Inventory Tracking vs Materials Traceability

Introduction

Tracking materials using conventional inventory tracking, warehouse management, and ERP systems is becoming increasingly problematic due to rapidly increasing requirements for supply-chain data exchange, especially in the area of materials traceability. This has resulted in an "explosion" of work-arounds using paper forms, Excel spreadsheets, and manual data entry into computers, which can cost large amounts of money in labor costs and can be the cause of many operational mistakes.

This white paper looks at the complexities of tracking inventory, with a focus on manufacturers, industrial distributors, defense contractors, and other industrial, food, pharmaceutical, and medical organizations that need materials traceability.

It recommends replacing the traditional tracking of inventory by location with the adoption of "license-plate" container tracking principles, such as those described in the GS1 standard for global supply chain tracking, and is also as used by Fedex and UPS for package delivery.

What do we mean by Inventory?

In a manufacturing or similar industrial operation, inventory refers to raw materials, partially finished products, work-in-progress and finished products, prior to shipment. In a warehouse or distribution operation this simplifies to the products held within the warehouse, although there may be complexities such as kitting, packing, and labeling going on, which can make these operations seem more like manufacturing operations.

From an accounting viewpoint, an organization is interested in the total quantity of each part an organization has in stock and its value. From a Materials Requirements Planning (MRP) viewpoint, an organization is interested in the quantity of inventory available (or predicted to be available) for conversion into finished products, for shipments to customers, according to a sales and operations forecast. From an Enterprise Resource Planning (ERP) viewpoint this extends to inventory in multiple facilities to be consumed by multiple plants in producing intermediate and finished products.

From an operations viewpoint, material handlers need to be able to quickly locate and pick inventory for use in production processes or shipment to the customer. While knowing the total quantity in stock or in a warehouse may be useful for financial or MRP/ERP purposes it does not help the material handler quickly locate the correct material in a FIFO or age first order from among thousands of possible warehouse locations. It also does not help in managing the rapid replenishment of commonly used inventory retained in each work cell for ease of production.

From a materials traceability viewpoint, we are interested in which raw materials get transformed into which intermediate products and then into finished products that are shipped to specific

customers. This is so that we can trace forward from a defective raw product to a finished product shipped to a customer and from a defective finished product to the intermediate and raw materials that went into it.

As a result, what you mean by inventory tracking depends on your perspective, whether it be financial, materials planning, operations tracking, or materials traceability.

Tracking Inventory

How we track inventory depends on our objectives. If we simply want to have an accurate financial accounting of the value of our inventory, then the simplest way is to go around the warehouse and count the quantity of inventory that an organization has in stock at the end of each accounting period, assign some unit value to it (a black-magic art all of its own), and post appropriate adjustments to general ledger accounts in the accounting system.

If we want to track inventory from an MRP or ERP viewpoint then we simply need to check inventory into and out of each warehouse, stock room, and other storage facility so that we know the net amount on hand whenever we want to do an MRP run to project what materials the organization needs to buy or make to fulfill its sales and operations plan (a fictitious plan dreamt up by sales people based on overly optimistic forecasts and modified by pessimistic operations people based on their experience with prior sales forecasts).

From an operational viewpoint, we need to track where inventory is located on warehouse racks and shelves as well as on floor locations. This is the realm of Warehouse Management Systems (WMS) and Inventory Tracking Systems which typically use barcode tracking and mobile computing technology to track whenever materials are added to or removed from a specific warehouse shelf, rack, or floor location. These systems typically track the quantity of each part at each location to enable quickly finding parts for production or shipment to customers.

These systems typically use location barcodes on shelves, racks, and hung over floor locations, which are scanned to record when materials are added or subtracted from each location. These systems work well when each part number has its own location and parts do not need to be tracked by serial or lot number, expiration date, or other characteristics such as length and/or width. Many of these systems have problems when the same part stored in different locations, especially when the parts are of different age have different expiration dates. These systems also typically fail to take account of inventory in KanBan bins and floor stock locations.

As a result, simple Inventory Tracking Systems and WMS systems work well for those stock rooms and warehouses where simply knowing the quantity of materials at each location in the stock room or warehouse is enough. This encompasses most "retail" distribution warehouses but excludes their use in most manufacturing applications, as well as the in distribution of food, pharmaceuticals, medical, and other products that need traceability, especially where kitting, packing and labeling operations occur.

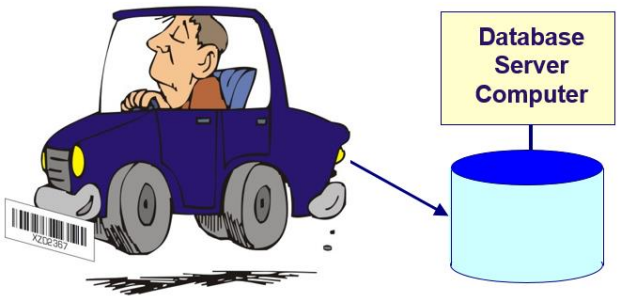
So how do we integrate all these competing inventory tracking requirements?

If all we need to do is to track the value of inventory, or the quantity of inventory at a location, then simple inventory tracking or warehouse management systems will provide an adequate solution. But as soon as we need to track inventory by lot and serial number, expiration date and other characteristics, such as length and width, then these system fail to meet the needs of manufacturers, industrial distributors, defense contractors, and other industrial, food, and medical organizations.

Some ERP systems attempt to "patch" over this problem by tracking inventory by location (for financial and MRP purposes) and then having subsidiary tables for quantities by location, serial number and date entered into inventory. But this becomes very cumbersome to maintain, especially as most of the data entry in all of these tables has to be performed manually. As a result, most ERP system deployments use large "locations" such as "Warehouse A", "Warehouse B", etc. to avoid the problem of having to do data entry whenever a product is moved from a storage location to a picking bin within the warehouse.

We propose instead, that manufacturers, industrial distributors, defense contractors and other industrial, food, and medical organizations should adopt the principles used by the GS1 standard for shipment of products in the global supply chain, as well as by Fedex and UPS.

This principle is based on the use of "License-Plate-Number" tracking where each container of material we need to track is identified by a unique tracking barcode, and then all the data about the contents of that container, such as the part number, quantity, lot number, age and cost are stored in a database and can be exchanged electronically over the Internet.



This so-called "license-plate-number" tracking gets its name by analogy to license plates on cars and trucks which simply contain the state of issue (the originator) and a sequence of letters and numbers that uniquely identify the container (car or truck) to which it is attached. All the important data about the vehicle and its owner is stored in a data base from which the data can be readily retrieved by simply entering the license plate number. Note that in license-plate tracking there is no data stored in the barcode beyond the issuer and the assigned unique identifier.

In manufacturing, we track the movement of each container of raw materials from when it is received and put away, to when some or all of its contents are consumed in the manufacture of another product. This product is then put into a container, with its own license-plate tracking barcode, which is scanned to track the product into warehouse and again when the finished product is shipped to a customer. This gives the manufacturing organization the traceability data it needs to quickly determine the source of defects and to recall defective products, if needed.

Note that this use of container tracking is very different from tracking inventory at a location. It enables us to associate characteristics like supplier, lot number, age and expiration dates with the

materials in the container. It also enables us to simply record the movement of the container from location to location by simply scanning the tracking barcode on a container and scanning the location barcode on the shelf, rack, or floor location. This is far simpler than recording the withdrawal of inventory from one location and its entry into another location.

By using container based tracking, we are able to meet the requirements of material handlers to quickly locate materials in age first or FIFO order or even to match parts from the same lot number, even though the same part may be stored in containers in multiple different locations. In fact, when picking materials, the material handlers are guided by systems like BellHawk to the locations from which to pick materials based on their age, lot number, quality inspection status, and other characteristics. This guidance is provided on the screens of their mobile computers as they proceed through the picking process.

We can also add up the quantities and costs of all the materials in each container in each warehouse or other facility and export these to accounting, MRP, and ERP systems for use in inventory value accounting and for materials requirements planning purposes.

We thus see that container tracking is able to meet all the complex inventory tracking requirements of manufacturers, industrial distributors, defense contractors, and other industrial, food, and medical organizations while still satisfying their need to accurately account for inventory value and to perform materials requirements planning.

Extending Container Tracking Principles

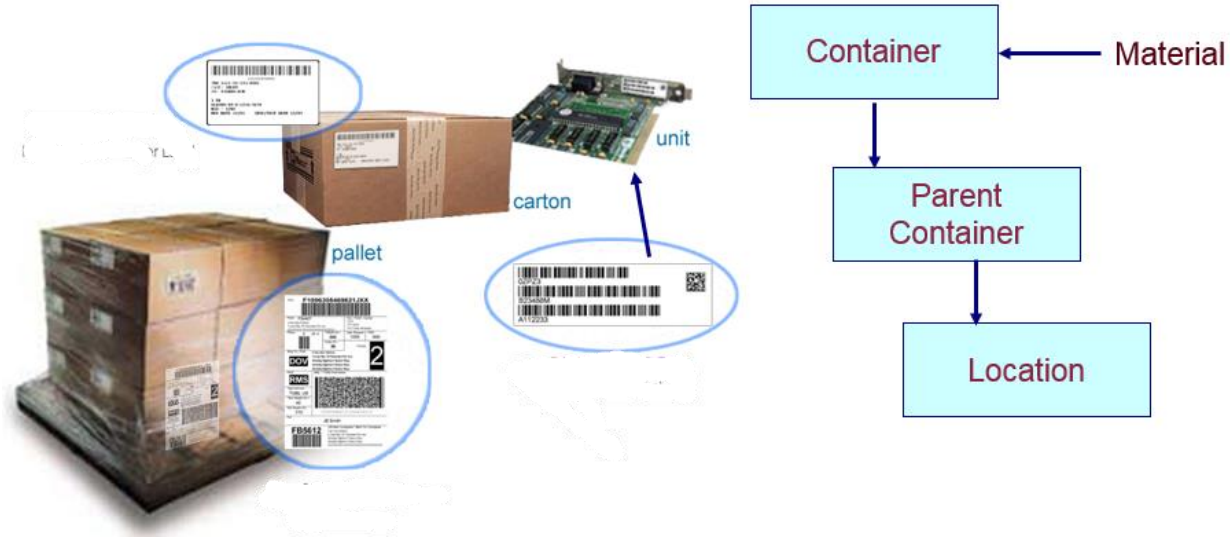
While tracking containers with "license-plate" tracking barcodes is at the heart of inventory tracking systems like BellHawk, we do need to extend the principle to make it truly useful. Some of the ways that we do this are:

1. Recognizing that "containers" come in many forms, besides boxes, pallets, cans and the like. This includes rolls, reels, and spools that hold quantities of materials but are not strictly containers in the common sense of use.

2. Tracking items with their own tracking barcodes. These include items such as large electric motors and medical instruments as well as electromechanical sub-assemblies that typically have their own serial number. Here we attach tracking barcodes directly to the items as well as, possibly, to the container in which they are packed.

3. Tracking items in "virtual" containers. This includes materials stored as "loose" material at a location or materials stored in boxes, and the like, which do not have tracking barcodes. We track these virtual containers with their own unique tracking "license-plate" tracking number but they do not have a barcode label. A system like BellHawk is still able to track this inventory by lot number, expiration date and other characteristics and allow for picking based on these characteristics.

4. Tracking nested containers. Here we introduce the concept of "parent" containers, such as pallets and shipping cartons that can contain a collection of "child" containers with tracking barcodes, virtual containers with different parts, and individually barcoded items. These parent containers can be nested to represent the packing of cartons on pallets, for example, as shown below.



When recording the packing of materials into a parent container, the license-plate tracking barcode on the containers or items are scanned or selected as they are being placed in the parent container. A tracking barcode label is then scanned, or is printed, and attached to the outside of the container. This parent container license-plate tracking barcode, such as on a carton, can then be scanned when the carton is placed on a pallet or in a shipping container.

The data recorded during this packing process then forms the basis for Advanced Shipment Notices (ASNs) which can then be sent by EDI or other means to the customer to which the pallet is shipped. Equally ASN data can be imported into BellHawk and used as the basis of receiving pallets or other shipping containers from suppliers.

When the materials are received, all that is necessary is to scan the license plate tracking barcode on the outermost container and all the materials specified in the ASN can be automatically received into inventory by BellHawk.

License-Plate-Number Container Tracking Barcodes

For internal use within an organization, simple barcode labels with serialized tracking numbers can be used. These can be purchased as pre-printed rolls, as shown here, or the organization can print their own. In this case we recommend that these internal-use-only labels have a barcode that is prepended by a # sign to avoid confusion with other barcodes.

For use on shipping containers we recommend that our clients use GS1 standard SSCC (serialized shipping container codes) barcodes which are globally unique license-plate tracking barcodes accepted throughout the global supply chain. There are exceptions (of course) such as the tracking barcodes used by FedEx and UPS and the DoD (Department of Defense) which uses its own variant of the GS1 standard.

Both internal use and GS1 standard barcode tracking labels can be printed on demand by the BellHawk software so that they can contain human readable information such as item description, quantity and lot number, as well as hazardous materials information.

License-plate tracking barcodes can also be placed on totes, carts, mixing vats, and other similar reusable containers so that these can be used as parent containers on a temporary basis. In this case the barcodes are typically made of laser etched metal and may have a ceramic cover to make them impervious to chemicals.

Commentary

We strongly recommend that manufacturers, industrial distributors, defense contractors, and other industrial, food, and medical organizations adopt Container Tracking principles for tracking their Inventory if their requirements are more complex than simply tracking the quantity of material at a location.

This will enable the organization to unify their inventory tracking for financial, materials planning, operational and traceability requirements. It will align their inventory tracking with the information exchange and barcode labeling requirements of the global supply chain. It will also enable the organization to meet the traceability requirements of standards organizations such as GS1 as well as US Government organizations such as the FDA.

Most importantly, container tracking methods, such as are used by the BellHawk software, have been shown to improve operational efficiency, result in Lean inventory, and to result in improved customer satisfaction

Authors

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Dr. Peter Green serves as the Technical Director of KnarrTek Inc. Dr Green obtained his BSC (Hons) in Electrical Engineering and his Ph.D. Degrees in Electronics and Computer Science from Leeds University in England. Subsequently Dr. Green was a senior member of technical staff at Massachusetts Institute of Technology and a Professor of Computer Engineering at Worcester Polytechnic Institute.

Dr Green is a Systems Architect who is an expert in using real-time artificial intelligence methods to implement real-time Inventory Tracking and Operations Management systems for Industrial Organizations. He has led the implementation of over 100 such systems over the past decade. Dr Green also led the team which developed the BellHawk job and materials tracking software, the MilramX decision support and intelligent information integration software platform.

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Eric Green serves as the Director of Support of KnarrTek Inc. Eric Green obtained is bachelor's degree from UMASS Dartmouth in Operations Management and Management Information Systems. Eric has been a part of 40 plus implementations of operations management systems over his 8 years of experience in this field. This includes receiving, production, inventory management, shipping, order management, as well as integrations with a number of ERP systems and a range of different manufacturing equipment.

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