

**2013-2014**  
**Material Handling Student Design Competition**

# **ABC Inc.**

## **Competition Case**

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### **Deliverables:**

- Financial summary for analyzed options
  - Modified CAD layout for recommended process
- Flow chart with throughput rates for recommended process
  - Description of operations for recommended process
    - Team assumptions

### **Inputs and Data:**

- Project objectives and pain points
- Historical orders and expected growth for design period
  - Facility layout
- Description of current operation
  - Engineering time standards
  - Equipment cost estimators

## Introduction

The objective of this project is to redesign the picking process of ABC, Inc. to support changes in the ordering profiles of the “clients” (stores and consumers) of their distribution centers. ABC, Inc. currently operates a chain of 200 retail (brick and mortar) stores across the US. Its product line is home electronics, including:

- Video equipment (TVs, home theaters, cameras, etc.)
- Audio equipment (for homes and vehicles)
- Computers and peripherals (desk-tops, laptops, tablets, etc.)
- Phones (mobile and landlines)
- GPS navigators
- Video games
- Toys and games
- Office equipment

ABC, Inc. currently services its stores from 2 distribution center campuses, one services the Eastern US and the other the Western US. These facilities were designed and are currently optimized for shipping to brick and mortar stores. Recent changes in ordering patterns are forcing ABC, Inc. to process order profiles not consistent with brick and mortar profiles. These new profiles include:

- Online orders
- Type I small stores
- Type II small stores
- Type III small stores

Details about each store type/profile follow.

## Brick and Mortar Stores

- Brick and mortar stores are 30,000-50,000 sq. ft. and carry about 11,000 SKUs.
- Product is shipped to these stores as full cases and also as “eaches” inside plastic totes that stores need to return to the distribution centers.
- Brick and mortar store orders are shipped to stores in company’s trucks. Normally these trucks carry an average of three store orders, loaded in the trailer in reverse stop sequence.
- Mixing of containers for different stores in the truck is not allowed (it significantly slows down the unloading process at the destinations); the loaders use plastic curtains to separate containers for different stores in the truck. Due to this requirement, loading of a store cannot start until all the containers for the previous store in the truck have been loaded.
- The numbers of serviced stores, brick and mortar shipped volume, and brick and mortar SKUs are not expected to increase any soon.

## Online Orders

- Online orders have been picking up fast for ABC, Inc. The company offers a wider assortment of SKUs through their web site (approximately 15,000 SKUs).

- A large portion of the yearly orders is shipped during the last two months of the year in the holiday season, so the provided data only includes the November and December orders so that you can plan for peak demand (and not be overwhelmed with data). These orders are shipped in carton boxes that require dunnage.
- *The profile of these orders is not expected to change, but the number of daily orders is expected to increase by 20% every year for the next five years.*

### Type I Small Stores

- These stores are 1,200 to 2,000 sq. ft. and carry about 430 SKUs, a subset of the brick and mortar SKUs.
- Product is shipped to these stores as eaches inside shipping cartons.
- Regular parcel services are used to deliver the orders to the stores. Orders need to be ready at shipping by 3:00 PM in order to be shipped that day.
- The profile of these orders is not expected to change, but the number of these stores is expected to increase by 75% every year for the next five years. Currently they have 30 of these stores.

### Type II Small Stores

- These stores are 300 to 400 sq. ft. and carry about 200 SKUs, a small subset of the brick and mortar SKUs.
- Product is shipped to these stores as eaches inside shipping cartons.
- Regular parcel services are used to deliver the orders to the stores. Orders need to be ready at shipping by 3:00 PM in order to be shipped that day.
- The profile of these orders is not expected to change, but the number of these stores is expected to increase by 175% every year for the next five years. Currently they have five of these stores.

### Type III Small Stores

- These are vending machines located in malls and airports; they carry about 80 SKUs, a very small subset of the brick and mortar SKUs.
- Product is shipped to these locations as eaches inside shipping cartons.
- Regular parcel services are used to deliver the orders to the destinations. Orders need to be ready at shipping by 3:00 PM in order to be shipped that day.
- The profile of these orders is not expected to change, but the number of these stores is expected to increase by 150% every year for the next 5 years. Currently they have 10 of these machines.

### Design Criteria

Multiple options for order picking (e.g. discrete order picking, cluster picking, manual batch pick to put, automated goods-to-person based systems, also different manual pick technologies, etc.) need to be developed and analyzed before the recommended option can be selected based on solid financial reasons. General selection criteria include:

- The company's CFO will demand an attractive payback period based on current requirements (Y2012).

- The company's CEO will demand a solution that can handle the projected new order profiles in an efficient way.
- The proposed solution needs to be implemented within the existing facilities. Additional material handling equipment can be acquired as long as there is room for it in the existing facilities.
- The provided current data is for November and December of Y2012. The proposed solutions are expected to start operating in January 2014. The proposed solution should have enough capacity to handle peak day conditions until the end of Y2019 for all order types.
- During non-peak season, the facilities operate two 7.5-hour shifts per day. When needed, during peak season, the facilities can operate three 7.5-hour shifts per day.
- FTEs (full-time equivalents) work 7.5 hours and are paid 8 hours per day.
- Product that is shipped as eaches needs to be consolidated in a minimum number of shipping containers. Eaches picked in different areas of the facility cannot be shipped in different containers if they can be consolidated in fewer containers.
- Any batch pick to put solution needs to include provisions to efficiently manage batch transitions at put stations (handling of exceptions, stragglers, etc.).
- Storage capacity requirements are not part of this project. It can be assumed that the current capacity will support the operation until Y2019.
- Only conveyable product is included in the scope of this project.

## Deliverables

- Description of options considered.
- Summary of financial metrics for considered options.
- Narrative detail description of recommended option.
- Required labor for peak conditions of recommended option.
- Flow process chart(s) indicating throughputs between functional areas for average and peak conditions for recommended option.
- Modified CAD layout(s) for the recommended option.
- Material handling equipment specifications for recommended option.
- Narrative of how the proposed solution addresses key issues.
- If the team needs to make assumptions regarding not specifically provided information, these assumptions need to be documented as part of the project.

## Current Operation

The Eastern DC operates from two buildings: One processes the full case portion of the orders (Building "B") and the other processes the eaches portion of the orders (Building "A"). The Western DC operates from one building. The following description is based on the Eastern DC. The Western DC operates in the same way, unless it is indicated that their operation is different.

## Receiving

All products are received in pure SKU cases. The cases are palletized as pure SKU pallets and putaway in storage in the reserve area (pallet rack). Product shipped as eaches is received in Building "A", while product shipped as full cases is received in Building "B". All

received cases are labeled with bar codes that identify the SKU in the case. Cases with the same SKU always have the same quantity in the case (full case quantity).

The facility can receive pre-allocated products. If the store for which the product is allocated is active at the shipping sorter when the pre-allocated product is received it can be sent straight to the shipping sorter. If the store is not active at the time the product is sent to stage in a priority bin (super-sized mail box cubby holes for the stores – one per store).

After the product is received, it is labeled for putaway, one label per “container”. A container may consist of multiple boxes. Non-conveyable and white good container labels are one for multiple items; the number of items is an attribute of the specific product call SUQ (standard unit quantity). Items of same label have to put in the same location.

## Putaway

The putaway process is system-suggested. Any operator currently can override the system suggestion without the system creating a historical log of who overrode the suggestion or the reason for doing so. Putaway operators scan the container putaway label to initiate a putaway transaction. If the container label is for multiple boxes, all boxes need to go to the same putaway location – putaway operators are not allowed to split containers during the putaway process. Same SKU with multiple labels can be put in the same location. The putaway operator also has to scan the putaway location to communicate to the system where the product was putaway.

All conveyable products are putaway as pallets to reserve. However, product received as small quantity of cases (less than ten) is sent directly to its FPL (forward pick location). FIFO is not a requirement for this operation. If there is not enough room in the FPL to accept the entire product sent there, the excess boxes are left behind the flow rack.

Most of the time, operators will follow the suggested location to put away items. Unfortunately, the system is not smart enough to always find best locations. For example, the system suggests the higher shelf, although there is space on the ground in the same location. Shelves near the pick tower always have a lot of empty space.

All FPL are static locations. All reserve locations are random/dynamic locations. The existing system only allows one FPL per product. Behind FPL in building “A” there are a limited number of shelves. There are not enough shelves to map all FPL’s. The existing system is not aware of the shelves behind the FPL. Currently these shelves are used only to stage product to be replenished into the FPL’s, they are never used to store overstocked product.

Currently putaway operators keep the container labels that are required only to complete the transaction but do not need to remain attached to the product after it is dropped at the location. Putaway operators stick the labels to pieces of paper handwriting the worker’s name, the location where the product was putaway, and the quantity that was putaway. These sheets are the only available records today that keep track of who did what.

## Allocation/Waving

The WMS (warehouse management system) manages allocation. The WMS can allocate product the day after it is received, regardless of the product being or not being putaway by then. Two main waves are processed during the day: The day wave and the evening wave. Each of these waves has multiple sub-waves that are processed independently in different

areas of the facility: Full case, repack, add-ons/rush orders, and bulk. Replenishment is done after the second wave is completed. Replenishment is a very manual process triggered at locations that are below a re-order point that can be set by the facility – one value for all the locations.

Repack sub-waves (eaches portion of orders) have up to six clustered stores per wave. The Eastern DC had a shipping sorter with 48 diverts. Two repack sub-waves are continuously processed concurrently and sorted in 12 dedicated diverts of this sorter. While one repack sub-wave is processed at its peak in six diverts, the previous wave is tailing off in the other six diverts. Repack sub-waves are processed in advance of the full case sub-waves and staged at shipping. Repack sub-waves are picked one wave ahead of corresponding full case waves.

**The Western DC does not have a shipping sorter. In this facility the clustered stores never exceed five stores per wave. Without a shipping sorter, they manually sort the orders on floor locations.**

Full case sub-waves have up to 36 stores (and as few as 23). Each day, wave one consists of 36 stores and 2nd wave consists of remaining stores on the schedule. Currently 2nd wave is never larger than 36 stores as well. The reason they pick 36 stores is because they have 36 shipping sorter diverts for full case (the remaining 12 are used for repack, as described above).

**Without a shipping sorter the Western DC does not batch pick full cases. In the Western DC the full case portions of the orders are picked to single store pallets, one store at a time.**

For a product to be waved, it needs to be in a pick-able location. Reserve locations are pick-able location through “dynamic picking” transactions. Dynamic picking transactions are different in Building “A” than they are in Building “B”.

Building “A” dynamic transactions occur when a store demand is larger than the product full case quantity. When this happens, the system allocates as much as possible to be picked as full case. Picking full cases is always more efficient than picking from the module’s flow rack, so dynamic picking transactions are always welcomed in Building “A” due to this efficiency.

For super-fast movers such as computer mice, there is an area for placing pallets of fast movers. The picker can pick from this area by item and by case.

Building “B” dynamic transactions occur when a FPL runs out of stock before all the day’s demand for the product in the location is satisfied. When this happens the system has to allocate from reserve locations (a current system limitation of the system prevents replenishment transactions to FPL before picking for the day has completed). Picking full cases from reserve with a stock picker is always less efficient than picking the cases from FPL. As such, dynamic pick transactions are never welcomed in Building “B”.

In Building B, operators take the whole pallets of dynamic picking items and stage them by the conveyer. When the wave comes, operators stick labels on the cases and then put them on the conveyor. After they finish picking from the pallet, they put the pallet back to the shelf. Sometimes, the operator can’t remember the shelf the pallet was allocated before, so they just put the rest of pallet in another empty space nearby.

## Each Picking

About 8,000 SKUs are shipped from the facility as repack products (eaches).

The Eastern facility has two 3-level repack modules with case flow rack. They have 4,600 FPL's. Along the center of the aisles there is power takeaway conveyor with gravity conveyor on each side. The takeaway conveyor starts at the bottom level and serpentine through the three levels exiting the module from the top level. Orders are cluster picked in batches of up to six stores (totes) that pickers push on the gravity conveyor. Levels are divided in pick zones. Totes have to begin and complete in the same pick zone – they are not allowed to pass from zone to zone. Empty totes are available in several points along the aisle. Normally there is only one picker per pick zone; it is possible to have more than one picker in the same pick zone to handle excessive activity, but it is not desirable due to congestion issues.

The facility has one aisle with pallet floor locations to pick super-fast moving repack products. The facility also has multiple ground aisles with shelving to pick slow moving repack products. These aisles are called floor locations and have 3,500 FPL's. The facility also added an aisle with 400 locations reserved for type I small store products. Type I orders are picked directly into their shipping carton – they are not sorted through the shipping sorter, as they are taken directly to the carrier door from the pick walkie.

Pickers use walkies to cluster pick up to six stores' batches when picking from floor locations.

Picking is directed by RF hand terminals (Motorola 9090) that all pickers carry. Before each wave pickers need to go to a central label printing desk to get their labels for the wave. Totes are not cartonized by the system; pickers determine how much product can go in a tote. When a picker starts picking into a tote, the picker labels the tote with a master label that the picker scans; the picker scans the orders (master label) to pick in sequence. The system directs the picker to the first location to pick from. The picker goes to the indicated location and scans an item from the location. The system indicates the picker how many items to pick and in which tote (based on the initial scan sequence) to place the product. There is no validation to check that the picker placed the item in the correct tote. When the picker decides that a tote is full and cannot take more products the picker scans another master label; when the picker scans the next label the system "transfers" the order to the second tote.

At Building "A" pallets are also picked, as pallets, when the demand for a single store exceeds the quantity in a pallet. Also, if the aggregated demand, as store full cases, for the stores in a wave exceeds the number of cases in a pallet, a pallet is taken to a de-pal module to be inducted directly to the shipping sorter. When the demand for a single store of a particular product exceeds the product case quantity that product is picked as a case from overstock. This transaction is called dynamic picking. Picking product as cases is always more efficient than picking product as eaches.

A takeaway conveyor from slow moving aisles merges with the takeaway conveyor from one of the repack modules, crosses to Building "B" through the conveyor bridge between the two buildings and connects with the main merge before the shipping sorter. Another takeaway conveyor from the super-fast moving aisle and the de-pal module merges with the conveyor from the other repack module and follows the same path to the main merge in building "B".

Each picking in the Western DC is the same process as in the Eastern DC with a couple of differences:

- **Western DC - only one 3-level module**
- **Western DC - no “fingers” (over-flow shelving) behind flow rack in the pick module resulting in capacity issues when day’s demand exceed FPL slot capacity**
- **Maximum number of clustered orders while picking from pick module is five instead of six.**
- **There is no cluster picking of order while picking from aisles, it is one store at a time**

### Full Case Picking

Between 2K and 3K products are handled in Building “B”. The facility has one 4-level pick-to-belt full case module. Orders are batch picked in waves of up to 36 stores. At Building “B” pallets are also picked, as pallets, when the demand for a single store exceeds the quantity in a pallet. Also, if the aggregated demand for the stores in a wave exceeds the number of cases in a pallet, a pallet is taken to a de-pal module to be inducted directly to the shipping sorter. Building “B” has 3 de-pal stations.

Building “B” has a small portion of repack picking. These are products that are too large to be picked into totes (as they take too much space in the tote), too small to convey, and are received by the facility from the vendor as eaches inside a case. These products are picked to a store pallet and taken to the shipping area by a vehicle.

When the full case demand for a store cannot be completed from the product’s FPL the missing cases need to be picked with a stock picker vehicle from overstock. Picking with order pickers from high locations is always less efficient than picking with walkies from ground locations. In building “B” these transactions are called dynamic picking transactions.

Crossover (product already boxed and labeled by the vendor) or pre-allocated (product mixed with stock product that needs to be sorted) orders are also processed in building “B”. When the store for which the product is pre-allocated is active at the shipping sorter when the pre-allocated product is received it can be sent straight to the shipping sorter. If the store is not active at the time the product is sent to stage in a priority bin (supersized mail box cubby holes for the stores – one per store) to be staged until it the store becomes active at shipping.

### Pain Points

- **Without conveyor diverts to pick zones in the pick modules totes need to start and complete in single pick zones. This works OK with large brick and mortar orders but it is unacceptable with smaller orders that need to consolidate product from multiple pick zones. These smaller orders cannot be processed in the facilities and they need to send them out to be processed in an outside 3PL (third-party logistics) facility.**
- Replenishment is a system and space issue. The Western DC doesn’t have “finger storage” for split case module so there is not enough space to stock the overstock repack item. This results in what they call a “replenishment to bin”.
- No task interleaving capabilities.
- Replenishment has multiple issues:

- Cannot be done while picking is happening. Not only that, but any location with a pending transaction is blocked for all transactions until the pending transaction is completed.
- Manual process based on a global parameter (percent of location fullness) for the replenishment performed after picking is completed. Not based on known demand.
- Not enough “finger” staging capacity to use them as overflow stock.
- No system tracking of inventory in “fingers”.
- Transactions cannot include locations with pending transactions. As a result, if product is needed for a new order, the only option is to allocate from a different location than the current active/preferred location. This impacts storage utilization as multiple locations of the same product are partially depleted. During peak season the facility runs out of locations and needs to schedule consolidation tasks to recover miss-utilized locations.
- No slotting tools.
- Lack of system tools to identify dead inventory.
- Rush orders cannot be added on the fly to store waves even when the waved stores have not started picking. They need to be picked as a separated wave.
- Lead-time of replenishment orders to stores can take up to 10 days. New small stores want overnight deliveries.
- If a worker identifies a problem with a location, the system cannot put the location on-hold. The system continues creating transactions for the problem location.
- Because of store service level requirements, repack volume has significantly increased. Every time that an item is sold at a store, a replenishment transaction at the DC is created to replace the sold item at the store, resulting in too much split case processing. The facility was originally designed for 50/50 repack/full case; currently is already 80/20.
- New small stores are much smaller than brick and mortar stores, but because of system limitations each of these stores need to be sorted to an individual shipping sorter divert consuming too many diverts that are significantly underutilized by these stores during the waves.
- Too many work around workflows required as a result of current system limitations.
- MRs (emergency / rush orders) are not in their labor planning so they must stop planned orders/labor, handle MRs and then go back to planned orders. They want to make decision that based on his knowledge of the current daily volume of regular orders if they will process to request date or push.
- Sortation. The sorter’s down lanes are manually mapped daily based on the trailer load plan. The trailer load plan is a manual process, not system based, and is dependent on cube roll up and the experience of the load planner.
- System does not handle multiple units of measure. (case, each, etc.)

## Provided Data

- Facility layout drawings indicating the location of forward pick locations
- Two months' (November and December) of Detailed shipping logs for all orders types, including:
  - DC ID
  - Order type
  - Ship date
  - Customer/Order ID
  - SKU ID
  - Shipped quantity
  - Split case flag (true if shipped as eaches, false if shipped as full case)
  - Forward pick location ID
- SKU master table, including:
  - SKU ID
  - Full case quantity
  - Each dimensions
- Brick and mortar store loading sequence by day of the week
- Engineering time standards for different motions required in the processing of orders
- Full loaded labor cost (\$/FTE-Hour)
- Shipping cartons and shipping tote dimensions
- Automated material handling equipment (goods-to-person) capacities and prices

## Data Notes

- Detailed shipping logs (split case orders)
  - The same SKU for the same order/store may appear more than once on the same day. In this case, these multiple lines need to be merged in a single line with a picked quantity equal to the sum of all the multiple lines
  - In some lines, the picked quantity for a given SKU could be larger than the full case quantity. This happens because some SKUs are not available at the facility to be picked as full-cases; their entire inventory is in the split case module. So, they need to be picked as split case
- SKU master table
  - Dimensions for some products are equal to zero. For cubing calculations, zeros are converted into 1/16"
  - Dimensions for some products are larger than 20". For cubing calculations, these dimensions are converted into 20"

## Required Options to Evaluate

There are multiple options that can be evaluated to address this project's requirements. The client has specifically requested to include in the evaluation the following 4 options:

- 1) Current operation (5/6 order cluster picking) with automated print and apply labeling: Instead of having the pickers going to a print room to get pre-printed labels for the next orders to pick, use totes with permanent LPN that will be scanned on their way to shipping to be labeled by print and apply equipment.
- 2) Current operation (5/6 order cluster picking) directed with voice instead of R/F terminals.
- 3) Batch-pick-to-put with non-automated picking. Batch pick orders in sets of up to 50 orders per batch and consolidate the orders in put stations. R/F terminals direct pickers. Pick as much of the product as possible from reserve (as full cases) aggregating the batch demand by SKU. Have the full cases going through a de-trash area where product is transferred from the original full case to totes. If the product from the full case is going to different put stations split the content by put station destination in different totes. Use put-to-light technology in the put stations. Residual quantities (less than full case) are picked from the existing pick modules into totes by put station (different totes to different put stations).
- 4) Batch-pick-to-put with automated picking. Same as the previous option but instead of manual picking of residuals from pick modules consider an automated (goods-to-person) machine bringing the required SKUs to the put area to fill residual demand. The goods-to-person machine needs to have at least one open carton of each SKU in the machine. Full case demand still will be supplied from reserve.

The above options have to be evaluated. Any other option that the project team also considers worthy to evaluate needs to be included.