

## GLOSSARY

Below are working definitions referenced by Best Plants applicants in 2015:

**Absenteeism:** (Actual hours lost through unscheduled job absence ÷ actual hours worked ) x 100. Include all unscheduled absences during normal work hours, including scheduled overtime.

**Activity-based costing system:** A system that tracks costs based on the activities that are responsible for driving costs in the production of manufactured goods

**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.

**Advanced product quality planning:** A structured method of defining and establishing the steps necessary to ensure that a product satisfies the customer. By moving quality efforts into planning and prevention, this multistage process identifies and anticipates potential problem areas.

**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 surprises.

**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.

**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. Benchmarking: Formal programs that compare a plant's practices and performance results against "best in class" competitors or against similar operations.

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

**Cellular manufacturing:** A manufacturing approach in which equipment and workstations are arranged to facilitate small-lot, continuous-flow production. In a manufacturing "cell," all operations necessary to produce a component or subassembly are performed in close proximity, thus allowing for quick feedback between operators when quality problems and other issues arise. Workers in a manufacturing cell typically are cross-trained and, therefore, able to perform multiple tasks as needed.

**Changeover:** the time required to modify a system or workstation, including teardown and setup time.

**Computer-aided design (CAD):** Computer-based systems for product design that may incorporate analytical and "what-if" capabilities to optimize product designs. Many CAD systems capture geometric and other product characteristics for engineering-data-management systems, producibility and cost analysis, and performance analysis. In many cases, CAD-generated data is used to generate tooling instructions for computer-numerical-control (CNC) systems.

**Computer-aided manufacturing (CAM):** Computerized systems in which manufacturing instructions are downloaded to automated equipment or to operator workstations.

**Computer-aided process planning (CAPP):** Software-based systems that aid manufacturing engineers in creating a process plan to manufacture a product whose geometric, electronic, and other characteristics have been captured in a CAD database. CAPP systems address such manufacturing criteria as target costs, target lead-times, anticipated production volumes, availability of equipment, production routings, opportunity for material substitution, and test requirements.

**Computer-integrated manufacturing (CIM):** A variety of approaches in which computer systems communicate or interoperate over a local-area network. Typically, CIM systems link management functions with engineering, manufacturing, and support operations. In the factory, CIM systems may control the sequencing of production operations, control operation of automated equipment and conveyor systems, transmit manufacturing instructions, capture data at various stages of the manufacturing or assembly process, facilitate tracking and analysis of test results and operating parameters, or a combination of these.

**Computerized maintenance management systems (CMMS):** Software-based systems that analyze operating conditions of production equipment—vibration, oil analysis, heat, etc.—and equipment-failure data, and apply that data to the scheduling of maintenance and repair inventory orders and routine maintenance functions. A CMMS prevents 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.

**Computerized SPC:** See "statistical process control." **Concurrent engineering:** Across-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 taken into account earlier in the development cycle. Fully configured concurrent-engineering teams include representation from marketing, design engineering, manufacturing engineering, and purchasing, as well as supplier—and even customer companies.

**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.

**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.

**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:** A statistical calculation of process capability based on the relationship between process variability and design specifications. A good Cpk value indicates that the process is consistently under control—i.e., within specification limits—and also is centered on the design target value. A Cpk value of 1.33 typically is considered a minimum acceptable process capability; as the Cpk value approaches 2.0, the process approaches Six Sigma capability (3.4 defective units per million).

**Cross-functional teams:** Teams of employees representing different functional disciplines and/or different process segments that tackle a specific problem or perform a specific task, frequently on an ad hoc basis.

**Cross-training:** Skill-development practices that require or encourage production workers and other employees to master multiple job skills, thus enhancing workforce flexibility.

**Customer lead-time:** The time elapsed from receipt of an order until the finished product is shipped to the customer.

**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:** See "manufacturing cycle time." **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.

**Demand flow scheduling systems:** Software systems designed to optimize demand-based manufacturing techniques.

**Design for assembly:** The practice in which ease and cost of assembly is emphasized during the product-design stage.

**Design for logistics:** The practice in which physical handling and distribution of a manufactured product are emphasized during the product-design stage.

**Design for manufacturability:** The practice in which ease and cost of manufacturing, as well as quality assurance issues, are emphasized during the product-design stage.

**Design for procurement:** A practice in which product designers work effectively with suppliers and sourcing personnel to identify and incorporate technologies or designs that can be used in multiple products, facilitating the use of standardized components to achieve economies of scale and assure continuity of supply.

**Design for quality:** The practice in which quality assurance and customer perception of product quality are emphasized as an integral part of the design process.

**Design for recycling/disposal:** The practice in which ultimate disposal and recycling of the manufactured product are considered during the product-design stage.

**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.

**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.

**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.

**Electronic data interchange (EDI):** Information-system linkages, based on communication protocols and document formats, that permit intercompany computer-to-computer communications. It not only speeds communication, but also eliminates re-keying of information and reduces the opportunity to introduce errors. A typical EDI application might speed information exchange between a customer and supplier company for purchase orders, invoices, or other transactions. EDI communications are often facilitated through "electronic mailbox" systems on third-party value-added networks or over the Internet.

**Empowered natural work teams:** Teams that share a common workspace and/or responsibility for a particular process or process segment. Typically such

teams have clearly defined goals and objectives related to day-to-day production activities, such as quality assurance and meeting production schedules, as well as authority to plan and implement process improvements. Unlike self-directed teams, empowered work teams typically do not assume traditional "supervisory" roles.

**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. In a manufacturing enterprise, EI may be regarded as an extension of CIM that integrates financial or executive decision-support systems with manufacturing tracking and inventory systems, product-data management, and other information systems.

**Enterprise resource planning (ERP):** An extension of MRP II software designed to operate on enterprise-wide computing platforms. ERP systems typically claim the ability to achieve tighter (or "seamless") integration between a greater variety of functional areas, including materials management, supply-chain management, production, sales and marketing, distribution, finance, field service, and human resources. They also provide information linkages to help companies monitor and control activities in geographically dispersed operations.

**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.

**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 scheduling systems, running on desktop computers, often compensate for the "infinite capacity" assumptions built into capacity-planning modules in traditional MRP II systems.

**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-pass yield:** The percentage of finished products that meet all quality-related specifications at a final test point. When calculating yield for components, the percentage that meets all quality-related specifications at a critical test point without being scrapped, rerun or reworked. In process industries, yield often is calculated as the percentage of output that meets target-grade specifications (excluding saleable "off-grade" product).

**5S:** A method of creating a clean and orderly workplace that exposes waste and errors. Originally summarized by 5 Japanese words beginning with S, 5S is widely translated as Sort, Shine, Set in Order, Standardize and Sustain.

**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 is able to 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.

**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 takes into account historical demand trends, but also may calculate the impact of planned sales promotions, price reductions, and other factors that cause spikes in demand levels.

**In-plant defect rate:** The fallout rate, parts per million (ppm), of all components in manufacturing and assembly that fail quality tests at any point in the production process. Intranet: A secure, internal, corporate Internet-based network.

**Inventory turn rate:** A measure of asset management capability (see "annual total inventory turns").

**ISO 9000:** An international quality-process auditing program, based on a series of standards published by the International Standards Organization in Geneva, Switzerland, through which manufacturing plants receive certification attesting that their stated quality processes are adhered to in practice.

**ISO 14000:** Standards and guidelines defined by the International Standards Organization for environmental management systems.

**JIT/continuous-flow production:** Implementation of "just-in-time" techniques to reduce lot sizes, reduce setup times, slash work-in-process inventory, reduce waste, minimize non-value-added activities, improve throughput, and reduce manufacturing cycle time. JIT production typically involves use of "pull" signals to initiate production activity, in contrast to work-order ("push") systems in which production scheduling typically is based on forecasted demand rather

than actual orders. In many pull systems, a customer order/shipment date triggers final assembly, which in turn forces replenishment of component WIP inventory at upstream stages of production.

**JIT delivery:** Delivery of parts and materials in small lots—and on a frequent basis—timed to the needs of the production system.

**Kaizen:** The systematic, organized improvement of processes by those who operate them, using straightforward methods of analysis. It is a "do-it-now" approach to continuous improvement.

**Kaizen event:** A concentrated effort, typically spanning three to five days, in which a team plans and implements a major process change or changes to quickly achieve a quantum improvement in performance. Participants generally represent various functions and perspectives and may include non-plant personnel.

**Kanban signal:** A method of signaling suppliers or upstream production operations when it is time to replenish limited stocks of components or subassemblies in a just in-time system. Originally a card system used in Japan, kanban signals now include empty containers and even electronic messages.

**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.

**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 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.

**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 particular product through to 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 execution system (MES):** A software-based system that provides a link between planning and administrative systems and the shop floor. It can link MRP II-generated production schedules to direct process control software. An element of computer-integrated manufacturing, MES encompasses such functions as planning and scheduling, production tracking

and monitoring, equipment control, maintaining product histories (verifying and recording activities at each stage of production), and quality management. Mean time between equipment failure: the mean (or average) time in hours expected between failures of a given device.

**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.

**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 31 through 33.

**Natural work team:** A team of employees, often-hourly personnel, who share a common workspace and have responsibility for a particular process or process segment.

**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.

**On-time delivery rate:** The percentage of time that products ordered by customers is received by the specified time or date

**Operating equipment efficiency or effectiveness (OEE):** The percentage of time that equipment, when running or required for production, is producing good-quality products at an acceptable rate. It is the product of three ratios, availability, performance and quality. OEE equals machine availability as a percentage of scheduled uptime x quality yield percentage of all products for a given line x percentage of optimal production rate at which equipment operates.

**Order-to-shipment lead-time:** The time from when a specific order is released to the shop floor until that order is shipped to the customer, including any storage time in finished goods inventory.

**Order-to-delivery lead-time:** The time from when a specific customer order is received by the plant until product is delivered to customer, including any warehousing, cross-docking and transportation time.

**Order fill rate:** Annual sales orders filled completely divided by the total annual number of sales orders.



**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 doing lighter or re-restricted duties.

**Pick-to-ship cycle time:** Pick-to-ship begins when an order is released to be picked from inventory and ends at the time the order is shipped. Planning and scheduling technologies: A variety of software-based advanced planning, scheduling, and optimization systems.

**Plan for Every Part (PEFP):** A component of lean strategies for purchased parts. To introduce such a system, you have to understand everything about every part: How each part is purchased, received, packaged, stored, and delivered to its point of use. In fact, much of this information exists in your organization, but it is stored in many different places under the control of many managers and is mostly invisible. The first step in creating a lean material handling system for purchased parts is collect all of the necessary parts information in one place.

**Poka-yoke:** "Fail-safe" techniques to eliminate errors or quality-related production defects as far upstream in the process as possible. Example: requiring completed components to pass through a customized opening to ensure that dimensions do not exceed tolerance limits. Also includes methods to check equipment operating conditions prior to making a part. A major objective is to minimize the need for rework.

**Predictive maintenance:** Practices that seek to prevent unscheduled machinery downtime by collecting and analyzing data on equipment conditions. The analysis is then used to predict time-to-failure, plan maintenance, and restore machinery to good operating condition. Predictive maintenance systems typically measure parameters on machine operations, such as vibration, heat, pressure, noise, and lubricant condition. In conjunction with computerized maintenance management systems (CMMS), predictive maintenance enables repair-work orders to be released automatically, repair-parts inventories checked, or routine maintenance scheduled.

**Premium freight:** air or other expedited shipment method that increases the standard cost of filling a customer order.

**Preventive maintenance:** Maintenance activities, often performed by machine operators at regularly scheduled intervals, to keep equipment in good working condition.

**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 actions.

**Problem-solving methodologies:** A variety of approaches to problem solving, including the Deming Circle (Plan-Do-Check-Act), used by all persons working in the same team or organization. Considered fundamental to teamwork.

**Process manufacturing:** The manufacture of products such as chemicals, gasoline, beverages, and food products that typically 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).

**Product data management (PDM):** Enabling software-based systems that link, manage, and organize product related data from various sources—both internally and externally with suppliers—across various computer platforms, divisions, departments, and geographic locations. PDM incorporates CAD files, manufacturing data, and documents to reduce engineering design times; ensures timely access to consistent, up-to-date product information; and improves information flow and cross-functional communications.

**Product-development cycle:** Sometimes called "time to market," this is the period of time from the start of design/development work to commercial product availability.

**Productivity change:** The plant wide 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. The Best Plants entry form also includes a secondary calculation, which many manufacturers prefer to use: "increase in sales per employee."

**Pull system:** A system for controlling work flow and priorities whereby 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 or not it is really needed.

**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.

**Quick-changeover methods:** A variety of techniques, such as SMED (single-minute exchange of dies), that reduce equipment setup time and permit more frequent setups, thus improving flexibility and reducing lot sizes and lead-times.

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

**Rapid prototyping:** A variety of techniques for quick conversion of CAD-generated product designs into useful, accurate physical models, typically using computer controlled systems. In the stereo lithography approach, controls based on CAD designs guide laser beams that create precise plastic models by polymerizing and fusing liquid resins into a laminated composite of very thin slices.

**Raw-materials 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 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.

**Return on invested capital (ROIC):** A measure of how effectively a company uses the money (borrowed or owned) invested in its operations.  $ROIC = \text{net operating profit after taxes (NOPAT)} / \text{capital invested (total assets less excess cash minus non-interest-bearing liabilities)}$ . Total assets = fixed assets + current assets intangible assets + investments. For plants that are cost centers, net operating profits after taxes = annual value of shipments - direct costs, indirect costs, depreciation and taxes.

**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.

**Safety-improvement programs:** Practices intended to constantly improve safety within a plant or across a company, including, but not limited to, 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.

**Scrap/rework costs:** Parts or materials wasted in the production process, plus the cost of fixing defective products so that they pass final inspection.

**Self-directed natural work teams:** Nearly autonomous teams of empowered employees, including hourly workers, that share a common workspace and/or responsibility for a particular process or process segment. Typically such teams have authority for day-to-day production activities and many supervisory responsibilities, such as job assignments, production scheduling, maintenance, materials acquisition, training, quality assurance, performance appraisals, and customer service. Often called "self-managed" work teams. All self-directed teams are empowered.

**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.

**Six Sigma:** A program that originated at Motorola where the objective is customer satisfaction through continuous improvement in quality. Six Sigma means products and processes will experience only 3.4 defects per million opportunities or 99.99966% good.

**Supply Chain Management (SCM):** Supply chain management encompasses the planning and management of all activities involved in sourcing and

procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies.

**Statistical process control (SPC):** Use of variation analysis, with manual or computerized control charts, to detect non-normal variations in a process as quickly as possible. Often, SPC charts display upper and lower limits for part characteristics or process parameters and show trends over time, indicating when the limits were exceeded or approached and corrective actions were needed. In some closed-loop systems, adjustments are made automatically when readings indicate that a control limit is being approached.

**Supplier JIT deliveries:** See "JIT delivery."

**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/logistics systems:** A class of manufacturing software designed to optimize scheduling and other activities throughout the supply chain—or "value chain"—including transportation and distribution functions.

**Takt time:** the optimum frequency at which product should be produced to meet customer demand, calculated by dividing available work time per shift by actual customer demand. For example, an 8-hour, one-shift operation might have 435 minutes of available time (480 minutes minus two 15-minute breaks and a 15 minute cleanup period). If daily demand is 1,305 products, then the takt time of the operation would be 20 seconds.

**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 base-line but add specific performance metrics and a formal benchmarking mechanism.

**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. That a manufacturer calculates and monitors such a measure indicates that management is not only focused on improving efficiencies within the walls of the factory, but also on the total order-fulfillment process.

**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. It uses a variety of quality tools, such as QFD, Taguchi methods, SPC, corrective-action response teams, cause-and-effect analysis, problem-solving methodologies, and fail-safing.

**Transitional work program:** A transitional work program offers various options to assist an injured worker in progressively performing the duties of a targeted job.

**Value-added per employee:** Calculate by subtracting cost of purchased materials, components, and services from value of shipments divided by number of employees. See "productivity change."

**Vendor-managed inventory:** Materials, components or subassemblies managed and replenished by on-site vendors "resident suppliers" with whom the plant has prearranged purchasing agreements. The supplier takes responsibility for the availability of supplies.

**Visibility systems:** Visual systems on the plant floor and design areas and elsewhere that enable anyone familiar with the work to understand its status and condition at a glance, or to respond to work priorities. This can be done with standard layouts, signal lights, kanban systems, or other methods. The distinguishing feature is that communication is rapidly executed by line of sight.

**Voice recognition/response:** Computerized systems capable of recognizing or synthesizing human voices. Such systems capture verbalized data for quality-control or inventory-tracking purposes (often when operators' hands are busy), recognize spoken commands that activate equipment, and convert computer data into audible information.

**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.

**World-class manufacturer:** A somewhat arbitrary designation that can be supported by performance results related to various manufacturing metrics. (World-class metrics may vary from one industry to another.) Typically, it denotes "best-in-class" producers on a worldwide basis. In the broadest sense, world-class manufacturers are those perceived to deliver the greatest value at a given price level.

**Work-in-process inventory (WIP):** The amount or value of all materials, components, and subassemblies representing partially completed production; and anything between the raw material/purchased component stage and

finished-goods stage. Value should be calculated at plant cost, including material, direct labor, and overhead.

**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%.