

# Forensic Diagnosis of the Poorly Performing Automated Warehouse



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# Introduction



- Capital investment in warehouse automation
  - Does not always meet the objectives
  - Often the expected efficiencies are not realised
  - Sometimes the capacity is less than planned
  - Occasionally the new facility compromises the business

# Introduction

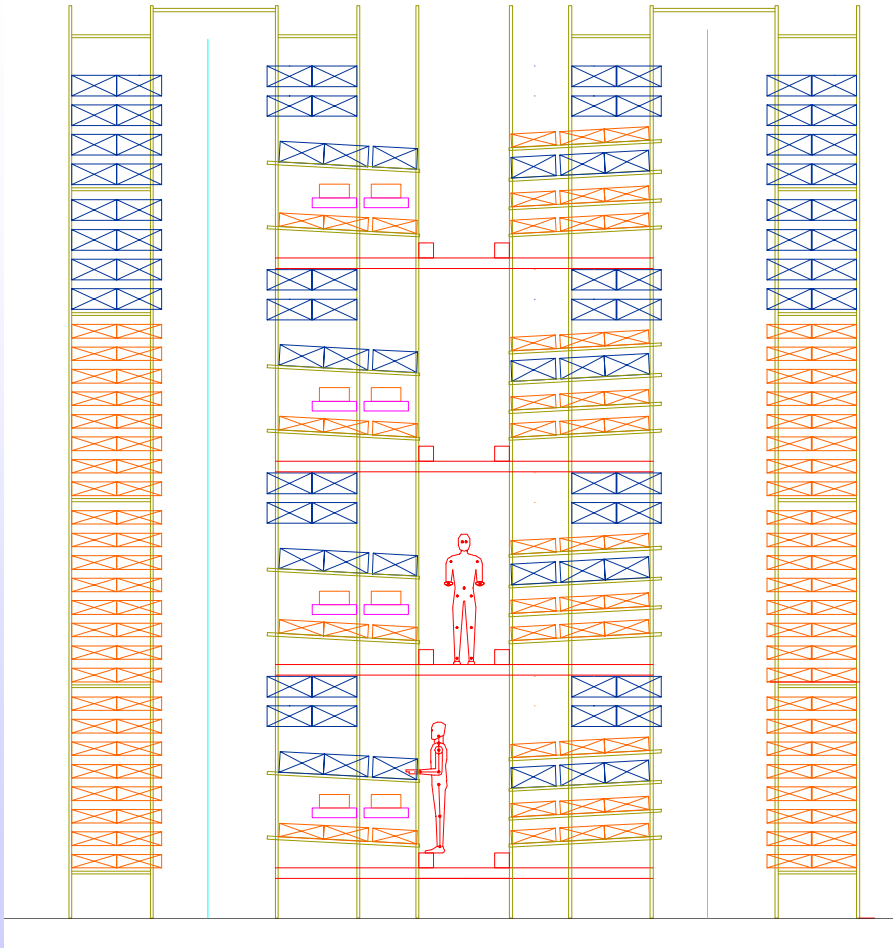


## Typical comments

- “The data is set up badly”
- “The WMS is making the wrong decisions”
- “The operators are not trained properly”
- “The design met the requirements of your business”
- “There is not enough accumulation on the conveyors”
- “Your business has changed”
- “The equipment is not fast enough”

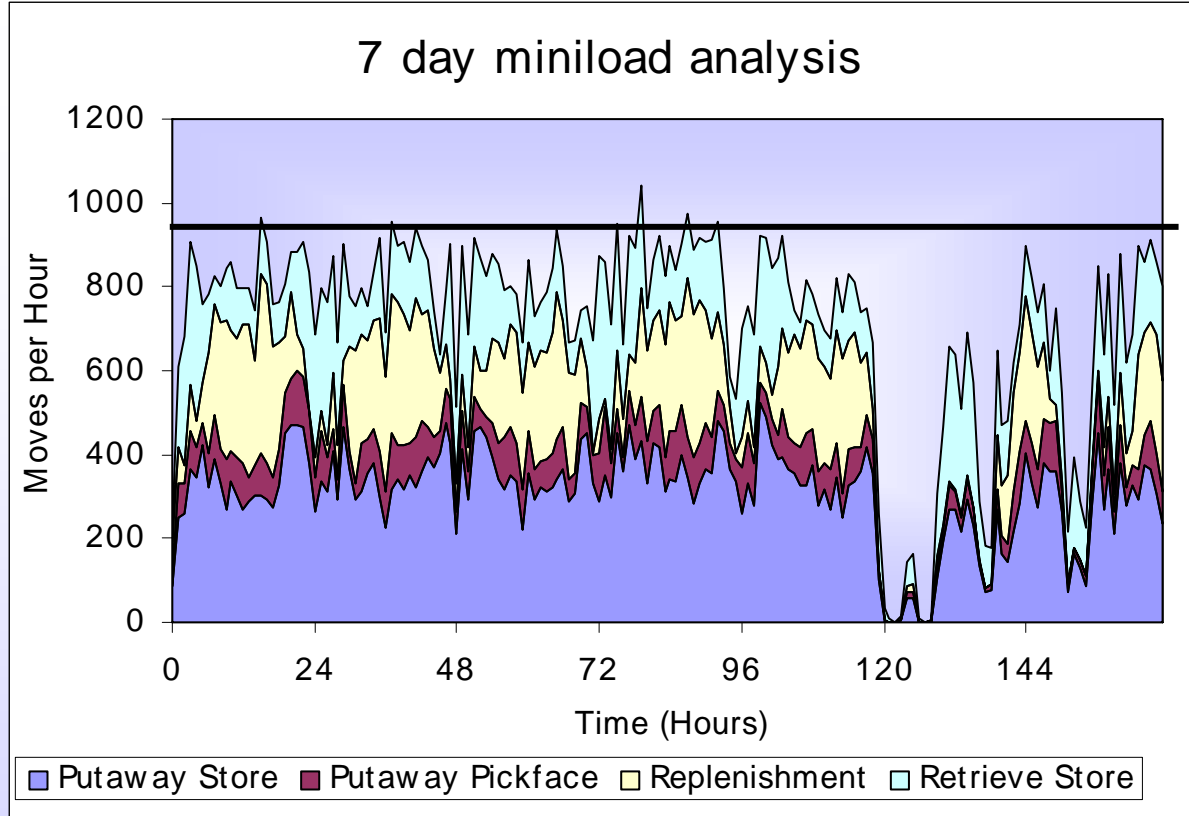
# Case Study

## Direct to consumer tools and hardware



- 1 year old automated warehouse designed with 40% growth
- Warehouse at capacity of both SKUs and throughput
- Large throughput and SKU growth forecast
- Operational difficulties, particularly with the miniloads and picking

# Part 1 - Miniloads

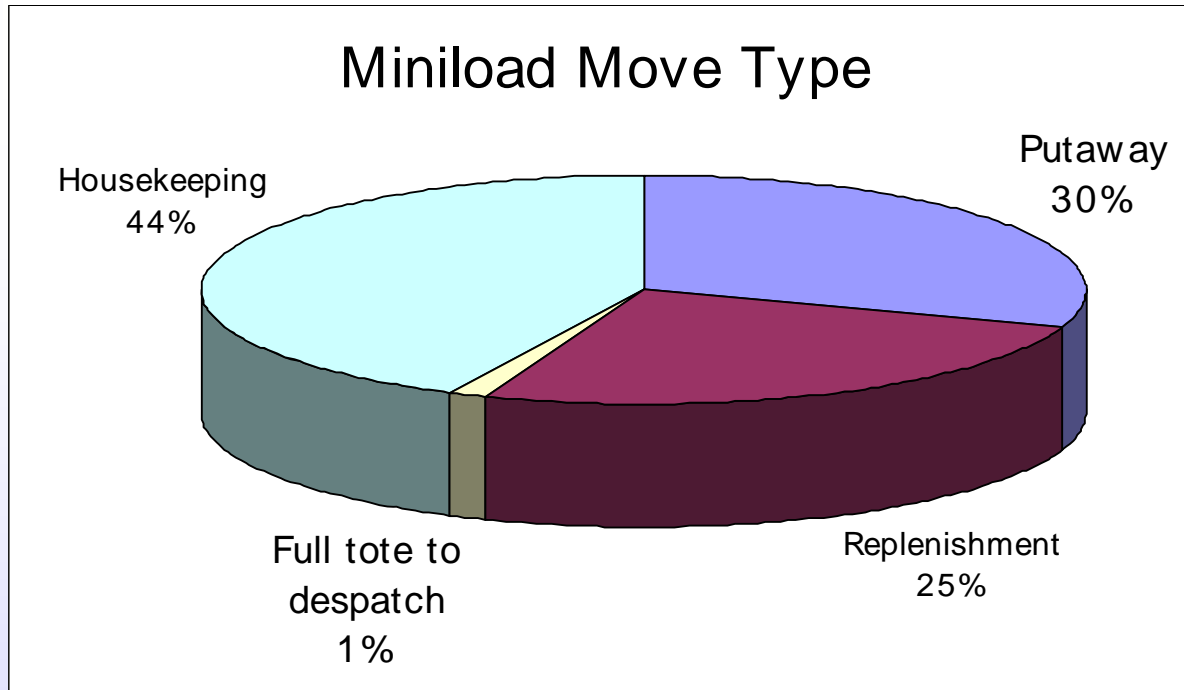


Peak shown as  
118 moves per hour  
per miniload

Calculated from earlier slide

- Very little spare capacity at peak times, 3% in-fault time is significant
- Recommendation - Introduce miniload fault auto-recovery
  - Log small faults & continue
- In fault time reduced to less than 1%
- Surprised at the number of retrieves (very few full tote orders)

# Miniload Utilisations

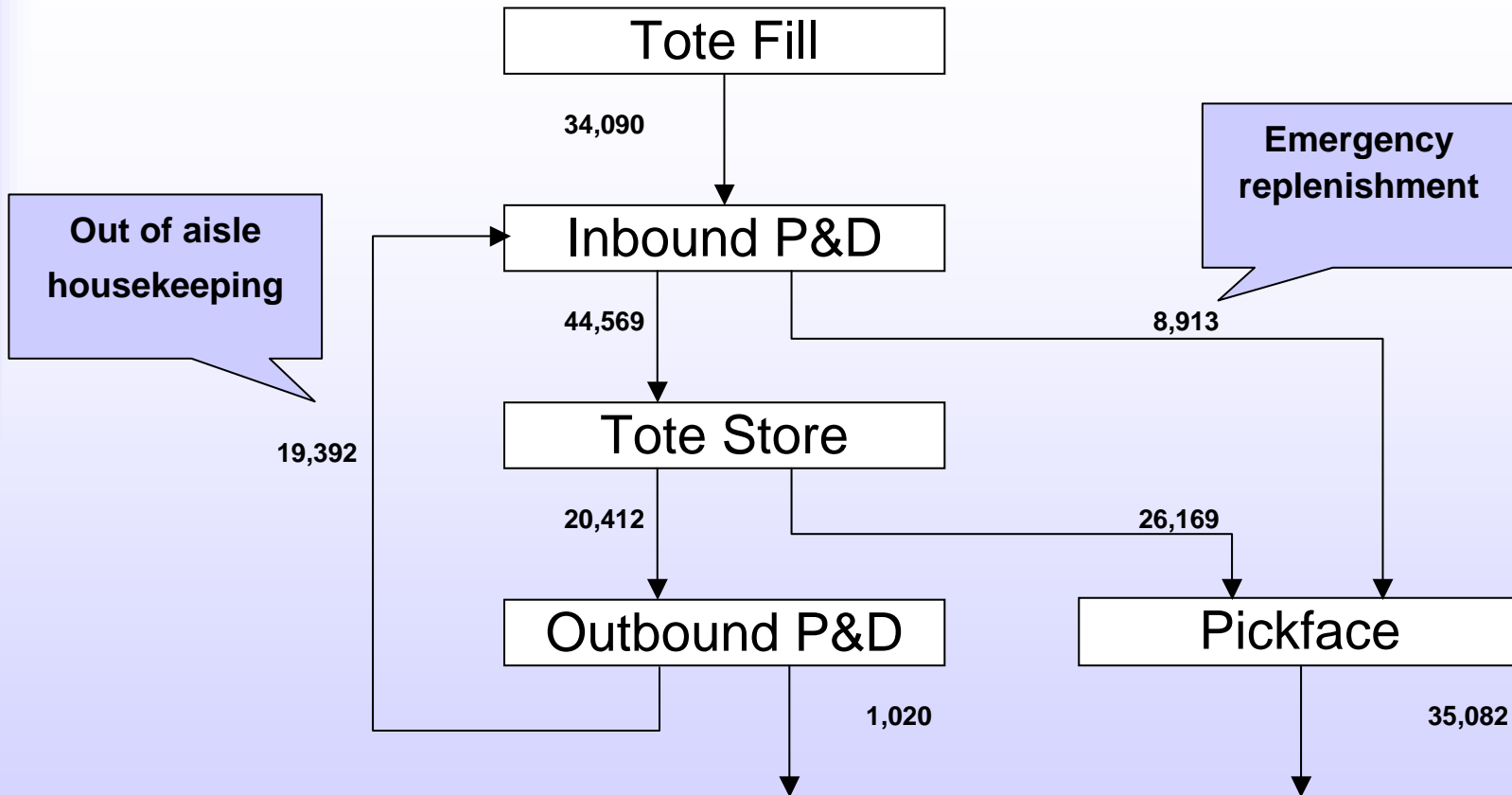


SKUs are fixed to specific locations therefore WMS attempts to locate reserve stock in same aisle

If the input conveyor to the chosen aisle is full, then another aisle is chosen and this will cause a subsequent housekeeping move

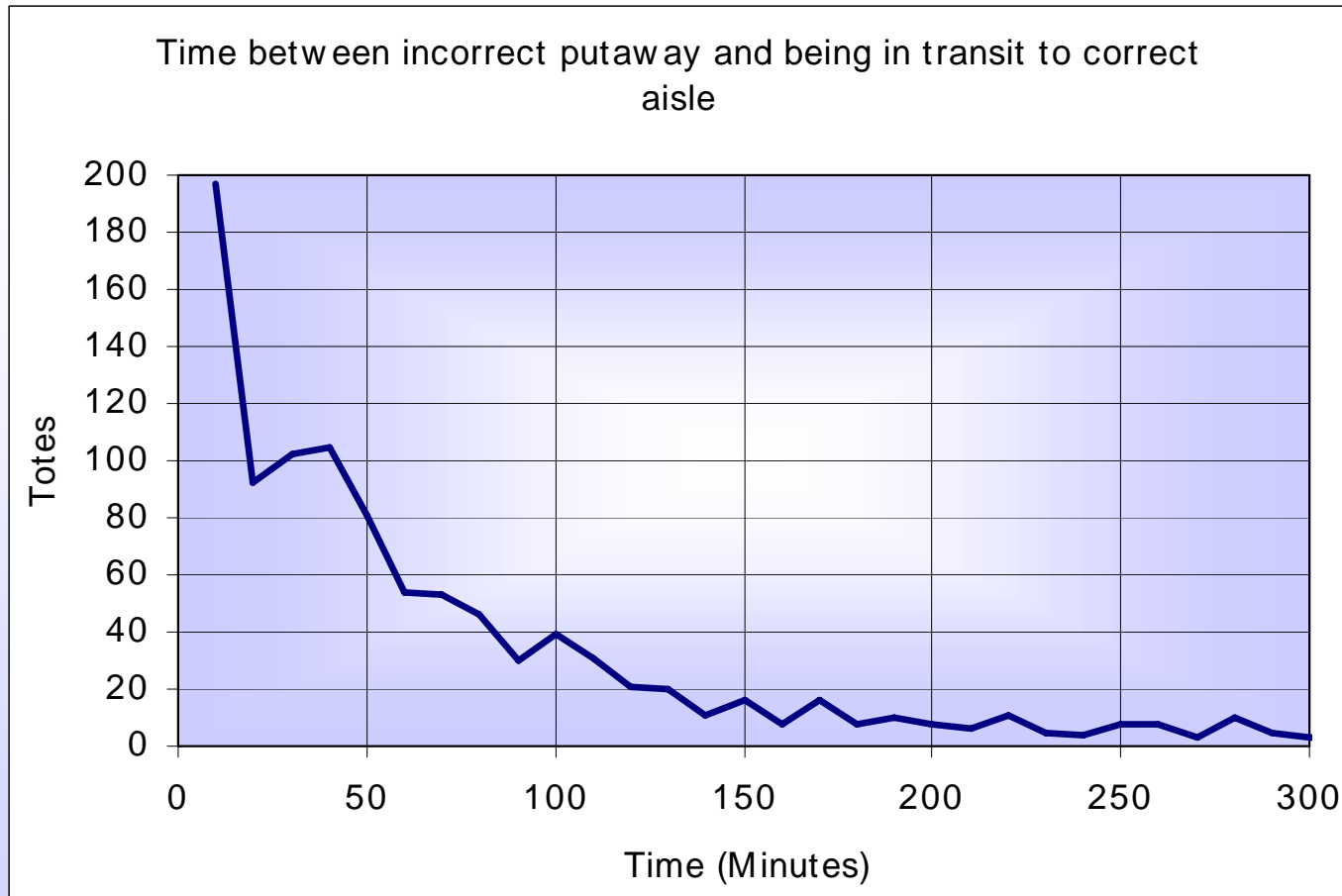
- 44% Housekeeping
- All valid moves – some could be performed at non-peak times
  - Sending totes to different aisle
  - Extracting totes from double deep racking
  - Pairing same SKUs together

# Actual Tote Moves



- 1/3 of totes are putaway in incorrect aisle
  - Continuous flow of out of aisle housekeeping
- Emergency replenishment (25%)

# Housekeeping – moving totes into the correct aisle



- 200 Totes moved again less than 10 minutes after put away into incorrect aisle
- WMS generates housekeeping move at peak times

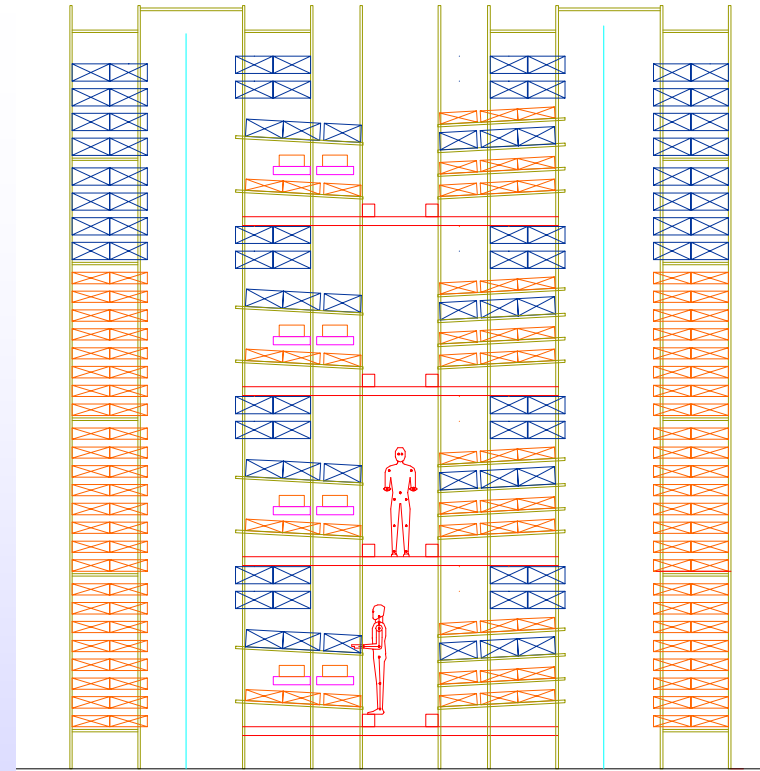
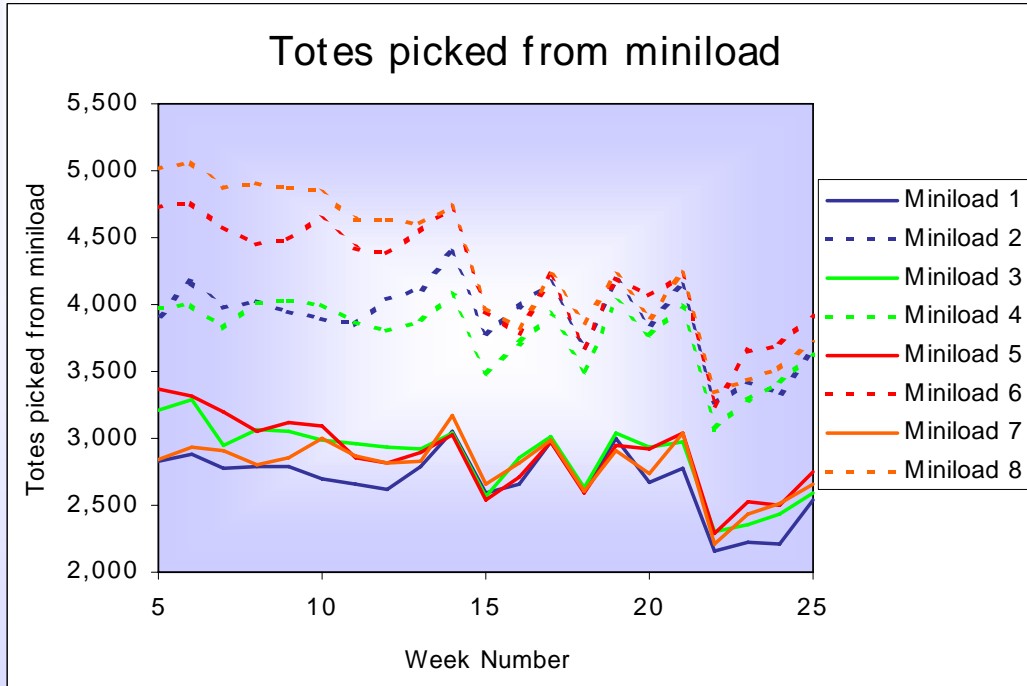


# Stock Replenishment



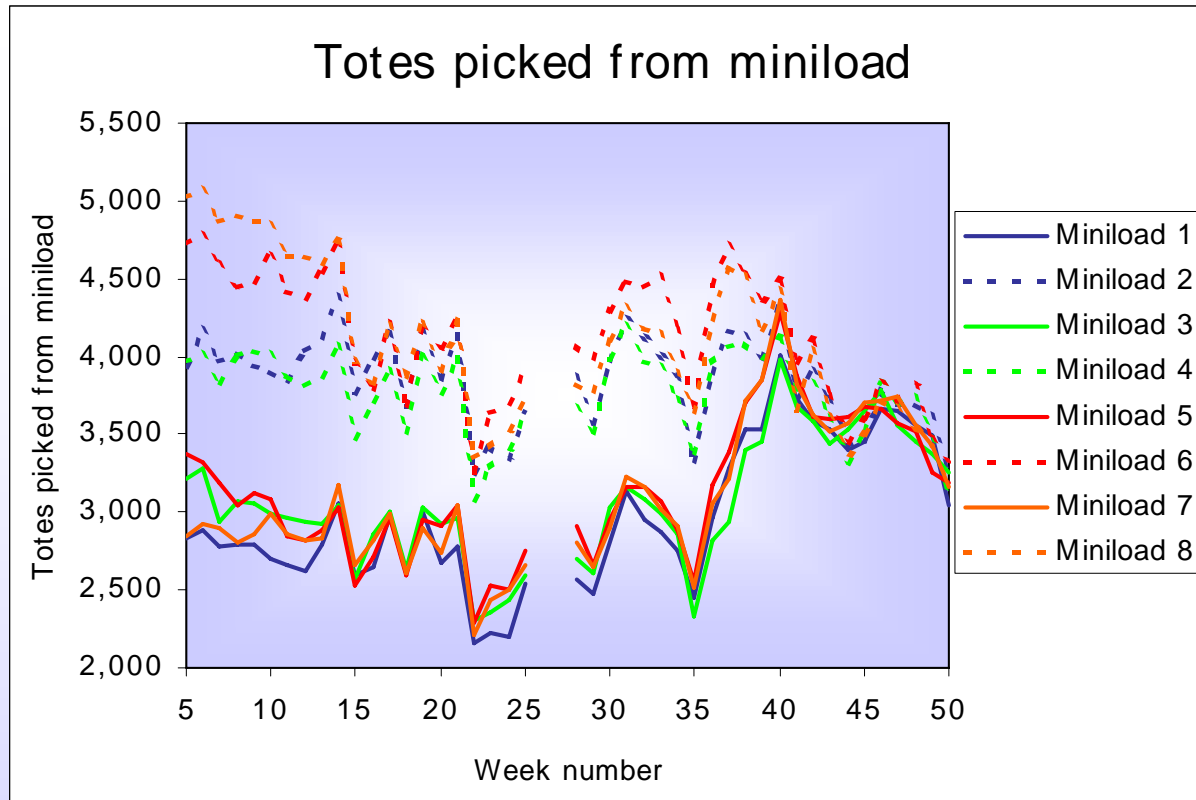
- Investigate stock replenishment calculation
  - Is it the correct algorithm?
    - Other methods showed only minor improvements
  - Is the algorithm programmed correctly?
    - No! Error found in calculation
      - Replenishment based on number of days stock
      - Based on automatic usage calculation
      - Daily usage rounded down to the nearest tote
      - All SKUs selling less than 1 per day had a zero usage and were not replenished
- Algorithm was fixed by rounding up daily usage
- Resulting in 24% fewer emergency replenishments

# Miniload balancing work for all miniloards



- Miniloards not evenly balanced or utilised
  - Whole site throughput is dependent on miniload 6
  - WMS algorithm to balance miniloards flawed as the right side of aisle is different to left

# Picking Locations



- Algorithm fixed
- Miniloading now performing equally
- Overall throughput potential now higher
  - Most used miniload previously had to do 4000 totes
  - Most used miniload now has to do 3500 totes



# Part 1 - Conclusion

## ■ Actions

- Miniload auto-recovery
- Out of aisle house keeping only done at night
- Replenishment algorithm fixed
- Miniload cranes balanced by fixing bug in profiling tool
- Racking changed to reflect tote size requirement

## ■ The miniloads

- Have less to do
  - More time to do it in
- No longer cause the site throughput constraint

# Part 2 - Controlling pick release



- 11,000 orders per day
  
- Symptoms
  - Large orders not released for picking until late in day
    - Orders were available to be picked earlier in the day
  - Many completed picked cartons, but unable to be packed as the whole order was not picked
    - Congestion and inefficiency in the packing area
  - Pickers needed to chase the work between zones
  
- There are many WMS parameters to control order release
  - Limiting order release based on number of containers already released and not completed
  
- In the live operation it was not clearly understood how the WMS parameters interacted

# Simulation



- Business risk to “live” experiments with parameters
- Constructed simulation of picking system, using actual orders with objective of changing WMS parameters and quantifying the effect
- Simulation
  - 64 pick zones, typically 32 pickers
  - 2647 conveyor sections, 12 km of conveyors
  - WMS and PLC logic included

# Simulation



Warehouse Workshop

File Edit Insert Data Simulation Camera Layers Report Help | 20000-010-7\_nolimits.whf

300x 1

13:08:27 01:08 PM Errors: 0 Mouse XY ( 57.39, 73.58 )m FPS: 12.7

LOGISTICS SIMULATION

SELECT NONE PAUSE

- Available Pallets : 2
- + Conveyor Pallets : 343
- + Consolidation List : 0
- + Reservation List : 0
- + Check List : 0
- + Paused Pallets : 0
- + Waiting Pallets : 0
- + Teleport Pallets : 0
- + En Route Pallets : 5
- = Incompleted Pallets : 350
- + Completed Pallets : 15624
- + Scheduled Pallets : 0
- = Total Pallets : 15974

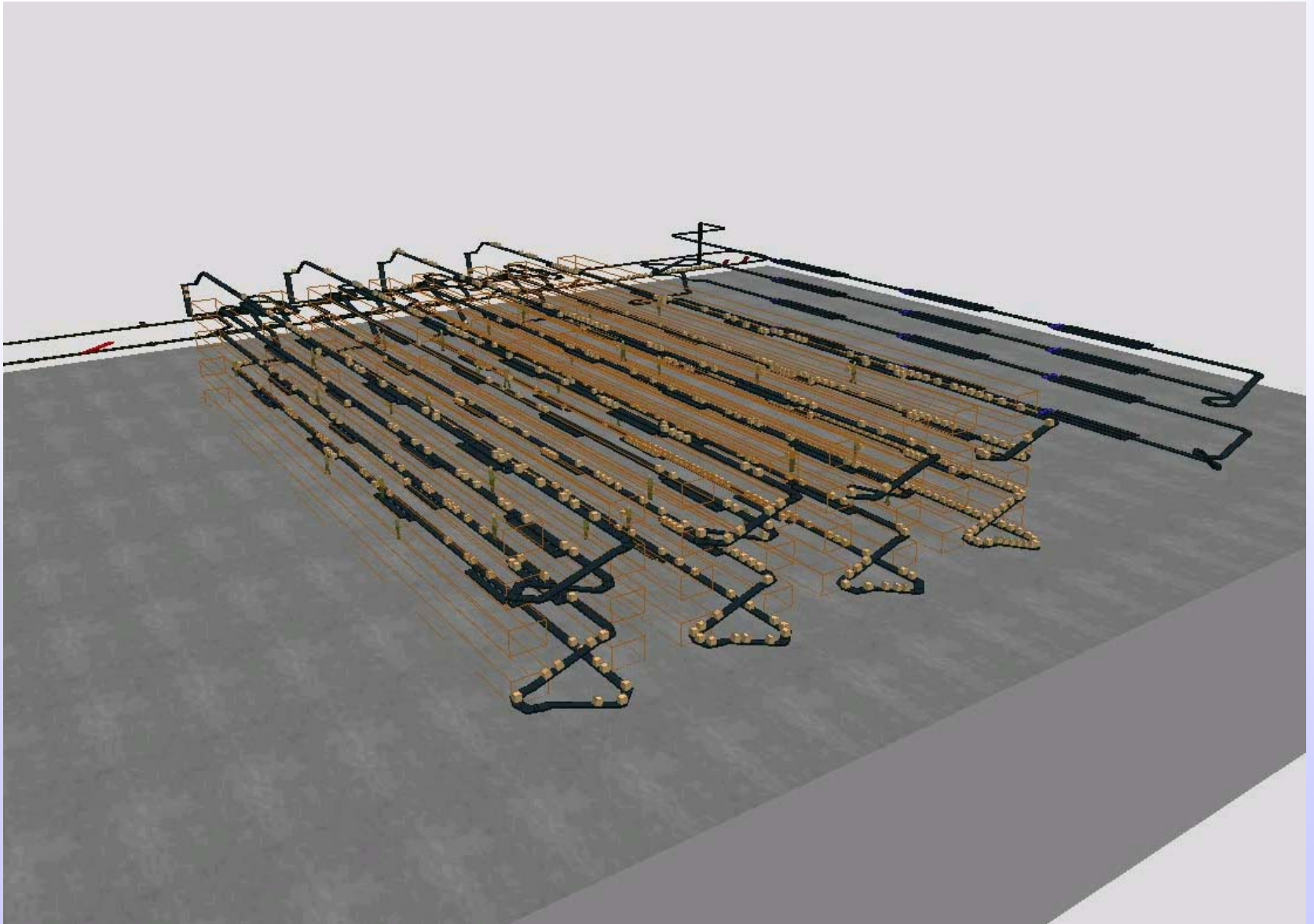
Created Pallets : 15971

- Received Pallets : 0
- Despatched Pallets : 0
- Lorries Scheduled : 0
- Lorries Queued : 0
- Lorries Docked : 0
- Lorries Departed : 0

Conveyors With Pallets : 102

Conveyors Without Pallets : 2525

# Movie





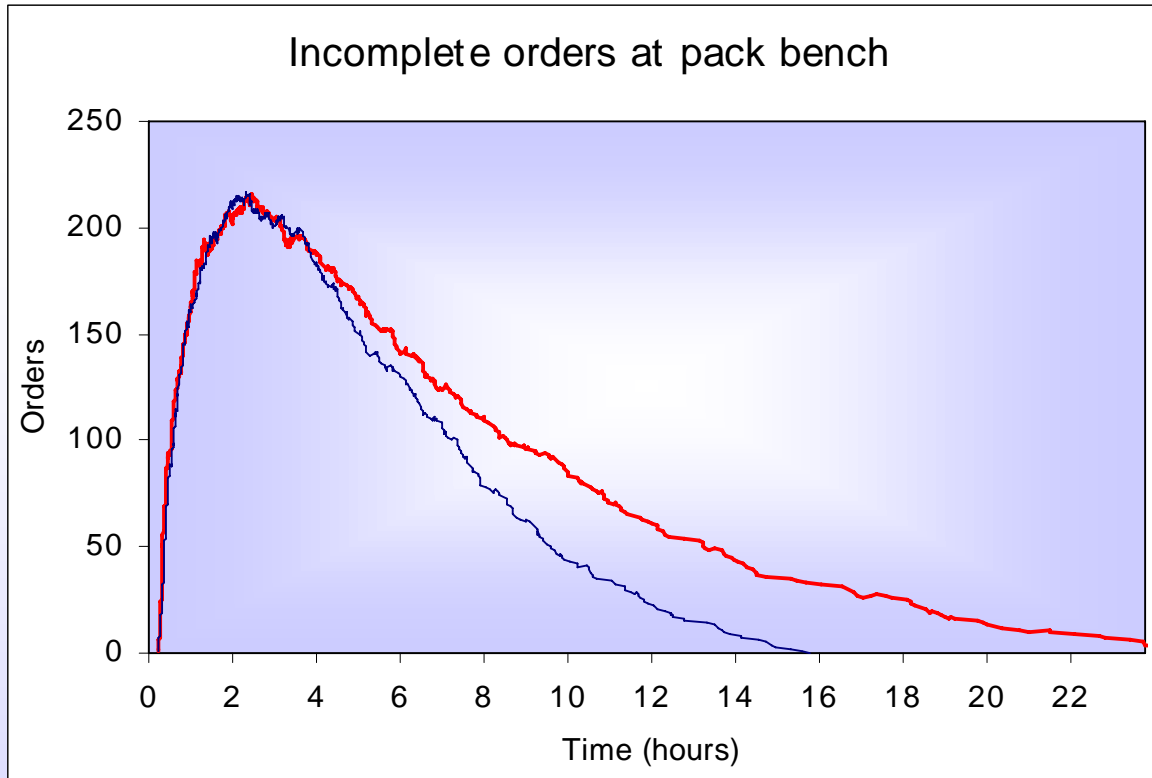
# Base Case Calibration



- Each zone (64) has a maximum in transit – called zone limits.
- Cartons are not released until all the zones that the carton needs to visit has capacity
- For multi carton orders, the cartons can be released at different times and therefore arrive at the pack bench at different times

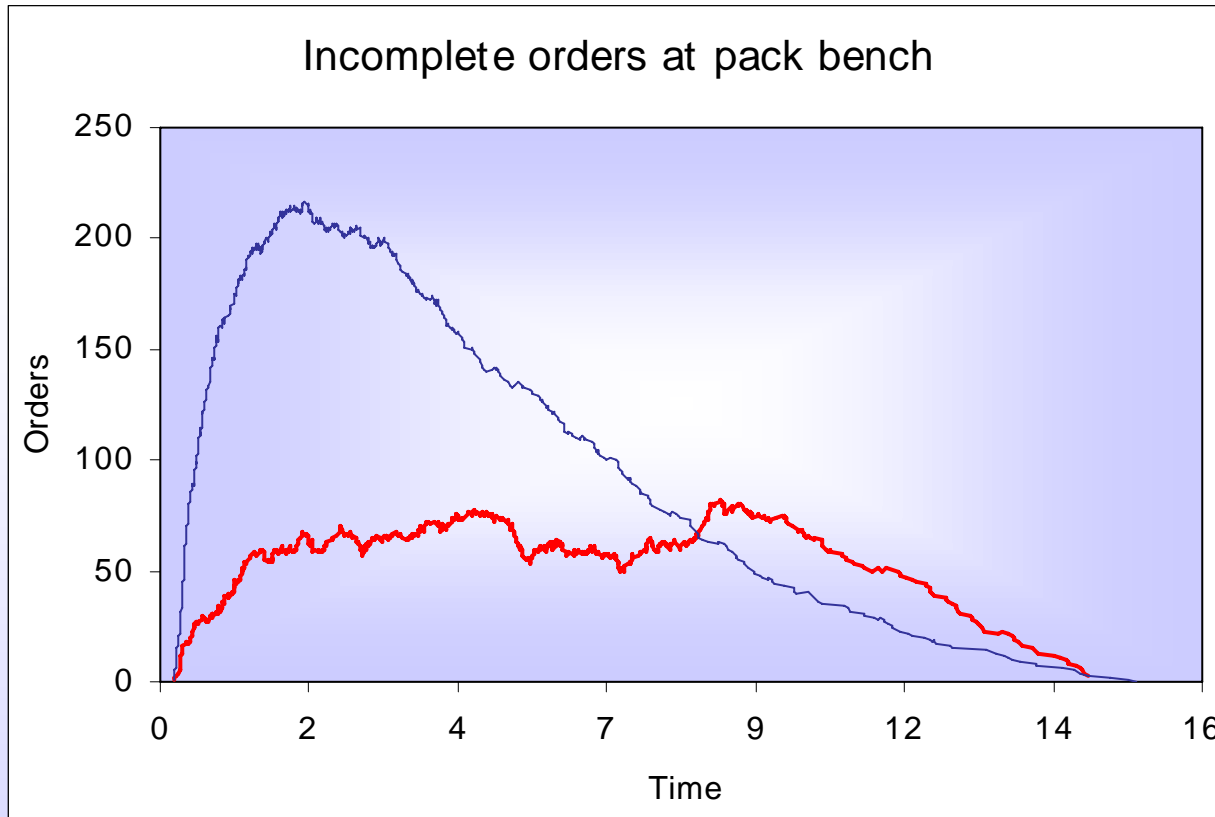
- This creates congestion and shuffling of cartons at the pack bench
- One proposition was that lowering the zone limits would reduce the number of orders in the system

# Experiments – Zone Limits



- Simulation showed the zone limit parameter was ineffective at controlling the number of incomplete orders at pack benches
- Try experimenting without zone limits, but have a new parameter to limit total orders in system
  - Thus all cartons for an order will be released at the same time

# Experiments – Total Order Limits



- Introducing this parameter reduced the number of incomplete orders at the pack benches
- No adverse impact on completion time

# Carton allocation

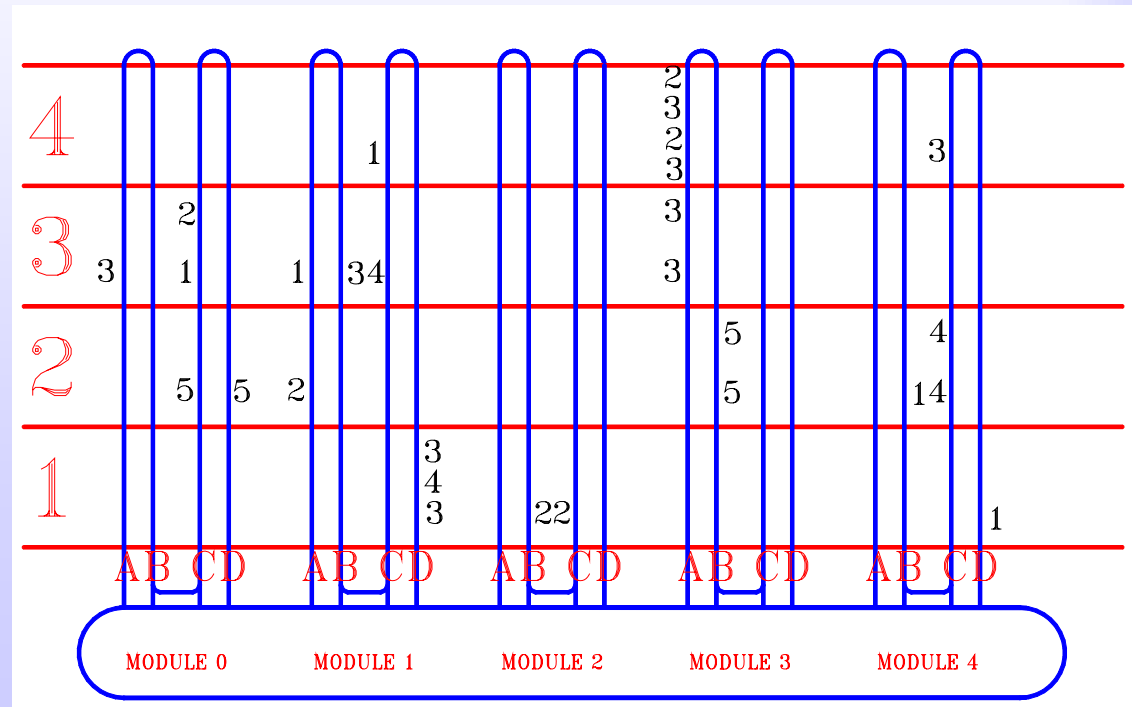


The simulation showed another potential problem; cartons from large orders, were visiting most of the modules

## Example order of 5 cartons

- On average each carton visits 3 modules

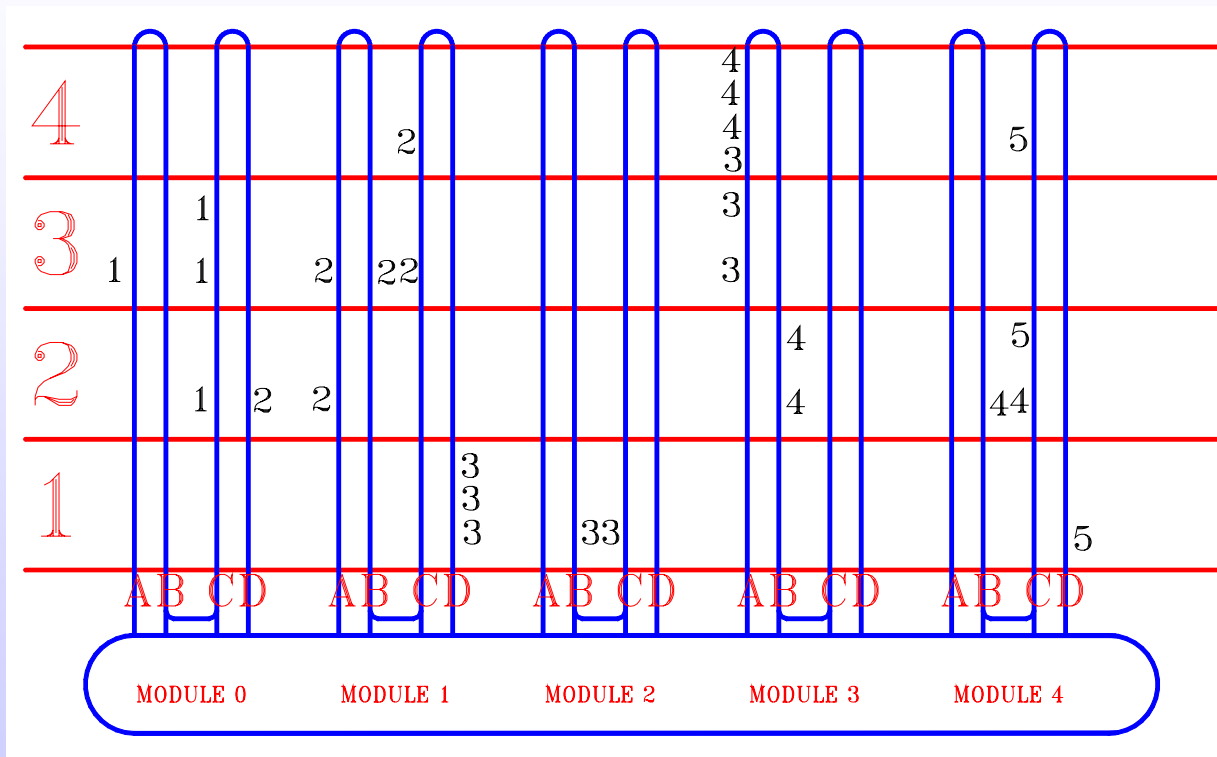
- WMS does not use location sequence in allocation routine



# Carton allocation



- Carton allocation algorithm was optimised to minimize number of module visits for the same number of carton

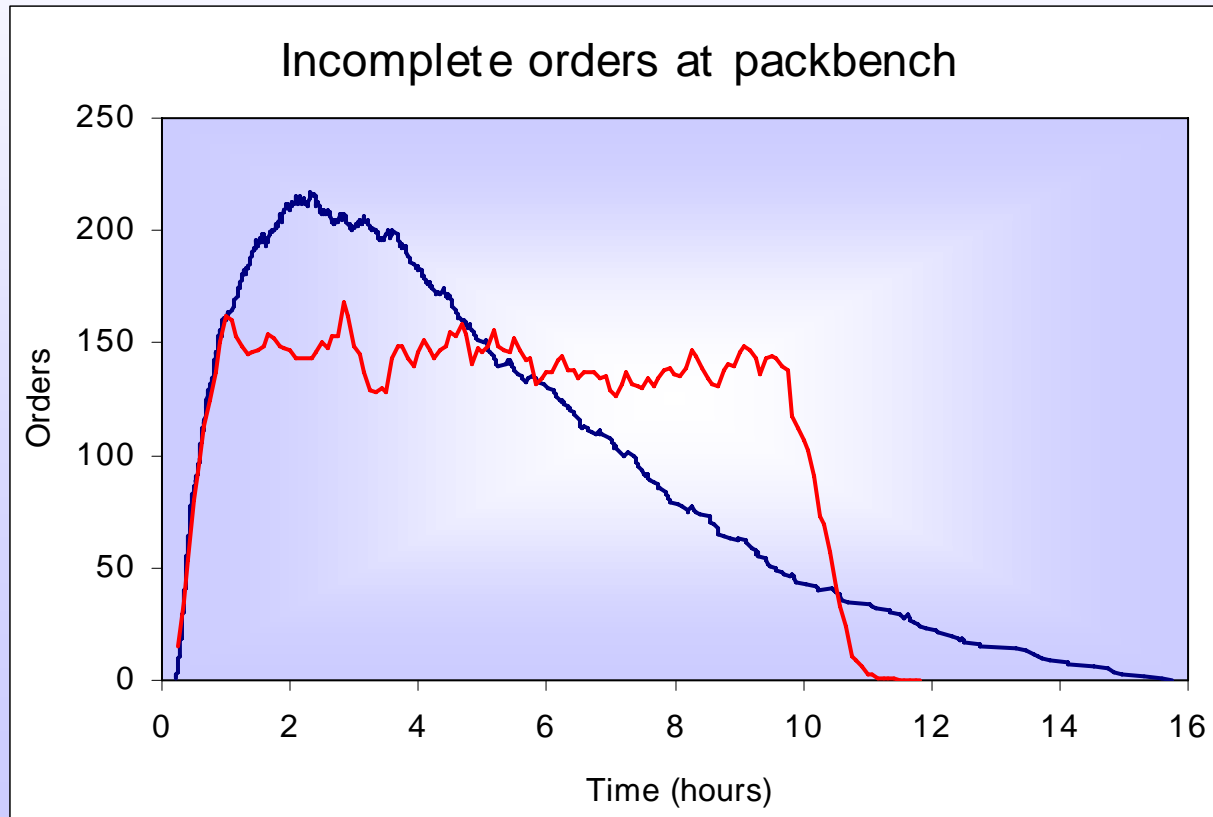


- Carton module visits reduced from 3 to 1.5

# Combined Effects



- Combine all conclusions into a single simulation:
  - Removed zone limits
  - Optimised picked carton allocation
  - Limited module visits
  - Balance zones



# Part 2 Conclusions



- The simulation showed that it was appropriate to implement the recommended changes into live system
- Post implementation, key performance indicators show that
  - Orders completed earlier
  - Picker utilisation improved
  - Increased throughput
- Simulation allowed experimentation
  - Did not compromise business
  - Allowed all parties to understand effect of parameters
  - Can be re-run in future if business changes

# Conclusions



- The design was not flawed
- The WMS needed a few minor changes
- Some parameters and pickface location are critical to a smooth and balanced operation
- All solutions were simple, low cost but not obvious, required detailed analysis, modelling and simulation to expose them



# Logistics Simulation



- Mike Wilson is managing director of Logistics Simulation Ltd
- A consultancy specialising in internal warehouse design: automated or traditional: existing, extensions or new build
- Logistics Simulation are a member of the Supply Chain Group

