

## Glossary

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**acceptance quality limit (AQL):** In a continuing series of lots, a quality level that, for the purpose of sampling inspection, is the limit of a satisfactory process average.

**acceptance number:** The maximum number of defects or defectives allowable in a sampling lot for the lot to be acceptable.

**acceptance sampling:** Inspection of a sample from a lot to decide whether to accept that lot. There are two types: attributes sampling and variables sampling. In attributes sampling, the presence or absence of a characteristic is noted in each of the units inspected. In variables sampling, the numerical magnitude of a characteristic is measured and recorded for each inspected unit; this involves reference to a continuous scale of some kind.

**acceptance sampling plan:** A specific plan that indicates the sampling sizes and associated acceptance or nonacceptance criteria to be used. In attributes sampling, for example, there are single, double, multiple, sequential, chain and skip-lot sampling plans. In variables sampling, there are single, double and sequential sampling plans. For detailed descriptions of these plans, see the standard ANSI/ISO/ASQ A3534-2-1993: Statistics—Vocabulary and Symbols—Statistical Quality Control.

**accuracy:** The characteristic of a measure.

**activity based costing:** An accounting system that assigns costs to a product based on the amount of resources used to design, order or make it.

**activity network diagram:** An arrow diagram used in planning.

**Advanced Product Quality Planning (APQP):** High level automotive process for product realization, from design through production part approval.

**affinity diagram:** A management tool for organizing information (usually gathered during a brainstorming activity).

**American National Standards Institute (ANSI):** A private, nonprofit organization that administers and coordinates the U.S. voluntary standardization and conformity assessment system. It is the U.S. member body in the International Organization for Standardization, known as ISO.

**American Society for Quality (ASQ):** A professional, not-for-profit association that develops, promotes and applies quality related information and technology for the private sector, government and academia. ASQ serves more than 108,000 individuals and 1,100 corporate members in the United States and 108 other countries.

**analysis of means (ANOM):** A statistical procedure for troubleshooting industrial processes and analyzing the results of experimental designs with factors at fixed levels. It provides a graphical display of data. Ellis R. Ott developed the procedure in 1967 because he observed that nonstatisticians had difficulty understanding analysis of variance. Analysis of means is easier for quality practitioners to use because it is an extension of the control chart. In 1973, Edward G. Schilling further extended the concept, enabling analysis of means to be used with non-normal distributions and attributes data in which the normal approximation to the binomial distribution does not apply. This is referred to as analysis of means for treatment effects.

**analysis of variance (ANOVA):** A basic statistical technique for determining the proportion of influence a factor or set of factors has on total variation. It subdivides the total variation of a data set into meaningful component parts associated with specific sources of variation to test a hypothesis on the parameters of the model or to estimate variance components. There are three models: fixed, random and mixed.

**andon board:** A production area visual control device, such as a lighted overhead display. It communicates the status of the production system and alerts team members to emerging problems (from andon, a Japanese word meaning “light”).

**arrow diagram:** A planning tool to diagram a sequence of events or activities (nodes) and their interconnectivity. It is used for scheduling and especially for determining the critical path through nodes.

**assignable cause:** A name for the source of variation in a process that is not due to chance and therefore can be identified and eliminated. Also called “special cause.”

**attribute data:** Go/no-go information. The control charts based on attribute data include percent chart, number of affected units chart, count chart, count per unit chart, quality score chart and demerit chart.

**attributes, method of:** Method of measuring quality that consists of noting the presence (or absence) of some characteristic (attribute) in each of the units under consideration and counting how many units do (or do not) possess it. Example: go/no-go gauging of a dimension.

**audit:** The on-site verification activity, such as inspection or examination, of a process or quality system, to ensure compliance to requirements. An audit can apply to an entire organization or might be specific to a function, process or production step.

**Automotive Industry Action Group (AIAG):** A global automotive trade association with about 1,600 member companies that focuses on common business processes, implementation guidelines, education and training.

**average chart:** A control chart in which the subgroup average, X-bar, is used to evaluate the stability of the process level.

**average outgoing quality (AOQ):** The expected average quality level of an outgoing product for a given value of incoming product quality.

**average outgoing quality limit (AOQL):** The maximum average outgoing quality over all possible levels of incoming quality for a given acceptance sampling plan and disposal specification.

**average run lengths (ARL):** On a control chart, the number of subgroups expected to be inspected before a shift in magnitude takes place.

**average sample number (ASN):** The average number of sample units inspected per lot when reaching decisions to accept or reject.

**average total inspection (ATI):** The average number of units inspected per lot, including all units in rejected lots (applicable when the procedure calls for 100% inspection of rejected lots).

**baka-yoke:** A Japanese term for a manufacturing technique for preventing mistakes by designing the manufacturing process, equipment and tools so an operation literally cannot be performed incorrectly. In addition to preventing incorrect operation, the technique usually provides a warning signal of some sort for incorrect performance. Also see “poka-yoke.”

**balanced scorecard:** A management system that provides feedback on both internal business processes and external outcomes to continuously improve strategic performance and results.

**Baldrige Award:** See “Malcolm Baldrige National Quality Award.”

**baseline measurement:** The beginning point, based on an evaluation of output over a period of time, used to determine the process parameters prior to any improvement effort; the basis against which change is measured.

**batch and queue:** Producing more than one piece and then moving the pieces to the next operation before they are needed.

**Bayes’ theorem:** A formula to calculate conditional probabilities by relating the conditional and marginal probability distributions of random variables.

**benchmarking:** A technique in which a company measures its performance against that of best in class companies, determines how those companies achieved their performance levels and uses the information to improve its own performance. Subjects that can be benchmarked include strategies, operations and processes.

**benefit-cost analysis:** An examination of the relationship between the monetary cost of implementing an improvement and the monetary value of the benefits achieved by the improvement, both within the same time period.

**black belt (BB):** Full-time team leader responsible for implementing process improvement projects—define, measure, analyze, improve and control (DMAIC) or define, measure, analyze, design and verify (DMADV)—within a business to drive up customer satisfaction and productivity levels.

**block diagram:** A diagram that shows the operation, interrelationships and interdependencies of components in a system. Boxes, or blocks (hence the name), represent the components; connecting lines between the blocks represent interfaces. There are two types of block diagrams: a functional block diagram, which shows a system's subsystems and lower level products and their interrelationships and which interfaces with other systems; and a reliability block diagram, which is similar to the functional block diagram but is modified to emphasize those aspects influencing reliability.

**brainstorming:** A technique teams use to generate ideas on a particular subject. Each person on the team is asked to think creatively and write down as many ideas as possible. The ideas are not discussed or reviewed until after the brainstorming session.

**breakthrough improvement:** A dynamic, decisive movement to a new, higher level of performance.

**business process reengineering (BPR):** The concentration on improving business processes to deliver outputs that will achieve results meeting the firm's objectives, priorities and mission.

**C chart:** See "count chart."

**calibration:** The comparison of a measurement instrument or system of unverified accuracy to a measurement instrument or system of known accuracy to detect any variation from the required performance specification.

**capability:** The total range of inherent variation in a stable process determined by using data from control charts.

**cause:** An identified reason for the presence of a defect or problem.

**cause and effect diagram:** A tool for analyzing process dispersion. It is also referred to as the “Ishikawa diagram,” because Kaoru Ishikawa developed it, and the “fishbone diagram,” because the complete diagram resembles a fish skeleton. The diagram illustrates the main causes and subcauses leading to an effect (symptom). The cause and effect diagram is one of the “seven tools of quality” (see listing).

**centerline:** A line on a graph that represents the overall average (mean) operating level of the process.

**central tendency:** The tendency of data gathered from a process to cluster toward a middle value somewhere between the high and low values of measurement.

**certification:** The result of a person meeting the established criteria set by a certificate granting organization.

**Certified Six Sigma Black Belt (CSSBB):** An ASQ certification.

**Certified Six Sigma Green Belt (CSSGB):** An ASQ certification.

**chain reaction:** A chain of events described by W. Edwards Deming: improve quality, decrease costs, improve productivity, increase market with better quality and lower price, stay in business, provide jobs and provide more jobs.

**chain sampling plan:** In acceptance sampling, a plan in which the criteria for acceptance and rejection apply to the cumulative sampling results for the current lot and one or more immediately preceding lots.

**champion:** A business leader or senior manager who ensures resources are available for training and projects, and who is involved in periodic project reviews; also an executive who supports and addresses Six Sigma organizational issues.

**change agent:** An individual from within or outside an organization who facilitates change in the organization; might be the initiator of the change effort, but not necessarily.

**changeover:** A process in which a production device is assigned to perform a different operation or a machine is set up to make a different part—for example, a new plastic resin and new mold in an injection molding machine.

**changeover time:** The time required to modify a system or workstation, usually including both teardown time for the existing condition and setup time for the new condition.

**characteristic:** The factors, elements or measures that define and differentiate a process, function, product, service or other entity.

**chart:** A tool for organizing, summarizing and depicting data in graphic form.

**charter:** A written commitment approved by management stating the scope of authority for an improvement project or team.

**checklist:** A tool for ensuring all important steps or actions in an operation have been taken. Checklists contain items important or relevant to an issue or situation. Checklists are often confused with check sheets (see listing).

**check sheet:** A simple data recording device. The check sheet is custom designed by the user, which allows him or her to readily interpret the results. The check sheet is one of the “seven tools of quality” (see listing). Check sheets are often confused with checklists (see listing).

**classification of defects:** The listing of possible defects of a unit, classified according to their seriousness. Note: Commonly used classifications: class A, class B, class C, class D; or critical, major, minor and incidental; or critical, major and minor. Definitions of these classifications require careful preparation and tailoring to the product(s) being sampled to ensure accurate assignment of a defect to the proper classification. A separate acceptance sampling plan is generally applied to each class of defects.

**common causes:** Causes of variation that are inherent in a process over time. They affect every outcome of the process and everyone working in the process. Also see “special causes.”

**compliance:** The state of an organization that meets prescribed specifications, contract terms, regulations or standards.

**conformance:** An affirmative indication or judgment that a product or service has met the requirements of a relevant specification, contract or regulation.

**conformity assessment:** All activities concerned with determining that relevant requirements in standards or regulations are fulfilled, including sampling, testing, inspection, certification, management system assessment and registration, accreditation of the competence of those activities and recognition of an accreditation program’s capability.

**constraint:** Anything that limits a system from achieving higher performance or throughput; also, the bottleneck that most severely limits the organization’s ability to achieve higher performance relative to its purpose or goal.

**consumer:** The external customer to whom a product or service is ultimately delivered; also called end user.

**continuous flow production:** A method in which items are produced and moved from one processing step to the next, one piece at a time. Each process makes only the one piece that the next process needs, and the transfer batch size is one. Also referred to as one-piece flow and single-piece flow.

**continuous improvement (CI):** Sometimes called continual improvement. The ongoing improvement of products, services or processes through incremental and breakthrough improvements.

**continuous quality improvement (CQI):** A philosophy and attitude for analyzing capabilities and processes and improving them repeatedly to achieve customer satisfaction.

**continuous sampling plan:** In acceptance sampling, a plan, intended for application to a continuous flow of individual units of product, that involves acceptance and rejection on a **\*\*\*\*\*unit-byunit** basis and employs alternate periods of 100% inspection and sampling. The relative amount of 100% inspection depends on the quality of submitted product. Continuous sampling plans usually require that each t period of 100% inspection be continued until a specified number, i, of consecutively inspected units are found clear of defects. Note: For single level continuous sampling plans, a single d sampling rate (for example, inspect one unit in five or one unit in 10) is used during sampling. For multilevel continuous sampling plans, two or more sampling rates can be used. The rate at any time depends on the quality of submitted product.

**control chart:** A chart with upper and lower control limits on which values of some statistical measure for a series of samples or subgroups are plotted. The chart frequently shows a central line to help detect a trend of plotted values toward either control limit.

**control limits:** The natural boundaries of a process within specified confidence levels, expressed as the upper control limit (UCL) and the lower control limit (LCL).

**control plan (CP):** Written descriptions of the systems for controlling part and process quality by addressing the key characteristics and engineering requirements.

**corrective action:** A solution meant to reduce or eliminate an identified problem.

**corrective action recommendation (CAR):** The full cycle corrective action tool that offers ease and simplicity for employee involvement in the corrective action/process improvement cycle.

**correlation (statistical):** A measure of the relationship between two data sets of variables.

**cost of poor quality (COPQ):** The costs associated with providing poor quality products or services. There are four categories: internal failure costs (costs associated with defects found before the customer receives the product or service), external failure costs (costs associated with defects found after the customer receives the product or service), appraisal costs (costs incurred to determine the degree of conformance to quality requirements) and prevention costs (costs incurred to keep failure and appraisal costs to a minimum).

**cost of quality (COQ):** Another term for COPQ. It is considered by some to be synonymous with COPQ but is considered by others to be unique. While the two concepts emphasize the same ideas, some disagree as to which concept came first and which categories are included in each.

**count chart:** A control chart for evaluating the stability of a process in terms of the count of events of a given classification occurring in a sample; known as a “c-chart.”

**count per unit chart:** A control chart for evaluating the stability of a process in terms of the average count of events of a given classification per unit occurring in a sample.

**C<sub>p</sub>:** The ratio of tolerance to 6 sigma, or the upper specification limit (USL) minus the lower specification limit (LSL) divided by 6 sigma. It is sometimes referred to as the engineering tolerance divided by the natural tolerance and is only a measure of dispersion.

**C<sub>pk</sub> index:** Equals the lesser of the USL minus the mean divided by 3 sigma (or the mean) minus the LSL divided by 3 sigma. The greater the C<sub>pk</sub> value, the better.

**cumulative sum control chart (CUSUM):** A control chart on which the plotted value is the cumulative sum of deviations of successive samples from a target value. The ordinate of each plotted point represents the algebraic sum of the previous ordinate and the most recent deviations from the target.

**customer relationship management (CRM):** A strategy for learning more about customers’ needs and behaviors to develop stronger relationships with them. It brings together information about customers, sales, marketing effectiveness, responsiveness and market trends. It helps businesses use technology and human resources to gain insight into the behavior of customers and the value of those customers.

**customer satisfaction:** The result of delivering a product or service that meets customer requirements.

**cycle time:** The time required to complete one cycle of an operation. If cycle time for every operation in a complete process can be reduced to equal takt time, products can be made in single-piece flow. Also see “takt time.”

**data:** A set of collected facts. There are two basic kinds of numerical data: measured or variable data, such as “16 ounces,” “4 miles” and “0.75 inches;” and counted or attribute data, such as “162 defects.”

**D chart:** See “demerit chart.”

**decision matrix:** A matrix teams use to evaluate problems or possible solutions. For example, a team might draw a matrix to evaluate possible solutions, listing them in the far left vertical column. Next, the team selects criteria to rate the possible solutions, writing them across the top row. Then, each possible solution is rated on a scale of 1 to 5

for each criterion, and the rating is recorded in the corresponding grid. Finally, the ratings of all the criteria for each possible solution are added to determine its total score. The total score is then used to help decide which solution deserves the most attention.

**defect:** A product's or service's nonfulfillment of an intended requirement or reasonable expectation for use, including safety considerations. There are four classes of defects: class 1, very serious, leads directly to severe injury or catastrophic economic loss; class 2, serious, leads directly to significant injury or significant economic loss; class 3, major, is related to major problems with respect to intended normal or reasonably foreseeable use; and class 4, minor, is related to minor problems with respect to intended normal or reasonably foreseeable use. Also see "blemish," "imperfection" and "nonconformity."

**defective:** A defective unit; a unit of product that contains one or more defects with respect to the quality characteristic(s) under consideration.

**demerit chart:** A control chart for evaluating a process in terms of a demerit (or quality score); in other words, a weighted sum of counts of various classified nonconformities.

**Deming cycle:** Another term for the plan-do-study-act cycle. Walter Shewhart created it (calling it the plan-do-check-act cycle), but W. Edwards Deming popularized it, calling it plan-do-studyact. Also see "plan-do-check-act cycle."

**dependability:** The degree to which a product is operable and capable of performing its required function at any randomly chosen time during its specified operating time, provided that the product is available at the start of that period. (Nonoperation related influences are not included.) Dependability can be expressed by the ratio: time available divided by (time available + time required).

**design of experiments (DoE):** A branch of applied statistics dealing with planning, conducting, analyzing and interpreting controlled tests to evaluate the factors that control the value of a parameter or group of parameters. Design for Six Sigma (DFSS): See "DMADV."

**design record:** Engineering requirements, typically contained in various formats; examples include engineering drawings, math data and referenced specifications. Designing in quality versus inspecting in quality: See "prevention versus detection."

**deviation:** In numerical data sets, the difference or distance of an individual observation or data value from the center point (often the mean) of the set distribution.

**dissatisfiers:** The features or functions a customer expects that either are not present or are present but not adequate; also pertains to employees' expectations. Distribution (statistical): The amount of potential variation in the outputs of a process, typically expressed by its shape, average or standard deviation.

**DMADV:** A data driven quality strategy for designing products and processes, it is an integral part of a Six Sigma quality initiative. It consists of five interconnected phases: define, measure, analyze, design and verify.

**DMAIC:** A data driven quality strategy for improving processes and an integral part of a Six Sigma quality initiative. DMAIC is an acronym for define, measure, analyze, improve and control.

**Dodge-Romig sampling plans:** Plans for acceptance sampling developed by Harold F. Dodge and Harry G. Romig. Four sets of tables were published in 1940: single sampling lot tolerance tables, double sampling lot tolerance tables, single sampling average outgoing quality limit tables and double sampling average outgoing quality limit tables.

**downtime:** Lost production time during which a piece of equipment is not operating correctly due to breakdown, maintenance, power failures or similar events.

**effect:** The result of an action being taken; the expected or predicted impact when an action is to be taken or is proposed.

**effectiveness:** The state of having produced a decided on or desired effect.

**efficiency:** The ratio of the output to the total input in a process.

**efficient:** A term describing a process that operates effectively while consuming minimal resources (such as labor and time).

**eight wastes:** Taiichi Ohno originally enumerated seven wastes (muda) and later added underutilized people as the eighth waste commonly found in physical production. The eight are: 1. overproduction ahead of demand; 2. waiting for the next process, worker, material or equipment; 3. unnecessary transport of materials (for example, between functional areas of facilities, or to or from a stockroom or warehouse); 4. over-processing of parts due to poor tool and product design; 5. inventories more than the absolute minimum; 6. unnecessary movement by employees during the course of their work (such as to look for parts, tools, prints or help); 7. production of defective parts; 8. under-utilization of employees' brainpower, skills, experience and talents.

**eighty-twenty (80-20):** A term referring to the Pareto principle, which was first defined by J. M. Juran in 1950. The principle suggests most effects come from relatively few causes; that is, 80% of the effects come from 20% of the possible causes. Also see "Pareto chart."

**error detection:** A hybrid form of error proofing. It means a bad part can be made but will be caught immediately, and corrective action will be taken to prevent another bad part from being produced. A device is used to detect and stop the process when a bad part is made. This is used when error proofing is too expensive or not easily implemented.

**error proofing:** Use of process or design features to prevent the acceptance or further processing of nonconforming products. Also known as “mistake proofing.”

**experimental design:** A formal plan that details the specifics for conducting an experiment, such as which responses, factors, levels, blocks, treatments and tools are to be used.

**external customer:** A person or organization that receives a product, service or information but is not part of the organization supplying it. Also see “internal customer.”

**external failure:** Nonconformance identified by the external customers.

**failure:** The inability of an item, product or service to perform required functions on demand due to one or more defects.

**failure cost:** The cost resulting from the occurrence of defects. One element of cost of quality or cost of poor quality.

**failure mode analysis (FMA):** A procedure to determine which malfunction symptoms appear immediately before or after a failure of a critical parameter in a system. After all possible causes are listed for each symptom, the product is designed to eliminate the problems.

**failure mode effects analysis (FMEA):** A systematized group of activities to recognize and evaluate the potential failure of a product or process and its effects, identify actions that could eliminate or reduce the occurrence of the potential failure and document the process.

**failure mode effects and criticality analysis (FMECA):** A procedure performed after a failure mode effects analysis to classify each potential failure effect according to its severity and probability of occurrence.

**first in, first out (FIFO):** Use of material produced by one process in the same order by the next process. A FIFO queue is filled by the supplying process and emptied by the customer process. When a FIFO lane gets full, production is stopped until the next (internal) customer has used some of that inventory.

**first pass yield (FPY):** Also referred to as the quality rate, the percentage of units that completes a process and meets quality guidelines without being scrapped, rerun, retested, returned or diverted into an offline repair area. FPY is calculated by dividing the units entering the process minus the defective units by the total number of units entering the process.

**first time quality (FTQ):** Calculation of the percentage of good parts at the beginning of a production run.

**fishbone diagram:** See “cause and effect diagram.”

**fitness for use:** A term used to indicate that a product or service fits the customer’s defined purpose for that product or service.

**five S’s (5S):** Five Japanese terms beginning with “s” used to create a workplace suited for visual control and lean production. Seiri means to separate needed tools, parts and instructions from unneeded materials and to remove the unneeded ones. Seiton means to neatly arrange and identify parts and tools for ease of use. Seiso means to conduct a cleanup campaign. Seiketsu means to conduct seiri, seiton and seiso daily to maintain a workplace in perfect condition. Shitsuke means to form the habit of always following the first four S’s.

**five whys:** A technique for discovering the root causes of a problem and showing the relationship of causes by repeatedly asking the question, “Why?”

**flow:** The progressive achievement of tasks along the value stream so a product proceeds from design to launch, order to delivery and raw to finished materials in the hands of the customer with no stoppages, scrap or backflows.

**flowchart:** A graphical representation of the steps in a process. Flowcharts are drawn to better understand processes. One of the “seven tools of quality” (see listing).

**force field analysis:** A technique for analyzing what aids or hinders an organization in reaching an objective. An arrow pointing to an objective is drawn down the middle of a piece of paper. The factors that will aid the objective’s achievement, called the driving forces, are listed on the left side of the arrow. The factors that will hinder its achievement, called the restraining forces, are listed on the right side of the arrow.

**gage repeatability and reproducibility (GR&R):** The evaluation of a gauging instrument’s accuracy by determining whether its measurements are repeatable (there is close agreement among a number of consecutive measurements of the output for the same value of the input under the same operating conditions) and reproducible (there is close agreement among repeated measurements of the output for the same value of input made under the same operating conditions over a period of time).

**Gantt chart:** A type of bar chart used in process planning and control to display planned and finished work in relation to time.

**geometric dimensioning and tolerancing (GD&T):** A set of rules and standard symbols to define part features and relationships on an engineering drawing depicting the geometric relationship of part features and allowing the maximum tolerance that permits full function of the product.

**go/no-go:** State of a unit or product. Two parameters are possible: go (conforms to specifications) and no-go (does not conform to specifications).

**green belt (GB):** An employee who has been trained in the Six Sigma improvement method and will lead a process improvement or quality improvement team as part of his or her full-time job.

**Hawthorne effect:** The concept that every change results (initially, at least) in increased productivity.

**heijunka:** A method of leveling production, usually at the final assembly line, that makes just-in-time production possible. It involves averaging both the volume and sequence of different model types on a mixed model production line. Using this method avoids excessive batching of different types of product and volume fluctuations in the same product. Also see “production smoothing.”

**histogram:** A graphic summary of variation in a set of data. The pictorial nature of a histogram lets people see patterns that are difficult to detect in a simple table of numbers. One of the “seven tools of quality” (see listing).

**hoshin kanri:** The selection of goals, projects to achieve the goals, designation of people and resources for project completion and establishment of project metrics. Also see “policy deployment.”

**hoshin planning:** Breakthrough planning. A Japanese strategic planning process in which a company develops up to four vision statements that indicate where the company should be in the next five years. Company goals and work plans are developed based on the vision statements. Periodic submitted audits are then conducted to monitor progress. Also see “value stream.”

**house of quality:** A product planning matrix, somewhat resembling a house, that is developed during quality function deployment and shows the relationship of customer requirements to the means of achieving these requirements.

**in-control process:** A process in which the statistical measure being evaluated is in a state of statistical control; in other words, the variations among the observed sampling results can be attributed to a constant system of chance causes. Also see “out-of-control process.”

**incremental improvement:** Improvement implemented on a continual basis.

**indicators:** Established measures to determine how well an organization is meeting its customers’ needs and other operational and financial performance expectations.

**inputs:** The products, services and material obtained from suppliers to produce the outputs delivered to customers.

**inspection:** Measuring, examining, testing and gauging one or more characteristics of a product or service and comparing the results with specified requirements to determine whether conformity is achieved for each characteristic.

**inspection cost:** The cost associated with inspecting a product to ensure it meets the internal or external customer's needs and requirements; an appraisal cost.

**inspection lot:** A collection of similar units or a specific quantity of similar material offered for inspection and acceptance at one time.

**inspection, normal:** Inspection used in accordance with a sampling plan under ordinary circumstances.

**inspection, 100%:** Inspection of all the units in the lot or batch.

**internal customer:** The recipient (person or department) within an organization of another person's or department's output (product, service or information). Also see "external customer."

**internal failure:** A product failure that occurs before the product is delivered to external customers.

**International Organization for Standardization:** A network of national standards institutes from 157 countries working in partnership with international organizations, governments, industry, business and consumer representatives to develop and publish international standards; acts as a bridge between public and private sectors.

**interrelationship diagram:** A management tool that depicts the relationship among factors in a complex situation; also called "relations diagram."

**Ishikawa diagram:** See "cause and effect diagram."

**jidohka:** Stopping a line automatically when a defective part is detected. Any necessary improvements can then be made by directing attention to the stopped equipment and the worker who stopped the operation. The jidohka system puts faith in the worker as a thinker and allows all workers the right to stop the line on which they are working. Also see "autonomation."

**just-in-time (JIT) manufacturing:** An optimal material requirement planning system for a manufacturing process in which there is little or no manufacturing material inventory on hand at the manufacturing site and little or no incoming inspection.

**kaizen:** A Japanese term that means gradual unending improvement by doing little things better and setting and achieving increasingly higher standards. Masaaki Imai made the term famous in his book, *Kaizen: The Key to Japan's Competitive Success*.

**kanban:** A Japanese term for one of the primary tools of a just-in-time system. It maintains an orderly and efficient flow of materials throughout the entire manufacturing process. It is usually a printed card that contains specific information such as part name, description and quantity.

**key performance indicator (KPI):** A statistical measure of how well an organization is doing in a particular area. A KPI could measure a company's financial performance or how it is holding up against customer requirements.

**key product characteristic:** A product characteristic that can affect safety or compliance with regulations, fit, function, performance or subsequent processing of product.

**key process characteristic:** A process parameter that can affect safety or compliance with regulations, fit, function, performance or subsequent processing of product.

**leadership:** An essential part of a quality improvement effort. Organization leaders must establish a vision, communicate that vision to those in the organization and provide the tools and knowledge necessary to accomplish the vision.

**lean:** Producing the maximum sellable products or services at the lowest operational cost while optimizing inventory levels.

**lean enterprise:** A manufacturing company organized to eliminate all unproductive effort and unnecessary investment, both on the shop floor and in office functions.

**lean manufacturing/production:** An initiative focused on eliminating all waste in manufacturing processes. Principles of lean manufacturing include zero waiting time, zero inventory, scheduling (internal customer pull instead of push system), batch to flow (cut batch sizes), line balancing and cutting actual process times. The production systems are characterized by optimum automation, just-in-time supplier delivery disciplines, quick changeover times, high levels of quality and continuous improvement.

**lean migration:** The journey from traditional manufacturing methods to one in which all forms of waste are systematically eliminated.

**lot:** A defined quantity of product accumulated under conditions considered uniform for sampling purposes.

**lot, batch:** A definite quantity of some product manufactured under conditions of production that are considered uniform.

**lot quality:** The value of percentage defective or of defects per hundred units in a lot.

**lot size (also referred to as N):** The number of units in a lot.

**lower control limit (LCL):** Control limit for points below the central line in a control chart.

**maintainability:** The probability that a given maintenance action for an item under given usage conditions can be performed within a stated time interval when the maintenance is performed under stated conditions using stated procedures and resources.

**Malcolm Baldrige National Quality Award (MBNQA):** An award established by the U.S. Congress in 1987 to raise awareness of quality management and recognize U.S. companies that have implemented successful quality management systems. Awards can be given annually in six categories: manufacturing, service, small business, education, healthcare and nonprofit. The award is named after the late Secretary of Commerce Malcolm Baldrige, a proponent of quality management. The U.S. Commerce Department's National Institute of Standards and Technology manages the award, and ASQ administers it.

**master black belt (MBB):** Six Sigma or quality expert responsible for strategic implementations in an organization. An MBB is qualified to teach other Six Sigma facilitators the methods, tools and applications in all functions and levels of the company and is a resource for using statistical process control in processes.

**matrix:** A planning tool for displaying the relationships among various data sets.

**mean:** A measure of central tendency; the arithmetic average of all measurements in a data set.

**mean time between failures (MTBF):** The average time interval between failures for repairable product for a defined unit of measure; for example, operating hours, cycles and miles.

**measure:** The criteria, metric or means to which a comparison is made with output.

**measurement:** The act or process of quantitatively comparing results with requirements.

**median:** The middle number or center value of a set of data in which all the data are arranged in sequence.

**metric:** A standard for measurement.

**MIL-STD-105E:** A military standard that describes the sampling procedures and tables for inspection by attributes (See the Standards & Specifications section of the CD Rom for a copy).

**mistake proofing:** Use of production or design features to prevent the manufacture or passing downstream a nonconforming product; also known as "error proofing."

**mode:** The value occurring most frequently in a data set.

**muda:** Japanese for waste; any activity that consumes resources but creates no value for the customer.

**multivariate control chart:** A control chart for evaluating the stability of a process in terms of the levels of two or more variables or characteristics.

**n:** The number of units in a sample.

**N:** The number of units in a population.

**nominal group technique:** A technique, similar to brainstorming, to generate ideas on a particular subject. Team members are asked to silently write down as many ideas as possible. Each member is then asked to share one idea, which is recorded. After all the ideas are recorded, they are discussed and prioritized by the group.

**nonconformity:** The nonfulfillment of a specified requirement. Also see “blemish,” “defect” and “imperfection.”

**nondestructive testing and evaluation (NDT, NDE):** Testing and evaluation methods that do not damage or destroy the product being tested.

**nonlinear parameter estimation:** A method whereby the arduous and labor intensive task of multiparameter model calibration can be carried out automatically under the control of a computer.

**nonparametric tests:** All tests involving ranked data (data that can be put in order). Nonparametric tests are often used in place of their parametric counterparts when certain assumptions about the underlying population are questionable. For example, when comparing two independent samples, the Wilcoxon Mann-Whitney test (see listing) does not assume that the difference between the samples is normally distributed, whereas its parametric counterpart, the two-sample t-test, does. Nonparametric tests can be, and often are, more powerful in detecting population differences when certain assumptions are not satisfied.

**nonvalue added:** A term that describes a process step or function that is not required for the direct achievement of process output. This step or function is identified and examined for potential elimination. Also see “value added.”

**normal distribution (statistical):** The charting of a data set in which most of the data points are concentrated around the average (mean), thus forming a bell shaped curve.

**operating characteristic curve (OC curve):** A graph to determine the probability of accepting lots as a function of the lots' or processes' quality level when using various sampling plans. There are three types: type A curves, which give the probability of

acceptance for an individual lot coming from finite production (will not continue in the future); type B curves, which give the probability of acceptance for lots coming from a continuous process; and type C curves, which (for a continuous sampling plan) give the long-run percentage of product accepted during the sampling phase.

**operations:** Work or steps to transform raw materials to finished product.

**out-of-control process:** A process in which the statistical measure being evaluated is not in a state of statistical control. In other words, the variations among the observed sampling results can be attributed to a constant system of chance causes. Also see “in-control process.”

**out of spec:** A term that indicates a unit does not meet a given requirement or specification.

**outputs:** Products, materials, services or information provided to customers (internal or external), from a process.

**Pareto chart:** A graphical tool for ranking causes from most significant to least significant. It is based on the Pareto principle, which was first defined by Joseph M. Juran in 1950. The principle, named after 19th century economist Vilfredo Pareto, suggests most effects come from relatively few causes; that is, 80% of the effects come from 20% of the possible causes. One of the “seven tools of quality” (see listing).

**parts per million (PPM):** A method of stating the performance of a process in terms of actual nonconforming material, which can include rejected, returned or suspect material in the calculation.

**P chart:** See “percent chart.”

**PDCA cycle:** See “plan-do-check-act cycle.”

**percent chart:** A control chart for evaluating the stability of a process in terms of the percentage of the total number of units in a sample in which an event of a given classification occurs. Also referred to as a proportion chart.

**plan-do-check-act (PDCA) cycle:** A four-step process for quality improvement. In the first step (plan), a way to effect improvement is developed. In the second step (do), the plan is carried out, preferably on a small scale. In the third step (check), a study takes place between what was predicted and what was observed in the previous step. In the last step (act), action is taken on the causal system to effect the desired change. The plan-do-check-act cycle is sometimes referred to as the Shewhart cycle, because Walter A. Shewhart discussed the concept in his book *Statistical Method From the Viewpoint of Quality Control*, and as the Deming cycle, because W. Edwards Deming introduced the concept in Japan. The Japanese subsequently called it the Deming cycle. Also called the plan-do-study-act (PDSA) cycle.

**point of use:** A technique that ensures people have exactly what they need to do their jobs—work instructions, parts, tools and equipment—where and when they need them.

**Poisson distribution:** A discrete probability distribution that expresses the probability of a number of events occurring in a fixed time period if these events occur with a known average rate, and are independent of the time since the last event.

**poka-yoke:** Japanese term that means mistake proofing. A pokayoke device is one that prevents incorrect parts from being made or assembled or easily identifies a flaw or error.

**precision:** The aspect of measurement that addresses repeatability or consistency when an identical item is measured several times.

**preventive action:** Action taken to remove or improve a process to prevent potential future occurrences of a nonconformance.

**prevention cost:** The cost incurred by actions taken to prevent a nonconformance from occurring; one element of cost of quality or cost of poor quality.

**probability (statistical):** The likelihood of occurrence of an event, action or item.

**procedure:** The steps in a process and how these steps are to be performed for the process to fulfill a customer's requirements; usually documented.

**process:** A set of interrelated work activities characterized by a set of specific inputs and value added tasks that make up a procedure for a set of specific outputs.

**process average quality:** Expected or average value of process quality.

**process capability:** A statistical measure of the inherent process variability of a given characteristic. The most widely accepted formula for process capability is 6 sigma.

**process capability index:** The value of the tolerance specified for the characteristic divided by the process capability. The several types of process capability indexes include the widely used Cpk and Cp.

**process control:** The method for keeping a process within boundaries; the act of minimizing the variation of a process.

**process flow diagram:** A depiction of the flow of materials through a process, including any rework or repair operations; also called a process flow chart.

**process improvement:** The application of the plan-do-check-act cycle (see listing) to processes to produce positive improvement and better meet the needs and expectations of customers.

**process management:** The pertinent techniques and tools applied to a process to implement and improve process effectiveness, hold the gains and ensure process integrity in fulfilling customer requirements.

**process map:** A type of flowchart depicting the steps in a process and identifying responsibility for each step and key measures.

**process owner:** The person who coordinates the various functions and work activities at all levels of a process, has the authority or ability to make changes in the process as required and manages the entire process cycle to ensure performance effectiveness.

**process performance management (PPM):** The overseeing of process instances to ensure their quality and timeliness; can also include proactive and reactive actions to ensure a good result.

**process quality:** The value of percentage defective or of defects per hundred units in product from a given process. Note: The symbols “p” and “c” are commonly used to represent the true process average in fraction defective or defects per unit; and “100p” and “100c” the true process average in percentage defective or in defects per hundred units.

**production part approval process (PPAP):** A Big Three automotive process that defines the generic requirements for approval of production parts, including production and bulk materials. Its purpose is to determine during an actual production run at the quoted production rates whether all customer engineering design record and specification requirements are properly understood by the supplier and that the process has the potential to produce product consistently meeting these requirements.

**project management:** The application of knowledge, skills, tools and techniques to a broad range of activities to meet the requirements of a particular project.

**project team:** Manages the work of a project. The work typically involves balancing competing demands for project scope, time, cost, risk and quality, satisfying stakeholders with differing needs and expectations and meeting identified requirements.

**proportion chart:** See “percent chart.”

**pull system:** An alternative to scheduling individual processes, in which the customer process withdraws the items it needs from a supermarket (see listing) and the supplying process produces to replenish what was withdrawn; used to avoid push. Also see “kanban.”

**quality:** A subjective term for which each person or sector has its own definition. In technical usage, quality can have two meanings: 1. the characteristics of a product or service that bear on its ability to satisfy stated or implied needs; 2. a product or service free of deficiencies. According to Joseph Juran, quality means “fitness for use;” according to Philip Crosby, it means “conformance to requirements.”

**quality assurance/quality control (QA/QC):** Two terms that have many interpretations because of the multiple definitions for the words “assurance” and “control.” For example, “assurance” can mean the act of giving confidence, the state of being certain or the act of making certain; “control” can mean an evaluation to indicate needed corrective responses, the act of guiding or the state of a process in which the variability is attributable to a constant system of chance causes. (For a detailed discussion on the multiple definitions, see ANSI/ISO/ASQ A3534-2, Statistics—Vocabulary and Symbols—Statistical Quality Control.) One definition of quality assurance is: all the planned and systematic activities implemented within the quality system that can be demonstrated to provide confidence that a product or service will fulfill requirements for quality. One definition for quality control is: the operational techniques and activities used to fulfill requirements for quality. Often, however, “quality assurance” and “quality control” are used interchangeably, referring to the actions performed to ensure the quality of a product, service or process.

**quality audit:** A systematic, independent examination and review to determine whether quality activities and related results comply with plans and whether these plans are implemented effectively and are suitable to achieve the objectives.

**quality costs:** See “cost of poor quality.”

**quality function deployment (QFD):** A structured method in which customer requirements are translated into appropriate technical requirements for each stage of product development and production. The QFD process is often referred to as listening to the voice of the customer.

**quality loss function:** A parabolic approximation of the quality loss that occurs when a quality characteristic deviates from its target value. The quality loss function is expressed in monetary units: the cost of deviating from the target increases quadratically the farther the quality characteristic moves from the target. The formula used to compute the quality loss function depends on the type of quality characteristic being used. The quality loss function was first introduced in this form by Genichi Taguchi.

**quality management (QM):** The application of a quality management system in managing a process to achieve maximum customer satisfaction at the lowest overall cost to the organization while continuing to improve the process.

**quality management system (QMS):** A formalized system that documents the structure, responsibilities and procedures required to achieve effective quality management.

**queue time:** The time a product spends in a line awaiting the next design, order processing or fabrication step.

**quick changeover:** The ability to change tooling and fixtures rapidly (usually within minutes) so multiple products can be run on the same machine.

**random cause:** A cause of variation due to chance and not assignable to any factor.

**random sampling:** A commonly used sampling technique in which sample units are selected so all combinations of n units under consideration have an equal chance of being selected as the sample.

**range (statistical):** The measure of dispersion in a data set (the difference between the highest and lowest values).

**range chart (R chart):** A control chart in which the subgroup range, R, evaluates the stability of the variability within a process.

**regression analysis:** A statistical technique for determining the best mathematical expression describing the functional relationship between one response and one or more independent variables.

**relations diagram:** See interrelations diagram

**reliability:** The probability of a product's performing its intended function under stated conditions without failure for a given period of time.

**repeatability:** The variation in measurements obtained when one measurement device is used several times by the same person to measure the same characteristic on the same product.

**reproducibility:** The variation in measurements made by different people using the same measuring device to measure the same characteristic on the same product.

**requirements:** The ability of an item to perform a required function under stated conditions for a stated period of time.

**risk management:** Using managerial resources to integrate risk identification, risk assessment, risk prioritization, development of risk handling strategies and mitigation of risk to acceptable levels.

**robustness:** The condition of a product or process design that remains relatively stable, with a minimum of variation, even though factors that influence operations or usage, such as environment and wear, are constantly changing.

**root cause:** A factor that caused a nonconformance and should be permanently eliminated through process improvement.

**run chart:** A chart showing a line connecting numerous data points collected from a process running over time.

**sample:** In acceptance sampling, one or more units of product (or a quantity of material) drawn from a lot for purposes of inspection to reach a decision regarding acceptance of the lot.

**sample size [n]:** The number of units in a sample.

**sample standard deviation chart (S chart):** A control chart in which the subgroup standard deviation,  $s$ , is used to evaluate the stability of the variability within a process.

**scatter diagram:** A graphical technique to analyze the relationship between two variables. Two sets of data are plotted on a graph, with the y-axis being used for the variable to be predicted and the x-axis being used for the variable to make the prediction. The graph will show possible relationships (although two variables might appear to be related, they might not be; those who know most about the variables must make that evaluation). One of the “seven tools of quality” (see listing).

**seven tools of quality:** Tools that help organizations understand their processes to improve them. The tools are the cause and effect diagram, check sheet, control chart, flowchart, histogram, Pareto chart and scatter diagram (see individual entries).

**seven wastes:** See “eight wastes.”

**Shewhart cycle:** See “plan-do-check-act cycle.”

**sigma:** One standard deviation in a normally distributed process.

**single-piece flow:** A process in which products proceed, one complete product at a time, through various operations in design, order taking and production without interruptions, backflows or scrap.

**SIPOC diagram:** A tool used by Six Sigma process improvement teams to identify all relevant elements (suppliers, inputs, process, outputs, customers) of a process improvement project before work begins.

**Six Sigma:** A method that provides organizations tools to improve the capability of their business processes. This increase in performance and decrease in process variation lead to defect reduction and improvement in profits, employee morale and quality of products or services. Six Sigma quality is a term generally used to indicate a process is well controlled ( $\pm 6\sigma$  from the centerline in a control chart).

**Six Sigma quality:** A term generally used to indicate process capability in terms of process spread measured by standard deviations in a normally distributed process.

**special causes:** Causes of variation that arise because of special circumstances. They are not an inherent part of a process. Special causes are also referred to as assignable causes. Also see “common causes.”

**specification:** A document that states the requirements to which a given product or service must conform.

**stages of team growth:** Four stages that teams move through as they develop maturity: forming, storming, norming and performing.

**standard deviation (statistical):** A computed measure of variability indicating the spread of the data set around the mean.

**standard work:** A precise description of each work activity, specifying cycle time, takt time, the work sequence of specific tasks and the minimum inventory of parts on hand needed to conduct the activity. All jobs are organized around human motion to create an efficient sequence without waste. Work organized in such a way is called standard(ized) work. The three elements that make up standard work are takt time, working sequence and standard in-process stock (see individual listings).

**standard work instructions:** A lean manufacturing tool that enables operators to observe a production process with an understanding of how assembly tasks are to be performed. It ensures the quality level is understood and serves as an excellent training aid, enabling replacement or temporary individuals to easily adapt and perform the assembly operation.

**statistical process control (SPC):** The application of statistical techniques to control a process; often used interchangeably with the term “statistical quality control.”

**statistical quality control (SQC):** The application of statistical techniques to control quality. Often used interchangeably with the term “statistical process control,” although statistical quality control includes acceptance sampling, which statistical process control does not.

**strengths, weaknesses, opportunities, threats (SWOT) analysis:** A strategic technique used to assess what an organization is facing.

**supplier:** A source of materials, service or information input provided to a process.

**supplier quality assurance:** Confidence a supplier’s product or service will fulfill its customers’ needs. This confidence is achieved by creating a relationship between the customer and supplier that ensures the product will be fit for use with minimal corrective action and inspection. According to Joseph M. Juran, nine primary activities are needed: 1. define product and program quality requirements; 2. evaluate alternative suppliers; 3. select suppliers; 4. conduct joint quality planning; 5. cooperate with the supplier during the execution of the contract; 6. obtain proof of conformance to requirements; 7. certify qualified suppliers; 8. conduct quality improvement programs as required; 9. create and use supplier quality ratings.

**supply chain:** The series of suppliers to a given process.

**system:** A group of interdependent processes and people that together perform a common mission.

**Taguchi Methods:** The American Supplier Institute's trademarked term for the quality engineering methodology developed by Genichi Taguchi. In this engineering approach to quality control, Taguchi calls for off-line quality control, on-line quality control and a system of experimental design to improve quality and reduce costs.

**takt time:** The rate of customer demand, takt time is calculated by dividing production time by the quantity of product the customer requires in that time. Takt is the heartbeat of a lean manufacturing system. Also see "cycle time."

**team:** A group of individuals organized to work together to accomplish a specific objective. Also see *stages of team growth*.

**theory of constraints (TOC):** A lean management philosophy that stresses removal of constraints to increase throughput while decreasing inventory and operating expenses. TOC's set of tools examines the entire system for continuous improvement. The current reality tree, conflict resolution diagram, future reality tree, prerequisite tree and transition tree are the five tools used in TOC's ongoing improvement process. Also called constraints management.

**throughput:** The rate the system generates money through sales, or the conversion rate of inventory into shipped product.

**tolerance:** The maximum and minimum limit values a product can have and still meet customer requirements.

**total productive maintenance (TPM):** A series of methods, originally pioneered by Nippondenso (a member of the Toyota group), to ensure every machine in a production process is always able to perform its required tasks so production is never interrupted.

**total quality management (TQM):** A term coined by the Naval Air Systems Command to describe its Japanese style management approach to quality improvement. Since then, TQM has taken on many meanings. Simply put, it is a management approach to longterm success through customer satisfaction. TQM is based on all members of an organization participating in improving processes, products, services and the culture in which they work. The methods for implementing this approach are found in the teachings of such quality leaders as Philip B. Crosby, W. Edwards Deming, Armand V. Feigenbaum, Kaoru Ishikawa and Joseph M. Juran.

**Toyota production system (TPS):** The production system developed by Toyota Motor Corp. to provide best quality, lowest cost and shortest lead time through eliminating waste. TPS is based on two pillars: just-in-time and jidohka (see listings). TPS is maintained and improved through iterations of standardized work and kaizen (see listing.)

**tree diagram:** A management tool that depicts the hierarchy of tasks and subtasks needed to complete an objective. The finished diagram bears a resemblance to a tree.

**trend:** The graphical representation of a variable's tendency, over time, to increase, decrease or remain unchanged.

**trend control chart:** A control chart in which the deviation of the subgroup average,  $\bar{X}$ -bar, from an expected trend in the process level is used to evaluate the stability of a process.

**TRIZ:** A Russian acronym for a theory of innovative problem solving.

**T-test:** A method to assess whether the means of two groups are statistically different from each other.

**Type I error:** An incorrect decision to reject something (such as a statistical hypothesis or a lot of products) when it is acceptable.

**Type II error:** An incorrect decision to accept something when it is unacceptable.

**U chart:** Count-per-unit chart.

**unit:** An object for which a measurement or observation can be made; commonly used in the sense of a "unit of product," the entity of product inspected to determine whether it is defective or nondefective.

**upper control limit (UCL):** Control limit for points above the central line in a control chart.

**validation:** The act of confirming a product or service meets the requirements for which it was intended.

**validity:** The ability of a feedback instrument to measure what it was intended to measure; also, the degree to which inferences derived from measurements are meaningful.

**value added:** A term used to describe activities that transform input into a customer (internal or external) usable output.

**value stream:** All activities, both value added and nonvalue added, required to bring a product from raw material state into the hands of the customer, bring a customer requirement from order to delivery and bring a design from concept to launch. Also see "information flow" and "hoshin planning."

**value stream mapping:** A pencil and paper tool used in two stages. First, follow a product's production path from beginning to end and draw a visual representation of every process in the material and information flows. Second, draw a future state map of how value should flow. The most important map is the future state map.

**variable data:** Measurement information. Control charts based on variable data include average ( $\bar{X}$ -bar) chart, range (R) chart, and sample standard deviation (s) chart (see individual listings).

**variation:** A change in data, characteristic or function caused by one of four factors: special causes, common causes, tampering or structural variation (see individual entries).

**verification:** The act of determining whether products and services conform to specific requirements.

**voice of the customer:** The expressed requirements and expectations of customers relative to products or services, as documented and disseminated to the providing organization's members.

**waste:** Any activity that consumes resources and produces no added value to the product or service a customer receives. Also known as muda.

**Wilcoxon Mann-Whitney test:** Used to test the null hypothesis that two populations have identical distribution functions against the alternative hypothesis that the two distribution functions differ only with respect to location (median), if at all. It does not require the assumption that the differences between the two samples are normally distributed. In many applications, it is used in place of the two sample t-test when the normality assumption is questionable. This test can also be applied when the observations in a sample of data are ranks, that is, ordinal data rather than direct measurements.

**x-bar chart:** Average chart.

**zero defects:** A performance standard and method Philip B. Crosby developed; states that if people commit themselves to watching details and avoiding errors, they can move closer to the goal of zero defects.

analytical (inferential) studies:

bias:

binomial distribution:

causation:

central limit theorem:

chi square distribution:

Cpm:

critical path method (CPM):

critical to quality (CTQ):

cyclical variation:

Design for Six Sigma:

enumerative (descriptive) studies:

F distribution:

linearity:

multi-vari studies:

multi-voting:

paired-comparison tests:

Pp:

Ppk:

positional variation:

practical significance:

prioritization matrix:

process decision program (PDPC) charts:

program evaluation and review technique (PERT) charts:

rational subgrouping:

risk priority number (RPN):

statistical significance:

Student's t distribution:

temporal variation: