TAUBER INSTITUTE
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Lean Glossary

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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.

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.

BENCHMARKING: Benchmarking is defined as a process of continuous comparison of a company's performance on a 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: [definition missing]

BULLWHIP EFFECT: The increasingly variable orders in a supply chain that are caused by a basic instability in the supply chain policy. The effect is apparent when a small change in an order at one end of a supply chain produces very high variations at the other. "The Beer Game" is an example simulation of the bullwhip effect.

COEFFICIENTS OF VARIATION: [definition missing]

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.

COST OF GOODS SOLD (COGS, COS): 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, or corporate administration.

EIGHT-D (8-D): Eight-D (eight disciplines) has become a standard in the automotive and other industries that require a structured problem-solving process using a team approach. Organizations may adopt this or another similar approach as a uniform way to deal with problems. It is also used in process and product improvements. It attempts to correct the problem or resolve the issue permanently by finding the root cause and "putting the problem to bed." It parallels the PDCA cycle (plan, do, check, adjust). After deciding to address and solve the problem, the discipline steps are:

D1: **Use a Team**: Establish a team with product/process knowledge

D2: **Define and Describe the Problem**: Specify the problem by identifying in measureable terms the who, what, where, when, why, how, and how many (5W2H) for the problem.

D3: **Develop Interim Containment Plan; Implement and Verify Interim Actions**: Define and implement containment actions to isolate the problem from customers.

D4: **Determine Identify, and Verify Root Causes and Escape Points**: Identify all applicable causes that could explain why the problem has occurred. Also identify why the problem has not been noticed previously. All causes shall be verified or proven unidentifiable. One can use the five whys technique in this step.

D5: **Choose and Verify Permanent Corrections (PCs) for Problem**: Through preproduction testing, verify that the selected correction will resolve the problem for the customer.

D6: **Implement and Validate Corrective Actions**: Implement the best corrective actions.

D7: **Take Preventive Measures**: Modify the management systems, operation systems, work instructions, and operating procedures to prevent recurrence of this and all similar problems.

D8: **Congratulate Your Team**: Recognize the efforts of the team. The team should be formally thanked by the organization.

ERROR PROOFING (*See also* poka-yoke, jidoka): 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.

FISHBONE DIAGRAM: (Ishikawa diagram): The fishbone diagram is used to determine cause and effect of a defect or other issue in a product or process. It is named “fishbone” because it looks like a fish skeleton with the head still on. It is used in product design and process improvement as well as prevention of reoccurrence of problems. It highlights the four to six main precipitating items that cause defects: people, methods, machines, materials, measurements, and environment. It has many variants depending on the application area and industry; however, the concept is straightforward: using a knowledgeable team, identify and categorize the causes of a problem and take standard steps to resolve the problem once and for all. It is similar to the 8-D process for problem solving and is used in many industries. It was created originally by Kaoru Ishikawa in 1968 as a tool in problem solving in quality system deployment.

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

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

FIVE WHYs (5 whys): The process of getting to the root cause of a problem. It is the experience of TPS people that you must ask "why" several times to truly get to the basic cause of the problem. So it's necessary to ask "why" again and again until both parties are satisfied that the true cause of the problem has been found. Asking "why" five times generally suffices.

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.

GENBA OR GEMBA: Means "go see" or "go to the source."

GENCHI GEMBUTSU: Means almost the same thing as gemba: go out to the factory floor and see what is actually happening rather than looking at data in the office.

HEIJUNKA: The deployment of matched goals throughout the organization or process. The balancing of a line so that the average value-added time is the same for each stage of the process. This can also be achieved by having people move back and forth on the line spending more time on the average at one stage of the process than others. This requires cross-training, of course.

HOSHIN KANRI: The process of determining and deploying goals and plans throughout an organization that are integrated and consistent. Hoshin Kanri means direction of a compass needle along the planned direction. Its English equivalent is "goal deployment." It is also called policy deployment. Hoshin Kanri is part of a total quality management system that provides integrated and common direction to an organization so that everyone is pulling toward the same goals. It is probably the origin of the Plan-Do-Check-Adjust cycle common to Six Sigma and management by objectives.

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 SHOPS: [needs definition]

KAIZEN: The process whereby teams attack a manufacturing or service function or operation to make quick, small steps to improve processes. It is also the process by which such small improvements are continued. Standardized work is the result of kaizens. Continuous improvement is institutionalized by the kaizen process. Kaizen events usually last for one to two days and are staffed by both hourly and staff people in teams. Value stream mapping is often used to facilitate kaizen event identification. Wastes are found in a current state map. The kaizen even focuses on one area of waste to make

improvements and generate a new process map with the improvement. This map then becomes the new current state map upon which the next future state map can be hypothesized.

KANBAN: A card indicating demand for replacement parts or items. It is usually supplied by the customer to the supplier who then delivers the requested parts and picks up another card asking for the next supply. Visual kanbans (or supermarkets) are slots in WIP storage areas that indicate that a supplier should deliver just enough parts to fill the slot.

KIAKAKA: A large kaizen that takes significantly more time and resources than the typical improvement event.

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**.**

LEAN ENTERPRISE: Denotes a company that has implemented the Toyota Production System and advanced quality systems in all its functions, including corporate and staff functions, as well as in all service and operations environments.

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: THROUGHPUT = INVENTORY divided by FLOW TIME.

MASS CUSTOMIZATION: Operations that can produce a broad spectrum of products within a product family at almost the same value-added cost as producing identical products. GM's Alfred Sloan began this revolution by differentiating the various models by color, styling, and interiors on assembly lines where the choice of parts at any point on the line was limited to just a few items. The assembly line moved at the same speed as one that produced all the same cars and required very few if any more workers. Dell does that now in PC production with the assembly and shipping cost almost identical for a wide choice of configurations. Any process that produces custom products near the same cost as mass production.

MRO (Maintenance, Repair, and Operations): Those components and parts not associated with the direct material for a product. Tools, gloves, lubricants, and machine maintenance parts are examples of MRO.

MRP (Material Resource 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 not all parts can 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. Also, 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 set up because it requires and evaluation and possible change of all business practices.

MRP II: An advanced version of MRP that integrates the whole value chain in planning material orders, production, scheduling, and shipments.

MUDA, MURA, MURI: Three Japanese words used in lean. Muda—waste; mura—unreasonable, not natural, excessive; muri—uneven, irregular. Reducing waste, ferreting out the excessive, and making things regular and even are basic concepts in TPS and lean.

OM (Operations Management) TRIANGLE: This term is used to characterize the tradeoffs necessary when variability is present in an operation. One must pay in lower utilization or higher inventory when variability is present—you cannot have variability without lowering utilization, increasing inventory, or both. In other words, you must "pay" variability costs.

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.

PDCA (Plan, do, check, adjust [or act]): Action steps in a procedure to solve a problem. Used as a standard problem-solving tool.

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 utilizationρ, c servers, and input and demand coefficients of variation, the buffer inventory is:

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

POKA-YOKE (*See also* error proofing, jidoka): Error (or mistake) 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 or a machine if it has a quality defect as a result of the machine or operator action. Thus, defects are not propagated further in the production process. The defect must be corrected prior to release of the product from the activity.

PRODUCTION PART APPROVAL PROCESS (PPAP): The automotive industry standard process for approving parts by suppliers. This process requires that the supplier show that the quality, reliability, and performance specifications for parts and systems meet the customer requirements. It requires that the parts or systems be verified off production tools and processes, not prototypes. If any significant change is to be instituted in the production process, a new PPAP is required to show that

the changes do not affect the performance or quality of the parts. It is an Automotive Industry Action Group (AIAG) standard process.

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* push system.)

The idea is to produce what the customer requires. The main challenge in implementing this system comes when looking at the supply side of raw materials as well as the efficiency of the plants. A company that relies on JIT needs to have suppliers that can supply raw materials on 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. They require what is referred to as the seven zeros (listed below) that are essential for the success of this system. The implementation of this system took Toyota over 30 years to perfect. However, the trend seems to be going toward 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 helps companies to be more dynamic, flexible, and competitive in the industry.

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

The main disadvantage of the system comes when the plants have to keep excess inventory or have long lead times for the customers. Inventory costs money and long lead times lead to 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.

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.

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.

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 may 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.

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 engineered 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.

ROOT CAUSE ANALYSIS: [definition missing]

ROUTINGS: Routings are the sequences 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.

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 (7 0's): The TPS "zero" concepts to achieve perfect quality:

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 a 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 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 to $100 per hour. It is used to estimate the cost for bidding for new business.

SINGLE PIECE PRODUCTION: The 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 50 to 100 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 150 million-dollar sales per year, and Lear had less. In 1998, both Lear and JCI were above nine billion dollars in sales.

SIX SIGMA: A system to reduce variations in a process to less than five parts per million. It rigorously analyzes a process to understand and correct variations in a systemic way based on data. This system has evolved to the total quality system for many companies. It is based originally on Deming's SPC work.

STATISTICAL PROCESS CONTROL (SPC): 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.

SUPERMARKET: The 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.

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

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

THROUGHPUT: The production rate of a process or activity measured in units, money, or flow per unit time. Throughput divided by capacity equals utilization. Inventory divided by throughput gives cycle time. (*See* Little's Law.)

TOYOTA PRODUCTION SYSTEM (TPS): Toyota Motor Company developed a comprehensive business system that produced the remarkable results in quality, productivity, and continuous improvement for which Toyota's products and services are known. This system led to the "lean" manufacturing and "lean" enterprise concepts in the U.S. and Europe. It has also spawned numerous 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.

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 as a result of 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 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. The best lean plants designate all processes as either value-added or waste.

VALUE STREAM MAPPING (VSM): The process of mapping with standard symbols the current state of a process from supplier to customer. This tool is used to identify waste and to develop a future state map that is the blueprint for change. Kaizen events are often used to both develop the current and future state maps and to implement short-term changes. The process focuses a team on the value-added activities in the process so that waste can be identified and removed.

VARIABILITY: The variations in any portion of an operation: demand, processes, activities, supplier performance, quality, etc. Every manager's responsibility is to reduce variability in operations. (*See also* coefficients of variation.)

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 or 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 and fixture storage, and orders 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. Visual management implies that the visual system is the primary means of managing schedules, teams, and events, as opposed to a back-up system. Visual management simplifies management, since peer pressure induces people to perform as visually indicated.

WATER SPIDER: The person delivering material to a process on a JIT basis. Term derives from the spider that floats on the water, darting here and there to feed.

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 semi-finished 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.