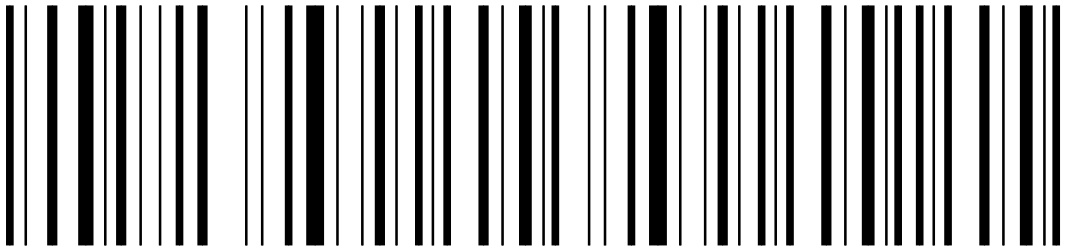
Bar Codes and Manufacturing



APPLICATION WHITE PAPER

Zebra Technologies

Bar Codes in the Manufacturing Process

Ever since the Wrigley Company put a Universal Product Code (UPC) label on a pack of gum, bar codes have been a key component of the retail industry. More recently, the industrial sector has applied bar coding solutions to the manufacturing, warehousing and distribution of goods.

The most recognized use of bar code symbologies in industry is for compliance labeling. This document takes you further into a manufacturing facility and provides an overview of the many, growing applications for bar coding in the manufacturing process.

Compliance Labeling

Manufacturers' shipping labels are often designed to meet the needs of their customers. Retailers like Wal-Mart and K-Mart require compliance labels on all incoming packaging. Today, compliance labeling is mandated by industry groups such as:

- AIAG (Automotive Industry Action Group)
- EIA (Electronic Industries Association)

or by regulatory/ safety bodies such as:

- DOT (Department of Transportation)
- NFPA (National Fire Prevention Association) for the chemical industry

Compliance requirements also are useful within a manufacturer's own facility. Bar codes on compliance labels identify the product serial number and other important product information. Bar code scanners or data collection terminals read this information and communicate with a computer host that processes the data. Bar code scanning improves the accuracy and the timeliness of the data.

Two Types of Manufacturing

There are two basic types of manufacturing: discrete and process. Discrete manufacturing (e.g., automobile manufacturing) relies on a Bill of Materials to identify the large number of specific parts or subassemblies and their quantities. Process manufacturing (e.g., chemical processing) is formula-based. It relies on weights and measures (pounds or gallons) of raw ingredients. In both cases, bar coding is used to identify component parts or containers of ingredients, work-in-process, finished goods inventory and products packaged for shipping.

Manufacturing and the Supply Chain

Manufacturing businesses depend on a well-coordinated chain of events to make their operations work effectively. Many companies initiated bar code labeling at the shipping dock to support their customers' compliance requirements. Today's business software packages (Enterprise Resource Planning (ERP) solutions from SAP, JD Edwards or Baan) depend on bar coding and data collection systems to provide information crucial to the entire manufacturing operation. As more companies turn to enterprise-wide software for process improvement and cost reduction, there is a significant opportunity to help these companies add bar coding throughout their manufacturing facilities.

What follows is a step-by-step journey through a typical manufacturing facility. At each step, we'll explain how and why bar coding is used.

Step 1: Receiving

Raw materials or sub-assemblies arriving at a manufacturer's receiving dock have bar code labels on their packaging to meet the company's requirements. Otherwise, the receiving department logs in the item and generates a 4" x 6" or smaller bar code label to identify the material before it is moved to an inventory location or inspection station.

Step 2: Raw Material Inventory

A warehouse operator transfers the material to an inventory location. These sites often are identified with bar codes printed on reflective labels. The reflective material (such as Zebra's RetroScan 4000 labels) improves readability from fork trucks up to 30 feet away. Bar codes are necessary because the operator scans both the package and the new storage location to complete the transfer operation and record it in the system.

Step 3: Picking

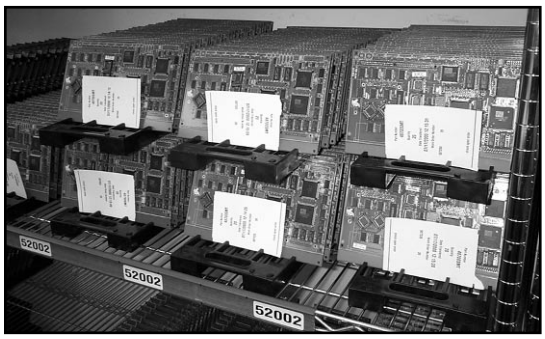
A work order from the factory floor signals the picking operation to retrieve raw materials or parts from inventory. The fork truck operator is directed to the exact inventory location where the material is located and told how many of each part to pick. Bar codes are scanned again to complete the transfer operation. In some cases, inventory labels may need to be updated or corrected in the warehouse to replace damaged labels or to identify a change in quantity. Mobile printers mounted to lift trucks simplify this operation.

Step 4: Work-in-Process (WIP)

The picked materials are checked to confirm the right parts and quantities were picked. Bar codes on each item are scanned for confirmation. As the parts are used in the assembly process, bar codes enable part tracking throughout the process — showing that it was consumed in an assembly, or was set aside due to a defect or other issue. As parts become assemblies, additional bar code labels can be added to identify and track the assembly by its new part number.

In some process manufacturing, bar code labels are used to identify transitions between lots or batches. For example, in paper, film, or coatings manufacturing, splices can be required between batches used to complete a master roll of material. The splice point is identified with a bar code label that identifies the time and batch number of the new material.

Step 5: Product Identification



Thermal transfer printing also is used to print nameplate identification labels on-demand with serial number information and/or UL/CSA regulatory content. Synthetic label materials ensure the durability of the image and the label's longevity. For electrical products, labels with UL/CSA logos or content are unique because only specific label supplies tested by UL or CSA are approved. More than 300 combinations of Zebra® labels and ribbons are tested and UL/CSA-approved for this purpose. Pre-approved label and ribbon combinations from Zebra can save manufacturers extensive paperwork and product delays when they need a new type of label or one for a new application. Contact a Zebra supplies specialist when regulatory requirements exist for a label application.

Step 6: Finished Goods

At the completion of the packaged assembly in discrete manufacturing, or the packaging of the product in process manufacturing, bar codes are used to identify the package contents. If no sales order for this product exists, the fork truck operator collects the package and takes it to a finished goods warehouse location for inventory. Bar codes on the product and at the warehouse location are scanned to complete the transfer operation.

A customer's sales order signals the picking operation to retrieve the product from finished goods inventory. Thanks to the information retrieved from the bar code, the operator knows the precise inventory location and picks the inventory for shipping. Bar codes are scanned to confirm the correct item was picked and to record the transfer to the shipping department.

Step 7: Shipping

The bar code on the package is scanned in the shipping department to acknowledge receipt. New labels are printed with shipping information. These labels are typically 4" x 6" paper labels with customer- or carrier-specific compliance formats. Compliance formats may include 2D symbologies such as PDF-417 found in the latest GM 1724A Compliance Label Mandate or UPS' Maxicode.

If a number of labeled packages are combined on a pallet and shrink-wrapped, a larger, master label is often required for the pallet. Paper labels are commonly used for these applications, but synthetic master labels should be specified if the shrink-wrapping is recyclable (such as Zebra PolyO™ 2000).

Other regulatory or environmental requirements may impact the label format and content, or the label materials. Local and federal U.S. Department of Transportation (DOT) and National Fire Protection Association (NFPA) regulations, for example, mandate the labeling of chemical packaging and containers used in transportation. Although many of these labels contain fixed information, on-demand, thermal transfer printing onto preprinted label materials can provide a substantial cost savings by reducing the storage of expensive label inventory and waste that occurs when adhesive backings degrade.

E-Commerce

The impact of e-commerce has reached far beyond consumers purchasing books and compact discs online. Business-to-business online purchasing now accounts for the bulk of e-commerce transactions, and it is steadily increasing. Today, instead of a small number of large, infrequent product shipments to a distributor, manufacturers often are asked to drop-ship individual packages directly to the end-users. As a result, the number of shipments (and shipping labels) required is dramatically higher.

JIT Purchasing

To reduce inventory levels and overall inventory carrying costs, resellers are pushing much of their earlier stocking levels of inventory back to the manufacturer and demanding faster response to their orders. Manufacturers are responding similarly with their parts suppliers. To avoid stock-outs or production downtime, manufacturers and other supply chain participants are investing heavily in methods that deliver inventory Just In Time (JIT)—the precise quantity of the specific product required, at precisely the time it is needed. As a result, JIT purchasing and enterprise system demands rely on bar code reading and printing to track products efficiently.

This improvement in tracking lowers Economic Order Quantity (EOQ) requirements by notifying part suppliers earlier about inventory replenishment requirements (EOQ levels alert purchasing to reorder parts). The result is lower inventory carrying costs, higher inventory turnover rates, reduced misplaced inventory and more room to manufacture product cost-effectively.

ERP and WMS Systems

Major manufacturers have implemented or at least initiated an ERP warehouse management systems (WMS), or related software system to manage their enterprise. These systems allow JIT purchasing to work by tracking process components throughout the Supply Chain. By knowing what is required by when, and what is available from where, the ERP system optimizes the timing and efficiency of the purchasing, production, and fulfillment components of its business.

This system investment completely depends on the ability to track each component part, subassembly, and finished product from the raw material supplier to the end-user. Data collection for each transaction is critical in providing the ERP system with continuous status updates. Likewise, the necessary data collection steps are not possible unless bar code printing is provided for each component part, subassembly, and finished product. Bar codes are the keystone of the ERP system. The result: both the parts labeling volume and the number of locations that perform bar code printing within a manufacturing plant increase.

A large number of manufacturers have initiated the implementation of an ERP system, although it is likely that they have not yet determined their label printer hardware requirements. That's because is often takes between two and four years before these companies have the budget available to select their printing solutions. Only in a project's second phase will middleware vendors specify the data collection and label printing hardware for the selected ERP solution. Enabling printers to connect to many ERP systems without expensive modifications or custom programming. This is a key selling point when talking to a manufacturer about their bar code printing needs.

Wireless Communication and Network Administration

Wireless communication in manufacturing is growing rapidly because it allows real-time data collection in remote portions of the plant. With wireless technology, label printers can operate on location, eliminating the need for an employee to run back and forth between a centrally located printer and the point requiring a label. For example, mobile printers with wireless RF communication capabilities are mounted on warehouse forklifts to provide on-demand printing whenever and wherever a label is needed. The information is uploaded immediately to the ERP system instead of synchronizing at a shift change. This increases productivity and reduces errors.

The growing use of networked peripherals, such as printers within ERP and other systems, increases the importance of network administration. Managing the network by remotely configuring or monitoring printers, or updating label formats, will become increasingly valuable in the future. Communication by the printer of situations requiring attention, such as the completion of a roll of labels, will be more critical to the efficient operation of the plant.

Thermal Transfer Printing Preferred for On-Demand Applications

Of all the methods available for printing bar codes, thermal transfer technology is preferred for on-demand applications. Thermal transfer printing consistently generates crisp, clear lines and spaces for the highest read rates with today's scanning technologies. Unlike laser or dot matrix printing, which wears over time, thermal transfer printing is long-lasting.

Thermal transfer printing also is the best choice for immediate, on-demand printing. It is fast (up to 12 ips), inexpensive, and offers the greatest flexibility for placing bar codes on different kinds of labels, or on products and packages of different sizes and shapes.

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.

Agile manufacturing strategies: 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. And, in the broadest sense, it includes the ability to react quickly to technical or environmental surprises.

Annual inventory turns: A measure of asset management that is calculated by dividing the annual cost of goods sold (for the most recent full year) by the average on-hand total inventory value at plant cost. Total inventory includes raw materials, work in process, and finished goods. Plant cost includes material, labor, and plant overhead.

Bar coding: A coding system used to identify products or packages by encoding identification data in a printed pattern that is then placed on an object. Data is retrieved with an electronic scanning device linked to a computer. Bar coding is frequently used by manufacturers for inventory control.

Bottleneck: Any point in manufacturing operations at which movement is slowed because demand placed on a resource is equal to or more than capacity.

Cellular manufacturing: A manufacturing approach in which equipment and workstations are arranged to facilitate small-lot, continuous-flow production—often in a U-shaped cell. 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, hence, able to perform multiple tasks as needed.

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

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.

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

Computer-integrated manufacturing (CIM): A variety of approaches in which computer systems communicate or "interoperate" over a 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 to equipment or operators, 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 the above.

Computerized maintenance management: 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, thus preventing unscheduled machine downtime and optimizing a plant's ability to process product at optimum volumes and required quality levels.

Computerized SPC: See "statistical process control."

Constraint: Anything that restricts a system's ability to reach its goal.

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.

Cross-functional teams: Teams of employees representing different functional disciplines and/or different process segments who 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 leadtime: The time elapsed from receipt of an order until the finished product is either shipped or delivered to the customer.

Cycle time: See "manufacturing cycle time."

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.

Downsizing: A reduction in the number of employees that occurs due to management decision, not associated with natural attrition.

Electronic Data Interchange (EDI) links: Information-system linkages, based on communication protocols and document formats, which permit intercompany computer-to-computer communications. EDI links not only speed communication, but also eliminate rekeying of information and reduce 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 often are facilitated through "electronic mailbox" systems on third-party value-added networks.

Empowered work teams: Empowered teams share a common workspace and/or responsibility for a particular process or process segment. Typically empowered 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. Empowered work teams typically do not assume traditional managerial responsibilities.

Enterprise resource planning (ERP) system: An extension of MRP II software. 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; and, in a fully deployed mode, ERP systems facilitate capture of transactional data into data warehouses to support executive decision-making systems.

Extranet: A seclusionary Internet-like network that securely connects customers and suppliers to a corporate or plant intranet in order to access information deemed shareable by the intranet operators.

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.

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

Finished-product first-pass yield: The percentage of finished products that meet all quality-related specifications at a final test point. In process industries, yield often is calculated as the percentage of output that meets target-grade specifications (excluding saleable "off-grade" product).

Focused-factory production: A plant configuration and organization structure in which equipment and manpower is 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: Software that provides front-end input to master production scheduling systems and helps to 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.

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

Intranet: A secure, internal corporate Internet-based network.

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.

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 departs annually—or an annualized rate of employee departures. High turnover rates often indicate employee dissatisfaction with either working conditions or compensation.

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 typically does not include purchased-materials costs or costs related to sales and other nonproduction functions.

Manufacturing cycle time: The length of time from the start of production and assembly operations for a particular (finished) product to the completion of all manufacturing, assembly, and testing for that product or specific customer order. (Does not include front-end order-entry time or engineering time spent on customized configuration of nonstandard items.)

Manufacturing execution systems (MES): Software-based systems that provide 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.

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.

On-time delivery rate: The percentage of time that ordered products are received by customers by the specified time or date. Some plants will base this calculation on the date "promised" to customers, but better facilities typically will calculate it against dates "requested" by customers.

Outsourcing: Shifting of production work or support activities to an outside (third-party) supplier.

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

Predictive maintenance: Practices that seek to prevent unscheduled machine 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.

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

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). Such products typically are measured by weight, volume, or length rather than by distinct numeric quantities.

Product data management (PDM): Software-based systems that link, manage, and organize product-related data from various sources : both internally and externally (from 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, cross-functional communications, and support services.

Productivity: The primary definition here is annual dollar value of shipments 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.

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

QS 9000: A common quality certification program for auto industry suppliers. Developed by the Big Three automakers, it includes ISO 9000 as a baseline.

Raw-materials turn rate: A measure of asset management that typically is calculated by dividing the annual cost of goods sold (for the most recent full year) by the average on-hand 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 to keep production processes operating within quality parameters.

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 reportables or lost-workday rates.

Self-directed 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 purchasing, training, quality assurance, performance appraisals, and customer service.

Standard Industrial Classification (SIC) code: A coding system of the U.S. government used to identify specific economic sectors. Coding for manufacturers encompasses the two-digit numbers of 20 through 39.

Statistical process control (SPC): Use of variation analysis, with manual or computerized control charts, to detect irregular 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 are exceeded (or are about to be exceeded) and corrective actions are 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."

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 (or "poka-yoke" methods).

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

WIP turn rate: A measure of the speed at which work-in-process moves through a plant. Typically calculated by dividing the annual cost of goods sold (for the most recent full year) by the average on-hand 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.

Notes

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