

OPERATIONS MANAGEMENT GLOSSARY

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This glossary includes terms pertinent to operations management. It was compiled to assist operations management students in courses at the University of Michigan Business School. Corrections, additions, and editorial suggestions are welcome (please send to ggoodsn@umich.edu).

ABC: See Activity Based Costing.

ABSENTEE POLICY: The policy that covers allowed absence from the workplace and the penalties that accrue for excessive absence. This policy is typically part of the employee handbook.

ACCOUNTS PAYABLE: Liabilities that result from a purchase of goods or services on an open account. Amounts owed to suppliers of goods or services.

ACCOUNTS RECEIVABLE: Amounts owed to a company by customers as a result of delivering goods or services and extending credit in the ordinary course of business.

ACQUISITION: Typically the purchase of a company or a significant business asset. In the defense industry, acquisition means the purchase of products and systems.

ACTIVITY: Generally the processing at a work station or equipment location

ACTIVITY BASED COSTING (ABC): An ABC system identifies and then classifies the major activities of a facility's production process into one of the following four categories: unit-level, batch-level, product-level, and facility-level activities. Costs in the first three categories of activities are assigned to products using bases (i.e. cost drivers) that capture the underlying behavior of the costs that are being assigned. The costs of facility-level activities, however, are treated as period costs or allocated to products in some arbitrary manner.

AD&D: Disability insurance as part of an employee benefit package

ADD: American Disabilities Act

AGGREGATION: The concept indicating that pooling of demand or other random variables reduces the variance of the resulting aggregated variable.

ALLOCATION: The assignment of costs incurred in one area or function of a plant or company to another because of the service to the charged unit.

AMORTIZATION: The systematic reduction of an asset, specifically when referring to a long-lived intangible asset such as goodwill or intellectual property. It usually means the allocation of costs of intangible assets to the periods that benefit from these assets. See also depreciation.

ANDON: The visible light or sign that denotes the state of an operation (i.e., on, trouble or off.) The process can be stopped or investigated for quality issues or defects as a result of the status of the lights. In addition, everyone in the immediate area can see that the problem is being addressed.

A/P: See Accounts Payable

A/R: See Accounts Receivable

ASSETS: The tangible and intangible goods, intellectual property, and goodwill that are listed under the asset column in the balance sheet for a company. Any beneficial item owned by a company.

ATTRIBUTE: A critical property of an activity or operation

AVAILABILITY: That time or percentage of time that a resource unit or activity center is ready to process or be activated.

BACKLOG: The amount of actual demand, orders or contracts that are in the pipeline for future sales. Can be expressed in units of production time or dollars; e.g. six weeks of firm orders for a plant that can produce \$2 million dollars per week would be a \$12 million backlog.

BACKROOM COSTS: Indirect costs that do not add direct value to a product and may or may not be necessary to support its production. Examples are matching supplier material receipts to their invoices to make sure that they are being paid accurately; sending invoices to customers; matching computer inventory records to actual inventory; accounting for product costs at each station on a production routing; keeping track of hazardous materials receipt, control, and proper disposal; tracking customer warranty issues; operation of the computer systems that control the production process, etc.

BATCH: The number of production units in an aggregation of units that can be produced by an activity that produces in batches. A multiple of units in a plant designated for any purpose such as packaging, outside services, etc.

BENCHMARKING: Benchmarking is defined as a process of continuous comparison of a company's performance on predetermined measure against that of the best in an industry or a class, considered the standard or the reference. Benchmarking is one of the most popular business management tools for establishing competitive advantage and initiating performance improvements. The Benchmarking process supports the adoption of best practices with enhanced organization performance. The goal is to attain low-cost producer status. **BENEFITS:**

BEST PRACTICE: Denotes that practice considered the most effective for an industry. Best practices continually evolve. Best practices are often assessed across industries to set new "best practice" standards.

BILL OF MATERIAL (BoM): A bill of material is an ordered listing of all the parts in a finished product. The listing usually includes the part number, how many of each part is required, and a brief word description of the part. It is best practice to use only words that appear in a parts dictionary. Bills of material are usually organized by indenting subsystems.

BLOCKAGE: Prevention of a processing unit to produce more units because of inadequate storage space or lack of authorization to produce

BLUE SKY: Goodwill associated with an acquisition of a company or asset.

BORROWINGS: Debt

BUFFERS: Inventory between processing or activity units.

BUILDING TO CUSTOMER ORDER versus **BUILDING TO FORECAST:** Building to customer order means that at least the final assembly, packaging, and shipping awaits a firm order for the product. Building to forecast means that the product is manufactured to a forecasted demand. Building to customer order means that the product is pulled by customer order rather than pushed by a forecast.

BURDEN: Also known as overhead and sometimes as indirect costs. It is the support system cost with respect to the direct costs for manufacturing a product. Burden rates vary widely among operations depending on the equipment investment and other factors. Burden rates include all indirect costs and are usually referenced to direct labor cost excluding fringes required for the direct product manufacture.

CAD: Computer aided design is a process of generating and manipulating product designs through computer software. The software allows all information of a part to be generated and stored electronically at a computer terminal and transferred to other sites or machines.

CAM: Computer aided manufacturing (often used synonymously with CAD) is a similar process of generating manufacturing processes electronically.

CAPACITY: For a process or activity, the maximum THROUGHPUT that can be sustained.

CAPITAL EXPENDITURES (CAPEX. CAPITAL): The cash cost of acquiring capital equipment or goods. Capital expenditures result in depreciation that is the cost that appears on the P&L statement.

CASH FLOW: The beginning and ending net cash as a result of cash that has flowed through an operation over a given period of time.

CENTRALIZATION: Combining of disparate inventories at a central location implying that the total inventory and logistics cost needed to meet anticipated demand can be lower. Availability may be a problem at regional locations.

CIM: Computer-integrated-manufacturing. Popular in the 1980s, it implied fully computer-controlled manufacturing processes. It has been supplanted by lean manufacturing concepts in the main.

CLASSIFICATION: The designation of the job function that an employee is proficient in and assigned to, e.g. machinist, welder, assembler.

CNC: Computer numerical control generally refers to equipment that is operated through the use of digital information rather than human input. For instance, a CNC milling machine will automatically produce the desired net shape of a part as specified by the controlling program.

COEFFICIENTS OF VARIATION: The ratio of the standard deviation to the mean for statistical demands & processes. See P-K Formula

CONTRIBUTION MARGIN: Sales minus the variable costs—the contribution of a sale to the fixed costs of an operation

CONTROL CHARTS: Statistical charting process that is used to identify sporadic and chronic faults in a process. Mean and variance measurements of a product are charted and acceptable limits are set on these values. An out of control process can be identified and adjustments made to remedy the situation through the use of control charts.

CORRELATED DEMANDS: Implies that aggregated demand would have less variability than separate demands because of correlation among demands.

COST OF GOODS SOLD (COGS): The term appearing on the income statement of a company or plant representing the manufacturing cost of the goods sold. The COGS does not include sales and marketing, engineering, and corporate administration.

COST OF SALES (COS): This abbreviation denotes the "cost of sales". It denotes all the costs in a plant. It is the sum of materials cost and value added. The COS can also be referred to as "cost of goods sold".

CRITICAL PATH: That path through a process or activity system that has the longest theoretical flow time (see flow time).

CURRENT: Meaning in the present period. Current assets mean cash, AR, inventories, and all accrued benefits on a balance sheet for the current time period.

CUSTOMER SATISFACTION: A term in Total Quality Management that implies the degree to which customers are pleased with a product or service.

DAYS (DAYS OUTSTANDING): Usually an adjective implying the amount of an asset or liability measured in days of sales, e.g. AP days is the average days that a company or plant delays payments of invoices to its suppliers.

DCF: Discounted cash flow. The process by which a stream of cash is related to its value at present by discounting future cash flows by an interest rate.

DEBT: Monies owed by a company or plant

DEMAND: Customer requirements measured in production or sales per unit time

DEPRECIATION: the systematic allocation and reduction of the acquisition cost of long-lived or fixed assets to the expense accounts over particular period to functions that benefit from the use of the assets. Also see amortization.

DFM: Design for manufacturing. The process by which designs are completed mindful of the cost of manufacturing.

DIES: Those special forms that are used in general purpose equipment to make specific parts. See tooling also.

DIRECT: Usually associated with functions that are directly associated with the production of a part.

DIRECT LABOR: Denotes that portion of the workforce directly assigned to manufacture the product. Direct labor also refers to the standard direct hours that are needed to manufacture a component or system, e.g., there are 1.25 hours DL in a Honda seat set. See also indirect labor.

DIRECT MATERIALS PURCHASING: is purchasing from suppliers on a contractual basis for a fixed period of time or amount of product. For job shops, the purchasing contract can be for only one job. For repetitive manufacturing, the materials are usually purchased on contracts that last for a model run or at least a year. The contract specifies the price, the delivery requirements, the tooling agreements, the quality standards, the release communications and data receipt requirements, and a host of other terms and conditions. The purchase contract does not specify the releases. That is done by the receiving plant as their forecasts or orders require. There can be confusion between purchasing and releasing. Purchasing usually does not release nor do operations purchase.

DISABILITY: That limitation of capacity that is covered by the American Disabilities Act or that limits a function in a plant or company.

DISCOUNTED CASH FLOW (DCF): See DCF.

DISPUTE RESOLUTION: The process of arbitration, mediation, or other means to settle disputes without going to court.

DISTRIBUTION: This term denotes the process and/or entities that take manufactured products and make them available to the ultimate customer. In the automotive and appliance industries, it is the automobile and appliance dealers. Distribution can be quite complicated. In the beverage industry, there may be bottlers who have their own distribution so that there are two levels of distribution. There may be several parallel distribution paths to consumers. Original equipment manufacturers (OEMs) may distribute to other OEMs.

DIVIDENDS: Distribution of monies to shareholders from company cash flow

DECOUPLING: Implies that through buffers and inventory, processes in a product line can operate relatively independently of the each other.

EBIT: Earnings before interest and taxes.

EBITDA: Earnings before interest, taxes, amortization, and depreciation. The single most used measure in valuing companies. It represents free cash flow quite accurately.

ECONOMIES OF SCALE: The unit cost reduction that accrues from larger volume production or distribution of similar products or products produced in similar operations.

ECONOMIC ORDER QUANTITY (EOQ): The optimal batch size for an order that minimizes the total period cost, including cost of ordering (setup cost), inventory holding cost, and cost of materials procured. For setup cost **S**, holding cost **H**, and throughput **R**, the optimal batch size **Q*** is given by **$Q^* = \text{square root } (2 \times S \times R/H)$**

EEOC--Equal Employment Opportunity Commission is the administrative agency that administers Title VII of the Civil Rights Act. It is headed by five commissioners appointed by the President. Title VII prohibits discrimination in employment based on race, color, religion, sex, or national origin.

EFFECTIVE: Adjective denoting real capacity of a processing unit is fully utilized when it was available.

EFFICIENCY: Measure of total processing cost of an activity or process.

EPS: Earnings per share of common stock for a company

EQUIPMENT: Those assets that are used to produce product in a manufacturing or operating environment

EQUITY: The assets minus the liabilities of a company. Stockholders equity implies joint ownership of the value of this equity in proportion to the stock held.

ER&D: Engineering, Research, and Development--usually appearing on the income statement of a company implying development costs for new products.

ERP: Enterprise Resource Planning--the latest designation of company-wide computer integrated information system. The term implies that disparate computers, information databases, and communications networks are integrated.

ERROR PROOFING (POKA YOKA): Error proofing seems to be a simple concept, but there are many variations on the primary theme. The basic concept is that a product is prohibited from being taken out of its fixture if it has a quality defect as a result of the machine or operator action. The defect must be corrected prior to release of the product from the fixture.

EVA: Economic Value Added--the amount the profits of a company or entity differs from its cost of capital times its net assets. EVA is increasingly used as a performance measure replacing return on equity and return on investment.

EXPECTED VALUE: In probability theory the mean value expected at any time or over a specified set of random variables.

FASB: The Financial Accounting Standards Board is a private-sector body that determines generally accepted accounting standards in the United States.

FILE FOLDER (PARTS): There are many names for a parts file folder. The concept is simple, however. A parts file folder contains all the required information about a part including cost, lead times for production, approved suppliers, tooling requirements and cost, drawings of the part, its tooling, and fixturing, computer data if it has been programmed for production on a computer-controlled machine, quality specifications, key characteristics, etc.

FILL RATE: Fraction of total demand satisfied by inventory on hand.

FINISHED GOODS: Finished goods inventory consists of goods that have been completed and are awaiting sale. Finished goods are valued at the cost of sales.

FIVE S's: Toyota defines the five S (for keeping an operation clean):

1. Seison: Maintaining a clean plant
2. Seiton: Ordered placement & identification of all parts & work items
3. Seiri: Identifying & separating necessary from unnecessary items
4. Seiketsu: Maintaining Seiri, Seiton, & Seison
5. Shitsuke: Instilling Seiri, Seiton, Seison, & Seiketsu in workforce

FIVE WHYs: The process of repeatedly asking why until the root cause of the problem is found. The purpose is to keep asking why until the root cause of the problem is known and the solution found. Toyota has found that asking "why" five times usually leads one to the root cause.

FIXED COST: That set of costs in an operation that does not vary with production volume.

FIXTURES: Fixtures are what secure tools and components to general-purpose machines. The location and fixture type make a significant difference in the speed with which tools can be changed and in the quality of the part produced. It is best practice to fix a tool at just the right point so that the key characteristics are produced with the most accuracy given the machine and tools being used to make the part.

FLOW SHOP: An operation that produces products at volume in a continuous flow or by a well-defined, connected sequence of activities or processes.

FLOW TIME: The average (actual) time for a unit of production to flow through a process unit or activity including input and output inventories. Theoretical Flow Time is the flow time without inventories.

FLOW TIME EFFICIENCY: The ratio of theoretical flow time to the actual flow time through a process.

FMEA: Failure mode and effects analysis--the process by which failures are hypothesized, valued, and corrected.

FOREWARD BUYING: Buying of materials in advance of need.

FORECAST: Usually the prediction of customer sales and the subsequent manufacturing schedule.

FORKLIFT: A general-purpose small truck for lifting and transporting materials and containers in a plant; not conducive to lean operations

FRINGES (FRINGE BENEFITS): Employee non-cash compensation such as medical coverage, insurance, etc.

GOODWILL: The excess of the cost of an acquired company over the book value. Intangible values on a company balance sheet.

GRIEVANCE: A formal complaint filed by a union member against a company. The resolution of grievances is a formal process also defined by contract.

GROSS MARGIN: The ratio in percent with the numerator the difference between sales and cost of sales and the denominator sales. Gross margin for a plant is revenue minus COS divided by revenue.

HAZMAT: Hazardous material handling process defined by environmental laws and legal precedents. A process has been defined by regulations that impose stiff fines for a plant if the regulations are ignored.

HEIJUNKA: The Deployment of matched goals throughout the organization

INDIRECT COSTS: All costs that are not direct costs. Usually associated with the functions in an operation that may be necessary to support direct production.

INDIRECT LABOR: Denotes the production workers that support the direct labor function. Indirect labor functions can include maintenance, material handling, setup, product testing, and inspection. Best practice limits indirect functions and indirect people by, for example, assigning direct responsibility for all functions at routing stations to teams that would include direct operations, maintenance, material movement, and scheduling.

INPUTS: The material or products that are presented or flow into an activity.

INTERNAL RATE OF RETURN: See IRR.

IRR: Internal rate of return--that period interest rate that makes the present value of the discounted cash flows zero. Given a stream of cash flows, iteration is required to find that interest rate that makes the net present value zero.

ISO 9000: International Standards Organization quality standard. The "9000" designation is a general one. Levels of quality achievement encompassing wider functions in a firm from manufacture to complete product design, customer service, and manufacture progress from "9003" to "9001". This quality standard is administered by approved consulting firms and denotes a company's commitment to follow standard processes in its business practice.

ISO CERTIFICATION: Denotes that a firm or plant has received an ISO quality standard. Also, it is the process by which a firm achieves such certification.

INVENTORY: Goods and products held by a company in the product value stream that are eventually intended for sale to customers on their own or as part of a product system. Inventory includes the material cost of the goods and the value added by the operation to reach its state of manufacture. Raw materials, work in process, and finished goods are three categories of inventory.

JIDOKA: The principle of stopping work (or the line) when there is a quality problem--the process for correcting that problem

JIT: Just-in-time manufacturing system. In a full JIT system, the only parts that enter a plant or move from process to process in a plant are those identified uniquely with a final product, no more or no less. Thus, every part being supplied and every part in the plant can be related directly to a bill of material of a product that is either in production or will shortly to be in production.

JOB SHOP: Job shops refer to those operations where each order is more or less unique and where the volumes are small or only one order. The clearest example of a job shop is a construction firm that constructs unique buildings. The book manufacturing industry is another example of a job shop if the production runs are small as is the case for a textbook. The automotive, appliance, towel, petroleum refining, and computer industries are examples of repetitive manufacturing. See also repetitive manufacturing.

Several industries have characteristics of both repetitive manufacturing and job shops in their operations. Even in job shops, standardized materials, machines, and tooling and fixtures are desirable. Standard sizes, capacities, and performance are characteristic of the construction industry. Also, either industry may incur high tooling costs. Even in the construction industry, repetitive manufacturing is gaining as modular assemblies are replacing craftwork in many of the subassemblies.

KAIZEN: The process whereby teams attack a manufacturing operation to make a series of quick, small steps to improve the process. It is also the process by which such small improvements are continued. Standardized work is the result of Kaizens

KANBAN: A card that signals the replenishment requirements in a production process. Associated with delivering just the amount of inventory needed at the right time. The heart of a pull system where the process need for inventory is signaled by the placement of a demand card with the supply process.

LAYOFF: The process by which employees that are not needed for some extended period of time are given notice that their services are not needed. Layoffs are usually associated with unionized operations although not always so. Layoffs do not necessarily imply that the employee will be called back, but in union contracts, laid-off employees have callback rights. Eligibility for unemployment benefits also depends on the layoff process. Seniority generally rules for layoffs, although voluntary layoffs where employees volunteer to a layoff are effective ways to allow flexibility in the layoff process. Benefits may or may not continue in a layoff.

LABOR: The workforce in a plant, the people activity that produces value in a product stream.

LEAD TIME: Time that is required to fill an order or meet customer demand.

LEAN: A term used to indicate that an operation adheres to the Toyota Production System and has achieved the level of quality, productivity, and customer satisfaction associated with application of that system

LEVELED PRODUCTION: The distribution of production of different kinds of items evenly through the day and week to allocate work evenly and thereby use resources optimally; also Heijunka.

LIABILITIES: Economic obligations of the organization to outsiders or claims against the assets by outsiders. Debt, accounts payable, taxes owed, and wages to be paid are examples of liabilities.

LIFE CYCLE COSTING: Using the full cost of a component or system over its useful life in a financial decision process instead of just original purchase price. For example, life cycle costs brought to present value may justify a higher initial purchase price.

LINE BALANCING: In a production or process operation line with several processes, machines, or operations in sequence, the discipline of balancing the throughput of each operation in the sequence such that production of any one unit in the sequence is equivalent or "balanced" with each of the other units in the sequence.

LITTLE'S LAW: The equation relating Throughput, Inventory, and Flow Time for a process. It is: $\text{THROUGHPUT} = \text{INVENTORY} \text{ divided by } \text{FLOW TIME}$

LOGISTICS: The process of managing materials for operations to meet certain objectives such as delivery speed, low inventories, and high accuracy. A new business opportunity has arisen for firms that specialize in logistics management to supply OEMs with JIT components and systems. Integrated Logistics handle a variety of unrelated components required by a customer or customers.

MAINTENANCE: That classification of employees and process by which machines and equipment are maintained for sustained production.

MAKE-TO-ORDER: Operations that make products or deliver services only to customer order--no finished goods inventory.

MAKE-TO-STOCK: Operations that make products to inventory in anticipation of customer demand--requires demand forecasts.

MANUFACTURING ENGINEERING: The discipline that plans and implements production processes in an operational setting.

MARGINAL ANALYSIS: Analysis of the effect of an action or activity at the limits or at a point in the operation rather than on the average. The marginal cost of an additional unit of production may be lower or higher than the average cost.

MASTER PRODUCTION SCHEDULE (MPS): The schedule of finished goods that are to be manufactured based on actual or forecasted customer demand. Work centers are scheduled to manufacture the products to meet the MPS.

MATERIAL CONTROL: That process whereby materials are ordered, received, and distributed throughout an operation to satisfy the master production schedule.

MATERIAL FLOW: That process that defines the flow of materials in an operation.

MATERIAL RELEASE: Release means the process and data by which a supplier is notified that material is to be shipped. Releases imply that the supplier already has a purchase contract for the goods to be supplied. The supplier may choose either to manufacture the product in anticipation of the release (forecasting) or wait until receiving the release and manufacture the product between the time that the release is received and the time that the supplier must ship the product to reach the customer plant on time. Release information usually specifies the part number and quantity required and the time it is to be received at the customer plant dock.

MATERIALS: Those components that are part of the production bill of material that are processed by an operation.

MIX: The breakdown of the total demand or production that identifies the different products in an aggregate demand or production run.

MRO: Those components and parts not associated with the direct material for a product. Tools, gloves, lubricants, machine maintenance parts are part of MRO.

MRP: Material requirements planning. MRP systems are used in almost all plants. They coordinate the bill of materials, forecasted demand, long lead-time parts, and the inventory in the plant. The reasons MRP systems are generally required relate to the fact that all parts cannot be supplied JIT and that schedules are not predictable. There are still suppliers that give price discounts for larger orders. Further, material receipt, inventory tracking, and engineering changes introduce complexity in plants unless the bills of material are few and simple. A plant that uses JIT exclusively is very rare. Forecasted demand is common for many supplied parts. Further, parts get lost, stolen, and damaged. Parts that do not meet quality standards must be reworked or resupplied. For all these reasons and more, an MRP system is required. MRP systems are quite complex and computer-based. The software incorporating MRP systems can be expensive and difficult to install because it requires an evaluation and possible change of all business practices.

MRP II: Material Resource Planning--an advanced version of MRP that integrates the whole value chain in planning material orders, production, scheduling, and shipments.

MOLDS: Molds are the same as tools but for plastic or chemical processing part production. A mold is the term used for the tools that shape plastic or other "soft" material parts in injection molding machines, that shape foam pads for furniture and automotive seating, and that shape baked goods. Thus, a baking pan is a mold for bread.

MUDA: Waste. Reducing waste throughout the enterprise is one of the fundamental tenets of the Toyota Production System.

MULTIPLE SOURCING: Sourcing more than one supplier for the same part or system.

NET INCOME: The income remaining after all expenses have been deducted from revenues including taxes and extraordinary.

NEWSVENDOR: Name of traditional problem and solution in operations management dealing with single order quantity optimization such as newspaper and other spoilable goods.

NLRB: National Labor Relations Board is an independent administrative agency responsible directly to the President who administers most of the provisions of the National Labor Relations Act. It is the federal agency responsible for administering union matters and issues.

NORMAL DISTRIBUTION: Denotes the Gaussian probability function defined by the exponent of the weighted squared probability variable

NPD: New product development

OSHA: Occupational Safety and Health Administration. The federal agency that administers The Occupational Safety and Health Act was formed by an Act of Congress in 1970. Ever since, OSHA's mission has been clear and unwavering: "to assure so far as possible every working man and women in the nation safe and healthy working conditions." Coverage of the Act extends to all employers and their employees in the 50 states, the District of Columbia, Puerto Rico, and all other territories under Federal Government jurisdiction.

OEM: Original Equipment Manufacturer. The term OEM denotes a company or sector that manufactures equipment ready for purchase by the end-use customer. The large automotive companies are referred to as OEMs. Suppliers to such companies supply to the OEMs, they are not OEMs themselves. There is an implication of a distribution entity between an OEM and the ultimate customer.

OPERATING INCOME: Gross profit less administrative (SG&A) and development (ER&G) expenses.

OPERATIONS: Any activity that transforms and adds value to an input stream. The input stream can be a physical entities, services, or flows. The valued added transformation produces products or services that are designed to meet a customer demand. Operations range from processing loan applications to production of computers, to designing buildings.

OVERHEAD: In general denotes an allocated cost to a direct operation. It includes all manufacturing costs, other than direct material and direct labor. In addition to indirect material and indirect labor, overhead cost includes utilities, maintenance, depreciation and taxes.

OVERTIME: Work beyond the federally mandated work period usually a day or a week. Overtime pay regulations are quite specific.

PARTS FILE FOLDER: See File Folder.

PACING PROCESS: That process in a product production line that is used to signal all the other processes in the line for the production Takt time. It is generally the final process but does not have to be. The production rate of each process is then tied to the production rate of the pacing process.

PAYROLL: The employees on a payroll for a company; also the process by which employees are paid including deductions and additions for taxes, savings, benefits, payroll deductions, overtime, etc. Payroll systems can be quite complex and must be updated continually as tax and benefit policies and procedures change.

PICK AND PLACE: Equipment that picks up parts from one station on an assembly line and places them on the next. It is usually a pick and place robot.

P-K FORMULA: An approximate formula for buffer inventory as a function of activity utilization, number of activity servers, and statistical coefficients of variation for the demand and the process. Given utilization ρ , c servers, and input and demand coefficients of variation, the buffer inventory is:

$$I = \frac{(C_i^2 + C_p^2) \rho \sqrt{2(c+1)}}{2(1-\rho)}$$

PLANT RATE: Plant rate is the total value added by a plant divided by the total direct labor hours in a yearly budget. It is the shop rate plus all other plant costs divided by the direct labor hours in a yearly budget.

POKA YOKA: See Error Proofing.

POOLING: That action that combines in parallel previously independent processes to reduce the total variance compared to the variances that would occur when the processes were independent. Generally reduces the variance of the combined processes by the square root of the sum of the squares of the independent processes.

POSTPONEMENT: That action that delays complexity to later stages in an operation so that product differentiation occurs later in the production cycle. Examples: 1. are different model cars using the same drive trains, suspensions, and mechanical components; differentiation coming with plastic and sheet metal ornamentation, 2. Chinese food that takes a few basic ingredients and develops a complex menu that can be prepared quickly.

PP&E: The property, plant and equipment or fixed assets of a company.

PRODUCT LIABILITY: That legal liability for product malfunction in the hands of a consumer or customer. It is also the process by which liability is established.

PRODUCT MIX: The proportion of different products in the total production of an operation or plant.

PRODUCTIVITY: Measure of labor efficiency. Amount of goods produced per unit of labor cost or hours. It can be applied more generally to the efficiency of machines and systems.

PULL SYSTEM FOR MATERIAL CONTROL: Equivalent to JIT but most often internal to operations. The pull system means that the "release" for moving material within the plant or from suppliers is signaled by the next process in line that needs the material. The material is moved by the demand from the succeeding process in the production chain or routings not by a central schedule or general release. See also Kanban and push system.

The idea is to produce what the customer requires. The main challenge in implementing this system comes in when looking at the supply side of raw materials as well as the efficiency of the plants. A company that produces JIT, need to have suppliers that can supply raw materials in a short notice and are therefore located close by in order to receive raw materials in a timely fashion for production. At the same time, manufacturing JIT requires more than just good plants. See the seven zeros. The implementation of this system took Toyota over 30 years to be perfected. However the trend seems to be going

towards this system in the United States. The biggest advantage of this system is the reduction in cost of the goods as well as the flexibility in production that help companies be more dynamic and competitive in the industry.

PURCHASING: That function that defines the conditions that govern purchases within a company as well as the actual purchase of the goods and services.

PUSH SYSTEM FOR MATERIAL CONTROL: The push system denotes a system whereby material is released for production and movement by a central or local scheduling algorithm and based on forecasted or anticipated needs for that material. See also pull system.

Traditionally, the Push system had been used in plants for production scheduling. The push system is simply when the demand for a product is forecasted and a production schedule is made up according to the forecast of demand through a centralized system. However, the main problem with this system is the variations between the forecasted and the actual demand that may cause excess inventory of finished goods or a backorder in production. In order to avoid problems that are caused due to forecasting errors, companies that use a push system may either:

- i. Keep finished goods on inventory (safety stock)
- ii. Have an excess lead-time on delivery to give enough time to produce enough

The main disadvantage of the system comes in when the plants have to keep excess inventory or have long lead times for the customers. Inventory costs money and long lead times cause dissatisfied customers. At the same time, companies have spent millions of dollars in the past just to get good MRP software that would be able to help planners plan the production effectively.

QFD--Quality Function Deployment: The formal process whereby products and services are designed that meet all customer expectations cognizant of costs, competitors, manufacturing, and flexibility.

QS 9000: The automotive industry version of the ISO 9000 requirements.

QUALITY COST: The sum of the preventive, measuring, internal failure, and external failure costs for a plant, division, or company. Implied in quality cost is that the least expensive way to lower quality costs is to invest in prevention rather than pay for external failures. These costs are not part of the general accounting systems and can be quite difficult to accrue.

QUEUEING: Formation of a line. Queueing theory is the study of the formation and variation of queues. It is applied to operations where capacity constraints or variations produce lines or queues.

REENGINEERING: The process of redesigning processes or activities to reduce flow times, inventories, and increase throughput. Its primary objective is to reduce costs and increase customer response. It is generally applied to service or support activities in contrast to physical operations. Redesigning or reconfiguring physical processes is usually referred to as lean transformation. The two terms generally refer to the same process of

RELEASE (MATERIAL): See Material Release.

RELEASING OFF BILL OF MATERIAL: Releasing off a bill of material means that the only information a supplier receives is a time sequence of finished product part or model numbers. The suppliers must then know which parts in the bill of materials are theirs. This sequence of final products can be the only information shipped out to all suppliers that do not use the "vending machine" approach. This greatly simplifies material control and release. Instead of each part number for each supplier part being separately communicated to the right supplier, all suppliers receive only the sequence of final product or model numbers. In the case of a vehicle or a refrigerator, the suppliers would only receive the model number of the product being produced in the production sequence along with the options code. It would then be the suppliers' responsibility to ship the right parts for that model in sequence to the customer plant JIT.

REORDER POINT: That inventory level where new is ordered.

REPETITIVE MANUFACTURING: Repetitive manufacturing refers to those operations where each product is produced more or less continuously at significant volumes usually on an assembly line. It is assumed that the products are completely engineering so that minimal design or craftwork is done on the manufacturing line. See also job shops.

Several industries have characteristics of both repetitive manufacturing and job shops in their operations. Even in job shops, standardized materials, machines, and tooling and fixtures are desirable. Standard sizes, capacities, and performance are characteristic of the construction industry. Also, either industry may incur high tooling costs. Even in the construction industry, repetitive manufacturing is gaining as modular assemblies are replacing craftwork in many of the subassemblies.

REWORK: That activity that reprocesses defective parts to make them satisfactory for reuse in the production process.

ROE: Return on equity--net income divided by average equity over a period.

ROI: Return on investment--average yearly income divided by the average investment--usually applicable for a project. See IRR and RONA.

RONA: Return on average assets--this measure is usually applied to plant or divisional operations to compare returns without considering debt.

ROS: Ratio of net profits to sales expressed in percent

ROUTINGS: Routings are the sequence of steps that a product follows through a manufacturing plant as it moves from machine to machine. There may be several subsystems in a product that follow different routes finally converging at one or more machines or assembly lines that complete the final product.

SALARIED STAFF: That staff in a plant or operation that supports the value-added activities in the operation and are paid salaries rather than an hourly rate.

SCHEDULE: Ordering of production to meet forecasted or actual customer demand.

SCRAP: Components or goods to be discarded usually because of poor quality or no demand.

SELLING AND ADMINISTRATIVE COST (SG&A): Those costs that are associated with the marketing, sales, and administrative functions for a plant or company.

SERVICE LEVEL: Probability that customer demand will not exceed inventory for an order cycle.

SERVICE OPERATION: Operations in a service industry or business. Such businesses are generally characterized by direct service to consumers rather than in the supply of manufactured products. As traditional manufacturing businesses have become more customer oriented and service businesses more product focused, such differentiation has blurred. Examples of service businesses are restaurants, banks, health care, and education.

SETUP: Denotes the process of changing or fitting tools on general-purpose equipment to produce a particular product. Best practice reduces setup times and effort by designing the tools and their clamping and fixing devices for rapid attachment and detachment, by having all the required hand and special tools located conveniently near the equipment, and by training the operational teams to make quick, safe tool changes.

SETUP TIME EFFICIENCY: The ratio of the setup time to the process flow time.

SEVEN ZEROS: The seven even zeros are an essential part of the TPS They are:

- Zero Defects: To avoid delays due to defects (Quality at the source)
- Zero (Excess) Lot Size: To avoid "waiting inventory" delays
- Zero Setups: To minimize setup delay and facilitate small lot sizes
- Zero Breakdowns: To avoid stopping tightly coupled line
- Zero (Excess) handling: To promote flow of parts
- Zero Lead-Time: To ensure rapid replenishment of parts
- Zero Surging: Necessary in system without work in progress buffers

SHOP COMMITTEE: That committee that represents the union in its relations and negotiations with a company or plant.

SHOP RATE: Shop rate is the direct labor cost plus the manufacturing overhead divided by the total direct labor hours in the yearly budget for the plant. It can range from \$20-100 per hour. It is used to estimate the cost for bidding for new business.

SHRINKAGE: The amount inventory is less than what is on the "books". Shrinkage can occur from unrecorded scrapped parts, short shipments by supplier, pilferage, unrecorded overshipments, and damaged parts that are discarded without relieving inventory. Shrinkage reduces pretax profits directly.

SINGLE PIECE PRODUCTION: That capability to produce a single unit of a product at the same throughput and cost as volume production. This generally requires that setup times be very small, that there is a production line, and that inventory is stored line side. It is an element of the Toyota Production System and related to JIT.

SINGLE SOURCING: Sourcing all the requirements for a particular part to one supplier is called single sourcing.

It has been a purchasing truism forever that sourcing to more than one supplier is required to obtain competitive pricing, quality, and delivery. The Japanese automotive industry developed a system, however, that made a form of single sourcing work more effectively than the multiple sourcing practiced by the U.S. automotive industry. This modified single sourcing system has begun to be adopted by all automotive companies and by other industries as well.

The system sources to a single supplier all the requirements for a product line early enough in the design cycle so that the supplier has significant design responsibilities. The volumes can be quite attractive. In the seating industry, the average contract in the early 1980s before this system was adopted was in the range of one to three million dollars per year for one year. After the new system was adopted the contracts were for fifty to one hundred million dollars per year for five years or more.

The supplier works to a target cost for the product that is set independently and prior to the design process. The responsibility of the supplier is then to design the product to the cost specified by the customer and make a profit, to deliver the product to the customer on time, and to meet the customer quality specifications. The supplier must develop significant expertise in such subsystems to win and keep business in this sourcing strategy.

In this system, a mutual dependency develops whereby the supplier has the business for a model run of four to six years. Since the supplier wants the business for the next model as well as the current model, the supplier is motivated to keep costs down, quality up, and delivery on time. At the next model design, more than one supplier has the opportunity to bid for the yet to be designed product. In this way, the full history of the current supplier is known during the bidding for the next design. However, new ideas and concepts can be brought to the customer by competitors. The system works well when there are at least two capable suppliers that can bid on such large contracts. The seating industry has evolved to this status from more than two dozen small firms in the early 1980s to a very few, very large firms in the late 1990s. In 1981, Hoover Universal seating (which JCI acquired) had less than one hundred fifty million-dollar sales per year and Lear had less. In 1998, both Lear and JCI are above nine billion dollars in sales.

SOURCING: The process by which supply contracts are let by purchasing.

SPARE PARTS (SERVICE PARTS): Parts for products already produced that can be shipped to customer order or stored for future orders.

SPC: Statistical process control involves the implementation of statistical tools (including control charts) that monitor processes in order to identify improvement opportunities. Process faults are identified, a root cause of the fault is isolated, and corrective actions are taken to improve the process.

STANDARD COST: A measure of how much one unit of product or services should cost to produce or deliver. Standard cost may be established using careful analysis of the product or service and the materials and processes used to create it. If established in this manner, standard costs may be thought of as ideal costs, and actual costs may differ from these costs because of actual price differences, errors or mistakes, or changed conditions from the ideal.

SUPERMARKET: That process where material for the next process in an operation is arranged as in a supermarket where visual control of the production is assured. The

following process takes from the "supermarket" area what it requires for production in that stage and the preceding process produces exactly what has been taken. Also known as a visual Kanban.

SUPPLY CHAIN: The supply chain denotes the process by which components are moved and produced from raw material to the ultimate consumer. It also includes the details of that process such as cost, time, transportation, packaging, etc. It may involve two or three levels of suppliers, one or more OEM plants, a distribution system, spare parts replacement parts flow, and the disposal and recycling process.

TAKT TIME: The pace at which consumers demand a product--production scheduling at that pace. The line speed in an auto assembly plant (around 1 vehicle per minute) is the Takt time for that plant.

TARGET COST: A system for utilized in product development where part of the specifications of the product is the cost. The system was developed by the Japanese auto manufactures and has become a concept and system in wide use in business.

T&E: Travel and entertainment costs

TIER ONE: Tier one designated those group of suppliers who have become directly responsible for not only product supply but product development. The tier one suppliers in the automotive industry, for example, supply complete seats, braking systems, drive trains, and other complete systems that have been developed in cooperation with the OEMs.

TERMINAL VALUE: The value of an operation or entity at the end of the time period considered. For discounted cash flow, it is the net value of the entity considering all future cash flows at a terminal time in the future.

THROUGHPUT: The production rate of a process or activity measured in units or flow per unit time. Throughput divided by Capacity is Utilization

TOOLING: Tooling and dies refer to hardware (or software) that is developed specifically for a part so that when that tool or die is inserted into a general-purpose machine, that machine will produce or shape that part uniquely. Tool and die makers design and make tooling and dies. The two terms are almost synonyms. Engineers or tool designers design tools and dies. Examples of tools and dies are:

- Molds that are used in plastic injection molding machines to make everything from plastic cups to complex plastic parts for industrial or commercial use
- Tool steel dies designed for hydraulic and mechanical presses so that a flat piece of steel or other metal can be formed into such products as fenders, CRT enclosures, or cooking ware
- Templates used for printing, painting, and lithography
- A set of patterns for cutting cloth or leather
- Digital data that guide a general purpose machine in its cutting of materials
- Cookie and bread molds for cooking
- A metal stamp that embosses the figures on a coin blank
- Camera-ready copy of a manuscript to be published

TOYOTA PRODUCTION SYSTEM: Toyota Motor Company developed a comprehensive business system that produced the remarkable results in quality, productivity, and

continuous improvement marked by Toyota's products and services. This system led to the "lean" manufacturing and "lean" enterprise concepts in the U. S. and Europe. It has also spawned innumerable other "production systems" for firms that have tried to emulate Toyota's record of success. Toyota bases the system on continuous reduction of waste, respect for their employees, and customer satisfaction.

TQC: Total quality control--a process by which a firm deploys its quality program throughout all functions of the company.

TQM: Total quality management--see TQC.

TURNS: Commonly thought of as inventory turns or turnover ratio, turns are defined as the ratio of throughput to average inventory. A high number of turns imply that less inventory is kept on hand and/or materials are received in smaller lots and processed quickly.

UNION CONTRACT: A formal contract between a union representing employees in a plant or firm and the company for whom the employees work. The contract covers all aspects of pay, working conditions, and strike options. Contracts usually run from 2-6 years.

UNION FREE: A designation that notes that an operation does not have a union.

UNION SHOP: A facility in which all hourly employees are unionized, or more formally a clause in a collective bargaining agreement under which membership in the union is required as a condition of employment.

UTILITIES: Services provided by utility companies--electricity, water, heating fuel, materials disposal, and communications.

UTILIZATION: The average fraction of the capacity of a process or activity that is utilized during an operation

VALUE ADDED: Denotes the "value" added to the materials received by a plant in the plant's operations. Usually a percentage of COS. Value added can be a combination of true value and the non-value added work done in manufacturing a product. Best practice requires a plant to continually assess which of its activities is true value added and eliminate or reduce the non-value added activities. This assessment can be complex, however. There is a gray area in determining what are the direct materials. There is no confusion on direct materials that are part of the bill of materials. The uncertainty is in the indirect materials some of which could be included in the bill of material. For example, adhesives and lubricants are generally bought in bulk and used as needed with the amounts not accurately specified in the bills. For most plants, these items are small compared with other costs.

VARIABILITY: The variations in any portion of an operation—demand, processes, activities, supplier performance, quality, etc.--See coefficients of variation.

VARIANCE: That deviation from the standard cost for a product or process in production. Positive variances denote performance better than standard.

VARIABLE MANUFACTURING COST: Those operational costs that vary with the production volume in contrast to fixed costs that are independent of production volume.

VENDING MACHINE MATERIAL CONTROL: Soft drink and snack suppliers to a plant replenish the previous day's employee purchases each day. They do not forecast demand in any formal way; they stock their delivery trucks with products that have been selling plus maybe some new, more enticing snacks. Plants can use this philosophy to have many types of production material stocked. Suppliers come to the plant daily and replenish bins from which material has been used the previous day. They do not forecast nor know except from recent historical data what the usage will be. Such parts are usually standard ones such as fasteners.

VISUAL MANAGEMENT: That system of deployment of visual graphs, charts, inventory arrangements, tool & fixture storage, and order that aids in implementing and maintaining lean manufacturing and order within a plant. It is based on the concept that people are apt to understand and relate to visual cues and data better than to other communication means.

VOLUNTARY LAYOFF: Layoffs where the employees are given the option of taking a non-paid leave from their work for a short, specified period of time.

WARRANTY: A guarantee of the quality of a product or service that lasts for some period of time and has some specific product or service coverage.

WELDING: The process by which two metals or materials are joined by heat or pressure most often resulting in melting of the materials

WELLNESS: The process of fostering healthy practices and lifestyles for people to improve foster health and well being.

WORKFORCE: The employees of a plant or company

WORK TEAMS: Teams of employees formed to shepherd a particular work area or function.

WORK IN PROCESS (WIP): Inventory consisting of products that are in a semifinished state. Work in process is valued at the cost of the purchased material plus the cost of manufacturing up to the stage of completion at the time that the inventory is valued.

WORKING CAPITAL: In a manufacturing operation, working capital generally refers to inventory plus accounts receivable minus accounts payable. These are the dominant requirements for cash in a plant in addition to payroll and property, plant, and equipment.

For a company, the accounting definition of working capital is current assets minus the current liabilities. This definition refers to the working capital that the company has. From a manufacturing perspective, the working capital requirement to run the operations is what is important. This allows a forecast of the cash required to produce a new order, to negotiate with suppliers and customer on payment terms, and to communicate with corporate treasury functions on the cash needed so that it can be lined up from banks or investors. For this purpose, working capital is current assets minus cash minus current liabilities plus the current portion of debt due.

WORKMAN'S COMPENSATION: This is a state-administered program whereby employees are guaranteed medical coverage in case they are injured on the job and companies are limited as to their liability for such job-related injuries.