



# Manufacturing Glossary

## A Guide to Industry Terms



Created by members of Acuity's Manufacturing Customer Team, this document serves as a resource for those seeking to enhance their knowledge and vocabulary of the multifaceted and ever-changing manufacturing industry.



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## #

### 3D Printing

An innovative technology that allows manufacturers to create physical objects from a digital model. While the technology was developed in the 1980s, it is becoming increasingly popular in commercial applications. In 3D printing, material is laid down in layers to generate a three-dimensional image. See [Additive Manufacturing \(AM\)](#).

### 5-Axis

Refers to the number of directions in which the cutting tool can move. On a 5-axis machining center (CNC), the machine tool moves across the X, Y, and Z linear axes and rotates on the A and B axes to approach the workpiece from any direction. See [Computer Numerical Control \(CNC\)](#).

## A

### Absenteeism (Percent)

All unscheduled absences during normal work hours and scheduled overtime. The formula is (Actual hours lost through unscheduled job absence ÷ actual hours worked) x 100.

### Additive Manufacturing (AM)

Refers to the manufacturing process of 3D printing. It is a process where material is added layer by layer to make the part. The process uses materials like metal, plastics, concrete, or even human tissue. The process has improved and is now a widely accepted manufacturing process, not only for prototype parts, but also production parts. Recent developments have combined 3D printing into traditional machine tools, allowing conventional subtractive machining and additive manufacturing to be in one machine. See [3D Printing](#).

### Advanced Planning and Scheduling System

Planning and optimization tool that balances demand with plant capacity, thus allowing manufacturers to identify bottlenecks and divert workload to alternative production cells.

## Agile Manufacturing

Tools, techniques, and initiatives that enable a plant or company to thrive under conditions of unpredictable change. Agile manufacturing not only enables a plant to achieve rapid response to customer needs, but also includes the ability to quickly reconfigure operations—and strategic alliances—to respond rapidly to unforeseen shifts in the marketplace. In some instances, it also incorporates mass customization concepts to satisfy unique customer requirements. In broad terms, it includes the ability to react quickly to technical or environmental changes.

## Alloy

A mixture of metals or a mixture of a metal with another element. Alloys are added to a base metal to improve the base metal's properties, increase corrosion resistance, reduce cost of base metal, or create additional properties. (e.g., Tungsten and vanadium are added to regular steel to improve hardness and abrasion resistance.)

## Annual Total Inventory Turns

A measure that is calculated by dividing the value of annual plant shipments at plant cost (for the most recent full year) by the total average daily inventory value at plant cost. Total average daily inventory includes raw materials, work in process, and finished goods. Plant cost includes material, labor, and plant overhead.

## Apprenticeship

A form of on-the-job training (OJT) for practitioners that will give them a license or journeyman's level of competencies.

## Approved Manufacturer List (AML)

A set of approved relationships between manufacturer parts and a company's internally defined parts. Each relationship links a manufacturer's part number to an internal part number and results from the R&D team's identifying the third-party parts that can be used to satisfy the manufacturing demand for the internal part. All approved AML parts for each internal part can share a single inventory bin.

## Approved Vendor List (AVL)

A list of all the vendors or suppliers approved by a company as sources from which to purchase materials.

## Artificial Intelligence (AI)

Intelligence demonstrated by machines in contrast to the natural intelligence displayed by humans and other animals.

## Asset Turnover

A measure of how efficiently assets are used to produce sales. The ratio shows how many dollars of sales were generated by each dollar of assets. Calculate by dividing net sales by average total assets.

## Augmented Reality (AR)

A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.

## Automated Fiber Placement (AFP)

An advanced method for fabricating composite structures. It is used almost exclusively with continuous fiber reinforced tape. A robot places composite material and builds the structure one ply (layer) at a time. Manufacturers can create highly customized components through this method.

## Automation

The use of mechanical equipment without a large need for human interaction in a system of manufacturing or other production process. See [Robot](#).

## B

## Batch Manufacturing

Batch manufacturing is a technique in which the product is staged in large groups between each workstation.

## Bearing

A mechanical device that reduces friction between two parts. Bearings can be made of a variety of material, including steel, plastic, carbon fiber, and ceramic.

## Benchmarking

Comparing business processes and performance metrics to industry best practices from other companies. See [Three Sigma Standard Deviations](#), [Statistical Process Control \(SPC\)](#), [Six Sigma](#).

## Bill of Material (BOM)

A BOM is a list of the parts or components that are required to build a product. The BOM provides the manufacturer part number (MPN) and the quantity needed for each component. BOMs are an intricate part of material resource planning (MRP). See [Single-Level BOM](#), [Multi-Level BOM](#).

## Blockchain

A system in which a record of transactions made in cryptocurrency (digital asset) is maintained across several computers that are linked in a peer-to-peer network. The greatest impact on manufacturing is the visibility across every area, starting with suppliers and all the way to consumers.

## Bottleneck

Any point at which movement is slowed because demand placed on a resource is greater than capacity.

## Brinell Hardness Tester

A hardness testing process that uses a machine that applies a known force to a known size steel ball and measures the indentation in the measured piece, which is then converted to a hardness reading. This reading can then be used to determine the hardness of the material or to compare hardness of different materials. The number is displayed as BHN (Brinell Hardness Number). Brinell hardness has limitations, as it can only measure hardness below the hardness of the steel ball. See [Rockwell Hardness Test](#), [Vickers Hardness Test](#).

## C

### C++

A general-purpose programming language used to edit programs and manipulate machine functions.

## Captive Shop (Captured Shop)

Many larger organizations rely on internal machine shops to provide specialized services such as prototyping, tooling, or engineering. A captive shop allows the larger organization to set priorities and direct the shop on what is needed versus having to get quotes and negotiate capacity and lead time with contract shops/job shops. In general, a captive shop has fewer accounting requirements; however, it has very similar management requirements.



## Carbide

Carbide and cemented carbide are manmade materials that consist of powdered carbon and other elements like tungsten, cobalt, and vanadium. Carbide is harder than regular tool steel. Tools made of carbide stand up to higher heat, can perform better at high speeds, and resist abrasion better. They are usually used to increase machine tool performance; carbide is more expensive than regular tool steel.

## Carbon Fiber

A carbon fiber is a long thin strand of material that consists mostly of polyacrylonitrile and carbon atoms. First the material is spun, the many strands are twisted together, and then woven, increasing strength multifold. Carbon fiber has a very high strength to weight ratio. It is used in the outdoor, aero, and automotive industries to reduce weight without sacrificing strength, which helps improve full economy.

## CAT 40/50 Taper

A steep taper ASME B5.50 CAT40/CAT50 is used to transfer high load or spindled forces to a machine tool. The traditional interface for milling spindles, ASME B5.50 distinguishes itself through its extremely robust design. Its field of application ranges from fine machining to heavy duty roughing. The tool holder is pulled in the milling spindle with the help of an additional pull stud.

## Cellular Manufacturing

A lean manufacturing method of organizing equipment, processes, work teams, and parts to ensure a single piece flow of manufactured goods. The key to cell manufacturing is that product is produced one piece at a time, at the rate of the customer demand (takt time), eliminating work in progress (WIP) and inventory. See [Work in Progress \(WIP\)](#), [Takt Time](#), [Cycle Time](#).

## Change Management

Process of creating, reviewing, and gaining formal approval for engineering change requests, change orders, and change notifications.

## Change Request

Outlines a problem and proposes an action to address the problem. Some types of change requests are: DCR (document change request), ECR (engineering change request), FFR (field failure request), MCR (manufacturing change request), and SCAR (supplier corrective action request).

## Changeover

The time required to modify a system or workstation, including teardown and setup time.

## Child Item

An item that appears in the BOM of another item is said to be a child of that item. For example, a motor would be a child item in the lawn mower. See [Bill of Material \(BOM\)](#).

## CO<sub>2</sub> Laser

One of the earliest laser technologies. The laser medium is a gas discharge, typically a mixture of carbon dioxide, nitrogen, hydrogen, or xenon. They are efficient lasers and produce a beam of infrared light.

## Cobot

A cobot is a computer-controlled device that is designed to work side-by-side with humans. They are programmed and have sensors attached to stop them before they touch a human. Cobots are not as heavy duty and move slower than industrial robots to ensure they can perform interactive work with humans. See [Robot](#).

## Compliance

The practice of tracking whether a product complies with government-imposed regulations or a company's self-imposed standards. Some types of compliance requirements are environmental requirements (e.g., RoHS and WEEE) and medical device regulations (e.g., 21 CFR Part 11 and 21 CFR Part 820).

## Compliance Mark

A physical mark listed on a product or its packaging to show the product's compliance with a specific requirement (e.g., UL, CE, CCC, FCC, and VCCI).

## Computer-Aided Design (CAD)

A CAD system is dedicated software on a computer that allows engineers, draftsmen, architects, and others to generate detailed 2D and 3D drawings in a digital format. This data can be stored on computers, sent over the Internet, or downloaded to a variety of data storage devices for safe keeping, transfer, or further processing. CAD/CAM files are used to operate computer numerical control machines (CNC). See [Computer-Aided Machining \(CAM\)](#), [Computer Numerical Control \(CNC\)](#).

## Computer-Aided Machining/Manufacturing (CAM)

CAM systems are used to convert CAD files/drawings into data that can then be used to communicate directly with machine tools or other manufacturing equipment to have them perform operations to manufacture parts or components. Many times, CAD/CAM systems are integrated into one system. See [Computer-Aided Design \(CAD\)](#), [Computer Numerical Control \(CNC\)](#).

## Computer Numerical Control (CNC)

A variety of machine tools that are controlled by a computer using a CAD/CAM file and programmable logic controller (PLC).

## Computerized Maintenance Management Systems (CMMS)

Software-based systems that analyze operating conditions of production equipment (e.g., vibration, oil analysis, heat, etc.) and equipment-failure data, and apply that data to the scheduling of maintenance, repair inventory orders, and routine maintenance functions. A CMMS reduces unscheduled machine downtime and optimizes a plant's ability to process product at optimum volumes and quality levels.

## Computerized Process Simulation

Use of computer simulation to facilitate sequencing of production operations, analysis of production flows, and layout of manufacturing facilities.

## Concurrent Engineering

A cross-functional, team-based approach in which the product and the manufacturing process are designed and configured within the same time frame, rather than sequentially. Ease and cost of manufacturability, as well as customer needs, quality issues, and product-life-cycle costs are considered earlier in the development cycle. Fully configured concurrent-engineering teams include representation from marketing, design engineering, manufacturing engineering, and purchasing, as well as suppliers and even customer companies.

## Continuous Fiber Management (CFM)

The 3D printing of fibrous materials including, but not limited to, carbon fiber and fiber optics.

## Continuous Flow Manufacturing (CFM)

Parts are flowing through the process in single piece flow from station to station as they are produced, rather than batch (making many at one station, than sending all at once to next processing station).

## Continuous Improvement (CI)

A continual process of improvement efforts to improve services, products, processes, and cost. It is one of the lean philosophies. See [Lean Manufacturing \(Lean\)](#).

## Continuous-Replenishment Programs

Arrangement with supplier companies in which the supplier monitors the customer's inventory and automatically replaces used materials, eliminating the need for purchase orders and related paperwork.

## Contract Manufacturer (CM)

A firm hired by a company to manufacture or assemble its product or part of its product.

## Contract Shop/Job Shop

Contract or job shops are independent shops that compete for work from a wide variety of companies. These shops can be focused on one product family or very diversified and servicing a wide variety of industries. Some job shops are specialized in one or two fields, while other job shops can offer a wide variety of services.

## Conveyer

A mechanical material handling equipment made of rolls, belts, or rotating balls that allow boxes and materials to be easily moved. Some systems have motors driving certain rolls, so material can be moved over long distances without human efforts.

## Coolant

Coolant covers a wide variety of fluid used to reduce friction, remove heat, and provide lubricant during cutting operations on a variety of machine tools. Coolants can be as simple as plain water or as high tech as fully synthetic engineered out of a variety of subcomponents to being totally organic. The composition depends on the primary function desired.

## Coordinate Measuring Machine (CMM)

A high precision machine that is used to measure physical geometric characteristics of a part. Many CMMs are computer and software controlled using CAD/CAM files; however, they can be manually operated as well.

## Core Competency

The processes, functions, and activities in a plant or company that are its life blood typically those activities for which the enterprise derives the greatest return for its investments or those that intrinsically align the enterprise with its core market.

## Corrective Action Request (CAR)

A change request documenting a critical problem with a product.

## Corrective Action/ Protective Action (CAPA)

A good manufacturing practice (GMP) concept in which product failures are investigated to correct their current occurrence (corrective action) and/or prevent similar occurrences in the future (protective action).

## Cost of Quality

The sum of all costs associated with conformance and nonconformance. Cost of conformance includes prevention costs (employee training, tooling maintenance, planned preventive maintenance, suggestion awards) and appraisal costs (inspection, testing, gages and instrumentation, audit expenses). The cost of nonconformance includes internal costs (unscheduled maintenance, pre-shipment scrap and rework, workers' compensation) and external costs (warranty, customer complaint investigation, rework of returned goods, and product liability insurance).

## Cpk or Process Capability Index

Cpk is an index, a simple number that measures how close a process is running/operating to its specification limits. A Cpk of 1.33 (4 sigma) or higher will satisfy most customers. 4 sigma will give you 6,210 bad parts per million manufactured (6,210 DPPM). A Cpk of 2.0 will give you 6 sigma or 3-4 bad parts per million. Every process has a Cpk, whether the process is perfectly centered between limits or shifted out of control. See [Three Sigma Standard Deviations](#), [Six Sigma](#), [Statistical Process Control \(SPC\)](#)

## Customer Reject Rate (ppm)

A quality measure, expressed in parts per million, reflecting the number of completed units rejected or returned by external customers. Calculation should include parts reworked by customers. Applies to all shipped units, including parts.

## Customer Retention Rate

The number of customers active three years ago and still active, divided by the total number of customers active three years ago.

## Cycle Time

Cycle time is the time it takes for one part to be processed at an individual process step. See [Takt Time](#).

## D

### Days of Inventory

Calculate days of inventory by dividing the average inventory on hand (raw-materials inventory, work-in-process inventory, finished-goods inventory, or total inventory) by average daily usage.

### Dead Man's Switch

A switch or control that is designed to be activated or deactivated if the operator becomes incapacitated.

### Dado

A slot made across the grain, typically by milling, sawing, or chiseling.

### Defective Part Per Million (DPPM)

The number of bad/defective parts that you would produce if you made 1,000,000 parts. Reporting bad parts as DPPM will give you a better understanding of the true impact of bad parts that a customer might receive if you do not improve or adjust your manufacturing process. Reporting defective parts as DPPM allows you also to compare different operations to the same output level. Scrap reported as % of total output might not give you a true understanding of the bad parts produced.

### Define, Measure, Analyze, Improve, Control (DMAIC)

DMAIC refers to a data-driven improvement cycle used for improving, optimizing, and stabilizing business processes and designs. The DMAIC improvement cycle is the core tool used to drive six sigma projects. However, DMAIC is not exclusive to six sigma and can be used as the framework for other improvement applications.

### Demand Flow Scheduling Systems

Software systems designed to optimize demand-based manufacturing techniques.

### Department of Labor (DOL)

The DOL is a cabinet-level department responsible for occupational safety (OSHA), wage and hour standards, unemployment insurance benefits, employment and labor

training, as well as economic statistics. See [Occupational Safety and Health Administration \(OSHA\)](#).

## Design for Manufacture and Assembly (DFMA)

DFMA is the combination of two methodologies: Design for Manufacture (DFM) and Design for Assembly (DFA), DFM means to design a part not only for ease in function and looks but for ease of manufacturing and production. DFA means the part is also designed for ease of final assembly. To truly improve overall manufacturing efficiencies, DFM and DFA need to be used as soon as a product concept is received

## Design for Postponement (DFP)

DFP is a relatively new business strategy that focuses on maximizing benefits and minimizing risk by delaying further investment until the last possible moment.

## Design for Service (DFS)

DFS means a product is designed to be easily serviceable by the end user, such as an air filter on a car that can be easily replaced by the owner without tools.

## Design History File (DHF)

A collection of records that describes the design history of a finished medical device. The design history file documents the design decisions made throughout the development of the device, including sign-off events, change information, meeting notes, test data and reports, and evidence that the device has been scrutinized against design and performance specifications. The design history file provides the chronology of the design, including previous revision information and phase gate details. Source: 21 CFR Part 820 Sec 820.3.

## Design of Experiments

An experimental design methodology that enables process designers to determine optimum product/process parameters by conducting a limited number of experiments involving combinations of variables. The usual objective is to determine which variables in a complex process are most critical for quality control or those that can be most easily changed to reduce overall process variance.

## Device History Record (DHR)

A collection of records containing the production history of a medical device. This includes the serial and lot numbers of the devices produced and any complaints or issues that are lodged against devices. In addition, it may include CAPA records

describing investigations, corrective and preventive actions, and details about how any complaints were addressed.

## Device Master Record (DMR)

A collection of records that contain the procedures and specifications for a finished medical device. This includes the BOM for the device, product and material specifications, and packaging and assembly instructions. Post processing, cleaning and sterilization requirements, hardware and software specifications, and source code may be included too, depending on the type of device. The DMR provides all information required to correctly build the current production revision of the device. Source: 21 CFR Part 820 Sec 820.3 and 820.181.

## Die

A special tool used to cut or shape material. A simple die would be a cookie cutter.

## Direct Diode Laser (DDL)

Laser technology that utilizes diodes directly. This is managed through eliminating the doped fiber system used in fiber laser technology. DDL is a more efficient process and results in a more reliable laser source.

## Direct Numerical Control (DNC)

Refers to a computer/server that is connected (wirelessly or by hardwire) to a CNC machine. This allows the CNC to access large machining files without using the machine's own memory (allowing faster processing). It also allows multiple machines to use the same program at the same time. An additional benefit is that any change to the file is immediately updated to all machines at once. A disadvantage is if the server goes down, all machines are down.

## Discrete Manufacturing

The production or assembly of parts and/or finished products that are recognizable as distinct units capable of being identified by serial numbers or other labeling methods and measurable as numerical quantities rather than by weight or volume.

## Disk Laser

Laser technology characterized by a heat sink and laser output that are realized on opposite sides of a thin layer of active medium.



## Document Change Request (DCR)

A change request that details a problem with a document, specification, or SOP (standard operating procedure) and proposes a change to fix it.

## Document Control

The function of managing and controlling product documentation. This includes maintaining and properly distributing product files while following revision control procedures.

## Downtime (DT)

The time when a machine or piece of equipment is not available for manufacturing. Planned/scheduled downtime (PDT) is time that has been scheduled to shut down equipment to perform maintenance, clean, or change the setup of the equipment. Unplanned downtime is when equipment is shut down due to failure, breakage, or lack of orders and material.

## Drill Bit

A cylindrical cutting tool that rotates and is pushed inward to remove material and create a hollow cylinder in the material. The chips are removed upwards through spiral flutes. Standard drill bits have two cutting edges and flutes, but specialty drill bits for hardened and stainless-steel material can have three cutting edges and flutes.

## Drill Press

A drill press is a stationary machine that has a motor attached and spindle with a chuck to hold the drill bit. Once the power is turned on, the operator rotates the quill feed lever, which pushes the drill bit into the material. Modern drill presses have power-operated quill feeds, reducing the force needed by the operator. Many machines, like mills and lathes, can have built-in tooling that mimics a drill press.

## E

## Economic Value Added (EVA)

A measurement of shareholder wealth created by an investment center. A trademark of Stern Stewart & Company, calculating EVA can be very complex but is basically net operating profit after taxes (NOPAT) minus an appropriate charge for the opportunity cost of all capital invested in an enterprise.

## Electric Discharge Machine (EDM)

A machine tool that uses electrical discharge between an electrode and the material to be machined. Sparks hit the material and remove tiny bits of metal, also called eroding. The part and electrode are submerged in a dielectric fluid. There are two general types of EDM machining: sinker EDM, where the electro resembles the negative image of the part, and wire-EDM, which uses a wire coming out of a spool as the electrode. Both EDM processes only work on electrically conductive materials. Sometimes this process is also referred to as spark machining or spark eroding.

## Electrical Engineer (EE)

Electrical Engineers generally design electrical systems, electrical components, computers, etc.

## Electron Beam Melting (EBM)

EBM is an innovative additive manufacturing (AM) process in which metal powder or filament is completely melted by a concentrated beam of electrons. Production in a vacuum chamber ensures that oxidation will not compromise highly reactive materials like titanium. Vacuum production is also required so electrons don't collide with gas molecules. Key advantages include build rates 3-5 times those of other AM technologies and the process is approximately 95% energy efficient.

## Electronic Data Interchange (EDI)

EDI is the electronic interchange of business information using a standardized format—a process that allows one company to send information to another company electronically rather than with paper.

## Electronic Design Automation (EDA)

Software tools used to develop integrated circuits and systems.

## Electroplating

Electroplating is a process that uses an electric current to dissolve metal from a cathode (positive charged ion) and place it on an anode (negatively charged ion) plate, coating it with the positively charged ion.

## Engineering Bill of Materials (EBOM)

A BOM organized according to CAD/EDA tool and engineers' preferences and processes. The EBOM represents only the physical product being engineered, not the packaging or manufacturing consumables. It often includes items for a single engineering discipline only, summarizing or excluding items from other disciplines.

## Engineering Change Notice (ECN)

An official notice that a change has been approved. Many companies use a formal ECN to ensure their CMs (contract manufacturers) and other manufacturing partners are building the right thing.

## Engineering Change Order (ECO)

Documentation that outlines a proposed change to a design, lists the product or part(s) that would be affected, and requests review and approval from the individuals who would be impacted or charged with implementing the change. ECOs are used to make modifications to components, assemblies, associated documentation, and other types of product information.

## Engineering Change Request (ECR)

A change request listing proposed improvements or problems with components or assemblies. An ECR may be a precursor to an ECO.

## Enterprise Integration (EI)

A broad implementation of information technology to link various functional units within a business enterprise; on a wider scale, it may also integrate strategic partners in an inter-enterprise configuration.

## Enterprise Resource Planning (ERP)

ERP refers to business management software. Typically, a suite of integrated applications that a company can use to collect, store, manage, and interpret data from many business activities, including product planning, cost, manufacturing, service delivery, marketing, sales, and human resources.

## Expert Systems

Software-based artificial-intelligence systems that capture the knowledge and experience of experts in a specialized field and make that expertise available to less-skilled personnel.

## Extranet

An exclusionary Internet-like network that securely connects customers and suppliers to a corporate or plant intranet in order to access information deemed sharable by the intranet operators.

## Extrusion

The product from the extrusion process, where material is pushed through a cross-section profile from the part. A raw billet of the material is placed in a press cylinder and heated to a material specific temperature, then a hydraulic ram/piston is pushed into the semi plasticized material, which forces the material through the cross-section image of the part (die), creating the shape/extrusion. Almost all material can be extruded.

## F

### Factory Acceptance Test (FAT)

A systems, machine, or project test at the place of manufacturing to ensure customer specifications are met before shipment or installation. If customer specifications are met, the equipment can be shipped to the customer. Many times, a second test is done at the place of install or use. Generally, the customer will sign off if all specifications are met. The test is done to the customer's functional requirement document (FRD), which is usually part of the contract agreement.

### Failure Mode and Effect Analysis (FMEA)

FMEA is methodology for analyzing potential reliability problems early in the development cycle when it is easier to take actions to overcome these issues, thereby enhancing reliability through design. FMEA is used to identify potential failure modes, determine their effect on the operation of the product, and identify actions to mitigate the failures.

### Fiber Laser

Laser technology where the active medium used is an optical fiber that has been doped in rare elements. The fiber being used is at the center of the laser machine.

### Fiberglass

A type of plastic material that is reinforced with a specialty glass fiber.

### Field Failure Request (FFR)

A change request that details a problem with the product as observed in the field.

## Finished Goods Turn Rate

A measure of asset management that typically is calculated by dividing the value of total annual shipments at plant cost (for the most recent full year) by the average finished-goods inventory value. Plant cost includes material, labor, and plant overhead.

## Finite Capacity Scheduling

Software-based systems that enable simulation of production scheduling (and determination of delivery dates) based on actual unit/hour capacity at each step in the production routing.

## Finite Element Analysis (FEA)

A mathematical method for analyzing stress. FEA is used in product-design software to conduct graphical on-screen analysis of a model's reactions under various load conditions.

## First Time Quality (FTQ)

The percentile of good units produced divided by the number of bad units (scrap and rework). The higher the FTQ, the better the total quality. See [Defective Part Per Million \(DPPM\)](#), [Statistical Process Control \(SPC\)](#), [Cpk](#), [Six Sigma](#).

## First-Pass Yield

The percentage of finished products that meet all quality-related specifications at a final test point.

## Fishbone/Ishikawa Diagram

The fishbone diagram uses a skeleton of a fish to document causes and effects and to develop improvement ideas.

## Fixture

A work holding device that is used to ensure a part is held securely in position or supported so it can be processed.

## Flexible Assembly Systems

Automated assembly equipment and/or cross-trained work teams that can accommodate a variety of product configurations in small lots.

## Flexible Machining Centers

Automated machining equipment that can be rapidly reprogrammed to accommodate small-lot production of a variety of product or component configurations.

## Flexible Manufacturing System (FMS)

Automated manufacturing equipment and/or cross-trained work teams that can accommodate small-lot production of a variety of product or part configurations. From an equipment standpoint, an FMS is typically a group of computer-based machine tools with integrated material handling that can produce a family of similar parts.

## Focused-Factory Production

A plant configuration and organization structure in which equipment and manpower are grouped to create essentially self-contained mini businesses, each with a specific product line or customer focus. A single plant may be divided into several focused-factory units, designed around process flows, each of which has control over such support activities as maintenance, manufacturing, engineering, purchasing, scheduling, and customer service.

## Foot Switch

A device that is placed on the floor and connected to a piece of equipment with an electrical wire. Once the foot switch is depressed by the operator, an internal electrical circuit is closed, sending a signal to the machine, and starting an operation cycle. Foot switches are used when operators need their hands free to perform other duties. In some cases, the operator needs to depress two foot switches to initiate the machine cycle. Foot switches can also be used to stop a cycle or open machine doors.

## Forecast/Demand Management Software

A class of software that provides front-end input to master production scheduling systems and helps optimize inventory planning. Such software not only considers historical demand trends, but also may calculate the impact of planned sales promotions, price reductions, and other factors that cause spikes in demand levels.

## Forging

A manufacturing process that involves heat and high force. The metal is heated to an orange red and then laid into a die where a ram or hammer (often power hammer) delivers a blow to shape the hot metal into the form of the die. Forging can help improve certain material properties like hardness and tensile strength.

## Form, Fit, and Function (FFF)

A description of an item's identifying characteristics. Form refers to the shape, size, dimensions, mass, weight, and other visual parameters that uniquely distinguish an item. Fit is the ability of an item to physically interface with, interconnect with, or become an integral part of another item. Function is the action or actions that an item is designed to perform. Changes in an item's form, fit, or function are typically considered significant enough to merit a new item number.

## Foundry

Produces metal castings by pouring heated and melted metal into molds. A mold is the opposite shape of the part (also called negative image/shape). Often, the molds are made of high-quality tool steel, allowing them to be used for thousands of shoots. If the mold is made of sand, the mold must be rebuilt for the next part.

## Functional Requirement Document (FRD)

A document with agreed-upon specification between the manufacturer and the customer. This document usually is part of the purchase agreement/order (PA/PO). It spells out in detail the requirements that the customer wants and is willing to pay for.

# G

## Gear

A round wheel with teeth. The teeth match another gear, allowing the transfer of rotation from one gear to another. If the outside circumference of the gears is different, a change of speed is noticed. Gears are drivers of shafts or splines.

## Good Manufacturing Practices (GMP)

A set of guidelines for how to manage each aspect of production and testing that can impact the quality of a product. GMPs are part of a quality system covering the manufacture and testing of active pharmaceutical ingredients, diagnostics, foods, pharmaceutical products, and medical devices.

## Grain

The longitudinal fibers in wood (direction of growth). In metal, it refers to the rolled or extruded direction.

## Gun Drilling

A process that produces straight deep holes in a variety of materials. A gun drill tool differs from a conventional drill by its unique head geometry, using a single effective cutting edge versus two or three.

## H

### Hand Drill

A portable hand-held drill in the shape of a pistol that is operated by battery or through a power cord. The drill has a chuck attached at the front, where the drill bit is held in place. The drill is then pushed into the part, removing material.

### Horizontal

A term used in machining to indicate the direction the spindle is mounted. A horizontal machine has the spindle perpendicular to a vertical line. See [Vertical](#).

### Hydrographic

A method of applying printed designs to three-dimensional surfaces. The result produces a decorative or applied art. This process is also known as hydro dipping, water transfer printing, and immersion printing.

## I

### Industrial Internet of Things (IIoT)

The extension of Internet of Things (IoT) in industrial sectors and applications. There is a strong focus on machine-to-machine (M2M) communication, big data, and machine learning. IIoT enables industries to have better efficiency and reliability in their operations. It encompasses industrial applications including robotics, medical devices, and software-defined production processes.

### Industry 4.0

A name given to the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of Things, cloud computing and cognitive computing. It is commonly referred to as the fourth industrial revolution.



## Injection Molding

Producing a part by injecting material into a mold. Material is heated and then moved with a screw toward the mold. Once the correct amount of molten material is ready, a hydraulic or mechanical system pushes the material into the mold. After the part cools to a stage where it will maintain the molded shape, the mold opens, and the part is ejected. You can injection mold a variety of materials, including aluminum, glass, elastomeric, thermoplastics, and thermosetting. Plastic injection molding is done at lower temperatures than metal and is one of the most common ways to produce plastic parts.

## In-Plant Defect Rate

The fallout rate in parts per million (ppm) of all components in manufacturing and assembly that fail quality tests at any point in the production process.

## Integrator

Integrators are companies that develop, design, and implement solutions for companies (manufacturers) with specific needs, mainly to make processes more efficient, cost effective, and/or reliable.

## International Organization for Standardization (ISO)

ISO is an independent non-governmental membership organization and the world's largest developer of voluntary international standards. The most commonly used certification standard in manufacturing is ISO9001-2015.

## International Traffic in Arms Regulations (ITAR)

A set of United States government import and export regulations. Manufacturers in the aerospace and defense industry and others that provide products to the U.S. military and government often must comply with ITAR.

## Internet of Things (IoT)

The network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity that enables these things to connect, collect, and exchange data.

## Intranet

A secure, internal, corporate Internet-based network.

## Inventory

Material, stock, or finished product that a business holds for production or sale.

## ISO 13485 (International Standards Organization 13485)

Quality system standards and guidelines for the development of medical devices.

## ISO 14000 (International Standards Organization 14000)

Standards and guidelines for environmental management systems.

## ISO 9000 (International Standards Organization 9000)

An international quality-process auditing program. Manufacturers that adhere to specified quality processes receive certification for complying with this standard.

## Item

A part, process, or document included in a manufacturer's product record.

## Item Master

List of all components that a manufacturer buys, builds, or assembles into its products. The item master includes information like size, shape, material, manufacturer, manufacturer part number, and vendor for each component.

## J

## Jig

A jig is a type of custom tool that is used to hold a tool or part in a set position. Jigs and fixtures are similar; however, fixtures are generally more complicated.

## Job Shop / Contract Shop

Contract or job shops are independent shops that compete for work from a wide variety of companies. These shops can be focused on one product family or very diversified and servicing a wide variety of industries. Some job shops are specialized into one or two fields, while other job shops can offer a wide variety of services.

## Jogging

Jogging is a manual override of a computer-controlled piece of equipment where a person takes control of the equipment and manually moves it to a desired position. The process is commonly used to find zero or set up new tools.

## Just-in-Time (JIT)

Have the product at the customer when needed, without inventory at the manufacturing facility. See [Lean Manufacturing \(Lean\)](#).

## Just-in-Time Hub (JIT Hub)

Product stored at locations close to the customer to ensure customer doesn't run out of parts. Generally used when shipping distances are large or due to possible customs import restrictions.

## K

### Kanban

Refers to a visual inventory system in which a card is placed before the last part. Once the part before the card is pulled, the card is given to purchasing to reorder more stock/parts. The card has all the part information on it. Kanban is the simplest form of inventory control and has its roots in how supermarkets are stocked.

### Key Performance Indicator (KPI)

Refers to a series of indicators/metrics that are used in business metrics to evaluate critical business performance, such as defective parts per million (DPPM), scrap, n-time delivery (OTD), cost of goods manufactured, etc. KPIs are used to drive goals and growth and can also be used to benchmark businesses within the same category.

## L

### Labor Turnover Rate

A measure of a plant's ability to retain workers, expressed as a percentage of the production workforce that annually departs, regardless of reason (layoff, quit, retirement, buyout, transfers, etc.). High turnover rates often indicate employee dissatisfaction with either working conditions or compensation.

## Lathe

A machine tool that rotates the work piece on its longitudinal axis to perform a variety of operations using a cutting tool. There are manual lathes, CNC lathes, and screw machines. Lathes are found in a wide variety of industries from metal and wood to plastics, as well as in tool and die shops.

## Lean Manufacturing (Lean)

A systematic approach to reducing waste within the manufacturing process. Lean manufacturing is the key strategy to run any business efficiently and without waste. See [5S](#), [Kaizen](#), [Just-in-Time \(JIT\)](#), [Kanban](#).

## Lights-Out Manufacturing

Lights-out manufacturing is a methodology, rather than a specific process. Factories that run lights out are fully automated and require no human presence on-site. Thus, these factories can run with the lights off.

## M

### Machine Availability Rate

The percentage of time that production equipment is available for use, divided by the maximum time it would be available if there were no downtime for repair or unplanned maintenance.

### Machine Learning

A method of data analysis that automates analytical model building. It is a branch of artificial intelligence (AI) based on the idea that systems can learn from data, identify patterns, and make decisions with minimal human intervention. See [Artificial Intelligence \(AI\)](#).

### Machine Vision

Optical systems in which video equipment is used to guide robotic or automated equipment during production operations; also, computerized visual inspection systems used for quality control.

## Machine-to-Machine (M2M)

Refers to direct communication between devices using any communications channel, including wired and wireless. An example is instrumentation enabling a sensor or meter to communicate the data it records to application software that can use it.

## Machining Center

A term that describes nearly any CNC milling and drilling machine. On a machining center, the tool rotates, but the work does not. See [Computer Numerical Control \(CNC\), Mill](#).

## Made-to-Spec

Describes an item that is made to a company's specifications internally or by a supplier.

## Management by Walking Around (MBWA)

MBWA refers to management wandering around in a random way to check on employees, processes, and equipment to see the actual status of things. MBWA should trigger improvement ideas.

## Manufacturing Bill of Materials (MBOM)

A BOM organized into subassemblies that reflect the manufacturing process. The MBOM represents the physical product, packaging, and included documentation. It contains all components required to build the product, including made-to-spec, off-the-shelf, mechanical, electrical, software, and firmware.

## Manufacturing Change Order (MCO)

A change order used to make a manufacturing change. This typically does not involve a design change to the item. An example is a change to the approved manufacturer list (AML) or a change in the manufacturing processes used to produce a part. If an MCO does require a design change, it is often accompanied by an ECO.

## Manufacturing Change Request (MCR)

A change request used to propose a manufacturing change that does not require a design change to an item. An example is a change to the approved manufacturer list (AML).

## Manufacturing Cost

Includes quality-related costs, direct and indirect labor, equipment repair and maintenance, other manufacturing support and overhead, and other costs directly associated with manufacturing operations. It does not include purchased-materials costs or costs related to sales and other non-production functions.

## Manufacturing Cycle Time

The time of actual production from when a customer order is released to the plant floor for a product through the completion of all manufacturing, assembly, and testing for that specific product. (Does not include front-end order entry time or engineering time spent on customized configuration of nonstandard items, or time in finished goods inventory.)

## Manufacturing Deviation

A temporary change in production or a manufacturing procedure. An example is the use of a substitute part. Deviations may be planned or unplanned.

## Manufacturing Execution System (MES)

Factory MES track and document the transformation of raw materials through finished goods. MES is real-time, provides the right information at the right time, and shows the manufacturing decision maker how the current conditions on the plant floor can be optimized. MES controls multiple elements of the production process (e.g., inputs, personnel, machines, and support services). Many companies connect MES to ERP systems. See [Enterprise Resource Planning \(ERP\)](#).

## Manufacturing Part Number (MPN)

A unique number assigned to each part. The MPN is stored in the BOM and MRP system. The number has all the details and information for that specific part. Information includes drawing number, revision level, material, manufacturing process, cost, if it is ordered from a vendor or internally manufactured, etc. An MPN serves a similar purpose as a vehicle's VIN. See [Bill of Material \(BOM\)](#), [Material Requirement Planning \(MRP\)](#).

## Manufacturing Work Instructions (MWI)

Information and directions on how to perform a manufacturing task.

## Markup

A document, such as a redlined drawing, that has annotations indicating recommended changes to a file.

## Material Requirement Planning (MRP)

MRP is a production planning, scheduling, and inventory control system used to manage manufacturing processes. MRP systems manage the material flow from order release through purchasing, stocking, manufacturing, and shipping. MRP systems can be standalone systems; however, they are often integrated into a company's ERP systems. See [Enterprise Resource Planning \(ERP\)](#), [Manufacturing Execution System \(MES\)](#).

## Material Safety Data Sheet (MSDS)

Document used to provide workers and emergency personnel with procedures for safe handling and working with substances. All material within a manufacturing plant should have an MSDS. MSDS are now called SDS (Safety Data Sheets). See [Safety Data Sheets \(SDS\)](#).

## Mean Time Between Equipment Failure

The mean (or average) time in hours expected between failures of a given device.

## Mechanical Engineering (ME)

Mechanical engineering applies engineering physics, engineering mathematics, and materials science principles to design, analyze, manufacture, and maintain mechanical systems. They are a key resource within manufacturing.

## MIG Welding

Metal inert gas (MIG) uses a consumable metal electrode to join two materials with a shielding gas.

## Mill

A machine tool that rotates and removes material from a work piece. Machines can be manual or CNC operated and controlled. Mills are found in a wide variety of industries, including metal, wood, and plastics, as well as in tool and die shops. See [Computer Numerical Control \(CNC\)](#), [Machining Center](#).

## MRP II

Software-based manufacturing resources planning systems that translate forecasts into master production schedules, maintain bills of material (lists of product components), create work orders for each step in the production routing, track inventory levels, coordinate materials purchases with production requirements, generate exception reports identifying expected material shortages or other potential

production problems, record shop-floor data, collect data for financial reporting purposes, and other tasks depending on the configuration of the MRP II package.

## Multi-Level BOM

A BOM that captures how multiple sub-assemblies come together to produce a final product. It can be visualized as a nested list whose parts or items are listed in two or more levels of detail. See [Bill of Material \(BOM\)](#).

## N

### NAICS

The North American Industry Classification System (NAICS) is a coding system of the U.S., Mexican, and Canadian governments that identifies specific economic sectors. It replaces the U.S. Standard Industrial Classification (SIC) system. Coding for most manufacturers encompasses the 6-digit subsets of numbers that begin with 31 through 33.

### National Institute for Occupational Safety and Health (NIOSH)

A division of the Center for Disease Control (CDC) that provides research and recommendation to prevent work-related injuries. In many cases, NIOSH provides OSHA with recommendations and advice. See [Occupational Safety and Health Administration \(OSHA\)](#).

### New Product Development (NPD)

The overall process of conceptualizing, designing, planning, and commercializing a new product. NPD is frequently referred to as product development.

### New Product Development Process (NPD Process)

A disciplined and defined set of tasks and steps that describes the normal means by which a company repetitively converts embryonic ideas into salable products or services.

### New Product Introduction (NPI)

The market launch or commercialization of a new product. NPI takes place at the end of a successful product development project.



## Nut

A part with a cylindrical helical internal thread. Is used with a screw. See [Screw](#).

## O

### Occupational Safety and Health Administration (OSHA)

The U.S. Department of Labor (DOL) agency in charge of establishing, monitoring, and enforcing workplace and worker safety policies, regulations, and administration. See [Department of Labor \(DOL\)](#), [National Institute for Occupational Safety and Health \(NIOSH\)](#).

### Offshoring

Manufacturing operations are moved from the domestic country to another country where labor is cheaper. See [Reshoring](#).

### Off-the-Shelf

Products or components that are ready-made and available for sale or do not require any additional processing to complete.

### On-the-Job Training (OJT)

Training that is completed at the workplace, the task, or area where they will be working.

### On-Time Delivery (OTD)

A metric measurement that tracks the % or \$ value of product that is received by the customer at the agreed upon delivery time. This can be part of the overall KPI. See [Key Performance Indicator \(KPI\)](#).

### Online Order Entry System

A computer-based system that enables distributors, field-sales representatives, and even customers to place orders directly, over the Internet or a corporate intranet, without intervention by an inside salesperson. An Internet-based transaction might be initiated by accessing a web page, then choosing a sales-order entry option. The software often includes a product configurator and pricing engine and may be linked to production scheduling systems.

## Operation Dynamics Integrator

Operations dynamics integrators perform the same work as integrators but take it one level further, like integrating a whole plant or the complete process of a product line, like automotive assembly. Many large companies have in-house operation dynamics integrators and get them involved early in new product development to ensure the most effective and efficient machine setup is implemented at production start. See Integrators/ Machine Solution/Integration.

## Order Fill Rate

Annual sales orders filled completely divided by the total annual number of sales orders.

## Original Equipment Manufacturer (OEM)

OEM refers to the company that has its name on the product. An example would be a car company like Ford. They do not make all the parts, but they developed and designed the car and manufacture some of the parts.

## OSHA-Reportable Incident Rates

Should be calculated as the number of injuries (N) divided by total hours worked by all employees in a calendar year (EH) multiplied by 200,000 (base for 100 equivalent full-time employees working 40 hours per week, 50 weeks per year):  $(N \text{ divided by } EH) \times 200,000$ . A separate calculation must be made for more serious injuries and illnesses that result in employees taking time off from their jobs, being transferred to another job, or performing lighter or restricted duties.

## Output

The number of parts produced during a given time. Used sometimes as part of KPI metrics. See [Key Performance Indicator \(KPI\)](#).

## Overall Equipment Effectiveness (OEE)

OEE measures the gap between optimal and actual performance. OEE measures the availability of equipment, the performance of cycle time, and quality. It is the only performance indicator that shows losses in a variety of areas. When used correctly, it is a great indicator for benchmarking.

## Overhead Crane (Bridge Crane)

Overhead cranes travel on rails mounted parallel to the ground above the manufacturing floor. They have a winch-style lift device that lifts parts up and down. The crane can also be moved along the rails to move parts from one area of the

building to another. Overhead cranes can range in capacity from a few hundred pounds to many thousands of tons.

## P

### Parent Item

Describes an item that contains another item (i.e., a child item) in its bill of materials. An assembly-component or assembly-subassembly relationship can be described as a parent-child relationship.

### Part Name

A unique name assigned to a part.

### Part Number

A unique numerical value assigned to a part.

### Passivation

Passivation is a process that places a controlled oxide layer on the surface of metal to prevent spontaneous and natural oxidation (normal corrosion). Many stainless-steel parts are passivated, giving them a gray no-shine surface.

### Pendant

A control or teach box attached to a robot or similar device. The pendant is used by the operator or programmer to move the robot and teach positions.

### Personal Protective Equipment (PPE)

Consists of a variety of wearable clothing, hearing, and visibility items that protect an employee from hazards or danger. Many times, OSHA requires PPE to ensure employees do not get injured. See [Occupational Safety and Health Administration \(OSHA\)](#).

### Pick-to-Ship Cycle Time

The period from when an order is released to be picked until the time the order has shipped.

## Plan—Do—Check—Adjust (PDCA)

PDCA is a repetitive four-step management method used in business for the control and continuous improvement of processes and products. It is also known as the Deming circle/cycle/wheel or Shewhart cycle/control.

## Planer

A machine tool used to produce flat surfaces by scrapping material off. This can be a hand-held tool or a standalone machine the material is fed into. Planers are mostly used in wood processing, but they can be used in metal manufacturing as well.

## Planned/Scheduled Downtime (PDT)

Time that has been scheduled to shut down equipment to perform maintenance, clean, or change the setup of the equipment.

## Planning and Scheduling Technologies

A variety of software-based advanced planning, scheduling, and optimization systems.

## Plasma Cutter

A machine tool that uses ignited gas to generate a torch-like flame that will cut through metal. It is primary used in fabrication shops.

## Plating

Applying a thin layer of metal to another metal through the galvanic process using electrodes. With advanced plating technologies, even plastic parts can be metal plated.

## Poka-Yoke

A Japanese word meaning error proofing. It is used to describe an improvement processes to machines or systems to make them fool proof, eliminating any chance of a person getting hurt, equipment getting damaged, or processes making bad parts.

## Powder Painting/Coating

A process that uses positively charged paint powder. The powder is sprayed by hand or robot onto a negatively charge material. Then the part is cured in a heated oven.

## Predictive Maintenance (PdM)

Maintenance technique designed to help determine the condition of in-service equipment in order to estimate when maintenance should be performed and reduce the likelihood of equipment failures. See [Preventative Maintenance](#).

## Premium Freight

Air or other expedited shipment method that increases the standard cost of filling a customer order.

## Prevention Through Design

Refers to an effort to eliminate or reduce the risk of injury, illness, or accidents by designing them out before the processes, products, equipment, or machines are manufactured or used. It is commonly referred to as safety by design.

## Preventative Maintenance (PM)

Maintenance activities, often performed by machine operators at regularly scheduled intervals, to keep equipment in good working condition. See [Predictive Maintenance](#).

## Printed Circuit Board (PCB)

A board with electrical circuits and other electrical components attached. The board is manufactured by applying a thin copper film to a non-conductive substrate (usually made of epoxy/phenolic reinforced with fiberglass). Then the board is chemically etched and covered with a nonconductive layer. Next additional components like diodes or capacitors, relays, or other can be brazed or soldered onto the board. The boards are part of electrical circuits of machinery, computers, and cell phones.

## Proactive Environmental Practices

The efforts of plant management to adopt, at its own fiscal and chronological pace, leading-edge environmental practices that reduce pollutants, emissions, etc., prior to regulatory actions that necessitate these practices.

## Process Manufacturing

The manufacture of products such as chemicals, gasoline, beverages, and food that are produced in batch quantities rather than discrete units. Many process operations require inputs such as heat, pressure, and time (for thermal or chemical conversion).

## Procurement Type

Describes how a part is bought or made, typically OTS (off-the-shelf) or MTS (made-to-specification). In some cases, the part may be built in house or outsourced from a vendor.

## Product Data Exchange (PDX)

An iNEMI (international electronics manufacturing initiative) standard. PDX is an open XML (extensible markup language)-based standard allowing organizations to access their data directly, even using their own XML-based applications/tools. PDX is commonly used throughout the design and supply chain to deliver the multi-level BOM, AML, recent change history, and supporting design files zipped in a single file.

## Product Data Management System (PDMS)

Also referred to as a work in progress (WIP) vault or file repository. A PDM system is used to hold mechanical CAD files, including parts and assembly models, as well as drawing files.

## Product Lifecycle Management (PLM)

The management of the product record, including bills of materials, specifications, revisions, and changes, from prototype through end-of-life.

## Product Record

A general term that describes all design, manufacturing, quality, sales, and repair information about a product.

## Product-Development Cycle

Refers to the process of taking a product or service from conception and design to manufacturing, marketing, and sales. See [New Product Development \(NPD\)](#), [New Product Development Process \(NPD Process\)](#), [New Product Introduction \(NPI\)](#).

## Production Control Board (PCB)

A board placed in the cell or workstation that tracks hourly, daily, or weekly output. The output is written on the PCB in green if the goal is met. If the goal is missed, the number is written in red. The cell leader or shop floor supervisor monitors the PCB and addresses any issues with the cell/team. All issues that prevented goals from being met need to be documented on the board.

## Production Part Approval Process (PPAP)

The PPAP process is designed to demonstrate that the component supplier has developed their design and production process to meet the client's requirements, minimizing the risk of failure by effective use of Advanced Product Quality Planning (APQP). Many large companies today will not use a supplier that has not provided PPAP documentation.

## Productivity Change

The plantwide change in annual value added per employee, based on total employment in the plant, not just direct labor. Value added should be calculated by subtracting cost of purchased materials, components, and services from value of shipments.

## Programmable Logic Controller (PLC)

Digital programmable computers that are used to communicate with automated equipment or machines sending or receiving analog or digital signals to ensure equipment is performing as expected.

## Prototype

An engineering-quality sample build of a product typically intended to test high-risk aspects of the design.

## Pull System

A system for controlling work flow and priorities where the processes needing materials (or attention) draw them from the feeding processes or storage areas as needed, typically using Kanban signals, in contrast to push systems in which material is processed then pushed to the next stage whether it is really needed. See [Kanban](#).

## Punch/Stamping Press

A press, manual or CNC operated, that holds one or more dies (progressive stamping) that by closing (collapsing) pushes a tool and die into the metal to achieve the desired cut or shape. Some presses can reach 1200-2000 strokes per minute (super high speed). Parts like car fenders, silverware, brackets, and hinges are stamped.

## Purchase Agreement (PA)

A legal contract between the seller and buyer, authorizing and specifying the purchase of product, delivery times, quantities, and other specifications. See [Purchase Order \(PO\)](#).

## Purchase Order (PO)

A written or electronic document requesting or authorizing the shipment or manufacturing of a part. See [Purchase Agreement \(PA\)](#).

## Q

### QS 9000

A common quality certification program for auto industry suppliers that includes ISO 9000 as a baseline.

### Quality Assurance (QA)

QA ensures you are doing the right things the right way, following established processes, procedures, and protocol. QA monitors processes and procedures, does data analysis (SPC), and performs audits.

### Quality Control (QC)

QC ensures that the results of what you have done are what is expected. They are checking parts on an ongoing basis and verifying things are in control, preventing non-conforming product from leaving the facility.

### Quality Engineering (QE)

A quality discipline that deals with the analysis of a manufacturing system at all stages to improve the quality of a production process and its output. QE works with in-house resources as well as customers to understand and improve quality.

### Quality Function Deployment (QFD)

A customer-focused approach to quality improvement in which customer needs (desired product or service characteristics) are analyzed at the design stage and translated into specific product- and process-design requirements for the supplier organization. Targeted customer needs may include product features, cost, durability, and other product characteristics.

### Quality Management System (QMS)

Documents all aspects of a company's design and operational controls, including monitoring, issue reporting, continuous improvements, and training, to ensure product design and manufacturing have statistically in-control repeatable product deliveries.



## Quick-Changeover Methods

A variety of techniques, such as SMED (single-minute exchange of dies), that reduce equipment setup time

## R

### Radio-Frequency Identification (RFID)

RFID is the wireless use of electromagnetic fields to transfer data for the purposes of automatically identifying and tracking parts by attaching tags to the objects. The tags contain electronically stored information. Many large companies have RFID tags on their in-house inventory to track location and movement of the inventory providing them with real-time information.

### Rapid Continuous Improvement (RCI)

A short (1-3-day) event to improve a specific operation or process or to eliminate a bottle neck within an operation. A team of people from within the area for improvement as well as from other disciplines is put together with a specific request to improve or eliminate an issue. See [Lean Manufacturing \(Lean\)](#).

### Rapid Prototyping

A quick way to manufacture a model of a part or an assembly using a 3D printer. The printer uses a CAD file and a resin or plastic to create the part. This allows manufacturers to have a real part in hand for testing or the customer. Some rapid prototyping is done with CNC machining centers that make the part out of the actual material.

### Raw Material

Raw material refers to unprocessed materials a manufacturer purchases and then uses within their process or product.

### Raw Materials Turn Rate

A measure of asset management that is typically calculated by dividing the value of total annual shipments at plant cost (for the most recent full year) by the average raw-material value at plant cost. Plant cost includes material, labor, and plant overhead.

## Real-Time Feedback

Instantaneous (or nearly instantaneous) communication of electronically captured data (typically quality data) to process operators or equipment to enable rapid or automated adjustments that keep production processes operating within quality parameters.

## Redline

The marking of an assembly drawing or bill of materials (BOM) to indicate a modification.

## Reference Designator

An alphanumeric code that gives the physical location of a component on a PCB (printed circuit board). A code for each part is listed on the bill of materials and physically printed on the PCB so the manufacturer knows where to place all the components.

## Requirement

References the standards against which companies measure their products. A requirement could be a government regulation regarding environmental or safety concerns, or any internal standard.

## Reshoring

The act of reintroducing domestic manufacturing to a country. It is the reverse process of offshoring. See [Offshoring](#).

## Respirable Crystalline Silica

Crystalline silica is found in many materials like clay, sand, stone, and cement. During processing, particles can become airborne in the form of dust or small pieces, which can cause cancer when inhaled. OSHA regulates the exposure of employees as of January 2019.

## Retooling (Retool)

Retooling is when current tooling within a machine, equipment, or assembly line is swapped out for new tooling. This happens often when product or model changes happen.

## Return Material Authorization (RMA)

A financial and work order tracking key to identify a returned item's origination that is used in a transaction in which a customer returns goods to a manufacturer, often to have them repaired or replaced. See [Supplier Corrective Action Request \(SCAR\)](#).

## Return on Invested Capital (ROIC)

A measure of how effectively a company uses the money (borrowed or owned) invested in its operations. ROIC = net operating profit after taxes (NOPAT) divided by total capital invested.

## Return on Investment (ROI)

ROI measures the efficiency of an investment or compares investments to each other. It is a measure that shows the financial return on money invested into new equipment, expansion of production, or upgrades of needed items.

## Revision Control

The process of tracking and documenting changes to a product, part, process, program, design, or document.

## Rework

Parts that do not meet internal or external requirements, but can be used after additional processing (saved, at extra processing cost). Lean manufacturing principles are applied to reduce or eliminate rework before it happens.

## Robot

In manufacturing, a robot is a machine or mechanical device that can perform simple to complex tasks with high repeatability. Robots can only perform work they have been programmed to perform. Most industrial robots are stationary and mounted to the floor or machinery. See [Cobot](#).

## Rockwell Hardness Test

The Rockwell hardness test uses either a 1/16" diameter or a 1/8" diameter steel ball or a 120-degree diamond cone probe to measure hardness. The probe is placed with a set preload on the metal, then the load is increased and the difference between the pre-load and final load indentation is measured and compared and read by the instrument. The diamond probe can be used to measure the hardest materials, as diamond is the hardest material on earth. The steel probes are limited in hardness testing. See [Brinell Hardness Tester](#), [Vickers Hardness Test](#).

## Rolled-Throughput Yield

Also known as multiple-point yield, this measure is calculated by multiplying together quality yield values at various points in a production process, not only at the end of the line. The purpose is to make problem areas within a process more visible.

## Router Machine/Handheld

A machine tool that has a rotation motor with spindle. The spindle has a chuck that a tool can be clamped within. The tool spins at high rpm (rotation per minutes). The part is placed on a table and clamped and moves in and out of the router. The motor and cutting tool move up and down as well as sideways. Routers can be manual, or CNC operated. Routers are very common machine tools found in the wood industry and sheet metal shops.

## S

### Safety Data Sheets (SDS)

Document used to provide workers and emergency personnel with procedures for safe handling and working with substances. All material within a manufacturing plant should have an SDS. SDS used to be called MSDS. See [Material Safety Data Sheet \(MSDS\)](#).

### Safety-Improvement Programs

Practices intended to improve safety within a plant or across a company, including safety teams, safety awareness programs and communications, safety days, safety training, and setting of continuous-improvement goals targeting safety metrics, such as OSHA incidents or lost-workday rates.

### Sales and Purchase Agreement (SPA)

A legal contract between the seller and buyer. The document usually has a PO or PA attached with detailed requirements and specifications. See [Purchase Order \(PO\)](#), [Purchase Agreement \(PA\)](#).

### Scrap

Bad parts, not meeting internal or external requirements, that cannot be reworked or used and need to be discarded. Scrap is expensive as you not only lose the worktime and the material cost, but you need to remake a new part.

## Screw

A shaft with a raised cylindrical helical thread around the perimeter that is used to create a connection that can be easily separated. It is also reusable. See [Nut](#).

## Screw Machine

A lathe that is mechanically automated to manufacture parts via a cam system. Generally used for very high-volume production of small and medium size parts, like screws, pins, and nuts.

## Scrubbing

Used in the phrase “scrubbing a BOM” to describe the process of confirming that all aspects of a bill of materials (BOM) are documented accurately in the appropriate control systems and verifying the BOM represents a manufacturable assembly.

## Shaper

A machine tool that uses linear motion to remove material by pushing a single point tool over the part. Shapers were very common in use even by the end of the 1970s but have been mostly replaced by CNC milling machines due to their versatility and speed. However, many small wood shops still use shapers.

## Shear Strength

Shear strength is a measurement (in megapascal, Mpa, or pounds per square inch, PSI) that represents the force needed to try to cut into a material before it breaks. Many materials have great tensile strength but low shear strength. See [Tensile Strength](#).

## Shop-Floor Data Collection

Automated collection of data on factory-production activities, including units produced, labor hours per unit or customer order, time and date of specific production activities, and maintenance and quality data.

## Single Minute Exchange of Die (SMED)

Used in lean manufacturing as a measure for changeover or setup times, it refers to having changeover time reduced to a single minute. SMED is used to reduce manufacturing downtime during retooling or setup switchover. See [Retooling \(Retool\)](#), [Lean Manufacturing \(Lean\)](#).

## Single-Level BOM

A document or file that only shows the components or parts needed for that assembly. See [Bill of Material \(BOM\)](#).

## Six Sigma

Six sigma is a disciplined, data-driven approach and methodology for eliminating defects (driving toward six standard deviations between the mean and the nearest specification limit) in any process, from manufacturing to transactional and from product to service. If you are six sigma, your defect rate is 3.4 parts per million. See [Three Sigma Standard Deviations](#), [Defective Part Per Million \(DPPM\)](#), [Lean Manufacturing \(Lean\)](#).

## Spot Welding

Welding technique that joins metal pieces through several separate points.

## Spray Painting

A process that uses a device that sprays liquid paint onto a part. Generally, the liquid paint is pulled out of a paint reservoir by blowing high speed air through a small orifice in a spray gun. The high-speed air creates a negative pressure in the paint hose, pulling the paint up and depositing it on the part.

## Stamping/Pressing

The process of placing a flat or coil piece of metal into a stamping press, where a tool and die forms or cuts the metal into the desired shape. Stamping dies are placed in presses, hitting the material hard with high force and speed until it displaces or is cut through the material.

## Standard Operating Procedure (SOP)

A written document or instruction detailing all steps and activities included in a process or procedure.

## Statistical Process Control (SPC)

A method of quality control that uses statistical method. SPC is applied to monitor and control a process. Monitoring and controlling the process ensures that it operates at its full potential without causing bad parts.

## Stock Keeping Unit (SKU)

A unique sales stock identifier usually controlled by the business side of a company. A SKU is generally disassociated from the engineering definition and engineering change controls for a product.

## Subassemblies

A smaller unit that has been assembled, in-house or by a sub-contractor, and will be part of a large assembly/finished product.

## Sub-Contractor

An outside contractor that performs work on a product.

## Supplier Corrective Action Request (SCAR)

A change request that describes an issue with a part, process, or component from a supplier and asks for a resolution. A SCAR sometimes includes details about how the complaint should be addressed.

## Supplier Partnerships

Agreements with suppliers whereby operations are linked together, information is openly shared, problems and issues are commonly solved, and joint performance is mutually approved. They usually include multiyear purchase agreements.

## Supply-Chain Management

A class of manufacturing software designed to optimize scheduling and other activities throughout the supply chain or value chain, including transportation and distribution functions. Also known as a logistics system.

## T

## Takt Time

The average time it takes to produce a product at the rate the customer needs it. Takt time is measured from the start of the first operation to the end of the last operation. Cycle time is part of takt time. See [Cellular Manufacturing](#), [Work in Progress \(WIP\)](#), [Cycle Time](#).

## Temperature Controlled Rooms

Large areas that have a microclimate established and maintained to ensure product or areas are not impacted by humidity and/or temperature changes. You find temperature controlled rooms/areas in food processing, IT server rooms, and other manufacturing areas.

## Tensile Strength

A measured force that is needed to pull a material apart.

## Three Sigma Standard Deviations

If data distribution is approximately normal, then about 68% of the data values are within one standard deviation of the mean (mathematically,  $\mu \pm \sigma$ , where  $\mu$  is the arithmetic mean), about 95% are within two standard deviations ( $\mu \pm 2\sigma$ ), and about 99.7 percent lie within three standard deviations ( $\mu \pm 3\sigma$ ), meaning that 99.68% of your product is good. Three sigma equals a defect rate of 66,800 bad parts per million. See [Six Sigma](#), [Statistical Process Control \(SPC\)](#).

## Throughput

The amount of parts or material that has passed through the process. Also used in KPI metrics to measure increase in throughput or decrease. Throughput impacts on-time delivery as well as total parts manufactured. See [Key Performance Indicator \(KPI\)](#).

## Tier 1 Manufacturer

Manufacturer that offers the most advanced processes in the supply chain. This is the final step before the product reaches the original equipment manufacturer (OEM) who may complete the product or distribute. These companies must generate reliable components on time and with strict adherence to safety and standards procedures.

## Tier 2 Manufacturer

The suppliers who are usually limited in what they can produce. These companies are usually smaller and have less technical advantages than tier 1 companies. Tier 2 manufacturers must be rigorous in safety and standard compliance.

## TIG Welding

Tungsten inert gas (TIG) uses a non-consumable tungsten electrode to generate the heat with shielding gas, like argon or helium, to prevent the weld from oxidation/corroding during welding.



## Time to Market (TTM)

The period from development of a product concept to availability of the finished product. It starts when a development project has been agreed to and resources have been committed and ends when the final product is shipped to customers.

## Time-Weighted Average (TWA)

A measurement that OSHA uses to establish threshold limits for workers who are exposed to hazards. If the TWA is exceeded, additional equipment like PPE needs to be provided by the employer. See [Occupational Safety and Health Administration \(OSHA\), Personal Protective Equipment \(PPE\)](#).

## Title 21

Code of Federal Regulations that deals with the Food and Drug Administration (FDA) guidelines on electronic records and electronic signatures in the United States. Defines the criteria under which electronic records and electronic signatures are trustworthy, reliable, and equivalent to paper records.

## TL 9000

A quality system certification program developed by the Quality Excellence for Suppliers of Telecommunications Leadership Forum for the telecommunications industry. The requirements include the ISO 9000 family of standards as a baseline but add specific performance metrics and a formal benchmarking mechanism.

## Torsion Strength

The measured force that a material can withstand before rupturing when twisted perpendicular to its axis.

## Total Cost of Quality

The aggregate cost of poor quality or product failures, including scrap, rework, and warranty costs, as well as expenses incurred to prevent or resolve quality problems (including the cost of inspection).

## Total Logistics Costs

Total costs for inbound delivery and storage of material and parts, plus the total cost to store, transport, and deliver (and possibly set up) product to the customer following final manufacture and assembly.

## Total Productive Maintenance (TPM)

A comprehensive program to maximize equipment availability in which production operators are trained to perform routine maintenance tasks on a regular basis, while technicians and engineers handle more specialized tasks. The scope of TPM programs includes unscheduled maintenance prevention (through design or selection of easy-to-service equipment), equipment improvements, preventive maintenance, and predictive maintenance (determining when to replace components before they fail).

## Total Quality Management (TQM)

A multifaceted, company-wide approach to improving all aspects of quality and customer satisfaction, including fast response and service, as well as product quality. TQM begins with top management and diffuses responsibility to all employees and managers who can have an impact on quality and customer satisfaction.

## Toyota Production System (TPS)

This system organizes manufacturing and logistics for the manufacturer, including every interaction with its suppliers and customers. Considered to be the precursor to what is now known as lean manufacturing. See [Lean Manufacturing \(Lean\)](#).

## Transitional Work Program

A proactive approach to aiding employees who remain working or return to work when a medical condition or disability interferes with their ability to perform job duties and functions.

## Turning

A machining process used to make cylindrical parts, where the cutting tool moves in a linear fashion while the workpiece rotates. Commonly performed with a lathe, turning reduces the diameter of the workpiece, typically to a specified dimension, and produces a smooth part finish.

## Two-Hand Switch

A switch or pushbutton that the operator needs to depress to close an electrical or air circuit, which will then operate the machine or start a process. Many times, two-hand switches are placed at a press, requiring the operator to use both hands to activate the press, which is a safety feature ensuring the operator's hand(s) are outside the machine, preventing bodily harm and injury. See [Foot Switch](#).

## U

### Unit of Measure (UOM)

Describes how manufacturers use or buy a part. The most common UOM is each, but standard measures like feet, inches, pints, drops, boxes, etc. can also be used.

### Unplanned Downtime (UDT)

When equipment stops operating due to breakdown or malfunction.

### Unscheduled Downtime

When equipment is shut down due to failure, breakage, or lack of orders and material.

## V

### Value Stream Mapping (VSM)

Value Stream Mapping is a lean-management method for analyzing the current state and designing a future state for the series of events that take a product or service from its beginning through to the customer. VSMs are used to generate Kaizens or RCI, which are then used to generate ideas to remove waste from the value stream.

### Vendor-Managed Inventory

Instead of a customer ordering inventory when supply has been depleted, suppliers are responsible for replenishing the stock to appropriate levels. Large amounts of data specific to processes and inventory are shared between both parties. See [Lean Manufacturing \(Lean\)](#).

### Vertical

A machining term to indicate the direction the spindle is mounted. A vertical machine has the spindle perpendicular to a horizontal line. See [Horizontal](#).

### Vice

A work holding device that is either mechanically, hydraulically, pneumatically, or otherwise operated to open and close jaws. The jaws hold parts securely, so they can be processed or machined.

## Vickers Hardness test

Uses a diamond that is in the form of a squared pyramid base that is then pressed into the material and the plastic deformation is then converted to a hardness number. See [Brinell Hardness Tester](#), [Rockwell Hardness Test](#).

## Virtual Reality (VR)

An interactive computer-generated experience taking place within a simulated environment. The immersive environment can be like the real world or it can be fantastical.

## Vision Systems

Also called machine vision, vision system is a technology used to provide imaging-based inspection and analysis for process control and robot guidance. For example, if a product coming through the packaging line has a defect, the vision system can recognize the defect and notify the operator of the issue. Robots can also use vision systems to recognize objects for sorting, picking, and other tasks.

# W

## Walk-in Cooler

An enclosed storage space refrigerated to temperatures above, at, or below 32 degrees Fahrenheit that can be walked into.

## Water Jet

A machine tool that uses high water pressure and an abrasive to cut through a wide variety of materials. Water jets are CNC controlled and one of the few machine tools that can cut virtually any material.

## Welding

Joining metal pieces or parts by heating the surfaces to the point of melting using a blowtorch, electric arc, or other means, and uniting them by pressing, hammering, etc.

## WIP Turn Rate

A measure of the speed with which work-in-process moves through a plant. Typically calculated by dividing the value of total annual shipments at plant cost (for the most recent full year) by the average WIP value at plant cost.

## Work in Progress (WIP)

A production and supply-chain management term describing partially finished goods awaiting completion. WIP refers to the raw materials, labor, and overhead costs incurred for products that are at various stages of the production process.

## World Class Manufacturing

World class manufacturing (WCM) is a methodology that focuses on eliminating waste, increasing productivity, and improving quality and safety in a systematic and organized way. WCM engages the workforce to provide and implement suggestions on how to improve their jobs and their plants, promoting a sense of ownership.

## X

## Y

## Yield Improvement

Defined as the percentage reduction in rejects within a five-year period. Example: If yield improves from 95% to 98%, that means rejects have been reduced by 60% -- from 5% to 2%. Therefore, yield improvement equals 60%.

## Yoke

A metal piece commonly found on drive trains. The yoke has a long piece with splines, that are driven by a shaft. The yoke has a knuckle on the end that connects to another yoke and then to a spline shaft to change rotational direction.

## Z

