of the other variable.

The purpose of the scatter diagram is to display what happens to one variable when the other variable is changed. The diagram is used to test the theory that the two variables are related. The slope of the diagram indicates the type of relationship that exists.

4. Flowchart

A flowchart (Figure 2.3) is defined as a graphic representation employing standard graphic icons, usually a series of blocks with each block representing one major process, that describes an operation that is studied or is used to plan stages of a project. Flowcharts provide an excellent form of documentation for a process operation, and often are useful when examining how various steps in an operation work together. A flowchart is an important project development and documentation tool; it visually records the steps, decisions, and actions of any manufacturing or service operation and defines the system, its key points, activities, and role performances.

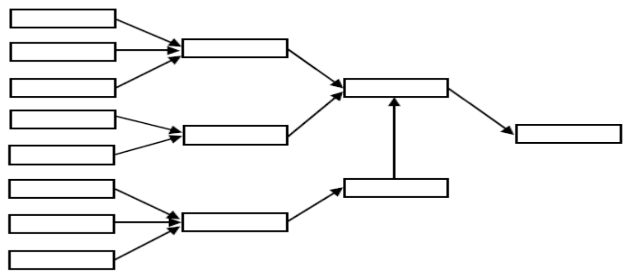

Figure 3. Flowchart

In a flowchart, the description of each process is written inside the blocks. Any other significant information is usually written outside the blocks. Each block is connected with an arrow to show where that process leads.

The graphic icons generally used are:

- the start/stop icon: ○
- the decision icon: ◊
- the result icon: □
- an icon to represent the flow itself, an arrow: →

5. Pareto Chart

Alfredo Pareto was an Italian sociologist who suggested that “80% of all wealth in this country is owned by 20% of the people.” This supposition, known as the “Pareto Principle” was further developed by business and industry leaders who found that most of the quality problems were confined to a small number of machines or workers. In other words, “80% of problems come from 20% of the equipment or workforce.”

The Pareto Principle is used by business and industry to work to continually improve quality, whether it is a product or a service. Quality improvement involves tackling one issue at a time. By addressing the ones causing the most difficulty (the 20% that are causing 80% of the problem), improvements can be made and monitored for continuous progress. Pareto charts are used to decide what steps need to be taken for quality improvement.

A Pareto chart (Figure 4) graphically summarizes and displays the relative importance of the differences between groups of data. A Pareto chart can be constructed by segmenting the range of the data into groups (also called segments, bins, or categories). The number of data points in each group is determined and the Pareto chart constructed; however, unlike the bar chart, the Pareto chart is ordered in descending frequency magnitude. The groups are defined by the user.

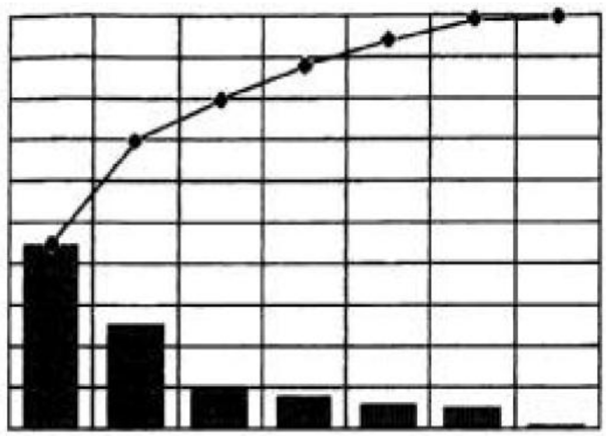

Figure 4. Pareto chart

The Pareto chart is valuable in answering questions such as: What are the largest issues facing a team or business? What 20% of sources are causing 80% of the problems (80/20 rule)? What efforts should be focused on to achieve the greatest improvements?

6. Histogram

A histogram (Figure 5) is used to graphically summarize and display the distribution of a process dataset. It can be constructed by segmenting the range of the data into equal-sized bins (segments, groups, or classes). The vertical axis of the histogram is the frequency (the number of counts for each bin), and the horizontal axis is labeled with the range of the response variable. The number of data points in each bin is determined and the histogram constructed. The user defines the bin size.

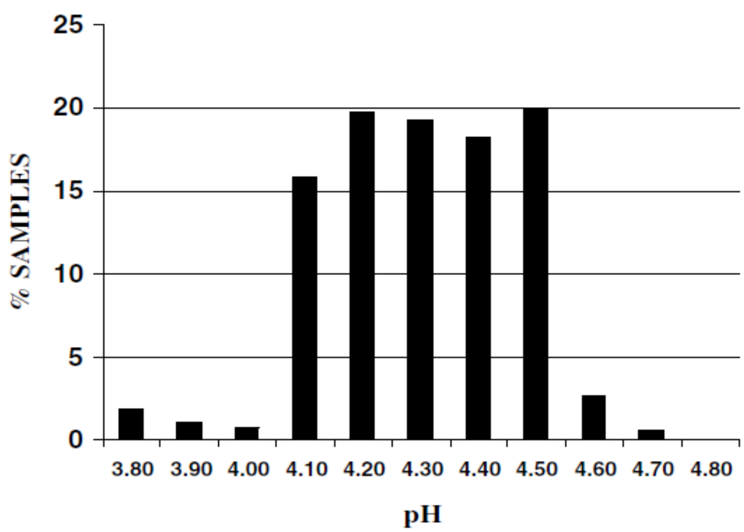

Figure 5. Histogram

A histogram can help answers questions such as: What is the most common system response? What distribution (center, variation, and shape) do the data have? Do the data look symmetric or skewed to the left or right? Do the data contain outliers?

7. Control Chart

Control charting is one of the most technically sophisticated tools of statistical quality control. Dr. Walter A. Shewhart of the Bell Telephone Labs developed it in the 1920s as a statistical approach to the study of manufacturing process variation for the purpose of improving the economic effectiveness of the process. These methods are based on continuous monitoring of process variation.

A control chart (Figure 6) is a graphical display of a quality characteristic that has been measured or computed from a sample vs. the sample number or time. The chart contains a center line that represents the average value of the quality characteristic corresponding to the in-control state.

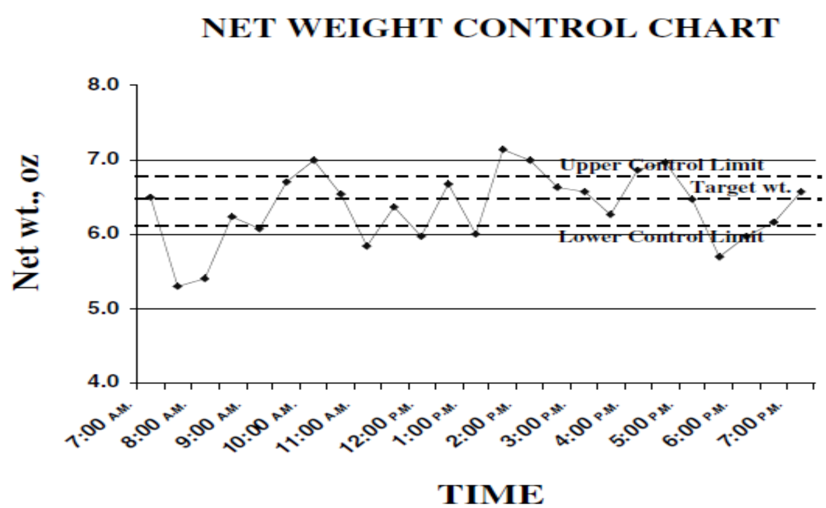

Figure 6.Control chart

Two other horizontal lines called the upper control limit (UCL) and the lower control limit (LCL) are also drawn. These control limits are chosen so that if the process is in control, nearly all of the sample points will fall between them. As long as the points plot within the control limits, the process is assumed to be in control and no action is necessary.

A point that plots outside of the control limits is interpreted as evidence that the process is out of control; investigation and corrective action are required in such a case to find and eliminate the causes responsible for this behavior. The control points are connected with straight-line segments for easy visualization.

Control charts are universally used to present quality data. They are sufficiently simple to interpret so that misunderstandings are avoided. Regardless of type, control charts all contain a few fundamental characteristics:

- They contain upper and lower control limits within which all observations will lie if the process is under control.
- They contain a center line which is usually considered the target value for the process.
- They generally show numbers along the vertical axis to define the values of the control limits and observations.

Control charts are used as a proven technique for improving productivity, as an effective tool in defect prevention, to prevent unnecessary process adjustments, to provide diagnostic information, and to provide information about process capability. A typical example of a control chart in the food industry is that used for net weight control.

X-Bar and R Charts

The X-bar and the R charts (Figure 7 and Figure 8) are the most commonly used of the control charts and the most valuable. They are easy to prepare, simple to understand, and extremely useful in locating problems. They are ideal tools to improve product quality and process control and can help to drastically reduce scrap and rework while assuring the production of only satisfactory products. In the food industry they can be used for controlling every step of a production process, for the acceptance or rejection of lots, and for early detection of equipment or process failures.

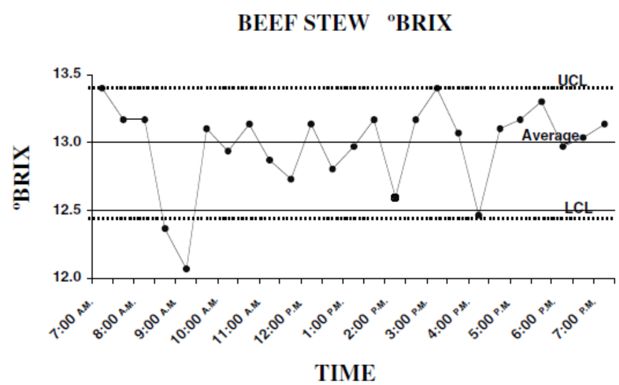

Figure 7. Average (X) chart

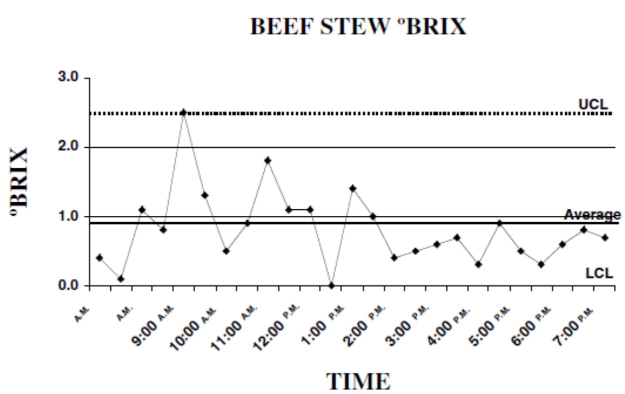

Figure 8. Range chart

The X-bar and the R charts are used for control of variables that are expressed in discrete numbers such as inches, pounds, pH units, angstroms, percent solids, or degrees of temperature.

Attribute Charts

In addition to X-bar and R charts, a group of charts called "attribute charts" are also used for control of defect analysis. They are particularly useful for controlling raw material and finished product quality and for analyzing quality comments in consumer letters. An attribute is a characteristic of a product, a process, or a population that can be counted but cannot be described in incremental numbers. It is a characteristic that is satisfactory or unsatisfactory, defective or non-defective, good or bad, heavy or light, etc. The only numbers that can be applied are the number or percentage of the satisfactory or unsatisfactory units. They are generally easier to construct and to use on a routine basis, although they occasionally lack the power of variable charts to spot problem areas quickly. A major advantage is the simple nature of the concept.

Attribute charts are of four types: p-charts (fraction or percent defective, with constant lot size and with variable lot size), np-charts (number of defectives), and c- or u-charts (number of defects).

Other Types of Charts

Other types of charts and diagrams used to graph and report manufacturing or quality control data and that are in common use include the following:

i. Bar Chart

A bar chart (Figure 9) is used to graphically summarize and display the differences between groups of data.

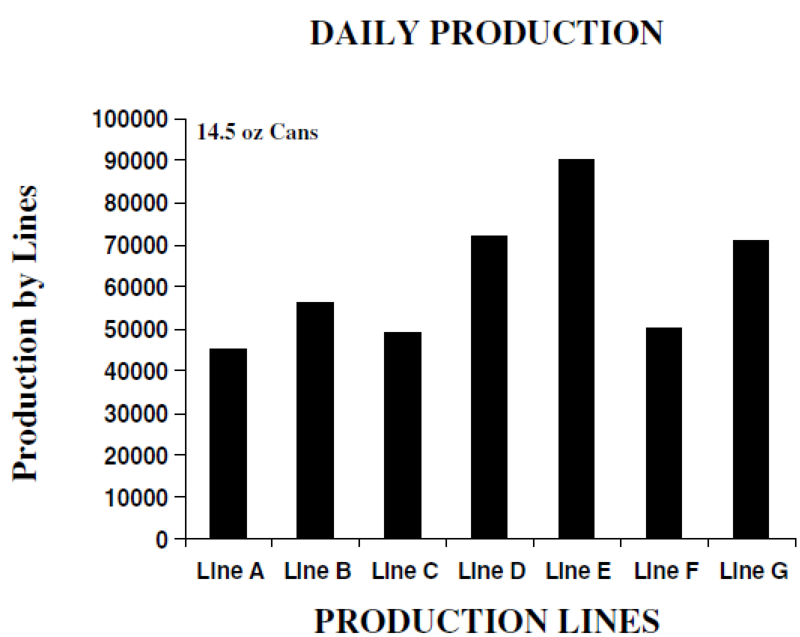

Figure 9. Bar chart

A bar chart can be constructed by segmenting the range of the data into groups (segments, bins, or classes). For example, if the data range from machine to machine, the data will consist of a group from machine 1, a second group of data from machine 2, a third group of data from machine 3, and so on.

The vertical axis of the bar chart is labeled frequency (the number of counts for each bin), and the horizontal axis is labeled with the group names of the response variables.
The number of data points that reside within each bin is determined by the user and the bar chart constructed.

A bar chart answers the questions: What are the differences in system response between the groups? Does the data contain outliers?

ii. Pie Chart

A pie chart (Figure 10) is a circle graph divided into pieces or segments, each displaying the size of some related piece of information. Pie charts are used to display the sizes of parts that make up some whole (i.e., percentages of a whole at a set point in time). They do not show changes over time. To create a pie chart, it is necessary to supply a value and a name for each segment (each slice) and the title of the graph.

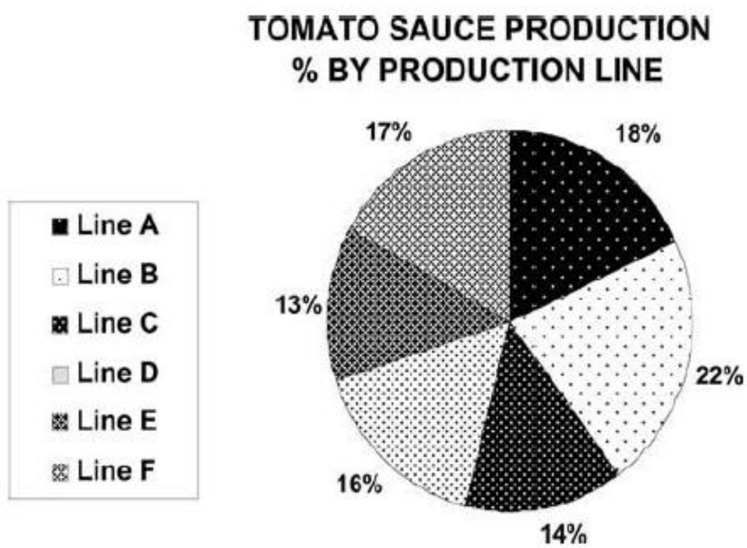

Figure 10. Pie chart

Pie charts should not include more than eight segments and each segment should be labeled with percentages of absolute amounts. Patterns or colors can be used to distinguish the segments.

The pie chart (Figure 10) shows the % production of tomato sauce by each production line. The information provided allows for comparisons of production efficiency and can contribute to the detection of malfunctioning conditions and their subsequent correction.

iii. Spider Chart

Spider charts (radar charts) (Figure 11) graphically display the performance of multiple variables on a single page providing easy-to-read data.

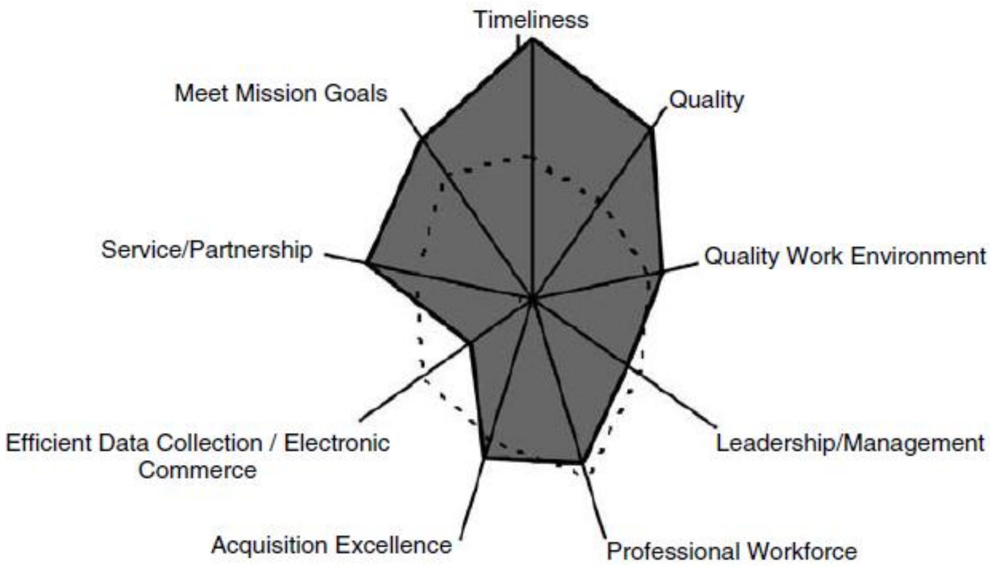

Figure 11. Spider chart

The normalized data spider chart depicts an activity's performance compared to other like activities. The activity's actual performance measurement value (raw data) is normalized for these spider charts. This is done to graphically display the difference in performance measurement values between activities when the range of values is too close to be distinguished.

The raw/normalized data spider chart shows a comparison between the activity's actual performance values (raw data) with their normalized data value.

Management and Planning Tools

i. Affinity Diagrams

An affinity diagram (Figure 12), also known as the KJ method after its creator Kawakita Jiro, is a process used by a group to gather and organize ideas, opinions, issues, etc. from a raw list — usually generated through brainstorming — into groups of related thoughts that make sense and can be dealt with more easily.

The emphasis is on a rational, gut-felt sort of grouping done by the members of the team. In doing so, it is important to let the groupings emerge naturally, rather than according to preordained categories. This approach makes it possible to break an operation down into categories to focus the analytical efforts on one area at a time. It is similar in use to an operational analysis, except that the affinity diagram groups similar items together instead of listing them in chronological sequence.

As a management tool, Kaoru Ishikawa recommends using the affinity diagram when facts or thoughts are uncertain and need to be organized, when preexisting ideas need to be overcome or clarified, and when unity within a team needs to be created.

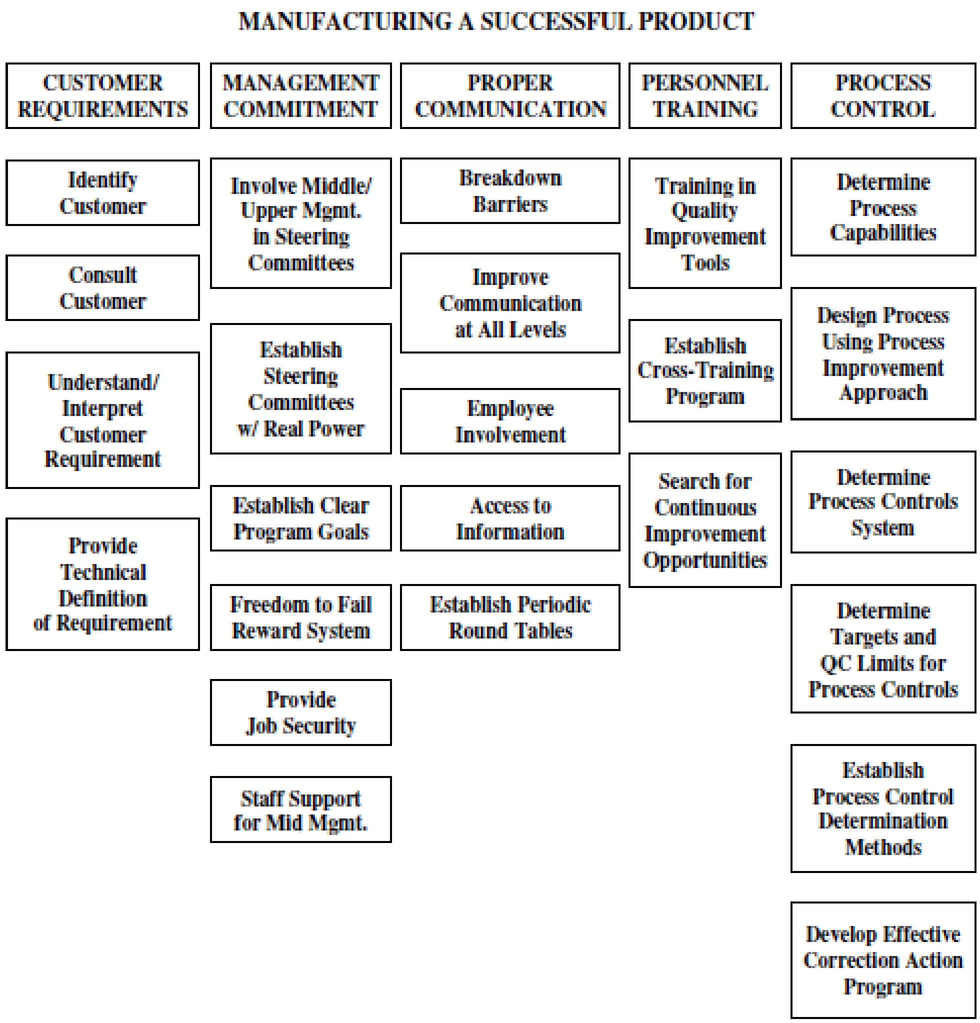

Figure 12. Affinity diagram

ii. Interrelationship Digraphs

A relations diagram, also known as an interrelationship digraph, is a tool for finding solutions to problems that have complex causal relationships. It helps to untangle and find the logical relations among the intertwined causes and effects and is a process that allows for multidirectional rather than linear thinking to be used.

iii. Tree Diagram

The tree diagram**,** systematic diagram, or dendrogram (Figure 13) is a technique for mapping out a full range of paths and tasks that need to be done in order to achieve a primary goal and related sub-goals. The tree diagram is an adaptation from the functional analysis system technique (FAST) diagram in value engineering. It shows in a simple way and with clarity not only the magnitude of a problem but also, when used carefully and thoroughly, it provides a better understanding of the true scope of a project and helps to figure out the tasks that must be undertaken to achieve a given objective. The tree diagram is one of the seven management and planning tools described by Shigeru Mizuno (1988).

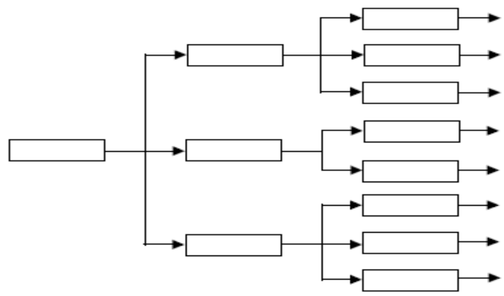

Figure 13. Tree diagram

The tree diagram is designed to assist the user in reviewing and systemically rearranging data in the affinity diagram, to classify the data and identify omitted elements. The tree diagram takes a purpose and logically breaks it down into action items. It allows breaking any broad goal, graphically, into increasing levels of detailed actions that must or could be done to achieve the stated goals. When read from left to right it progresses logically from general to specific, answering the question "how accomplished?" If read from right to left, it answers the question "why?"

iv. Matrix Diagram

A matrix diagram (Figure 14) assists the user to visually examine the relationship between data groups.

Factors to Compare	Methods for Comparison – Advantages		
	1	2	3
A			
B			
C			
D			

Figure 14. Matrix diagram

The matrix diagram shows the relationship between two or more sets of items. It can be very useful in facilitating an analysis of the relationship of each item in one set to all items in the other set and often triggers some thinking that would not have happened if this organized approach was not used. It is also helpful to see patterns of relationships: which items don't relate to anything and which ones do.

A matrix diagram consists of a number of columns and rows whose intersections are compared to find out the nature and strength of the problem. This allows the user to arrive at key ideas, analyze the relationship or its absence at the intersection, and find an effective way of pursuing the problem-solving method. This enables conception of ideas on two dimensional relationship bases. The intersection points are also called "idea conception points."

Matrix diagrams are used to reveal the strength of relationships between sets of items, tasks, or characteristics. In using matrix diagrams the following steps are of value:

1. Identify the sets of data to be compared.
2. Put the first set of items along the vertical axis. Put the second set of items along the horizontal axis.
3. Draw in grid lines.
4. Determine the symbols to be used to rate the relationships.

Provide a legend: i.e., 9 = strong+ = strong relationship
3 = some ***or*** 0 = some relationship
1 = weak
0 = none
D = no relationship

5. Enter the appropriate symbols into each box.

A matrix diagram allows a team or individual to systematically identify, analyze, and rate the presence and strength of relationships between two or more sets of information.

v. Prioritization Matrices

Prioritization matrices are useful when applying a systematic approach to weigh or prioritize criteria toward evaluating solutions against the criteria. The use of prioritization matrices helps teams focus and come to a consensus on key items.

Application of Prioritization Matrices:

- Obtain the list of items to be prioritized through customer input, brainstorming, affinity diagrams, or other appropriate sources such as legislative requirements. If there are more than 20 items to compare, reduce the list through an affinity exercise or by eliminating the items that are obviously a very low priority.
- Determine who will participate in the prioritization exercise and the most appropriate matrix to use considering the strengths and limitations of the matrices.
- Populate the horizontal and vertical columns of the matrix with a list. If customer "wants" are being prioritized, make every effort to bring the customer together with the team to complete the prioritization exercise. If this is not feasible, provide the matrix to the customer(s) for completion.

vi. Process Decision Program Chart

The Process Decision Program Chart (PDPC) is a very useful and powerful method to overcome an unfamiliar problem or goal to be achieved. With the help of a PDPC, it is possible to map out all conceivable events or contingencies that can occur in the implementation stage and also to discover feasible countermeasures to overcome these problems.

A PDPC graphically displays many contingencies and alternatives to a problem, which can be determined in advance to select a strategy for dealing with them.

Implementation plans do not always progress as anticipated. When problems, technical or otherwise, arise, solutions are frequently not apparent.

According to Mizuno,11 the PDPC method is useful in determining which processes to use to obtain desired results by evaluating the progress of events and the variety of conceivable outcomes. The PDPC method helps to prepare countermeasures that will lead to the best possible solutions.

The PDPC method can be used to:

- Explore all possible contingencies that could occur in the implementation of any new or untried plan that has risks involved
- Establish an implementation plan for management by objectives
- Establish an implementation plan for technology-development themes
- Establish a policy of forecasting and responding in advance to major events predicted in the system
- Implement countermeasures to minimize nonconformities in the manufacturing process
- Set up and select adjustment measures for negotiating process

vii. Activity Network Diagram

The activity network diagram, also known as an arrow diagram, project evaluation and review technique (PERT), or critical path method (CPM), is a network technique using nodes for events and arrows for activities for project planning, scheduling, and monitoring. It is a very useful tool when planning activities of a known but a complex task or project. With the help of this tool it is possible to work out an ideal project plan as well as daily plans for several tasks, and to monitor their progress in an effective manner.

As mentioned earlier, these seven new tools are very useful to top and middle management for strategic planning, goal setting, and problem solving. Knowledge of the basic seven tools is a must for every person from top management to lower-level employees.