Logistics Engineering and Management

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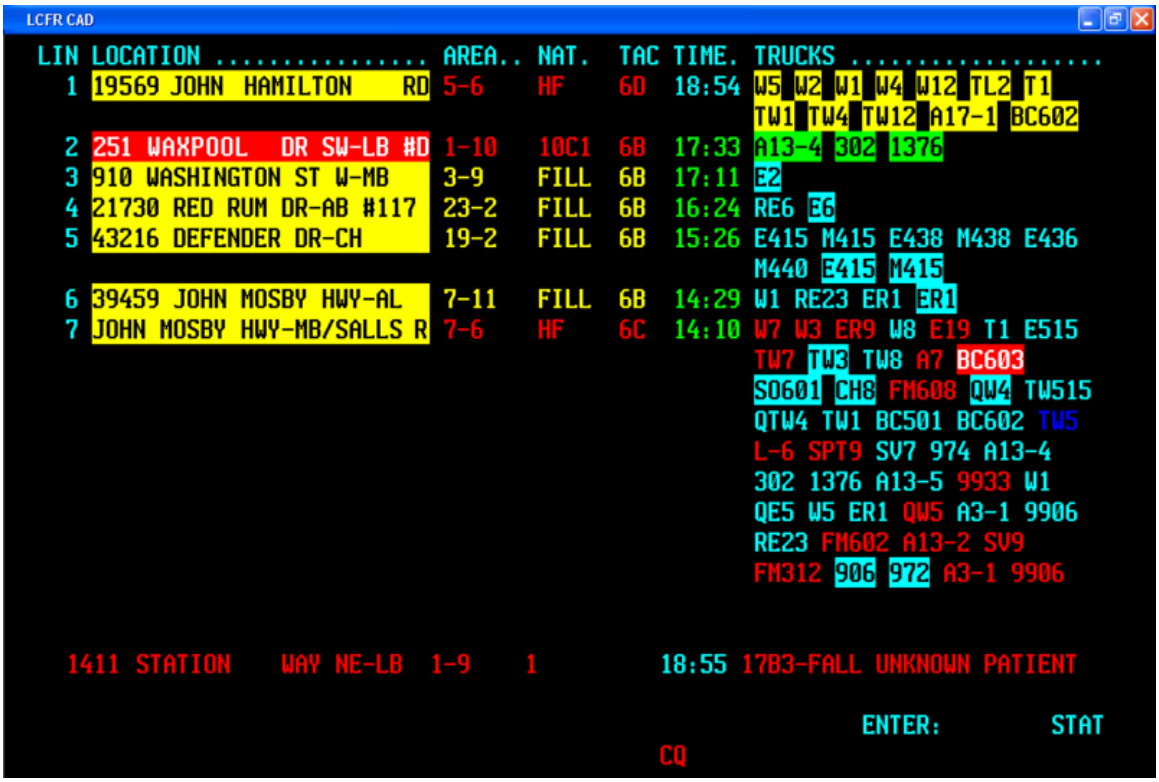
Chapter-1

Computer-aided Dispatch



The CAD system of a fire department on a busy day. The line at the bottom is about to be dispatched. (Note:addresses have been changed for privacy reasons.)

Computer-assisted dispatch, also called **Computer Aided Dispatch** (CAD), is a method of dispatching taxicabs, couriers, field service technicians, or emergency services assisted by computer. It can either be used to send messages to the dispatchee via a mobile data terminal (MDT) and/or used to store and retrieve data (i.e. radio logs, field interviews, client information, schedules, etc.). A dispatcher may announce the call details to field units over a two-way radio. Some systems communicate using a two-way radio system's selective calling features. CAD systems may send text messages with call-for-service details to alphanumeric pagers or wireless telephony text services like SMS. The central idea is that persons in a dispatch center are able to easily view and understand the status

of all units being dispatched. CAD provides displays and tools so that the dispatcher has an opportunity to handle calls-for-service as efficiently as possible.

CAD typically consists of a suite of software packages used to initiate public safety calls for service, dispatch, and maintain the status of responding resources in the field. It is generally used by emergency communications dispatchers, call-takers, and 911 operators in centralized, public-safety call centers, as well as by field personnel utilizing mobile data terminals (MDTs) or mobile data computers (MDCs).

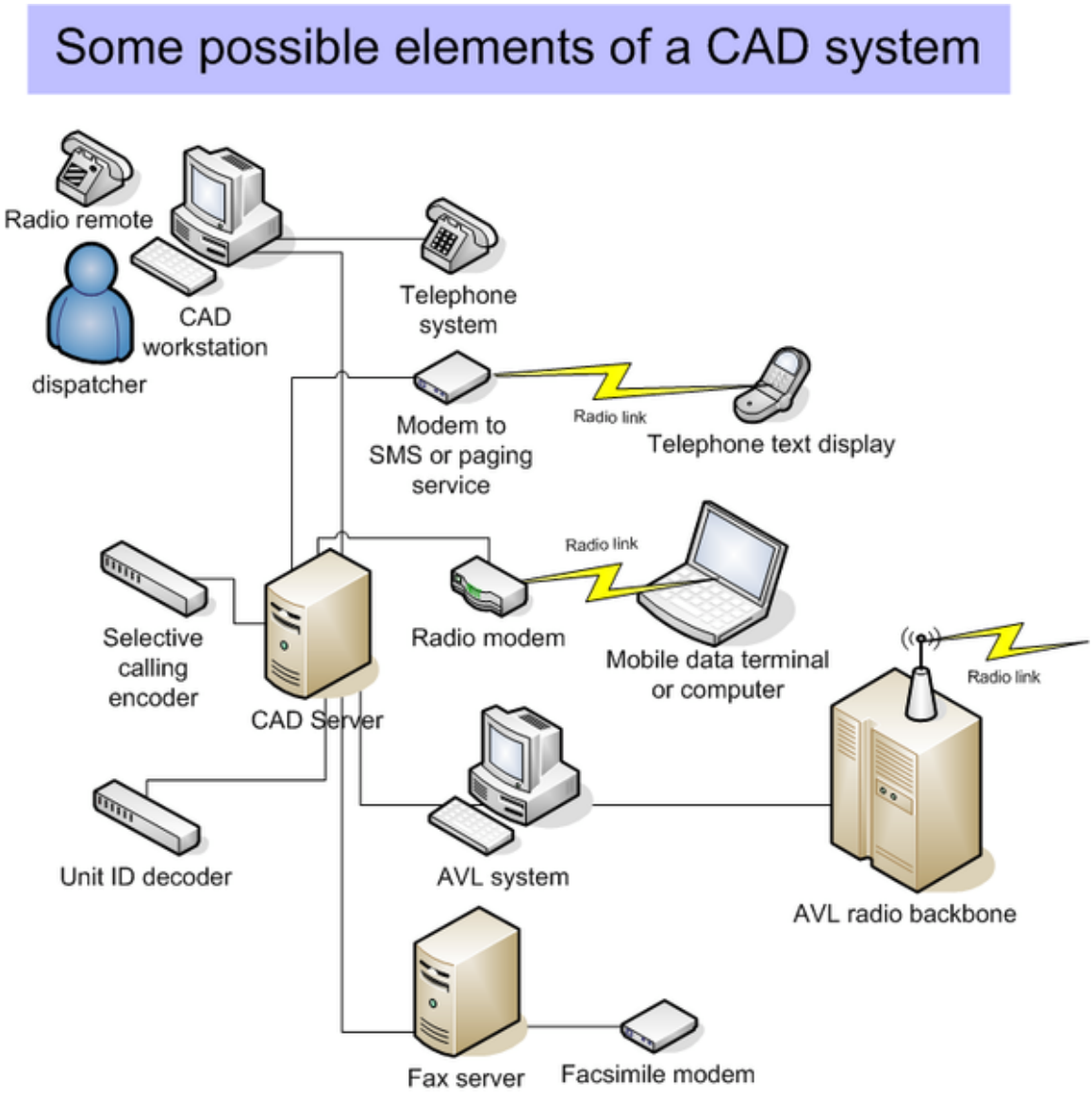
CAD systems consist of several modules that provide services at multiple levels in a dispatch center and in the field of public safety. These services include call input, call dispatching, call status maintenance, event notes, field unit status and tracking, and call resolution and disposition. CAD systems also include interfaces that permit the software to provide services to dispatchers, calltakers, and field personnel with respect to control and use of analog radio and telephony equipment, as well as logger-recorder functions.

Manual dispatching

Computer-assisted dispatching improves the efficiency and accuracy of each step of the manual process:

- The call taker records the details on a paper card and offers advice to the caller.
- The paper card is passed by hand or sent on a conveyor belt or pneumatic tube to the dispatcher.
- The dispatcher allocates the task to one or more available mobile units depending on each units capability and location.
- The dispatcher passes the details of the task to the mobile unit by reading the details over two-way radio or telephone.
- The mobile unit advises the dispatcher of their progress through the task till its completion which are recorded on a paper log.
- Paper logs can be reviewed afterwards for accounting for services and investigating problems with service delivery.

Methodology



CAD systems may be interconnected with automatic vehicle location systems, mobile data terminals, office telephones, and selective calling and push-to-talk ID.

Computer-assisted dispatch systems use one or more servers located in a central dispatch office, which communicate with computer terminals in a Communications Center or with mobile data terminals installed police vehicles. There are a multitude of CAD programs that suit different department needs, but the fundamentals of each system are the same. They include:

- Log On/Off times of Police Personnel (sworn/non-sworn)
- Generating and archiving incidents that begin with a phone call from a citizen or originate from personnel in the field
- Assigning field personnel to incidents

- Updating Incidents and logging those updates
- Generating Case Numbers for incidents that require an investigation
- Timestamping every action taken by the dispatcher at the terminal

In an ideal setting, a call is received by a call-taker and information about the call is inputted into the CAD template. Simply, Location, Reporting Party and Incident are the main fields that have to be populated by type-codes. For example, if there was a Burglary in progress, the type-code for that Incident could be "BURG"; when BURG is typed out, then the program will spell out "BURGLARY (in progress)". If the Location was at the 1400 block of Madison, the type-code could be "14MAD." The Reporting Party information would be populated by the call-taker including Last Name, First Name, Call-Back number, etc.

A typical CAD printout looks something like this based on the example above:

```
----------------------------------
LOCATION - 1400 Madison
RP       - Doe, John, 555-5555, 1404 Madison
INCIDENT - BURGLARY (in progress)
SYNOPSIS - "Caller reports a possible burglary in progress based on
seeing individuals
inside the residence/Caller advises 2 persons inside the location and
call advises
the current residents are on vacation."
----------------------------------
```

Again, granted as it can be seen that the fields are spelled out, the call-taker uses those abbreviations that are already predetermined in order to quickly gather and transmit the information.

The dispatcher then receives the call from the call-taker and is able dispatch the call to those available. The dispatcher's screen would show the available personnel that are dispatchable. A typical setting can be exemplified by this:

```
----------------------------------
INCIDENT # - 554123
LOCATION   - 1400 Madison
RP         - Doe, John, 555-5555
INCIDENT   - BURGLARY (In Progress)
SYNOPSIS   - "Caller reports a possible burglary in progress based on
seeing individuals
inside the residence/Caller advises 2 persons inside the location and
call advises
the current residents are on vacation."
UNITS      - 746 (Pri), 749 (Cov)
----------------------------------
Units available      - (3)
Units out of service - (2)

745 - Avail.
746 - Not Avail. Inc # 554121
```

```
747 - Avail.
748 - Avail.
749 - Not Avail. Inc # 554122
-----------------------------------
```

Everything that is gathered, dispatched and disposed is usually stored in a central server where the type codes reside in, or possibly another server. All of these calls which have incident numbers attached to them can be recalled by an internal search engine. For example, a request for a printout of all calls to Madison in the past hour could be gathered by querying the CAD program by Location:

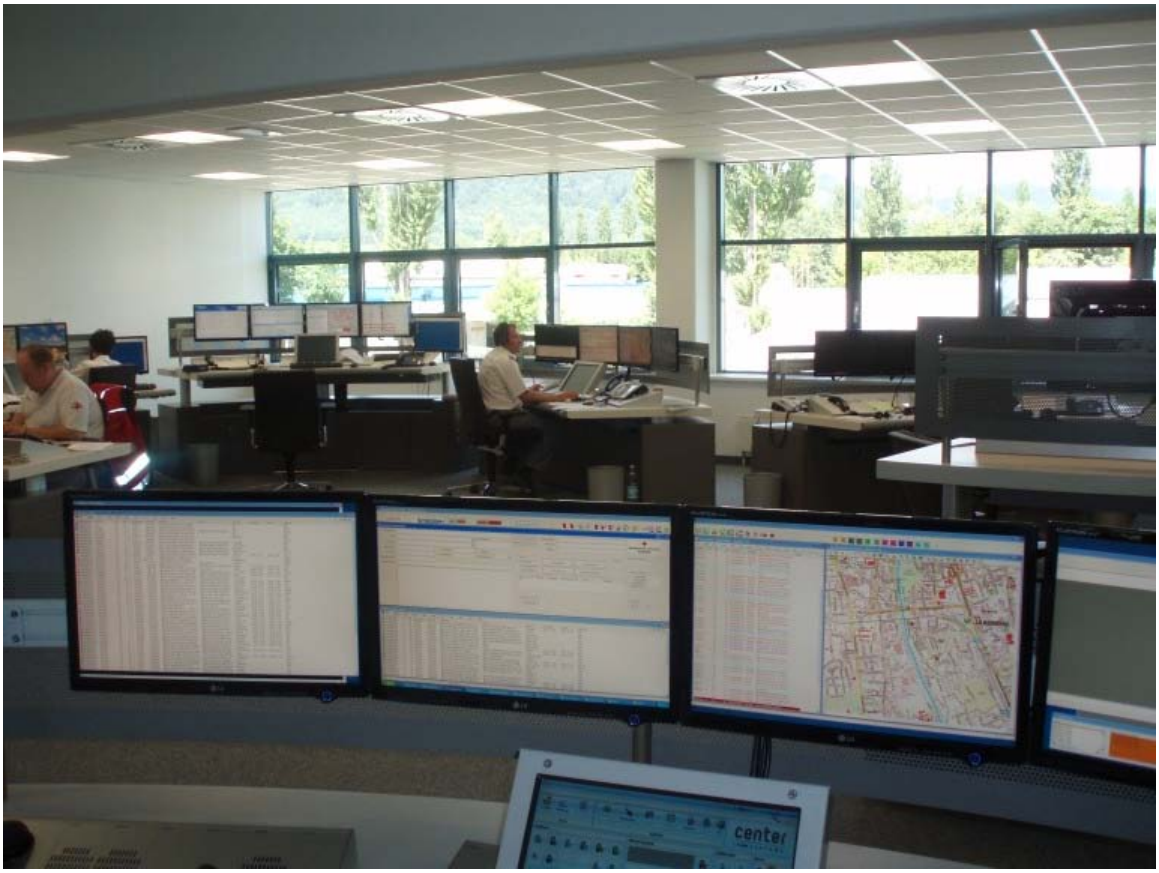
```
Search by: Location
LOCATION [          ]
---
Result:

(Now filled in)

Search by: Location
LOCATION [14MAD     ]
---
Result: (1) Incidents
```

CAD can be used in a multitude of ways, whether it is for radio logs, call logs or statistical analysis.

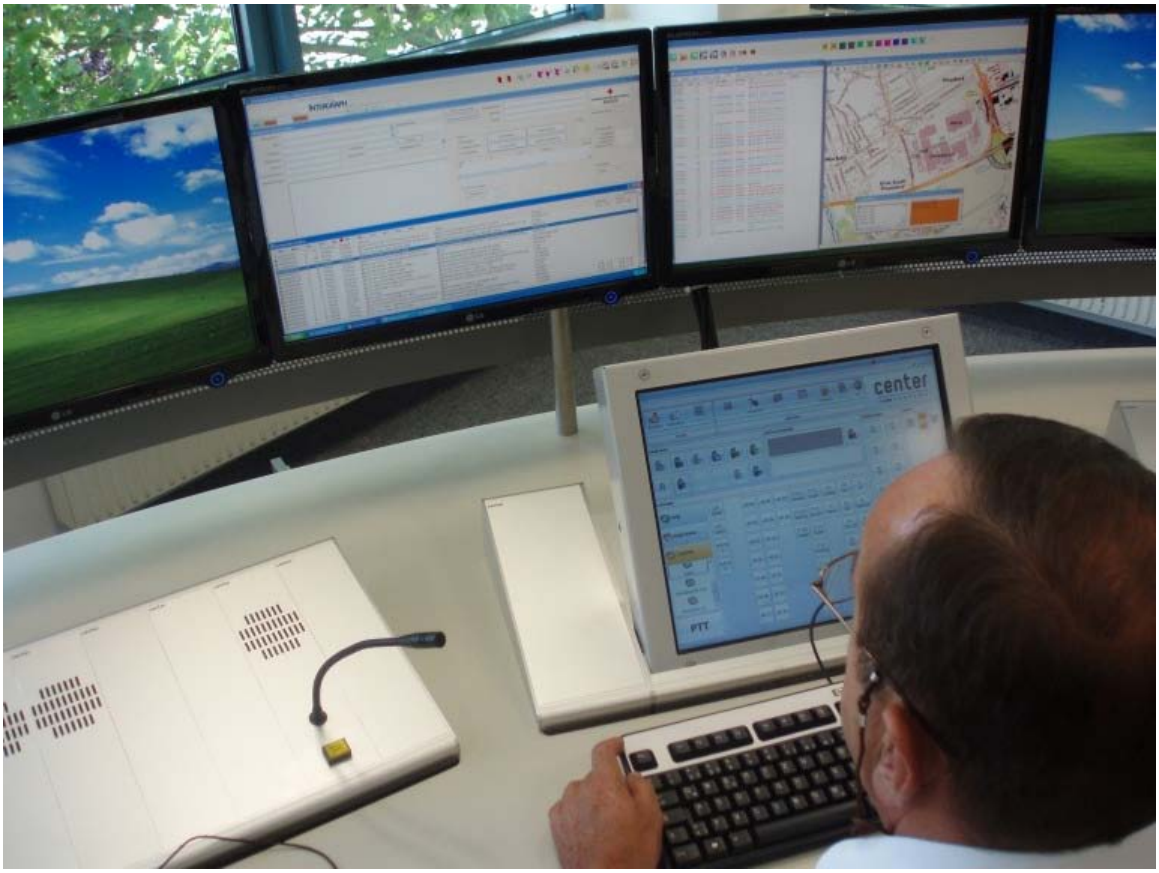
Consoles

A dispatch facility used by Denver RTD features Motorola Centracom radio communication consoles and a GPS-based AVL system. Left picture is dispatcher console position. Right picture is supervisor's console. At right is a drawing showing basic controls for a single channel.

Typical of local government dispatching facilities, the Denver RTD's facility is one example of a transit dispatch center. Communications consoles are mounted in desk-style electronics racks. Features include multi-line telephones. Modern facilities usually include a variety of computing systems for operational and administrative purposes.



Ambulance Dispatch Center Austria



Console with CAD and Voice Switch

Consoles serve as a human interface and connect to push-to-talk dispatch radio systems. Audio from all channels is processed through audio level compression circuits and is routed to two separate speakers identified as *select* and *unselect*. Each has a volume control. The select channel or channels carry the highest priority communications. To prevent missed messages on critical channels, the select volume may be configured so it cannot be set to an inaudible level. Unselect channels may be used for special events, other agencies, or purposes that do not involve dispatch and may be inaudible. By pressing a button, any channel on the console can be toggled between select and unselect status. Each channel has an independent push-to-talk button, allowing the dispatcher to talk over one channel at a time. For broadcast messages, a single button transmits over all selected channels at the same time. A digital clock and an LED bar-graph VU meter are included.

Each channel has a label identifying it and indicator lights and buttons to control settings. A typical channel has a busy light, a call light, select light, select button, and a transmit button. The steady, red busy light indicates another dispatch position is transmitting on the channel. The flashing yellow call light indicates a field unit is talking on the channel. The call light usually blinks for several seconds after a transmission ends allowing a busy dispatcher to look up from a telephone call and determine which channel the last message came from.

Some console dispatch panels are actually a PC based application. Such is the case of Zetron's Acom system and Avtec's Scout system. This allows for easy customization and modification of the dispatch key layout.

Service levels and geographic information

Computerized mapping, Automatic vehicle location, Automatic number identification and caller-identification technology are often used to enhance the service by pinpointing the locations of both the client and the most suitable vehicle for serving the client.

Some CAD systems allow several sources of information to be combined. For example, adding automatic vehicle location (AVL) and geographic information (GIS) could improve service by getting units to a service call location faster. Ideally, CAD is connected to monitor vehicle locations provided by an AVL system. This information is used to suggest the closest vehicle to an event. How is the closest unit determined?

Basic zone system

The simplest system is a beat or zone map system. For example, in a community with four fire stations, a grid is overlaid on a community map. Each zone of the grid is identified with a progression of police beats, ambulance zones, transit zones, or fire stations. One grid might be labeled: AB241. This means fire station 2, then 4, then 1, then 3 would respond to a fire call occurring inside this zone. The predefined order is created by persons with expertise in the service being provided, local geography, traffic, and patterns in calls for service.

Since only basic GIS information is included, if AVL was available, it would simply display service vehicle locations on a map. The closest unit would be interpreted by the dispatcher looking at vehicle locations projected on the map.

Where detailed geographic data are not available, units may be assigned based on the center of a district. To make the computing problem easier, the CAD system may use *centroids* to evaluate service vehicle locations. Centroids are estimated center points within a zone. The system calculates a distance from a fire station or AVL location to a centroid point. The closest fire station, according to CAD system rules, would be assigned. Systems may use centroids that are not exactly centered in order to skew or weight system decisions. Staff based at a fire station that is physically closer by drawing a straight line on the map may be slower to reach a zone. This can occur because responding units must drive around freeways, lakes, or terrain obstructions in order to reach a zone. A centroid may be moved because 200-car freight trains often block a railroad crossing used to access a particular zone.

This is the cheapest system to develop because it requires the least detailed geographic information and the simplest calculations. Another problem occurs where several services use the same system. Police and transit, for example, may have different ideas about what boundaries define the ideal zone or how centroids should be weighted.

CAD using geocoding

Geocoding is a translation system allowing addresses to be converted to X- and Y-coordinates. Someone placing a call for service has an address attached to a wired phone number or tells the dispatcher their address. For example, suppose the caller's address is *123 Main Street*.

The GIS or CAD system includes a look-up table. The table may identify odd-numbered addresses in the community as being on the north and east sides of streets. Addresses from 113 to 157 Main Street are identified as being along Main Street's center line between Broadway and Washington. 123 is estimated to be on the north side of Main Street somewhere closer to 113 than 157. This estimate produces a latitude and longitude, or a set of Universal Transverse Mercator coordinates. The coordinates are close enough to identify the closest service vehicle. This system may automatically append the name of the nearest cross-street or intersecting street.

Again, the system uses a straight-line distance to determine which service vehicle is closest to a call for service. If an AVL system is used, the CAD will look through a list of most recent reported vehicle positions. Next, the positions are compared to the service vehicle status. The CAD system may identify several of the closest units that have a status of *available*. The dispatcher makes an ideal choice from the CAD system shortlist.

This type of system is significantly more expensive than a zone system. The basic system may start with maps from the US Census Bureau or a county assessor's office. The quality of these maps may be good but will not be ideal for dispatching. There would normally be one or more persons on staff who would deal with data changes from new development, new streets, or data quality problems. The person would compile addresses and generate street centerlines in mapping software. Geocoding varies in accuracy depending on data sources and vendors. It normally takes years of work and planning before a system is implemented. Modern geocoded systems will often display service vehicle locations, the location of service calls, and the locations of callers on a map. This helps to disambiguate calls for service and reduces the likelihood of dispatching two reports of a single call for service as two separate calls.

Another problem comes from technologies using differing datums or coordinate systems. For example, suppose your AVL system uses degrees-decimal degrees format. The AVL display for a vehicle at the Heart Butte Post Office in Montana shows a latitude and longitude of 48.28333 N, -112.83583 W. The CAD system uses degrees-minutes-seconds format data and shows the same location as 481700N, 1125009W. How do you translate? This is sometimes a problem with neighboring CAD systems. Ideally, you should be able to send and receive calls to and from CAD systems in neighboring areas. What if the state or provincial government has standardized on a different coordinate system?

Full GIS/AVL integration

The most expensive and technically-challenging systems fully utilize the capabilities of GIS and AVL. In these systems, the street centerlines are described as *routable*. In addition to geocoding and accurate street centerlines, intersections have attributes or scores. Can a service vehicle turn left from eastbound Carnegie Street onto northbound Hooligan Boulevard? A scoring system is used to assess the difficulty of making the turn. At one end of the scoring system there might be an interchange where service vehicles had unrestricted access in making the turn. Perhaps both streets are one-way, making it relatively easy to turn from one onto another. In the middle scores, a left turn might be blocked occasionally by heavy traffic, a draw bridge, or street cars. At the most difficult score, the two streets may cross but the lack of any interchange does not allow service vehicles to get from one to the other.

To calculate the closest service vehicles, the CAD system does a network analysis of the road system based on these routable street centerlines. It assesses the path from the service call to the AVL location of available vehicles. The system recommends the service vehicles with the shortest path.

Routable street centerlines take into account differences between northbound and southbound lanes on a freeway or turnpike. For example, to reach a point in the southbound lanes of a turnpike, service vehicles may need to drive north to the next exit then return on the southbound side. The analysis of a routable street network takes this into account so long as the event location is accurately reported. Routable systems account for barriers like lakes by calculating the distance of the driven route rather than a straight line distance. It is assumed the service vehicle driver knows the shortest path or that all drivers make similar numbers of wrong turns.

Concentration

CAD systems require support staff with special skills. This can lead to concentration of dispatch facilities, particularly where there is population growth or where automation is required to meet defined service objectives.

In any system, concentration of facilities increases risks of outages or massive failures. In a system where the call traffic is so high that advanced technology is needed to handle routine levels of day-to-day calls, relatively minor failures can have major effects on service levels. For example, where everyone is used to the convenience of AVL, an AVL outage can suddenly increase staff workloads. Suppose a failure causes a condition where CAD cannot recommend a closest unit. How will the dispatcher efficiently assess which unit to assign?

Data management problem

Data quality and data management are significant issues in every system. Part of managing the problem is to establish and enforce standards for data.

Staffing will periodically change as people retire or are promoted. One staff member entered street names, "McDonald" while others enter the same street "Mc Donald." When a complaint-taker is typing a street name into the CAD system, these will sort differently:

- Mc Donald Av
- Mc Intosh Av
- Mc Gulliver Wy
- Mc Zzyrx Rd
- McDonald Av

How will quality standards be implemented to prevent mis-sorted type-ahead feature entries?

Disambiguation can be a problem in cases, for example, where a service area has two Main Streets. In large service areas it is normal to have dozens to hundreds of duplicated and similar street names. The problem can be complicated if the person requesting service is not calling from a wired phone and their location is unclear. Some long streets may have identical address ranges in each city along their route. The caller is in front of 2200 Main Street, but which one? How will the decision-making process be reinforced by good data quality?

Systems require perpetual software upgrades each of which may normalize data differently. Or, a different company may win the low bid next time a system is replaced. Imagine taking a file of 270,000 addresses that took a staff ten years to compile and feeding them through a parsing filter to split street, drive, or road, from each record. Imagine a new system stores apartment and suite letters, (2200 A Main Street) in separate fields and you are responsible for the conversion.

Data exchange (EDI)

In public safety systems, standards are under discussion to allow disparate systems to exchange call information. For example, a call taker at the county fire department receives a call for an auto accident inside a city limit. Evolving standards will allow CAD systems to send messages to one another for calls originating outside local jurisdiction. Some entities have arrangements that already support data exchange between systems, but standards aim to make these interconnections more common. Because of auditing trail and fail-safe needs, the problem is more complex than it sounds.

The usage of EDI applied to CAD is specific to the law enforcement community and should not be confused with Electronic Document Interchange (EDI) standards for eCommerce. Within law enforcement EDI is used as a buzzword to represent all electronic automated messaging.

More mature efforts to interconnect CAD can be found in the standards developed for the Intelligent Transportation Initiatives program of Department of Transportation This initiative sponsored the IEEE 1512 series of protocols for emergency management which

provides sophisticated means to coordinate incidents across operations centers using CAD software.

Additional work is occurring under the National Information Exchange Model to link homeland security with CAD. Also the OASIS international standards body has produced standards funded in part by the DHS and the disaster management e-gov initiative to communicate in emergencies.

Other interoperability technologies can bridge disparities between the data-format, software, and hardware that constitute various computer-aided dispatch systems in various jurisdictions. *Middleware*, software and servers (data brokers), can translate and integrate various systems into a seamless automated dispatch system. One example of such middleware (provided by Utah-based) exists in Orange County, Calif., where the Fire Authority has integrated different emergency service answering points into a seamless dispatching network. A similar project was completed for the Silicon Valley Regional Interoperability Project (SVRIP), and is part of the Dept. of Homeland Security's CADIP report.

Part of business enterprise computing system

In business use of CAD, the dispatch system may be a module or part of a larger enterprise computing system. Rather than having multiple infrastructure's, being able to have a single infrastructure with many applications running on it is important.

At the high end of enterprise integration for CAD there is SOS. SOS or Systems of Systems is a methodology and a set of technology for linking distributed independent applications into one meta-system or system of systems. These methods were originally being used at DOD for command and control (C2) but have now been applied to dispatch in efforts like the Department of Transportation Intelligent Transportation System at the Transportation Management Centers and other efforts involving DHS counterterrorism or fusion centers. Some local jurisdictions have also integrated their dispatch systems using EAI (Electronic Application Integration) software.

Recent developments

Computer aided call handling (CACH) is built on the premise that effective call handling is the foundation for an efficient dispatch response. By using structured call handling and a series of risk calculations, such systems can make objective dispatch recommendations based on information provided by the caller.

Chapter-2

Cold Chain

Vaccines are temperature controlled until use

Slurry ice used to ship sensitive food products

Truck with cooling system

Iced seafood on display

A **cold chain** is a temperature-controlled supply chain. An unbroken cold chain is an uninterrupted series of storage and distribution activities which maintain a given temperature range. It is used to help extend and ensure the shelf life of products such as fresh agricultural produce, frozen food, photographic film, chemicals and pharmaceutical drugs.

Uses

Cold chains are common in the food and pharmaceutical industries and also some chemical shipments. One common temperature range for a cold chain in pharmaceutical

industries is 2 to 8 °C. but the specific temperature (and **time** at temperature) tolerances depend on the actual product being shipped.

This is important in the supply of vaccines to distant clinics in hot climates served by poorly developed transport networks. Disruption of a cold chain due to war may produce consequences similar to the Smallpox outbreaks in the Philippines during the Spanish-American war.

Traditionally all historical stability data developed for vaccines was based on the temperature range of 2-8 °C. With recent development of biological products by former vaccine developers, biologics has fallen into the same category of storage at 2-8 °C due to the nature of the products and the lack of testing these products at wider storage conditions.

The cold chain distribution process is an extension of the good manufacturing practice (GMP) environment that all drugs and biological products are required to adhere to, enforced by the various health regulatory bodies. As such, the distribution process must be validated to ensure that there is no negative impact to the safety, efficacy or quality of the drug substance. The GMP environment requires that all processes that might impact the safety, efficacy or quality of the drug substance must be validated, including storage and distribution of the drug substance.

Validation

A cold chain can be managed by a quality management system. It should be analyzed, measured, controlled, documented, and validated.

The food industry uses the process of Hazard Analysis and Critical Control Point, HACCP, as a useful tool. Its usage continues into other fields. PDA (Parenteral Drug Association) Technical Report # 39 gives a rough summary of how the cold chain can be validated.

The overall approach to validation of a distribution process is by building more and more qualifications on top of each other to get to a validated state. This is done by executing a Component Qualification on the packaging components. Next, an Operational Qualification that demonstrates the process performs at the operational extremes. The final piece is the Performance Qualification that demonstrates that what happens in the real world is within the limits of what was demonstrated in the Operational Qualification limits.

The PDA's Technical Report states that a Component Qualification is required to demonstrate that a component can be manufactured to the design criteria of that individual component. This was put into the document because the industry did not understand the principles of Validation; all Validation processes were specific to equipment and not auxiliary processes such as shipping/distribution.

Performing thermal testing can also help with validating the cold chain. Certified test labs use environmental chambers to simulate ambient profiles that a package may encounter in the distribution cycle. Thermocouple probes and separate temperature dataloggers measure temperatures within the product load to determine the response of the package to the test conditions. Replicate testing based on a qualification protocols is used to create a final qualification report that can be used to defend the configuration when audited by regulators. It is normally best to have an individual that understands the principles of Validation, when defending such processes to a Federal Regulatory body of any nation.

Cold chains need to be evaluated and controlled:

- Carriers and logistics providers can assist shippers. These providers have the technical ability to link with airlines for real time status, generate web-based export documentation and provide electronic tracking.
- The use of refrigerator trucks, refrigerator cars, reefer ships, reefer containers, and refrigerated warehouses is common.
- Shipment in insulated shipping containers or other specialised packaging.
- Temperature data loggers and RFID tags help monitor the temperature history of the truck, warehouse, etc. and the temperature history of the product being shipped. They also can help determine the remaining shelf life.
- Documentation is critical. Each step of the custody chain needs to follow established protocols and to maintain proper records. Customs delays occur due to inaccurate or incomplete customs paperwork, so basic guidelines for creating a commercial invoice should be followed to ensure the proper verbiage, number of copies, and other details.

During the distribution process one should monitor that process until one builds a sufficient data set that clearly demonstrates the process is in compliance and in a state of control. Each time the process does not conform to the process, the event should be properly documented, investigated and corrected so that the temperature excursion do not occur on future shipments. Thus the process is continually evolving and correcting for anomalies that occur in the process. Eventually the process can evolve into periodic monitoring once sufficient data demonstrates that the process is in a state of control. Any anomaly that occurs once a process is in a state of control will result in the process being invalidated and not in control and result in product withdraw from the market to ensure patient safety.

It is necessary to develop an internal documentation system as well as multi-party communication standards and protocols to transfer or create a central repository or hub to track information across the supply chain. These systems would monitor equipment status, product temperature history, and custody chain, etc. These help ensure that a food, pharmaceutical, or vaccine is safe and effective when reaching its intended consumer.

Chapter-3

Dispatch (logistics)

Dispatch is a procedure for assigning employees (workers) or vehicles to customers. Industries that dispatch include taxicabs, couriers, emergency services, as well as home and commercial services such as maid services, plumbing, HVAC, pest control and electricians.

With vehicle dispatching, clients are matched to vehicles according to the order in which clients called and the proximity of vehicles to each client's pick-up location. Telephone operators take calls from clients, then either enter the client's information into a computer or write it down and give it to a dispatcher. In some cases, calls may be assigned a priority by the call-taker. Priority calls may jump the queue of pending calls. In the first scenario, a central computer then communicates with the mobile data terminal located in each vehicle in the second, the dispatcher communicates with the driver of each vehicle via two-way radio.

With home or commercial service dispatching, customers usually schedule services in advance and the dispatching occurs the morning of the scheduled service. Depending on the type of service, workers are dispatched individually or in teams of 2 or more. Dispatchers have to coordinate worker availability, skill, travel time and availability of parts. The skills required of a dispatcher are greatly enhanced with the use of computer dispatching software.

Manual dispatch systems

The following are examples of manual systems used to track the status of resources in a dispatched fleet.

Cards

Card systems employ a set of shelves with a slot for each unit in the dispatch fleet. Each vehicle or resource has a slot in the shelving system. In it, a card, like a time card used to track an employee's work hours, is stored. A time clock, similar to the one that stamps work hours on a time card, is used to stamp event times on each card. At the beginning of

a work day, the resource's identifier or other information is handwritten on the card. Each time the resource's status changes, the card is punched in the time clock and a new status entry is handwritten on the card. The card collects a series of entries through the work shift.

In a tow truck example, the card might be labeled with the tow car's radio identifier, "Downtown 6" and may be labeled with the vehicle number or data about the capabilities of the specific tow car. It might give a weight capacity, show the unit as a flat bed or cradle snatcher, or mention the unit carries a can of Diesel fuel. The name of the staff on the car might be noted. At the start of a shift, the dispatcher would note the unit "available" and time stamp the card. At the assignment to a call, the call information would be written on the card and the card might be stamped at the moment the assignment is read to the tow car crew. The string of notes and time stamps allows dispatch staff to get a clear picture of the status of a small fleet.

Some systems use shelving with red and green lights and a switch at the back of the card slot. If the resource's card is pushed all the way into the card slot, the switch is actuated and an indicator lamp turns red. This identifies the tow car whose card occupies that slot as not available or assigned to a call. Leaving the card pulled partway out leaves the indicator green, showing the dispatcher that unit is available. Is anyone available? The lights are supposed to give the dispatch staff a snapshot of their resource situation.

A major flaw of this system is that cards are inside shelves and trying to look at an entire set of cards to evaluate the overall situation requires the dispatcher to pull out every card, one at a time, and read it. If two or more resources are sent to the same call, the dispatcher has a lot of writing to do.

Punched tags

Punched tag systems employ a set of pegs with each peg holding tags for one unit in the dispatch fleet. Each vehicle working the current shift has a peg with a tag describing the unit's current status. A time clock, similar to the one that stamps work hours on a time card, is used to stamp times on each tag. At the beginning of a work day, the resource's identifier may be posted above the peg. The unit's start time is stamped and their status is written on the tag. Each time the resource's status changes, a new tag is written and the tag is time stamped in order to log the time the unit's status changed. The peg collects a stack of tags through the work shift.

In a tow truck example, the peg might be labeled with the tow car's radio identifier, "Downtown 6" and may be labeled with the vehicle number or data about the capabilities of the specific tow car. It might give a weight capacity, show the unit as a flat bed or cradle snatcher, or mention the unit carries a can of Diesel fuel. The name of the staff on the tow car might be noted. At the start of a shift, the dispatcher would note the unit "available" and time stamp a tag, then hang it on that unit's peg. At the assignment to a call, the call information would be written on another tag and the tag might be stamped at the moment the assignment is read to the tow car crew. The tag would then be hung on

that unit's peg. The stack of tags allows dispatch staff to get a clear picture of the status of a small fleet.

Some systems use colored tags to show general categories of events such as "available". For example, each unit that is available might have the fact noted on an orange tag. Is anyone available? A glance at the pegboard shows anybody whose tag is "orange" is available. An repossession might use a yellow tag to identify a service call with a safety issue where the police should be called in the event the tow car crew doesn't check in by radio within five minutes. A blue tag might show a resource is taking a dinner or lunch break.

A major flaw of this system is that tags can easily be posted on the wrong peg, causing confusion. This can be countered by writing unit identifiers on every tag: a lot of work. In colored-tag systems, it's always possible to run out of certain colors of tags, messing up the system. If two or more resources are sent to the same call, the dispatcher has a lot of writing to do.

Plastic icons

In a plastic icon system, the blank panel on the communications console or a nearby wall is fitted with a sheet of Velcro. The material has vertical stripes painted on it, making a column for each of several possible status conditions. The simplest system is two columns: available and unavailable. Magnetized icons can be used in place of Velcro. The icons can be colored or shaped to identify the type of unit or some other feature of the resource.

Each vehicle working the current shift has an icon placed in the column describing the unit's current status. A log book is used to track times, event details, and other information about calls for service. In a tow truck example, the icon might be labeled with the tow car's radio identifier, "Downtown 6". During a shift, the icon would be moved by the dispatcher into whatever column describes the resource's current condition. Alternatively, there could be columns for some other condition such as the names of move-up or standby points where resources are sent to backfill for busy tow cars.

A major flaw of this system is that icons can easily be misplaced or fall off of the status board. Magnetic objects can damage cathode ray tube displays if they get too close to the display face or housing.

Airline dispatch

In airline operations in a few countries, a dispatcher shares legal responsibility for a flight's safety with its pilot, and may delay, divert or cancel a flight if there is reason to do so. This checks and balances mechanism supposedly improves the safety of the dispatch system, although most countries do not use this system and there is no noticeable detriment to flight safety. A dispatcher typically must be licensed by the aviation authority of a country. The examination for the licence requires the candidate to

demonstrate knowledge in meteorology and aviation comparable to that required to obtain an Airline Transport Pilot Licence.

Mobile dispatch

In a mobile system, wireless technology is provided for efficient job planning, assignment and efficient job planning through the use of mobile dispatch systems sent out through a mobile network on to a mobile device such as PDA. This allows for more flexible management of the workers out in the field as a job can be dispatched to multiple users to accept or reject the job. The benefits of a mobile system as it can then be integrated back into the other software systems used by an organization such as asset management, rostering, and other financial systems.

Capacity and metrics

There is a limit to how many field units can be managed. This varies with circumstances. For example, a parcel delivery service dispatcher may encounter higher traffic around Christmas. Work is not evenly distributed across time: in any dispatch system there are traditional peaks or busy hours in requests for service. Some workplace cultures will allow longer wait times than others.

Systems may use a voice procedure to reduce talking time, allowing interaction with a larger dispatch fleet. Air traffic control and towing are two examples. The use of abbreviations or standard phrases can reduce the length of a transaction. Capacity may be reduced by relaxed voice procedure such as a delivery dispatcher giving a lengthy description of a customer complaint over the radio.

It's generally accepted that giving field units computers connected with the computer-aided dispatch, or another enterprise system used for dispatch, unloads voice two-way radio channels and increases capacity. Users research information on their terminal or laptop instead of calling in with a request that the dispatcher do it. One source suggests radio traffic drops by 30% when computers are available to mobile users.

Radio

Measurements of communications may reflect dispatch capacity. A partial definition of capacity comes from the number of communications channels required to support a dispatch fleet. Two metrics of channel capacity may be: 1) the number of field units or *resources* dispatched, and; 2)number of push-to-talk presses per day. A resource may refer to a fire engine, tow truck, taxi, or refuse truck, regardless of how many walkie-talkies, mobile radios, or persons were fielded along with each resource.

One suggestion is that 100 to 150 mobiles is the maximum practical on one channel. Another suggests 60-70 units as a maximum. The difference in these two ranges probably reflects the wording. For example, 120 *mobiles* may mean radios: 60 units each containing a mobile radio and an officer with a walkie talkie. For dispatch systems like

take-out food delivery, where life safety is not an issue, delays may be acceptable. Delays increase capacity.

Another possible measure of capacity is system push-to-talk presses. A 187-day study of four Contra Costa County, California Sheriffs Department conventional two-way radio dispatch channels showed an average of around 2,500 push-to-talk presses per day. The count was within +/-350 a day across all four primary dispatch channels.

Telephone

Multi-line phones are seen in many dispatching facilities. Rotary dials are rare.

A method used for telephone traffic analysis may fit some circumstances. One evaluation looked at 1) peak of busy hour usage, 2) average hourly usage, 3) message length in seconds, 4) maximum delay or wait time desirable, and; 5) maximum percent of users being delayed. Traffic analysis can be applied to radio or telephone communications.

Most office telephone systems have some facility for recording calling volumes, and incoming call timing. Dispatch centers use Automatic call distribution (ACD) groups which can be evaluated for metrics such as average wait time, abandoned calls, and calls per hour. These numeric data can be entered into spreadsheets for analysis of trends.

In dispatching, US emergency medical services literature suggests that telephone calls to a dispatching facility should be answered in the first few rings. One document suggests emergency calls to dispatch should result in busy signals once per 100 calls during the busiest hour. In business call centers, similar standards are suggested by consultants in order to provide an ideal customer experience and to outperform competing services. Sufficient staffing should be in place so that 90% of emergency calls are, "...answered within 10 seconds, or with no greater than three rings, during the average busy hour," according to one source. Tolerable wait times vary from one culture and region to another: some cultures expect immediate service; others will tolerate waits for some services.

Zone system to assign service calls

Dispatch consoles used by Denver RTD, a transit service provider in a US city. Drawing at right illustrates the controls associated with a single channel on the console.

One method for organizing assignments in a manual dispatch system is to use a zone map system. Consider a community with four fire stations and two ambulance service providers. A grid is overlaid on a community map. Saint Proximal Medical Center ambulance is identified by the notation *P* while Distal Volunteer Rescue Squad is noted with a *D*.

Each zone of the grid is identified with a progression of ambulance zones and fire stations. One zone might be labeled: DP241. This means fire station 2, then 4, then 1, then 3 would respond to a fire call occurring inside this zone. If fire stations 2, 4, and 1 were assigned to calls, Station 3 would be sent to this zone. Distal Volunteer Rescue Squad would be first-up for an ambulance call occurring inside zone DP241.

The predefined order is created by persons with expertise in the service being provided, local geography, traffic, and patterns in calls for service. In assigning resources to a zone, decision-makers may consider that responding units must drive around freeways, lakes, or terrain obstructions in order to reach a zone. Zone boundaries and designations will periodically change as communities grow or lessons are learned during day-to-day operations. Consider a zone with an irrigation canal defining one boundary. If a car crashes into the canal, which zone is it in?

Zone systems may include standby, move-up, or backfill points. For example, taxi drivers working in a certain zone in the evening hours may expect night club patrons to need a ride. Consider a standby point at Main Street and Railroad Avenue named *N*. Some fares will come from radio calls to dispatch. A taxi driver, Car 4, may go to predefined standby location *N*. In some dispatching systems, the driver will call the dispatcher and report they are available and located at standby point *N*. The dispatcher may respond by reporting the driver's position in the queue, "Car 4, second N." The first call in this district would go to the driver ahead of Car 4. Car 4 would be assigned the second call.

If automatic vehicle location is available, it would display service vehicle locations on a map. The closest unit would be interpreted by the dispatcher looking at vehicle locations projected on the map.

Chapter-4

Distribution Center

Sainsbury's distribution center in Waltham Point, Hertfordshire, United Kingdom.

A **distribution center** for a set of products is a warehouse or other specialized building, often with refrigeration or air conditioning, which is stocked with products (goods) to be redistributed to retailers, to wholesalers, or directly to consumers. A distribution center is a principal part, the order processing element, of the entire order fulfillment process. Distribution centers are usually thought of as being demand driven. A distribution center can also be called a warehouse, a DC, a fulfillment center, a cross-dock facility, a bulk

break center, and a package handling center. The name by which the distribution center is known is commonly based on the purpose of the operation. For example a "retail distribution center" normally distributes goods to retail stores, an "order fulfillment center" commonly distributes goods directly to consumers, and a cross-dock facility stores little or no product but distributes goods to other destinations.

Distribution centers are the foundation of a supply network, as they allow a single location to stock a vast number of products. Some organizations operate both retail distribution and direct-to-consumer out of a single facility, sharing space, equipment, labor resources, and inventory as applicable.

A typical retail distribution network operates with centers set up throughout a commercial market, with each center serving a number of stores. Large distribution centers for companies such as Wal-Mart serve 50–125 stores. Suppliers ship truckloads of products to the distribution center, which stores the product until needed by the retail location and ships the proper quantity.

Since a large retailer might sell tens of thousands of products from thousands of vendors, it would be impossibly inefficient to ship each product directly from each vendor to each store. Many retailers own and run their own distribution networks, while smaller retailers may outsource this function to dedicated logistics firms that coordinate the distribution of products for a number of companies. A distribution center can be co-located at a logistics center.

Scale

A large distribution center might receive and ship more than ten thousand truckloads each year, with an individual store receiving from only a couple trucks per week up to 20, 30, or more per week. Distribution centers range in size from less than 50,000 square feet (5,000 m^2) to the largest approaching 3 million square feet (300,000 m^2).

Storage

Although the primary role of a distribution center is to receive large quantities of products and ship small quantities to individual stores, an important secondary role is storage. Many retailers give priority to having as many items in stock at once as possible. To conserve space, minimize inventory costs, and maximize the variety they offer, the retailer might stock only one or a few items of a particular product. This requires the ability to ship a replacement quickly once an item is sold. By keeping product on hand in the distribution center, the retailer can ship a replacement almost immediately after a product is sold.

Storage locations and storage containers

Goods (products) arrive and are stored in a distribution center in varying types of storage locations and containers suited to the product characteristics and the amount of product to

be transported or stored. These types of locations and containers have specific industry-accepted names. Specialized pieces of equipment (material handling equipment, or MHE) are used to handle the various types of containers. The following is a list of some of the names and characteristics of common storage containers:

- Intermodal containers (shipping containers) are used for the efficient transportation of goods. Standards that specify the volume and dimensions of containers to facilitate efficient handling.
- Pallets are one of the most commonly used means to store and move product in a distribution center. There are many specialized devices (MHE) used to handle pallets, pallet jack, pallet inverter, and unit load ASRS. Pallets are stored on the floor, may be stacked, and may be stored in pallet rack.
- Gaylords are large single boxes usually connected or attached to a pallet.
- Cases and Cartons are boxes usually containing many items. In distribution centers there is a generally accepted distinction made between the terms "carton" and "case", although both are boxes. Goods are received and stored in cartons, while goods are shipped in cases. A stored carton is called a case once it has been picked or pulled for shipment.
- Totes are reusable containers used to hold and transport goods.

Storage volume

In addition to shipping quickly, preparing for busy shopping seasons requires retailers to stock up on product ahead of time. For most retailers, the Christmas shopping season is the busiest of the year. Ahead of this time, a distribution center might double the amount of inventory on hand and then draw this level down through the shopping season. This strategy is especially important for imported items. With lead times measured in weeks or months, stocking these products in a distribution center is often the only way to maintain in-stocks at the store. New seasons, holidays, or special promotions may also prompt a retailer to store specific items prior to a large rollout or demand forecast.

Processing

Another way to look at a distribution center is to see it as a production or manufacturing operation. Goods arrive in bulk, they are stored until needed, retrieved, and assembled into shipments. The efficient processing of a distribution center can greatly impact the final price of the product delivered to the end user. Efficient processing not only directly impacts the cost of goods through reduced labor, but it also indirectly impacts the cost of goods through reduced inventory. Inventory represents an investment with its associated investment interest or inventory carrying cost. Reducing the processing time of order processing can directly reduce the amount of inventory necessary to be stocked in the operation.

Costs

The most efficient method of distribution would be to ship a full truckload or railcar directly from the manufacturer to the retailer. The next most efficient method would be to ship a full truckload to a distribution center, unload full pallets of products, and immediately load the pallets onto trucks destined for individual stores. Both of these methods can only be used on very high-volume items. Most products cannot be delivered in this manner, and pallets or even individual boxes must be broken down and divided.

Once a full pallet must be broken apart, the costs of handling the product can increase quickly. Many distribution centers use large sortation systems with miles of conveyor to move products through the facility and into a truck. They may also have automated equipment for de-palletizing and re-palletizing product. Some of the most sophisticated systems can convey product directly into storage racks and then convey out of the racks to trucks, all automatically. With a wide variety of product sizes and weights, these systems are designed to handle a specific range of products. Very large, small, heavy, or light products require varying degrees of manual handling.

As the process of handling involves more steps and becomes increasingly manualized, the cost increases. Storing products instead of receiving and immediately shipping them adds cost. Firms must determine when lost sales due to not having product on the shelves are balanced by increased handling and storage costs.

Distribution center organization

All distribution centers have three main areas and may have additional specialized areas. The three main areas are the receiving dock, the storage area, and the shipping dock. In small organizations it is possible for the receiving and shipping functions to occur side by side, but in large centers, separating these areas simplifies the process. Many distribution centers have dedicated dock doors for each store in their shipping area. The receiving area can also be specialized based on the handling characteristics of freight being received, on whether the product is going into storage or directly to a store, or by the type of vehicle delivering the product.

Distribution center planning

A number of components go into the overall planning of a distribution center in order to maximize its efficiency. If the distribution center relies on a conveyor system suspended from the ceiling, consideration needs to be given to the weight-bearing capacity of the ceiling joists. If the conveyor system runs along the floor, than consideration needs to be given in the design stage to the placement of columns, particularly as they relate to the flue space between pallet rack frames. Other planning considerations include attention to such areas as slotting, product replenishment, storage media, and power requirements.

Simple distribution center outline

Because many distribution centers service both large and small clients, especially those which store a specific type of service as opposed to those which serve a specific company, roles and departments are generally more complicated. A simple distribution center which serves many clients of a specific theme or type of service may include:

- Goods in: Usually containing specialized container unloading equipment and workers, including pallet wrapping, conveyor belt unloaders (as used on 40 ft shipping containers), forklift drivers, and administrative staff
- Bulk: As a rule, a bulk department controls and ships larger orders or orders that contain only full cartons/boxes. A bulk department includes forklift truck drivers to load containers and wagons, and *man-up* or *combi* forklift trucks to unload full pallets from warehouse racking.
- Break-bulk: Break-bulk (also known as split case) is a lower-capacity version of the *bulk* department. Orders usually contain part boxes or items not requiring pallets. Due to the number of smaller customers a distribution center may serve, a break-bulk department may need more workers than a bulk department. A break-bulk department usually uses trolleys or, for palleted/heavy orders, small electric *PPT* or *walkie low lift* trucks. Items shipped by break-bulk are usually stored in *pick,* which are usually the bottom two *pick-faces* of warehouse racking. A pick-face is the space on such a racking system onto which a pallet can be loaded.
- Export: An export department controls orders which are leaving the country of the distribution center. This department is almost identical in function to a bulk or break-bulk department; however, workers in this department build pallets conforming to different standards and sizes. An export department also uses different shipping containers or haulage firms.
- Quality assurance: A quality assurance (*QA*) department performs periodic checks of random samples of stock to check quality, including from the warehouse racking, goods in, and returned stock. This department may also take on cycle count duties to find missing stock.
- Administration
- Packing and production: In many distribution centers it is not feasible to store stock in many different packaging styles or quantities, and while it may cost a customer more to do so, many customers, such as supermarkets, prefer their own packaging on stock. Because of this, packing benches are used to take raw items, such as a box of balloons, and pack them at a specific unit quantity, which are then packed into cartons and labeled accordingly for a customer. In many circumstances this may be more inexpensively done at a distribution center than by a customer or client.
- Transportation: Arranges and coordinates shipments in and out of the distribution center.
- Dedicated product departments: Divisions may be based on handling characteristics or storage characteristics, for example, refrigerated and non-refrigerated [meat and produce, frozen, dairy/deli, dry]. Each of these three areas have both shipping and receiving departments as well.

Distribution centers also have a variety of supporting departments, including human resources, maintenance/facilities operations, production control, and accounting.

Distribution jobs

A distribution center typically has a general manager who manages the facility and typically has a number of department managers who report directly to him/her. Most distribution centers divide staff into two categories, direct labor and indirect labor. Direct labor staff execute the distribution processes, while indirect labor staff support the direct labor staff. Each department is in turn composed of supervisors and warehouse workers. The direct labor jobs of a warehouse can include:

- Unloader - unloads trucks and breaks down pallets as needed, using various pieces of power equipment
- Receiver - inventories and tags unloaded pallets using a mobile cart computer unit and printer
- Hauler - transports received pallets with equipment from the receiving dock to the storage racks
- Putaway driver - puts product into racks with forklift
- Lumper - helps unload shipments
- Replenishment driver - pulls product from the racks and places it into the "pick slot" with forklift
- Order filler - picks product from the "pick slot" by hand and moves with power equipment
- Loader - wraps the order-filled pallets and loads trucks, using equipment

Indirect labor departments and jobs within a warehouse can include:

- Supervision - floor (process) supervision, indirect labor supervision
- Human resources - employment office and employee benefits
- Facilities and housekeeping - maintenance of buildings
- Inventory management - tracking and placement of product
- Quality assurance - inspection and acceptance of incoming and outbound product
- Asset protection - building security and loss prevention
- Safety - insurance of safe operating practices
- Equipment maintenance - electrical, mechanical, and pneumatic maintenance of MHE
- Operations research - Industrial engineering, process improvement, labor standards
- Information technology - support of information systems

Chapter-5

Freight Audit and Insulated Shipping Container

Freight audit

Definition

By definition an **audit** is,

- An examination of records or financial accounts to check their accuracy.
- An adjustment or correction of accounts.
- An examined and verified account.

A **freight audit vendor** is therefore one who examines, adjusts and verifies freight bills for accuracy.

Therefore, a freight audit is the process of examining, adjusting and verifying freight bills for accuracy.

Freight costs

- Costs incurred by the merchant in moving goods, by whatever means, from one place to another under the terms of the contract of carriage. In addition to transport costs this may include such elements as packing, documentation, loading, unloading and transport insurance.

Complexity of Freight Audit

Rising freight cost is an emerging area of concern as seen in recent years. The cost of freight has been rising due to the increase in oil prices and all freight cost is highly dependent on the cost of transportation which relates directly to fuel prices. With high fluctuations of fuel costs, low visibility of the future freight costs and high complexity of the freight quotes, freight cost verification are vulnerable to human and process errors

and this requires proper auditing to ensure that the organization does not overpay for services it did not incur.

The forwarder freight rates are usually maintained in multiple spreadsheets and usually each forwarder has a different freight rate format to the customer. An organization is daunted with the task of calculating the freight rates manually and this task can be challenging when the customer has hundreds of shipments shipped each month. Most organizations do not have the manpower to calculate all the freight invoices issued to them and at best, they perform random sampling to check if the sample invoice is billed correctly. Some organizations have the manpower to perform freight audit themselves, the manual and tedious efforts required for a freight audit will usually end up much more expensive than an outsource vendor might be able to provide.

Based on the research of inboundlogistics.com, freight costs can make up 10% of an organization's expenditure . As a consequence of rising freight costs, an increasing number of organizations has been more proactive in controlling freight cost and outsourced the freight audit process to freight audit specialists.

Freight Audit Process

Inbound logistics details the freight audit process as "To begin the auditing process, a freight bill payment company receives its clients' freight bills directly from carriers. When the bills are received, either via electronic data interchange (EDI) or manually, they are entered into the contractor's system, providing immediate visibility. Once the bills are entered, they are audited for accuracy. Auditors verify the bills' validity, mileage, duplicate payments, accessorial charges, and use of correct tariffs. After auditing, the charges are coded and reconciled, and the bills are paid."

Some companies have gone forward with a process to pay freight bills called self billing. The customers calculate their freight cost themselves and instruct the freight forwarder to invoice using credit notes. This process transfers the responsibility to correct freight calculation from the customer to the forwarder.

Models of freight audit

GT Nexus noted that there are 3 models of freight audit in used today. The 3 models are listed as below.

1. Manual match—Pay for in-house staff to manually process invoices and conduct audits, with costs, errors and unrecovered charges rising as international transportation volumes grow;
2. Buy packaged software—Pay an upfront license to acquire a software package, and then install, operate and maintain the software, rates, and electronic integrations to carriers, using expensive internal resources; or

3. Outsource -- Pay fees to a third-party firm, send them freight invoices, and then absorb additional costs and time to administer the service, track discrepancies, and recoup unrecovered charges.

The first option of manual matching is tedious and the cost of auditing a freight invoice rise with the number of freight invoice proportionally.

The 2nd option of buying packaged software allows the company to save time and resources in the invoice processing but the company will need to invest in the training of the staff and system infrastructure to maintain an expert process and system. The freight audit system will be able to eliminate the mundane freight calculation and matching process and the users of the system will be able to perform value add activities such as analyzing freight rates, negotiation with freight forwarders or recovering freight invoice discrepancy with freight forwarders.

For option 3, ideally, the 3rd party firm should use a freight audit system and not handle the freight invoices manually. The freight audit system maintained by a team of expert users will eliminate the cost of training users and infrastructure setup cost. Although the cost of outsource may seem to be higher than buying a packaged software, it includes the maintenance cost of a freight system which may cost more for a team of non experts from the customer to manage.

Insource audit names model 2 and model 3 ASP, application service provider, and BPO, business process outsourcing respectively . These business models converges expert systems with organisation capability and trained staffs, the combined knowledge of the organisation and the vendor has the benefit of the combination of knowledge and resources. Hence these 2 models are well positioned to take on the challenges of tomorrow's freight audit.

Freight audit on shipment or freight invoice level

Freight audit can be conducted at the shipment or freight invoice level. A company that has standard weights for standard packages may opt to audit freight invoices at freight invoice level to reduce complexity in the freight audit process. This is known as freight invoice validation and this process is simple as compared to a freight audit at shipment level. A company that has a more complex shipping process may choose to go for freight invoice verification. This freight invoice verification process is a flexible solution that allows the customer to use their shipment and package measurements and calculate against the freight quotes and finally compared against the freight invoice. By having detail shipment information, customers can analyze freight cost by product line reports or interface payment information into their ERP systems .

Benefits of freight audit

Inbound logistics noted that for many companies, outsourcing could be the most economical way to properly audit and process freight invoices. They have also noted that

the cost to verify, process and finally pay an internal freight invoice is around USD 11 and the cost of outsourcing is around 5 to 10% of the internal cost and that has not included the cost savings from the invoice discrepancies. The discrepancies can be as much as 8.8% of the freight invoices. CT Logistics believes that accuracy of a freight invoice is assured by outsourcing because freight audit company audits for freight rates, freight discounts, misapplied accessorial charges, and prevent possible duplication of payment. The provider of a freight audit can also provide comprehensive reports for the customer to make intelligent business decisions such as consolidation of shipments to a certain forwarder and landed costing of each product group. These reports are critical to a product costing and planning strategy in order to make the product successful in the targeted area.

Freight cost reports can be generated to compare the freight costs for forwarders and the customers may use such reports to flag out service failures, negotiate for better freight deals or the opportunity to consolidate the shipments to a forwarder for a better rate. Customers can simulate the freight cost calculation for new freight rates or packages proposed by the forwarder and determine if this is suitable for their business model . With large fluctuations in the surcharges, the accounts department will have lower visibility in accruing freight cost. By choosing a freight invoice verification model, a customer can forecast the freight cost to be accrued for accounting purposes. This translates to lesser risk and more predictability in cash flow for the company . Akzo Nobel's automated freight audit process has also instilled tighter controls over their freight accounting by eliminating human communication and intervention from the point of the freight quote to the payment process. By controlling the human communication and minimizing human intervention, the audit process will be unbiased and less likely to deviate from the proper process.

Insulated shipping container

Insulated shipping containers are a type of packaging used to ship temperature sensitive products such as foods, pharmaceuticals, and chemicals. They are used as part of a cold chain to help maintain product freshness and efficacy. The term can also refer to insulated intermodal containers or insulated swap bodies.

Construction

An insulated shipping container might be constructed of:

1. a vacuum flask, similar to a "thermos" bottle
2. fabricated thermal blankets or liners
3. molded expanded polystyrene foam (EPS, styrofoam, etc), similar to a cooler
4. other molded foams such as polyurethane, polyethylene, etc
5. sheets of foamed plastics
6. reflective materials: (metallised film, etc)
7. bubble wrap or other gas filled panels
8. other packaging materials and structures

Some are designed for single use while others are returnable for reuse. Some empty containers are sent to the shipper disassembled or “knocked down”, assembled and used, then knocked down again for easier return shipment.

Use

Insulated shipping containers are part of a comprehensive cold chain which controls and documents the temperature of a product through its entire distribution cycle. The containers may be used with a refrigerant or coolant such as :

- block or cube ice, slurry ice, etc
- dry ice
- Gel or ice packs (often formulated for specific temperature ranges)
- Some products (such as frozen meat) have sufficient thermal mass to contribute to the temperature control
- etc

A temperature data logger or time temperature indicator is often enclosed to monitor the temperature inside the container for its entire shipment.

Labels and appropriate documentation (internal and external) are usually required.

Personnel throughout the cold chain need to be aware of the special handling and documentation required for some controlled shipments. With some regulated products, complete documentation is required.

Design and Evaluation

The use of “off the shelf” insulated shipping containers does not necessarily guarantee proper performance. Several factors need to be considered :

- the sensitivity of the product to temperatures (high and low) and to time at temperatures
- the specific distribution system being used: the expected (and worst case) time and temperatures
- regulatory requirements
- the specific combination of packaging components and materials being used
- etc

In specifying an insulated shipping container, the two primary characteristics of the material will be the insulation properties of the matieral known as the "K Value" and the thickness of the material. These two attributies determine that majority of the functionality of the component. One should attempt to control the latent heat of any insultated shipping container when is use, as this will affect the overall performance of the component when integrated into a system (closed system with refrigerant & product).

It is wise (and sometimes mandatory) to have formal verification of the performance of the insulated shipping container. Laboratory package testing might include ASTM D3103-07, Standard Test Method for Thermal Insulation Performance of Packages, ISTA Guide 5B: Focused Simulation Guide for Thermal Performance Testing of Temperature Controlled Transport Packaging, and others. In addition, validation of field performance is extremely useful.

Specialists in design and testing of packaging for temperature sensitive products are often needed. These may be consultants, independent laboratories, universities, or reputable vendors.

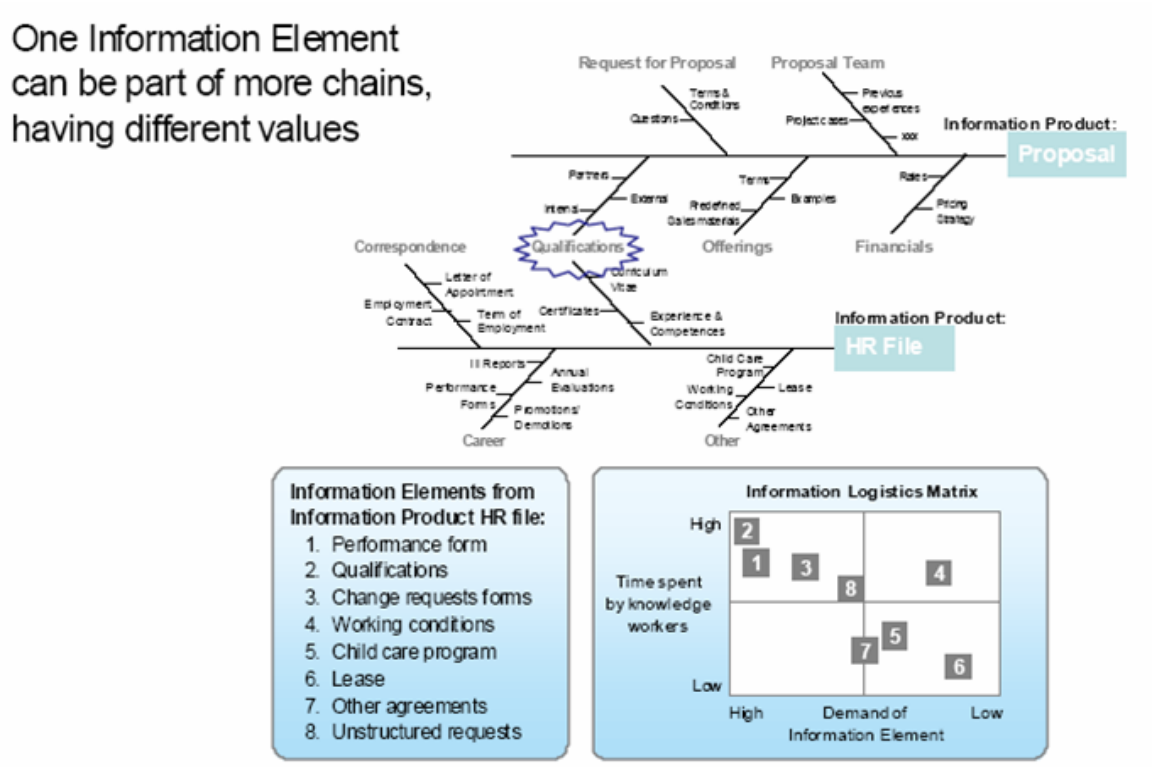
Chapter-6

Information Element and Information Logistics

Information Element

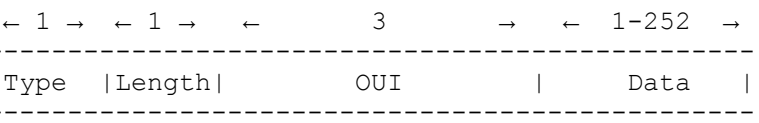
1. In terms of information logistics (IL), an **Information Element** (IE) is an information component that is located in the organizational value chain. The combination of certain IEs leads to an information product (IP), which is any final product in the form of information that a person needs to have. When a higher number of different IEs are required, it often results in more planning problems in capacity and inherently leads to a non-delivery of the IP.

To illustrate the concept of an IP, an example is shown of a bottleneck analysis in HR (by J. Willems 2008). Here, the illustration shows how the Information Elements (e.g. Qualifications) build up the Information Product (e.g. HR File).



2. In terms of ICT, an **Information Element** (IE) is a part of management frames in the IEEE 802.11 wireless LAN protocol. IEs are a device's way to transfer descriptive information about itself inside management frames. There are usually several IEs inside each such frame, and each is built of TLVs mostly defined outside the basic 802.11 specification.

The common structure of an IE is as follows:



Whereas the OUI (Organizationally Unique Identifier) is only used when necessary to the protocol being used, and the Data field holds the TLVs relevant to that IE.

Information logistics

Information logistics (IL), as a section of information management, deals with the flow of information within an organizational unit or between any number of organizations that in turn form a value creating network.

Definition

- Information Logistics (IL) can be defined as "managing and controlling information handling processes optimally with respect to time (flow time and capacity), storage, distribution and presentation in such a way that it contributes to company results in concurrence with the costs of capturing (creation, searching, maintenance etc)."

Goal

- The goal of Information Logistics is to deliver the right information product, consisting of the right Information Element, in the right format, at the right place at the right time for the right people and all this customer demand driven.
- If this goal is achieved, the knowledge worker is best equipped with information for the task at hand for improved interaction with its customers.

With other words, information logistics is about providing:

- the correct information product
- at the accurate point of time
- in the correct format / quality

- for the intended recipient
- at the right location

Methods for achieving the goal are:

- the analysis of the information demand
- intelligent information storage
- the optimization of the flow of information
- securing technical and organizational flexibility

The expression was formed by the Indian mathematician and librarian S. R. Ranganathan.

The supply of a product is part of the discipline Logistics. The purpose of this discipline is described as follows:

Logistics is the teachings of the plans and the effective and efficient run of supply. The contemporary logistics focuses on the organization, planning, control and implementation of the flow of goods, money, information and flow of people.

Information Logistics focusses on information. Information (from Latin informare: "shape, shapes, instruct") means in a general sense everything that adds knowledge and thus reduce ignorance or lack of precision. In stricter sense information becomes information only to those who can interpreted it. Interpreting information will provide knowledge.

These definitions explain what the Information Logistics is all about. The provision of information for the knowledge worker within the correct context, enabling him or her to make the right decision.

Chapter-7

Inventory Management Software

Inventory management software is a computer-based system for tracking product levels, orders, sales and deliveries. It can also be used in the manufacturing industry to create a work order, bill of materials and other production-related documents. Companies use **inventory management software** to avoid product overstock and outages. It is a tool for organizing inventory data that before was generally stored in hard-copy form or in Microsoft Excel spreadsheets.

Components

Inventory management software is made up of several components, all working together to create a cohesive inventory control system. These components include (in alphabetical order):

Asset tracking

When a product is in a warehouse or store, it can be tracked via its bar code and/or other tracking criteria, such as serial number, lot number or revision number.

Barcoding

Barcodes are the means whereby data on products and orders is inputted into inventory management software. A barcode reader is required to read barcodes and look up information on the products they represent.

Order management

Once products reach a certain low level, a company's inventory management system can be programmed to tell managers to reorder that product. This helps companies avoid running out of products or tying up too much capital in inventory.

Service management

Companies that are primarily service-oriented rather than product-oriented can use inventory management software to track the cost of the materials they use to provide services, such as cleaning supplies. This way, they can attach prices to their services that reflect the total cost of performing them.

History

The Universal Product Code (UPC) was adopted by the grocery industry in April 1973 as the standard barcode for all grocers, though it was not introduced at retailing locations until 1974. This helped drive down costs for inventory management because retailers in the United States and Canada didn't have to purchase multiple barcode readers to scan competing barcodes. There was now one primary barcode for grocers and other retailers to buy one type of reader for.

In the early 1980s, personal computers (PCs) debuted and started becoming popular. This further pushed down the cost of barcodes and readers. It also allowed the first versions of inventory management software to be put into place. One of the biggest hurdles in selling readers and barcodes to retailers was the fact that they didn't have a place to store the information they scanned. As computers became more common and affordable, this hurdle was overcome. Once barcodes and inventory management programs started spreading through grocery stores, inventory management by hand became less practical. Writing inventory data by hand on paper was replaced by scanning products and inputting information into a computer by hand.

Starting in the early 2000s, inventory management software progressed to the point where businesspeople no longer needed to input data by hand but could instantly update their database with barcode readers.

Purpose

Companies often use inventory management software to reduce their carrying costs. The software is used to track products and parts as they are transported from a vendor to a warehouse, between warehouses, and finally to a retail location or directly to a customer.

Inventory management software is used for a variety of purposes, including:

- Maintaining a balance between too much and too little inventory.
- Tracking inventory as it is transported between locations.
- Receiving items into a warehouse or other location.
- Picking, packing and shipping items from a warehouse.
- Keeping track of product sales and inventory levels.
- Cutting down on product obsolescence and spoilage.

Manufacturing uses/applications

Manufacturers mainly use inventory management software to create work orders and bills of materials. This facilitates the manufacturing process by helping manufacturers efficiently assemble the tools and parts they need to perform specific tasks. For more-complex manufacturing jobs, manufacturers can create multilevel work orders and bills of materials, which have a timeline of processes that need to happen in the proper order to build a final product. Other work orders that can be created using inventory management software include reverse work orders and auto work orders. Manufacturers also use inventory management software for tracking assets, receiving new inventory and additional tasks businesses in other industries use it for.

Advantages

There are several advantages to using inventory management software in a business setting.

Cost savings

In many cases, a company's inventory represents one of its largest investments, along with its workforce and locations. Inventory management software helps companies cut expenses by minimizing the amount of unnecessary parts and products in storage. It also helps companies keep lost sales to a minimum by having enough stock on hand to meet demand.

Warehouse organization

Inventory management software can help distributors, wholesalers, manufacturers and retailers optimize their warehouses. If certain products are often sold together or are more popular than others, those products can be grouped together or placed near the delivery area to speed up the process of picking, packing and shipping to customers.

Updated data

Up-to-date data on inventory conditions and levels is also an advantage inventory management software gives companies. Company executives can usually access the software through a mobile device, laptop or PC to check current inventory numbers.

Time savings

With the aid of restricted user rights, company managers can allow many employees to assist in inventory management. They can grant employees enough information access to receive products, make orders, transfer products and do other tasks without compromising company security. This can speed up the inventory-management process and save managers' time.

Disadvantages

The main disadvantages of inventory management software are its cost and complexity.

Expense

Cost can be a major disadvantage of inventory management software. Many large companies, such as Polo Ralph Lauren, Macy's, Nordstrom and Wal-Mart, use inventory management software, but small businesses can find it difficult to afford it. Barcode readers and other hardware can compound this problem by adding even more cost to companies. The advantage of allowing multiple employees to perform inventory-management tasks is tempered by the cost of additional barcode readers.

Complexity

Inventory management software is not necessarily simple or easy to learn. A company's management team must dedicate a certain amount of time to learning a new system, including its software and hardware, in order to put it to use. Most inventory management software includes training manuals and other information available to users. Despite its apparent complexity, inventory management software offers a degree of stability to companies. For example, if an IT employee in charge of the system leaves the company, a replacement can be comparatively inexpensive to train compared to if the company used multiple programs to store inventory data.

Chapter-8

DASH7

DASH7 is a new wireless sensor networking technology using the ISO/IEC 18000-7 standard for active RFID, operating at in the 433 MHz unlicensed spectrum. DASH7 provides multi-year battery life, range of up to 2 km (potentially farther), low latency for tracking moving objects, small protocol stack, sensor and security support, and data transfer of up to 200 kbit/s. DASH7 is the name of the technology promoted by the non-profit consortium called the DASH7 Alliance.

International Standard

DASH7 follows the ISO/IEC 18000-7 open standard for the license-free 433 MHz ISM band air interface for wireless communications. 433 MHz is available for use worldwide. The wireless networking technology was originally created for military use and is now being re-purposed for many commercial applications in place of wireless protocols like ZigBee or IEEE 802.15.4.

History

In January 2009, the U.S. Department of Defense announced the largest RFID award in history, a $429 million contract for DASH7 devices, to three hardware vendors: Savi Technology, Evigia Systems, and Identec Solutions.

In March 2009, the DASH7 Alliance, a non-profit industry consortium to promote interoperability among DASH7-compliant devices, was announced and as of July 2010 has more than 50 participants in 23 countries. Similar to what the WiFi Alliance does for IEEE 802.11, the DASH7 Alliance is doing for the ISO 18000-7 standard for wireless sensor networking.

Technical summary

DASH7 contrasts with existing wireless data technologies like ZigBee:

Technology	Global standard used	Frequencies used	Globally available frequency (ies)?	Penetrates water	Penetrates concrete	Range	Average power draw	Average latency	Device cost	Multi-hop capabilities	Sensor and Security support	Interference from 802.11n	Maximum bit rate
DASH7	ISO/IEC 18000-7	433.92 MHz	Yes	Yes	Yes	1,000 m	30–60 µW	2 seconds worst case	$10+	Yes	Yes	No	200 kbit/s
ZigBee	IEEE 802.15.4	2.4 GHz, 915 MHz, 868 MHz	2.4 GHz – yes; 915 MHz – no; 868 MHz – no	No	No	30–500 m	125–400 µW	varies from seconds to potentially minutes	$10+	Yes	Yes	Yes	250 kbit/s

433.92 MHz

DASH7 utilizes the 433.92 MHz frequency, which is globally available and license-free. 433.92 MHz is ideal for wireless sensor networking applications since it penetrates concrete and water, but also has the ability to transmit/receive over very long ranges without requiring a large power draw on a battery. The low input current of typical tag configurations allows for battery powering on coin cell or thin film batteries for up to 10 years.

Tag-to-Tag Communications

Unlike most active RFID technologies, DASH7 supports tag-to-tag communications which, combined with the long range and signal propagation benefits of 433 MHz, makes it an easy substitute for most wireless "mesh" sensor networking technologies. DASH7 also supports sensors, encryption, IPv6, and other features.

BLAST networking technology

Networks based on DASH7 differ from typical wire-line and wireless networks that operate with a "session". DASH7 networks serves applications in which low power usage is essential, and data transmission is typically much slower and/or sporadic, like basic telemetry. So instead of replicating a wire-line "session", DASH7 was designed with the concept of BLAST:

*B*ursty
: Data transfer is abrupt and does not include content such as video, audio, or other isochronous forms of data.

*L*ight
: For most applications, packet sizes are limited to 256 bytes. Transmission of multiple, consecutive packets may occur but is generally avoided if possible.

*AS*ynchronous
: DASH7's main method of communication is by command-response, which by design requires no periodic network "hand-shaking" or synchronization between devices.

*T*ransitive
: A DASH7 system of devices is inherently mobile or transitional. Unlike other wireless technologies DASH7 is upload-centric, not download-centric, so devices do not have to be managed extensively by fixed infrastructure (i.e. base stations).

Range

DASH7 devices today advertise read ranges of 1 kilometre or more, however ranges of up to 10 km have been tested by Savi Technology and are easily achievable in the European Union where governmental regulations are less constrained than in the USA.

Interoperability

DASH7 devices use a single global frequency, which simplifies deployment and maintenance decisions relative to specifications using multiple frequencies. A neutral, third party testing authority also conducts conformance and interoperability testing under the DASH7 Certified program.

Commercial Applications

Similar to other networking technologies that began with defense sector (e.g. DARPA funding the Internet), DASH7 is similarly suited to a wide range of applications in development or being deployed including:

- **Mobile Advertising** DASH7 is being developed for "smart" billboards and kiosks, as well as "smart" posters that can be ready from many meters (or even kilometers) away, creating new opportunities for both tracking the effectiveness of advertising spend but also creating new e-commerce opportunities. DASH7's potential to automate check-ins and check-outs provides essential infrastructure to location-based advertising and promotions

- **Location-Based Services** DASH7 is being used today to develop new location-based services using a range of DASH7-enabled devices including smartcards, keyfobs, tickets, watches and other conventional products that can take advantage of the unique small footprint, low power, long range, and low cost of DASH7 relative to less practical and high-power wireless technologies like WiFi or Bluetooth. Using DASH7, users can "check in" to venues in ways not practical with current check-in technologies like GPS, that are power-intensive and fail indoors and in urban environments. Location-based services like Foursquare, Novitaz, or Facebook can exploit this capability in DASH7 and award loyalty points, allow users to view the Facebook or Twitter addresses of those walking past, and more.

- **Ticketing** DASH7 can replace paper-based systems with low cost wireless systems that can be deployed using flexible substrates and thin-film batteries.

- **Building Automation, Access Control, Smart Energy** . DASH7's signal propagation characteristics allow it to penetrate walls, windows, doors, and other substances that serve as impediments to other technologies operating at 2.45 GHz, for example. For smart energy and building automation applications, DASH7 networks can be deployed with far less infrastructure than competing technologies and at far lower total cost of ownership.

- **Automotive** DASH7 is increasingly seen as the next-generation tire pressure monitoring system given its operation at the same frequency (433 MHz) as nearly all proprietary TPMS systems today. DASH7-based TPMS will provide end users with more accurate tire pressure readings, resulting in greater fuel economy, reduced tire wear and tear, and greater safety. DASH7 products are also being designed and used for other automotive applications like supply chain visibility.

- **Logistics** DASH7 is being used today to track the whereabouts of shipping containers, pallets, roll cages, trucks, rail cars, maritime vessels, and other supply chain assets, providing businesses with unprecedented visibility into their everyday operations. Also: cold chain management (vaccines, fresh produce, cut flowers, etc.), whereby DASH7 is used to monitor the in-transit temperature and other environmental factors that can impact the integrity of sensitive products.

As NATO militaries continue to deploy DASH7 infrastructure, defense suppliers are expected to also deploy DASH7 infrastructure given NATO requirements for supply chain visibility beyond just physical boundaries of a given military and deep into the supply chains of an array of suppliers around the world. DASH7 is expected to be adopted similar to the way barcoding was rapidly adopted by commercial companies, many of whom are also defense suppliers, following the LOGMARS barcoding mandate from the U.S. Department of Defense in 1981.

Defense Applications

DASH7 is being used extensively by the U. S. Department of Defense (DoD) and other militaries. In January 2009, DoD awarded a $429 million contract for DASH7 devices, making it one of the largest wireless sensor networking deployments in the world, especially when combined with DoD's $500 million + installed base of non-DASH7 infrastructure which DoD is upgrading to DASH7.

Commenting on the U.S. Department of Defense's move to an RFID III multi-vendor contract earlier this year, Lt. Col. Pat Burden, the DoD's Product Manager Joint-Automatic Identification Technology, stated, "This is a significant milestone for DoD in that this migration will not only give DoD and other Federal agencies' customers best-value solutions at competitive prices, but it moves us to ISO 18000-7:2008 compliant products, thus broadening interoperability with DoD and our coalition partners."

NATO military forces are required to interoperate with DoD's DASH7 network and are required to deploy interoperable infrastructure. All NATO militaries are deploying or in the process of deploying DASH7 infrastructure.

Semiconductor Industry Support

DASH7 developers receive support from the semiconductor industry including multiple options, with Texas Instruments, ST Microelectronics, Melexis, Semtech and Analog Devices all offering DASH7 hardware development kits or system-on-a-chip products. Texas Instruments also joined the DASH7 Alliance in March 2009 and announced their CC430 system-on-a-chip product for DASH7 in December 2009. Analog Devices also announced their ADuCRF101 single chip solution for DASH7 in November 2010.

One semiconductor industry approach is the combination of DASH7 with MEMS sensing products:

"We strongly believe that the next big wave in sensors will be driven by the combination of the sensing function with wireless transmission – and ISO 18000-7 is the right solution for security and asset monitoring applications," said Benedetto Vigna, group vice president and general manager of the MEMS and Healthcare Product Division at STMicroelectronics in the company's announcement. "The Smart Web-Based Sensor HDK is a best-in-class development platform that will help the adoption of wireless sensors across the industry."

ST Microelectronics announced the beta version of its DASH7 SmartSensor developers kit in May 2009 in collaboration with Arira Design.

Another semiconductor industry approach focuses on automotive:

"There is a great potential for DASH7 technology in the automotive area," said Gilles Cerede, Product Line Manager for Wireless Automotive & Sensing at Melexis. "We see a perfect fit between DASH7 features and performance and the requirements of wireless safety applications. For example the ultra low power consumption matches the TPMS life time constraints, while the "multi-kilometer" communication range is perfectly suited for car-to-car and car-to-infrastructure applications. Last but not least, DASH7 is compatible from a frequency point of view with existing Remote Keyless Entry systems."

DASH7 is also seen as a complement to 13.56 MHz NFC (Near Field Communications), where both technologies can "co-exist" in the same silicon with only minor adjustments to the NFC silicon to accommodate DASH7.

Device Integrators

Many companies are members of the DASH7 Alliance to produce DASH7-compliant hardware products, including:

- Confidex
- Convergence Systems
- DH Technology
- Evigia Systems
- Guard RFID
- Identec Solutions
- Cubic Global Tracking Solutions
- Lyngsoe Systems
- Novitaz
- RFind Systems
- Savi Technology (Lockheed Martin)
- Syrma
- Systems Planning Corp
- UDEA

The ISO/IEC 18000-7 Air Interface Standard

The original ISO 18000-7 standard was ratified in 2004 then modified in 2008. According to ISO:

ISO/IEC 18000-7:2009 defines the air interface for radio frequency identification (RFID) devices operating as an active RF tag in the 433 MHz band used in item management applications. It provides a common technical specification for RFID devices that can be used by ISO technical committees developing RFID application standards. ISO/IEC 18000-7:2009 is intended to allow for compatibility and to encourage inter-operability of products for the growing RFID market in the international marketplace. ISO/IEC 18000-7:2009 defines the forward and return link parameters for technical attributes including, but not limited to, operating frequency, operating channel accuracy, occupied channel bandwidth, maximum power, spurious emissions, modulation, duty cycle, data coding, bit rate, bit rate accuracy, bit transmission order, and, where appropriate, operating channels, frequency hop rate, hop sequence, spreading sequence, and chip rate. ISO/IEC 18000-7:2009 further defines the communications protocol used in the air interface.

Chapter-9

Clinical Engineering and Biomedical Equipment Technician

Clinical engineering

Clinical engineering is a specialty within Biomedical engineering responsible primarily for applying and implementing medical technology to optimize healthcare delivery. Roles of clinical engineers include training and supervising biomedical equipment technicians (BMETs), working with governmental regulators on hospital inspections/audits, and serving as technological consultants for other hospital staff (i.e. physicians, administrators, I.T., etc.). Clinical engineers also advise medical device producers regarding prospective design improvements based on clinical experiences, as well as monitor the progression of the state-of-the-art in order to redirect hospital procurement patterns accordingly.

Their inherent focus on *practical* implementation of technology has tended to keep them oriented more towards *incremental*-level redesigns and reconfigurations, as opposed to "revolutionary" R&D or cutting-edge ideas that would be many years from clinical adoptability; however, there is nonetheless an effort to expand this time-horizon over which clinical engineers can influence the trajectory of biomedical innovation. In their various roles, they form a sort of "bridge" between product originators and end-users, by combining the perspectives of being both close to the point-of-use ("front lines"), while also trained in product and process design. Clinical Engineering departments at large hospitals will sometimes hire not just biomedical engineers, but also industrial/systems engineers to help address operations research, human factors, cost analyses, safety, etc.

History

While some trace its roots back to the 1940s, the actual term "clinical engineering" was first used in 1969. The first explicit published reference to the term "clinical engineering" appears in a paper published in 1969 by Landoll and Caceres. Cesar A. Caceres, a cardiologist, is generally credited with coining the term "clinical engineering." Of course, the broader field of "biomedical engineering" has a relatively recent history as well. The first modern professional intersociety engineering meeting to be focused on the

application of engineering in medicine was probably held in 1948, according to the Alliance for Engineering in Medicine and Biology

The general notion of the application of engineering to medicine can be traced back centuries; for example, Stephen Hales's work in the early 18th century which led to the invention of a ventilator and the discovery of blood pressure certainly involved the application of engineering techniques to medicine .

The recent history of this sub-discipline is somewhat erratic. In the early 1970s, clinical engineering was thought to be a field that would require many new professionals. Estimates for the US ranged as high as 5,000 to 8,000 clinical engineers, or five to ten clinical engineers for every 250,000 of population, or one clinical engineer per 250 hospital beds..

The history of its formal credentialization and accreditation procedures has also been somewhat unstable. The International Certification Commission for Clinical Engineers (ICC) was formed under the sponsorship of the Association for the Advancement of Medical Instrumentation (AAMI) in the early 1970s, to provide a formal certification process for clinical engineers. A similar certification program was formed by academic institutions offering graduate degrees in clinical engineering as the American Board of Clinical Engineering (ABCE). In 1979, the ABCE agreed to dissolve, and those certified under its program were accepted into the ICC certification program. By 1985, only 350 clinical engineers had become certified. Finally, in 1999, AAMI after lengthy deliberation, and analysis of a 1998 survey demonstrating that there was not a viable market for its certification program decided to suspend that program, no longer accepting any new applicants as of July 1999.

The new, current Clinical Engineering Certification (CCE) program was started in 2002 under the sponsorship of the American College of Clinical Engineering (ACCE), and is administered by the ACCE Healthcare Technology Foundation. In 2004, the first year that the certification process was actually underway, 112 individuals were granted certification based upon their previous ICC certification, and three individuals were awarded the new certification. By the time of the publication of the 2006-2007 AHTF Annual Report (approx. June 30, 2007), a total of 147 individuals were included in the ranks of HTF certified clinical engineers.

Clinical engineering in India

Healthcare has increasingly become technology driven and requires trained manpower to keep pace with the growing demand for professionals in the field. An M-Tech Clinical Engineering course was initiated by Indian Institute of Technology Madras (IITM), Sree Chitra Tirunal Institute of Medical Sciences and Technology, Trivandrum and Christian Medical College, Vellore (CMC), to address the country's need of human resource development. This was aimed for indigenous Biomedical Device Development as well as Technology management, and thereby contribute to the overall development of healthcare delivery in the country. During the course, students of engineering are given

an insight into biology, medicine, relevant electronic background, clinical practices, device development and even management aspects. Additionally, students are paired with clinical doctors from CMC and SCTIMST to get hands-on experience during internships. An important aspect of this training is simultaneous, long term and detailed exposure to clinical environment as well as to medical device development activity. This is aimed at making students understand the process of identifying 'unmet clinical need' and thus, contributing to the development of new medical devices in the country. A unique feature of the course is clinical attachment which exposes the students to the clinical environment. The program also trains engineers to manage and ensure safe and effective use of technology in heath care delivery points. The minimum essential qualification for joining this course is bachelors degree in any discipline of engineering except civil engineering and a valid GATE score in their respective fields.

The Definition

A **Clinical engineer** is defined by ACCE as "a professional who supports and advances patient care by applying engineering and managerial skills to healthcare technology." This definition was first adopted by the ACCE Board of Directors on May 13, 1991. Clinical Engineering is also recognized by the Biomedical Engineering Society (BMES), the major professional organization for biomedical engineering, as being a branch within Biomedical Engineering.

There are at least two issues with the ACCE definition that cause some confusion. First, it is phrased so broadly that it's not readily evident that "clinical engineer" is but one subset of "biomedical engineer." Many times the terms actually get used interchangeably: some hospitals refer to their relevant departments as "Clinical Engineering" departments, while others call them "Biomedical Engineering" departments. Indeed, as noted above, the *technicians* are almost universally referred to as "biomedical equipment technicians," regardless of the name of the department that they might work under. However, the term "biomedical engineer" is generally thought to be more all-encompassing, including engineers who work in the primary design of medical devices for manufacturers, or in original R&D, or in academia—whereas clinical engineers generally work in hospitals solving problems that are very close to where equipment is actually used in a patient care setting. The clinical engineers in some countries such as India are trained to innovate and find technological solutions for the clinical needs.. The other issue not evident from the ACCE definition is the appropriate educational background for a clinical engineer. Generally, the expectation of the certification program is that an applicant for certification as a clinical engineer will hold an accredited bachelor's degree in engineering (or at least engineering technology).

The future

The management of healthcare technology is becoming increasingly complex. The driving factors and opportunities presented are examined in The Future of Clinical Engineering, published in the IEEE EMBS magazine in 2003.

Eligibility Requirements

To be eligible for certification in clinical engineering (CCE), a candidate must hold appropriate professional or educational credentials (an accredited engineering or possibly engineering-technology degree) have certain relevant experience, and pass an examination. The Examination for Certification in Clinical Engineering involves a written examination composed of a maximum of 150 multiple-choice objective questions with a testing time of three (3) hours, and a separate oral exam.. Particular weight is given to applicants for CE certification (CCE) who are already licensed as registered Professional Engineers (PE) -- which itself has extensive requirements (including an accredited engineering degree and engineering experience).

Biomedical Equipment Technician

A **Bio-Medical Equipment Technician, also referred to as a Biomedical Engineering Technologist (BMET) or Biomedical Equipment Specialist (BES)** is a highly skilled technologist that ensures that medical equipment is safe, functional and properly configured. They are employed by hospitals, clinics, private sector, and the military. These persons install, inspect, maintain, repair, calibrate, modify and design biomedical equipment and support systems to adhere to medical standard guidelines. BMETs educate and advise staff and other agencies on theory of operation, basic physiological principles, and safe clinical application of biomedical equipment maintaining the facility's patient care and medical staff equipment.

The acceptance of the biomedical equipment technician in the private sector was given a big push in 1970 when consumer advocate Ralph Nader wrote an article in which he claimed, "At least 1,200 people a year are electrocuted and many more are killed or injured in needless electrical accidents in hospitals."

These technicians perform much work in the biomedical/clinical engineering field that consists of and cover a vast array of different fields and devices.

Examples of different areas of biomedical equipment technology are: Radiographic and flouroscopic x-ray, Diagnostic ultrasound, LASERs, Mammography, Telemedicine, Film image processing, Nuclear Medicine, Gamma cameras, Positron emission tomography (PET), Medical imaging, Computed Tomography (CT), Electron microscope, Picture archiving and communication systems (PACS), Magnetic Resonance Imaging instrument (MRI scanner), Physiological monitoring, Sterilization, Dental, Optometry, Surgical, Anesthesia, Laboratory, Dialysis, Respiratory Services (ventilators) Computer Networking Systems integration, Information Technology, Patient Monitoring, and Cardiac Diagnostics

BMETs work closely with nursing staff, and Medical Material personnel to obtain parts, supplies, and equipment and even closer with facility management to coordinate equipment installations requiring certain facility requirements/modifications.

Regulatory issues

BMETs must conform with safety regulations, and most biomedical systems must have documentation to show that they were managed, modified, tested, delivered, and used according to a planned, approved process that increases the quality and safety of diagnostics and therapeutic equipment and reduces the risk of harm to patients and staff.

In the United States, BMETs may operate under various different regulatory frameworks. Clinical devices and technologies are generally governed by the Food and Drug Administration (FDA), National Fire Protection Agency (NFPA) particularly NFPA 99 and chapter 7, NFPA 70, Life Safety Code 101, Code of Federal Regulations (CFR) 21, Occupational Safety and Health Administration, Joint Commission on Accreditation of Healthcare Organizations (JCAHO) hospital or Accreditation Association for Ambulatory Health Care standards; and ensures compliance with these codes and standards for the US government registry of biomedical devices.

Other countries typically have their own mechanisms for regulation.

Biomedical equipment technology training

Traditionally, biomedical equipment technology has been an interdisciplinary field to specialize in after completing an Associate degree in Biomedical Equipment Technology, Biomedical Electronics Technology, or Biomedical Engineering Technology. Some BMETs get their training through the military.

Most entry-level BMETs enter into the field with a 2-year associate's degree in biomedical equipment technology, or they spend about one year in full-time military training. A 4-year graduate is an applied engineer who can perform the same medical equipment management duties as a clinical engineer, BMET Manager, or Director/Executive. Practical experience is gained through internships. Continuing education in the form of service schools is typically provided by specific medical device manufacturers. BMET educational degree programs can be accredited by the ABET (Accreditation Board for Engineering and Technology) or the ATMAE (Association of Technology, Management, and Applied Engineering) both of whom offer specialised/programmatic accreditation for BMET programs.

Professional certification

Many BMETs pursue professional certification, such as satisfying certain education requirements and passing an examination to become a certified biomedical equipment technician (CBET). There are two other certifications BMETs can obtain such as: Certified Radiology Equipment Specialists (CRES), and Certified Laboratory Equipment Specialists (CLES). In many cases, carrying the title of "CBET" is highly encouraged, not mandatory, and is respected within the technical community.

Employment

In-House: BMETs work in the hospital's Biomedical or Clinical Engineering Department, but can also find employment with a third-party independent service organization (ISO) or original equipment manufacturer (OEM).

Field Service: BMETs working for an OEM or ISO are many times called Field Service Engineers (FSE). FSE are more narrowly focused and specialized technicians who support Service and Sales.

Both must face increased risk of contact with electrical, mechanical, high pressure steam, noise, blood borne diseases, LASERs, chemicals and nuclear contaminates.

Military Roles

All military members entering the BMET career field receive comprehensive down to the component level and theory technical training. Prior to 1998, Army and Navy BMETs received training at the United States Army Equipment and Optical School (USAMEOS) at Fitzsimons Army Medical Center (FAMC) in Aurora, Colorado. Only after a July 1995 Base Realignment Closure Commission decided to close FAMC did the Army and Navy merge with the Air Force, conducting training at the DoD Biomedical Equipment Technician Training School. This school has a partnership with Aims Community College where students receive 81 quarter credits (from the Community College of the Air Force) toward an Associate of Applied Science (A.A.S.) Degree with an emphasis in Biomedical Electronic Technology. In addition to the credits acquired from DoD BMET Training School, a minimum of 24 credits must be completed through Aims Community College to receive a degree.

United States Air Force

- Air Force Specialty Code (AFSC) 4A2X1 (where X represents the corresponding skill level 3, 5, 7 or 9)
- Air Force Instruction 41-201, "Managing Clinical Engineering Programs"
    - More at about.com
    - More at airforce.com
    - Career Field Education & Training Plan (pdf)

United States Army

- Military Occupation Specialty (MOS) 68A.
- The Army recently redesignated this MOS from 91A to MOS 68A. (Also formerly MOS 35G & 35U)
    - More at about.com
    - More at goarmy.com
- Military Occupation Specialty - Warrant Officer (MOS) 670A Health Services Maintenance Technician.

United States Navy

- Navy Enlisted CodesHM-8498, HM-8479, HM-8478, HM-8410 and HM-8732 (Dental Repair Technician)
    - More regarding HM-8498 Medical Equipment Repair Tech.
    - More regarding HM-8479 Basic BMET at about.com
    - More regarding HM-8478 Advanced BMET at about.com

History of the HM-8410 NEC Prior to establishment of the NEC's HM-8478 & HM-8479 there was one NEC of HM-8498 Medical Equipment Repairman. This Navy Corpsman was required to complete both basic and advance medical equipment repair training courses at Fitzsimmons Army Medical Center in Denver, CO as one course of instruction. The navy had no basic repair tech. The total number of MER's in the navy was 92 until around 1974 when the numbers authorized was significantly increased and the basic repair tech NEC for the navy established. The basic course was a total of 15 weeks with the advance course being an additional approx. 36 weeks. The students enrolled after the period of 1969 could be awarded an AAS from Regis College(now Regis University) after completing a few additional courses. Later the school became affiliated with Colorado Technical College which the students again could be awarded an AAS with a few more courses and a BS with several additional semester hours of work. October 30, 2006 - HM-8410 was established and HM-8732 NEC was disestabilshed. Former HM-8732s were DNEC and given the 8479 NEC. This was done only because the HM-8732 was disestabilished. HM-8732 billets were converted to HM-8479 billets.

Chapter-10

Yard Ramp and Loading Dock

Yard ramp

A **yardramp**, sometimes called **mobile yardramp** or **container ramp**, is a movable metal ramp for loading and unloading of shipping containers and vehicle trailers, without the need for permanent docking bays. A yardramp is placed at the back of a vehicle to provide access for forklifts to ascend the ramp, quickly and safely into the container or truck body.

Using a yardramp for container loading or unloading allows the work to be carried out by a single forklift operator. Businesses handling only one or two loads per day normally find that a yardramp is more cost effective than a permanent loading dock.

Advantages of a yardramp

Containers, trucks and trailers are typically loaded / unloaded from the rear by reversing the vehicle up against a raised concrete loading bay, the cargo is then moved using counter-balanced forklift trucks. The loading bay is designed to be at approximately the height of the vehicle with a levelling device to accommodate any height differences. There are however many situations where it is not possible to utilise a permanent loading bay. In these situations, a yardramp is an ideal solution, providing fast, efficient loading and unloading of trucks/trailers by fork truck. The possession of a yardramp also provides a backup in case of any problems encountered with a normal loading bay/dock leveller system, and can also provide additional flexibility should vehicles be encountered that the normal loading bay cannot cope with.

Yardramps can also be used either inside or outside of buildings; they avoid the need to construct expensive permanent concrete docking bays; and are ideal for short term use in peak periods or on temporary sites.

Additionally, yardramps normally incorporate a tow bar or hitch allowing them to be quickly and easily moved around on site by forklift and placed in a new location as required. Their mobile design makes them ideal for small sites where space is a premium, or sites with rapidly changing operations/requirements.

Yardramp design

Some yardramps are constructed from aluminium, but although this has weight advantages, their cost is typically much higher than their steel equivalents; most yardramps are therefore constructed from welded steel unless the weather conditions are such that aluminium needs to be used, i.e. in climates with temperatures well below freezing.

There are a variety of choices for the decking material as it is required to be both tough and non-slip in a range of operating conditions. Most manufacturers use some form of open grill sheeting supported on a rugged base structure.

The basic layout of a yardramp is an inclined section of about 9 m (29'6") in length and 2.25 m (7'5") in width, followed by a flat approach section of about 2.5 m (8'3") in length at the top, with a lip to enter the container or truck being loaded or unloaded. Both sides of the ramp usually have safety rails to prevent forklifts from accidentally driving over the edges. The yardramp is supported on an undercarriage, or adjustable legs, fitted with wheels which are used to transport the yardramps around.

The undercarriage/legs are adjustable so that the height of the ramp can be raised whilst the truck is put into position, and then the yardramp is lowered so that the front lip supports the weight of the yardramp on the container or truck floor. It is then vitally important that the yardramp is allowed to float up and down with the vehicle as it raises/lowers on its suspension.

Standard yardramp features

Although most mobile yardramps are generally of a similar design, it is important to be aware of their individual features, and the potential impact they can have on operations:

- Usable width – It is strongly recommended to use a ‘full width’ yardramp which is the width of a container for the full length of the ramp. Some ramps on the market are narrow for the majority of their length, but flare out at the top. This can require additional positioning and can prevent pallets entering the vehicle parallel. Some yardramps are supplied narrower to allow them to be shipped in a container, ideally however they should be full width.

- Capacity – The industry standard capacity ramp is rated at 10 tonnes (22,000 lb), but some manufacturers produce alternative light duty 7-tonne (15,000 lb) models, and some produce heavy duty 12-tonne (26,000 lb), 15-tonne (33,000 lb) or higher capacity yardramps dependant upon the customers’ requirements.

- A level-off section at the top of the yardramp is required so that the load is inserted as parallel as possible to the floor of the vehicle, preventing impact with the roof, and also improving visibility for positioning.

- The working height of mobile yardramps needs to be adjustable to suit varying vehicle bed heights. The working height will also alter slightly as the vehicle is loaded or unloaded and moves on its suspension. Normally a working range of 1.0 to 1.7 m (3'3" to 5'7") is considered suitable as that allows the ramp to reach containers at around 1525 mm (5'0"), down to Euro Trailers at around 915 mm (3'0").

- A full width exit lip which sits securely on the bed of the vehicle to allow full width access to the vehicle/container. If the lip is narrower there is a risk of fork trucks falling or getting stuck in gaps between the ramp and vehicle. A few ramps have strengthening ribs on the top of the exit lip which can narrow the usable width and interfere with the loading/unloading operation, preventing the final pallets being loaded with the ramp.

- Fully mobile design with an easily operated tow mechanism; allowing the yardramp to be quickly and easily manoeuvred into position on the vehicle, or stored away until next needed.

Essential safety features:

1. A means of preventing the yardramp and vehicle from creeping apart during use.
2. Safety rails to prevent fork trucks driving off the sides during use.
3. High traction, non-slip flooring along the length of the yardramp.
4. Adequate signage to cover functions/instructions for the ramp.
5. The ramp should 'float' up and down with the vehicle as it moves on its suspension during the loading/unloading operation.
6. Handrails along the full length, if the yardramp is likely to be used by personnel.
7. Safe working load must be clearly stated.

Selecting the right yardramp

Careful consideration must be taken when selecting the correct yardramp for each application. The manufacturer should be able to provide information to help select the correct model, but important things to consider are:

- Capacity or rated load – The rated capacity of the ramp must always exceed the greatest total moving load (including goods, persons and transport equipment). If there is any likelihood of changes to operations; it is always better to over specify than under specify. It is also vitally important to be aware if quoted capacities are total load (uniformly distributed load: UDL), or single axle (dynamic load) capacities. Under heavy braking it is quite feasible to have the full weight of the fork truck acting through its front wheels only, therefore it is important to ensure the single axle rating of the ramp is sufficiently high.

- Frequency of use – High frequency usage, e.g. shift working can cause damage to light duty ramps which are only designed for occasional use.

- The load to be moved – The ramp must not restrict the movement of the load sizes required. Narrow, high side curbs are a hindrance if trying to load wide items, and long, tall items may foul on the top of the container if the level off top section at the top is too short.

- Usable width – This is typically full vehicle width, i.e. around 2.25 m (7'5" to allow straight access into the vehicle without the need for repositioning at the top of the ramp.

- The type of fork truck – 3-wheeled fork trucks for example will put additional pressure on the flooring of the yardramp. It is also important to check the trucks to be used are capable of running safely on the incline at which the yardramp will be working at, and have no under clearance problems.

- Height range – The maximum recommended incline of a yardramp is 7 degrees or 1 in 8, though some yardramps are capable of raising beyond this angle.

- Movement of the yardramp – Yardramps are typically moved around using a simple tow bar which is pinned into the tow hitch on the back of most standard fork trucks, though some designs offer alternative methods, such as pushing the ramp around using pockets which accept standard the forks of a fork truck.

- Yard Surface - If the ramp is to be regularly towed across rough or stony surfaces, or towed at high speeds then it is preferable to have a ramp fitted with conventional pneumatic tires rather than the cheaper solid tires normally used as standard on many European ramps.

Safety/Quality

As with any equipment, there are standards, directives and regulations that should all be fully considered to ensure that a yardramp meets the legislative requirements for the country in which it is being used.

In Europe 'CE' Marking is a manufacturer's declaration that a product complies with the provisions of all applicable Directives, including the essential safety and health requirements, and is proven by the demonstration of a route of compliance.

Loading dock

A **loading dock** is a recessed bay in a building or facility where trucks are loaded and unloaded. They are commonly found on commercial and industrial buildings, and warehouses in particular.

Loading docks may be exterior, flush with the building envelope, or fully enclosed. They are part of a facility's service or utility infrastructure, typically providing direct access to staging areas, storage rooms, and freight elevators.

Basics

In order to facilitate material handling, loading docks may be equipped with the following:

- Bumpers - protect the dock from truck damage, may also be used as a guide by the truck driver when backing up.
- Dock leveler - a height-adjustable platform used as a bridge between dock and truck, can be operated via mechanical (spring), hydraulic, or air powered systems.
- Dock lift - serves same function as a leveler but operates similar to a scissor lift to allow for greater height adjustments.
- Dock seals - compressible foam blocks against which the truck presses when parked; seals are used at exterior truck bays in colder climates where this will provide protection from the weather.
- Truck or vehicle restraint system - a strong metal hook mounted to the base of the dock which will hook to the frame or bumper of a trailer and prevents it from rolling away during loading operations, can be operated via manual, hydraulic, or electrical systems; this system can replace or work in conjunction with wheel chocks.
- Dock light - a movable articulating light mounted inside the dock used to provide lighting inside the truck during loading operations.
- Loading Dock Software - provides a method for tracking and reporting on the loading dock activity.

Warehouses that handle palletized freight use a dock leveler, so items can be easily loaded and unloaded using power moving equipment (e.g. a forklift). When a truck backs into such a loading dock, the bumpers on the loading dock and the bumpers on the trailer come into contact and create a gap; also, the warehouse floor and the trailer deck may not be horizontally aligned. The most common dock height is 48” – 52”, though heights of up to 55" occur as well. A dock leveler bridges the gap between a truck and a warehouse to accommodate a forklift.

Where it is not practical to install permanent concrete loading docks, or for temporary situations, then it is common to use a mobile version of the loading dock often called a yard ramp.

Dangers

There can be very serious accidents on loading bays. One example is trailer creep (also known as trailer walk, or dock walk) which occurs when the lateral and vertical forces exerted each time a forklift truck enters and exits the trailer cause the trailer to slowly move away from the dock resulting in separation from the dock leveler. Factors that

affect trailer creep are the weight and speed of the lift truck and load, the gradient of the ground the trailer is parked on, the condition of the suspension and the air pressures, the type of transition (dock levelers, dock boards) being used, and whether the trailer has been disconnected or if it is still connected to the tractor.

Separation of a vehicle from the loading also occurs when a driver prematurely pulls away while the truck is still being loaded/unloaded. This issue is usually caused through a driver not correctly observing traffic lighting signals on a loading bay which prohibit the movement of the trailer. Also, it is important to ensure drivers are fully trained with regard the Safe System of Work he/she is expected to follow.

A loading dock at the New Research Building, Harvard Medical School.

Typical warehouse exterior showing loading docks

Modern loading bay with overhead door, dock leveler, dock seals, canopy, and truck restraint system.

A reinforced concrete loading dock under construction.

Chapter-11

First-party, Second-party, Third-party and Fourth-party logistics

First-party logistics

A **First-party logistics provider** (abbreviated **1PL**) is a firm or an individual that needs to have cargo, freight, goods, produce or merchandise transported from a point A to a point B. The term **first-party logistics provider** stands both for the cargo sender and for the cargo receiver.

Type of 1PL

A 1PL can be anything from a manufacturer, to a trader, buying office, importer/exporter, wholesaler, retailer, and a distributor in the international commerce field.

It can also be institutions such as government department, NGO, associations, military, and post.

An individual or a family removing from one place to another also needs to have its personal effects transported from their place of origin to their new place, and is as such considered as a **first-party logistics provider**.

Type of transportation

Typically the **first-party logistics providers** subcontract their transportation's needs to 2PLs and 3PLs, which are companies specialized in transportation. This helps the **1PL** to benefit from cheaper transportation prices thanks to the specialization of the 2PLs and 3PLs, and the subsequent economies of scale.

The transportation needed by the **1PL** can be anything from transportation by ship, barge, aircraft, train, van or truck.

Terminology

In the freight industry, **first-party logistics providers** are called differently depending whether they are the sender of the merchandise or the receiver of the merchandise:

- Sender = Consignor = Shipper
- Receiver = Consignee

In the "**PL**" terminology, it is important to differentiate the **1PL** from the:

- 2PL, which are actual carriers,
- 3PL, which are one stop shops for the **1PL**, such as freight forwarders or courier companies,
- 4PL, which are consulting firms such as CPCS, SCMO, BMT, Deloitte, and Accenture.

Second-party logistics

A **Second-party logistics provider** (abbreviated **2PL**) is an asset-based carrier, which actually owns the means of transportation.

Type of 2PL

Second-party logistics providers are:

- shipping lines, which own, lease, or charter their ships,
- airlines, which own, lease, or charter their planes,
- truck companies, which own, or lease their trucks,
- barge companies, which own, lease, or charter their barge,
- rail companies, which own their trains,
- warehouse owners.

Transportation industry

In the transportation industry, the **second-party logistics providers** are segmented between different categories of transportation:

- seafreight, which regroups shipping lines and barge companies,
- airfreight, which regroups the airlines, as well as the cargo helicopter companies,
- trucking, which regroups the truck companies and the van companies,
- railways, which regroups the rail companies,
- warehousing and logistics.

Terminology

In the "**PL**" terminology, it is important to differentiate the **2PL** from the:

- 1PL, which are the shipper or the consignee,
- 3PL, which are one stop shops for the **1PL**, such as freight forwarders or courier companies,
- 4PL, which are consulting firms such as CPCS, SCMO, BMT, Deloitte, and Accenture.

Overlapping

2PL can also be 3PL at the same time in the following cases:

- when a shipping line owns a freight forwarder,
- when an airline owns a general sales agent (GSA),
- when a freight forwarder owns trucks, or a warehouse,
- when a courier company owns planes, trucks, or a warehouse.

Third-party logistics

A **third-party logistics provider** (abbreviated **3PL**, or sometimes **TPL**) is a firm that provides a one stop shop service to its customers of outsourced (or "third party") logistics services for part, or all of their supply chain management functions.

Third party logistics providers typically specialize in integrated operation, warehousing and transportation services that can be scaled and customized to customer's needs based on market conditions and the demands and delivery service requirements for their products and materials.

Definition

To put forward some standard definitions, we would adopt the definition of **3PL** found in the Council of Supply Chain Management Professionals' glossary, which reads as follows:

"A firm [that] provides multiple logistics services for use by customers. Preferably, these services are integrated, or "bundled" together, by the provider. Among the services **3PLs** provide are transportation, warehousing, cross-docking, inventory management, packaging, and freight forwarding."

Types of 3PL

Third-party logistics providers

- freight forwarders
- courier companies
- other companies integrating & offering subcontracted logistics and transportation services

Hertz and Alfredsson (2003) describe four categories of 3PL providers:

- *Standard 3PL provider:* this is the most basic form of a 3PL provider. They would perform activities such as, pick and pack, warehousing, and distribution (business) – the most basic functions of logistics. For a majority of these firms, the 3PL function is not their main activity.
- *Service developer:* this type of 3PL provider will offer their customers advanced value-added services such as: tracking and tracing, cross-docking, specific packaging, or providing a unique security system. A solid IT foundation and a focus on economies of scale and scope will enable this type of 3PL provider to perform these types of tasks.
- *The customer adapter:* this type of 3PL provider comes in at the request of the customer and essentially takes over complete control of the company's logistics activities. The 3PL provider improves the logistics dramatically, but do not develop a new service. The customer base for this type of 3PL provider is typically quite small.
- *The customer developer:* this is the highest level that a 3PL provider can attain with respect to its processes and activities. This occurs when the 3PL provider integrates itself with the customer and takes over their entire logistics function. These providers will have few customers, but will perform extensive and detailed tasks for them.

Non Asset-based Logistics Providers

Advancements in technology and the associated increases in supply chain visibility and inter-company communications have given rise to a relatively new model for third-party logistics operations – the "non-asset based logistics provider." Non-asset based providers perform functions such as consultation on packaging and transportation, freight quoting, financial settlement, auditing, tracking, customer service and issue resolution. However, they don't employ any truck drivers or warehouse personnel, and they don't own any physical freight distribution assets of their own – no trucks, no storage trailers, no pallets, and no warehousing. A non-assets based provider consists of a team of domain experts with accumulated freight industry expertise and information technology assets. They fill a role similar to freight agents or brokers, but maintain a significantly greater degree of "hands on" involvement in the transportation of products.

To be useful, providers must show their customers a benefit in financial and operational terms by leveraging exceptional expertise and ability in the areas of operations, negotiations, and customer service in a way that complements its customers' preexisting physical assets.

On-Demand Transportation

On-Demand Transportation is a relatively new term coined by 3PL providers to describe their brokerage, ad-hoc, and "flyer" service offerings.

On-Demand Transportation has become a mandatory capability for today's successful 3PL providers in offering client specific solutions to supply chain needs.

These shipments do not usually move under the "lowest rate wins" scenario and can be very profitable to the 3PL that wins the business. The cost quoted to customers for On-Demand services are based on specific circumstances and availability and can differ greatly from normal "published" rates.

On-Demand Transportation is a niche that continues to grow and evolve within the 3PL industry.

Specific modes of transport which may be subject to the on-demand model include (but are not limited to) the following:

- FTL, or Full Truck Load
- Hotshot (direct, exclusive courier)
- Next Flight Out, sometimes also referred to as Best Flight Out (commercial airline shipping)
- International Expedited

Terminology

In the "**PL**" terminology, it is important to differentiate the **3PL** from the:

- 1PL, which are the shipper or the consignee,
- 2PL, which are actual carriers such as YRC Worldwide, UPS, FedEx,
- 4PL, which are consulting firms such as CPCS, SCMO, BMT, Deloitte, and Accenture.

Overlapping

3PL can also be 2PL at the same time in the following cases:

- when a shipping line owns a freight forwarder,
- when an airline owns a general sales agent (GSA),
- when a freight forwarder owns trucks or a warehouse,

- when a courier company owns planes.

Fourth-party logistics

A **Fourth-party logistics provider** (abbreviated **4PL**), lead logistics provider, or 4th Party Logistics provider, is a consulting firm specialized in logistics, transportation, and supply chain management. Typical **fourth-party logistics providers** are CPCS, SCMO, BMT, Deloitte, Capgemini, 3t Europe and Accenture.

As the **4PL** industry is still in its infancy and currently being created throughout the world (Blue Ocean Strategy), its definition and function still leads to a lot of confusion, even for professionals of the transportation industry.

History

The term **4PL** is generally considered to have been introduced by Accenture, which registered it as a trademark in 1996. Accenture described the **4PL** as an "integrator that assembles the resources, capabilities, and technology of its own organization and other organizations to design, supply chain solutions".

The trademark was later abandoned, and the term has become a part of the public domain.

Definition

A **fourth-party logistics provider** is an independent, singularly accountable, non-asset based integrator of a client's supply and demand chains.

Conflict of interest

To avoid any conflict of interest, it is important that this **fourth-party logistics provider** be non-asset based, as far as logistics, transportation, and supply chain management assets are concerned. **4PL** use 2PLs and/or 3PLs to supply service to customers, owning only computer systems and intellectual capital.

Confusion

Nowadays advisors, consultants, software companies and even 3PLs lay claim to being a **4PL**. This is because any company advising a customer on logistics, transportation, and supply chain matters feels it may somehow claim to be a **4PL**. This is effectively the case only when the principle of neutrality is respected, and that any conflict of interest is avoided.

A **fourth-party logistics provider** must also offer services considering a 360 degree view, which is not focused on its ability to implement the recommendations it gives, but on all the options available in the market.

Principle of neutrality

As such an IT consulting firm specialized in WMS (Warehouse Management Systems), which is objectively considering all the various WMS present in the market is a **4PL**. It may obviously not represent any WMS brand or any software company, otherwise the concept of neutrality is broken, and it leads to conflict of interest.

Similarly a non-asset based consulting firm specialized in logistics, transportation, and supply chain management may claim it is a **4PL**. This is effectively the case if it does not own warehouses, logistics platforms, vans, trucks, ships, barges, planes, a freight forwarder, or a courier company, otherwise it would lead to conflict of interest.

It has been sometimes argued that a **4PL** is the same thing as a "non-asset based 3PL". This is not the case. Considering that probably 90% of the world's 3PL are "non-asset based", they nevertheless generate revenues & profits from their "non-asset based" activities. As such a 3PL cannot be a **4PL** in the same time, as this would lead to conflict of interest. Indeed it would then have a tendency to recommend to customers its "non-asset based" operation as the best possible option.

Examples of 4PL

The best examples of **fourth-part logistics provider**s are "non-asset based" consulting firms exclusively specialized in logistics, transportation, and supply chain management such as SCMO, BMT Limited, MVA Consulting, TTR, Intermodality, CPCS, and 3t-Europe, which offer complete ranges of services, from strategy to implementation.

Others are more generalist consulting firms such as the Big Four auditors, respectively Deloitte, PricewaterhouseCoopers, Capgemini, Ernst & Young, and KPMG, as well as Accenture, Arup, Atkins (company), Mott MacDonald, Parsons Brinckerhoff, and AECOM.

Other firms such as McKinsey & Company, Bain & Company, A.T. Kearney, the Boston Consulting Group, and Booz & Company, may also play the role of **4PL** with a different value proposition, and are considered to be "pure strategy" firms only.

Overlapping

Are often calling themselves **4PL**, advisors, or consultants:

- freight forwarders, who tell their customers they will advise them on the best possible solution (within the frame of their own operations),

- warehouse operators and logistics platform operators, who tell their customers they will advise them on the best possible solution (within the frame of their own operations).

3PL vs. 4PL

A 4PL is a consultant, and cannot be an operator. This is to respect the principle of neutrality.

A 3PL is an operator, which specializes in integrated operation, warehousing and transportation services. These services may be 100% outsourced, as in the case of "non-asset based 3PL". It is then a pure 3PL. It may also own part of its operations, such as warehouses, vans, or trucks. It then is both a 3PL and a 2PL, but is usually still called a 3PL. It can also offer genuine supply chain consulting services outside of its usual range of services. It is then both a 3PL and a 4PL, but is usually still called a 3PL.

It is important to differentiate 3PL, which actually deliver supply chain consulting services outside of their usual range of integrated operations, from 3PL which use the term consulting or 4PL abusively, as a marketing tool only. Some 3PL currently go as far as giving a title of consultant to their sales people, who are only selling their classical 3PL services. These are clearly 3PL only.

In other cases, 2PL logistics operators, or 3PL with advanced logistics and information technology capabilities may call themselves 4PL, or a mix of 3PL/4PL. Their capabilities are so advanced in logistics, wms, and/or communication that they effectively need to customize their operations for each new customer, which requires a lot intellectual capital, similar to the 4PL. Nevertheless, their ownership of logistics assets contradicts the 4PL status, and leads to conflict of interest for real consultancy. They may be called "advanced logistics 2PL/3PL" or "total logistics 2PL/3PL".

Example of "advanced logistics 3PL"

There are more and more such "advanced logistics 3PL" or "total logistics 3PL" on the market. It is mostly because logistics services stabilize customers longer than the simple delivery of freight services.

While the list of "advanced logistics 3PL" ranges in the thousands, some of the most famous in the market are DHL, Kuehne + Nagel, Schenker, Panalpina, UPS, 4PL, Theodore Wille Intertrade (TWI), Rollins 3PL, WS Logistics, Procurus, JSI Logistics, C.H. Robinson Worldwide, Nissin UK LTD, and Corporate Traffic.

Terminology

In the "**PL**" terminology, it is important to differentiate the **4PL** from the:

- 1PL, which are the shipper or the consignee,

- 2PL, which are actual carriers,
- 3PL, which are one stop shops for the **1PL**, such as freight forwarders or courier companies.

Chapter-12

Warehouse

Old warehouses in Amsterdam, Netherlands

Inside Green Logistics Co., Kotka, Finland. The image shows goods loaded on pallets to the left of the aisle, and stacked pallets with no loads to the right of the aisle.

A **warehouse** is a commercial building for storage of goods. Warehouses are used by manufacturers, importers, exporters, wholesalers, transport businesses, customs, etc. They are usually large plain buildings in industrial areas of cities and towns. They usually have loading docks to load and unload goods from trucks. Sometimes warehouses load and unload goods directly from railways, airports, or seaports. They often have cranes and forklifts for moving goods, which are usually placed on ISO standard pallets loaded into pallet racks.

Nature of goods stored

Stored goods can include any raw materials, packing materials, spareparts, components, or finished goods associated with agriculture, manufacturing, or commerce.

Types of warehouse storage systems

19th century warehouses in Gloucester docks in the United Kingdom, originally used to store imported corn

So-called *Sust*, a Middle Ages type of warehouse, in Horgen, Switzerland

Some of the most common warehouse storage systems are:

- Pallet rack including selective, drive-in, drive-thru, double-deep, pushback, and gravity flow
- Mezzanine including structural, roll formed, rack supported, and shelf supported
- Cantilever Rack including structural and roll formed
- Industrial Shelving including metal, steel, wire, and catwalk
- Automated Storage and Retrieval System (ASRS) including vertical carousels, vertical lift modules, horizontal carousels, robotics, mini loads, and compact 3D

Processes and IT

Major warehousing processes include:

- Receiving
- Inspection/ Acceptance
- Proper Storage
- Order preparation / picking
- Dispatching/ Delivery
- Inventory management (Checking as per System vs. Actual stock)

-It can be done daily, weekly, monthly or quarterly basis.

Warehouses frequently provide services, such as:

- Co-packing
- Kitting
- Repair

A **piece pick**, also known as **broken case pick, split-case pick, each pick, over-pack or pick/pack**, is a type of order selection process where product is picked and handled in individual units and placed in an outer carton, tote or other container before shipping. Catalog companies and internet retailers are examples of predominantly piece-pick operations. Their customers rarely order in pallet or case quantities; instead, they typically order just one or two pieces of one or two items.

Material direction and tracking in a warehouse can be coordinated by a Warehouse Management System (WMS), a database driven computer program. Logistics personnel use the WMS to improve warehouse efficiency by directing putaways and to maintain accurate inventory by recording warehouse transactions.

Automation and optimization

Automatic storage warehouse for small parts

Some warehouses are completely automated, and require only operators to work and handle all the task. Pallets and product move on a system of automated conveyors, cranes and automated storage and retrieval systems coordinated by programmable logic controllers and computers running logistics automation software. These systems are often installed in refrigerated warehouses where temperatures are kept very cold to keep product from spoiling, especially in electronic warehouse where they require specific temperature to avoid damaging the parts and also where land is expensive, as automated storage systems can use vertical space efficiently. These high-bay storage areas are often more than 10 meters (33 feet) high, with some over 20 meters (65 feet) high. Automated storage systems can be built up to 40m high.

For a warehouse to function efficiently, the facility must be properly *slotted*. Slotting addresses which storage medium a product is picked from (pallet rack or carton flow), and how they are picked (pick-to-light, pick-to-voice, or pick-to-paper). With a proper slotting plan, a warehouse can improve its inventory rotation requirements—such as first in, first out (FIFO) and last in, first out (LIFO)—control labor costs and increase productivity.

Modern trends

Aisle with pallets on storage racks

Traditional warehousing has declined since the last decades of the 20th century, with the gradual introduction of Just In Time (JIT) techniques. The JIT system promotes product delivery directly from suppliers to consumer without the use of warehouses. However, with the gradual implementation of offshore outsourcing and offshoring in about the same time period, the distance between the manufacturer and the retailer (or the parts manufacturer and the industrial plant) grew considerably in many domains, necessitating at least one warehouse per country or per region in any typical supply chain for a given range of products.

Recent retailing trends have led to the development of warehouse-style retail stores. These high-ceiling buildings display retail goods on tall, heavy duty industrial racks rather than conventional retail shelving. Typically, items ready for sale are on the bottom of the racks, and crated or palletized inventory is in the upper rack. Essentially, the same building serves as both warehouse and retail store.

Another trend relates to Vendor Managed Inventory (VMI). This gives the vendor the control to maintain the level of stock in the store. This method has its own issue that the vendor gains access to the warehouse.

Large exporters/manufacturers use warehouses as distribution points for developing retail outlets in a particular region or country. This concept reduces end cost to the consumer and enhances the production sale ratio.

Internet impact

19th century warehouse in Frankfort, Kentucky, United States used to age bourbon whiskey casks, seen closely through the warehouse windows

The internet has had an influence on warehouses. Internet-based stores do not require physical retail space, but still require warehouses to store goods. This kind of warehouse fills many small orders directly from end customers rather than fewer orders of many items from stores.

Having a large and complex supply chain containing many warehouse can be costly. It may be beneficial for a company to have one large warehouse per continent, typically located centrally to transportation. At these continental hubs, goods may be customized for different countries. For example, goods get a price ticket in the language of the destination country. Small, in-warehouse adjustments to goods are called value added services.

Chapter-13

Shipping Container and Track & Trace

Shipping container

A **shipping container** is a container with strength suitable to withstand shipment, storage, and handling. Shipping containers range from large reusable steel boxes used for intermodal shipments to the ubiquitous corrugated boxes.

Types of shipping containers

Intermodal freight containers

A spine car with a 20 ft tanktainer and an open-top 20 ft container with canvas cover

Freight containers are a reusable transport and storage unit for moving products and raw materials between locations or countries. There are approximately seventeen million intermodal containers in the world and a large proportion of the world's long distance freight generated by international trade is transported inside shipping containers.

Corrugated box

Corrugated boxes are commonly used as shipping containers. They are made of corrugated fiberboard which is light weight, recyclable, and strong enough to ship a variety of products.

Wooden box

Wooden boxes are often used for shipping heavy and dense products. They are sometimes specified for shipments of government or military shipments.

Crate

A crate is a large container, often made of wood, used to transport large, heavy or awkward items. A crate has a self-supporting structure, with or without sheathing.

Intermediate bulk shipping container

A typical IBC

An Intermediate bulk container (IBC) is a container used for transport and storage of fluids and bulk materials. The construction may be plastic, composite, steel, stainless steel, etc. Some are foldable (collapsable).

Flexible Intermediate Bulk Container

A Flexible Intermediate Bulk Container, *FIBC* , *big bag*, *bulk bag*, or *super sack* is a standardized container in large dimensions for storing and transporting and storing granular products. It is often made of a woven synthetic material.

Bulk box

A bulk box, bulk bin, skid box, or tote box is a pallet size box used for storage and shipping of bulk quantities.

Drum

Example of steel drum

Drums are cylindrical shipping containers made of steel, plastic or fiber. They are often used for liquids and granular materials.

Insulated shipping containers

Insulated shipping containers are a type of packaging used to ship temperature sensitive products such as foods, pharmaceuticals, and chemicals. They are used as part of a cold chain to help maintain product freshness and efficacy.

Unit load device

A "LD3-45" unit load device on a trailer.

A Unit Load Device, or ULD, is a container used to cargo on commercial aircraft.

A ULD can be a pallet or container used to load luggage, freight, and mail on wide-body aircraft and specific narrow-body aircraft. It allows a large quantity of cargo to be bundled into a single unit. Since this leads to fewer units to load, it saves ground crews time and effort and helps prevent delayed flights. Each ULD has its own packing list, manifest, or tracking identification to improve control and tracking of contents.

Specialized shipping containers

A container for shipping weapons, with carrying handles

Custom containers are used for shipments of products such as weapons and aviation components. Customized cushioning, blocking and bracing, carrying handles, lift rings, locks, etc. are common to facilitate handling and to protect the contents. Often, these shipping containers are reusable.

Transit and Flight Case

Flight cases and transit cases are usually custom designed for shipping and carrying fragile equipment: audio visual, camera, instruments, etc. Although generally light in construction, they tend to have reinforced edges and corners.

Road Case

Road cases are often used for shipping musical instruments and theater props.

Track & Trace

In distribution and logistics of many types of products, **track and trace** or tracking and tracing, concerns a process of determining the current and past locations (and other information) of a unique item or property.

This concept can be supported by means of reckoning and reporting of the position of vehicles and containers with the property of concern, stored, for example, in a real-time

database. This approach leaves the task to compose a coherent depiction of the subsequent status reports.

Another approach is to report the arrival or departure of the object and recording the identification of the object, the location where observed, the time, and the status. This approach leaves the task to verify the reports regarding consistency and completeness. An example of this method might be the package tracking provided by shippers, such as Deutsche Post, United Parcel Service or FedEx.

Products and industries

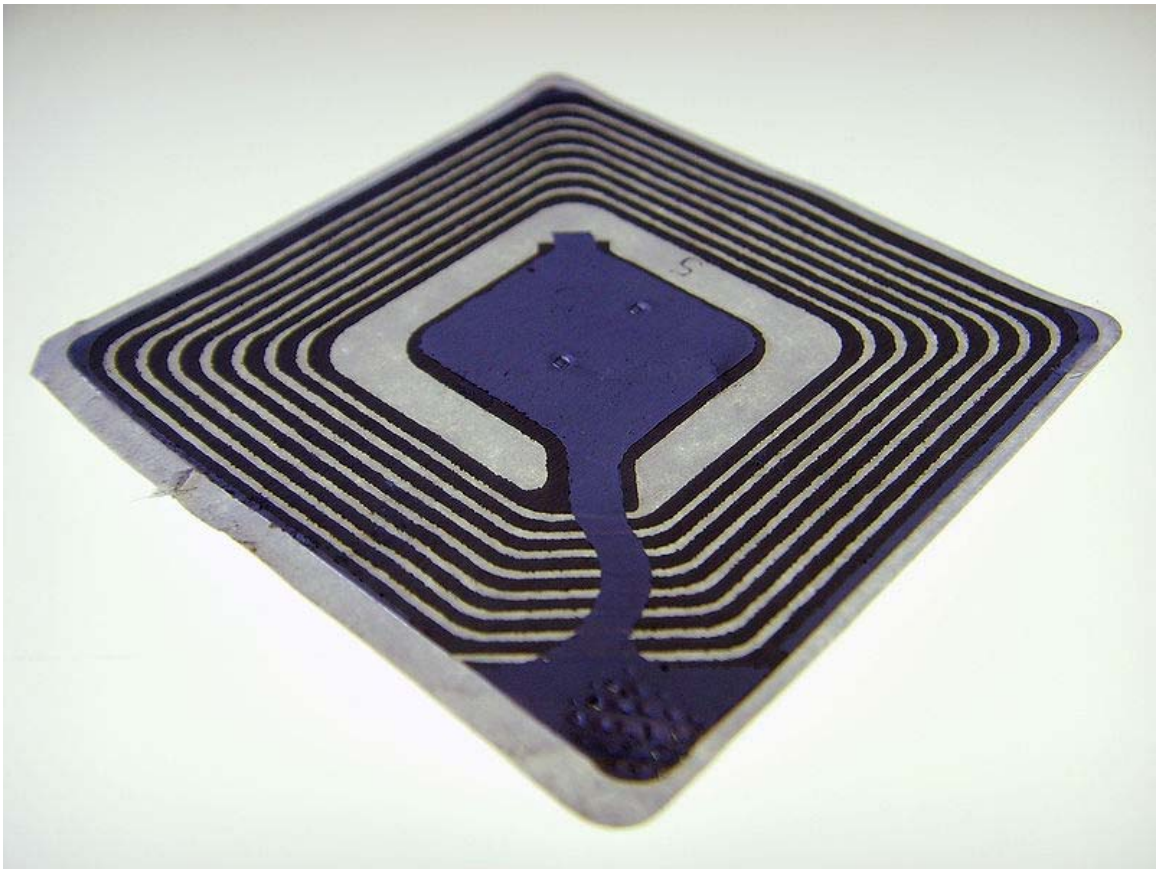
Examples include:

- Parcels shipped by postal or express couriers
- Intermodal containers
- Explosives
- Blood supply
- Food including produce, frozen foods, processed foods, meats, drinks etc
- Toys
- Pharmaceutical, vaccine, and drug products
- Medical devices
- Hospital supplies
- Weapons
- Chemicals
- Livestock
- Documents
- Software
- Employee monitoring
- Track-and-Trace.com:81

Technology

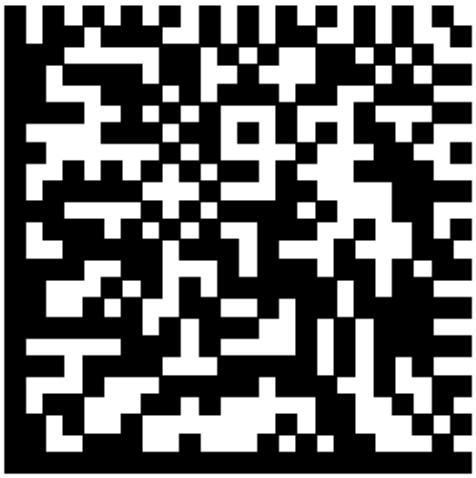
The international standards organization EPCglobal under GS1 has ratified the EPC Network standards (esp. the EPC Information Services EPCIS standard) which codify the syntax and semantics for supply chain events and the secure method for selectively sharing supply chain events with trading partners. Theses standards for Track and Tracing have been used in successful deployments in many industries and there are now a wide range of products that are certified as being compatible with these standards.

In response to a growing number recall incidents (food, pharmaceutical, toys, etc) , a wave of software, hardware, consulting and systems vendors have emerged over the last few years to offer a range of traceability solutions and tools for industry. Radio-frequency identification and barcodes are two common technology methods used to deliver traceability.



An example of a generic RFID chip.

RFID is synonymous with track-and-trace solutions, and has a critical role to play in supply chains. RFID is a code-carrying technology, and can be used in place of a barcode to enable non-line of sight-reading. Deployment of RFID was earlier inhibited by cost limitations but the usage is now increasing.



Some produce traceability makers use matrix barcodes to record data on specific produce.

Barcoding is a common and cost effective method used to implement traceability at both the item and case-level. Variable data in a barcode or a numeric or alphanumeric code format can be applied to the packaging or label. The secure data can be used as a pointer to traceability information and can also correlate with production data such as time to market and product quality. Packaging converters have a choice of three different classes of technology to print barcodes:

- Inkjet (dot on demand or continuous) systems are capable of printing high resolution (300 dpi or higher for dot on demand) images at press speed (up to 1000fpm). These solutions can be deployed either on-press or off-line. Companies such as Domino, MARKEM, VideoJet and EFI/Jetrion provide these technologies.
- Laser marking can be employed to ablate a coating or to cause a color change in certain materials. The advantage of laser is fine detail and high speed for character printing, and no consumables. Not all substrates accept a laser mark, and certain colors (e.g. red) are not suitable for barcode reading.

Thermal Transfer and Direct Thermal. For lower speed off-press applications, thermal transfer and direct thermal printers are ideal for printing variable data on labels.

Leveraging new advancements in mobile technology, food brands are now incorporating mobile messaging and QR codes on product labels. Consumers can text or scan the barcode with smartphones for immediate retrieval of product information. FoodLogiQ launched a mobile messaging solution that provides traceability and brand information about products to consumers via their mobile phones. YottaMark also announced the availability of the HarvestMark Traceability application for the G1-Phone which uses the phone camera to perform the traceback.

Consumers can access web sites to trace the origins of their purchased products or to find the status of shipments. Consumers can type a code found of an item into a search box at the tracing website and view information.