

## MOBILE-RACKS AND ROBOTS: A PARADIGM SHIFT IN ORDER PICKING

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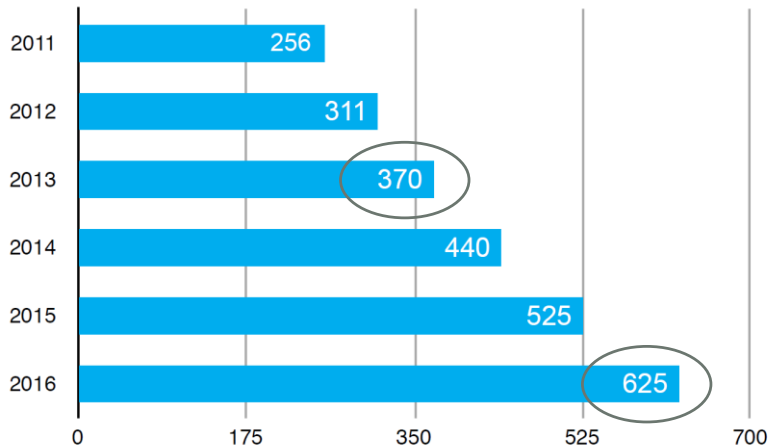
Material Handling Forum Seminar, VU Amsterdam

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### Outline

- eCommerce challenges and DC fit
- New mobile shelves-based order pick systems
- Decision areas, algorithms, and analytical models
- Insights from models
- Remarks from past implementations

## eCommerce Sales Forecast in Europe, billion Euros



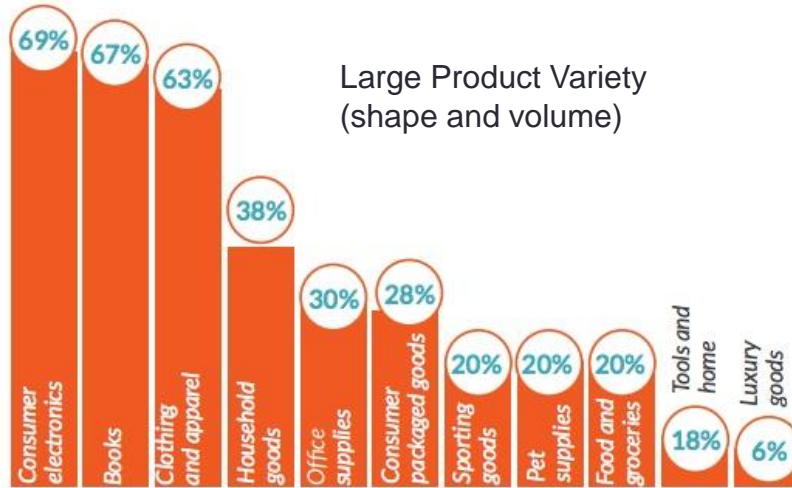
Source: <http://www.retailexcellence.ie>, Europe B2C Ecommerce Report 2013

## eCommerce in India

- India's eCommerce market rose 88% in 2013 (\$16 billion)
- Flipkart, Myntra, Snapdeal and Jabong - is today worth almost USD 3 billion in sales

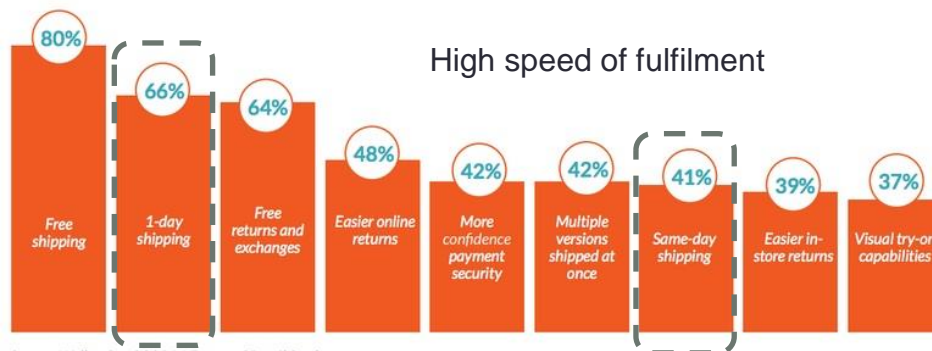


### The Most Common Types of Products Purchased Online



Source: Walker Sands' 2014 Future of Retail Study

### What Makes You More Likely to Purchase Products Online?



Source: Walker Sands' 2014 Future of Retail Study

Same day shipping was almost unheard of in India until...

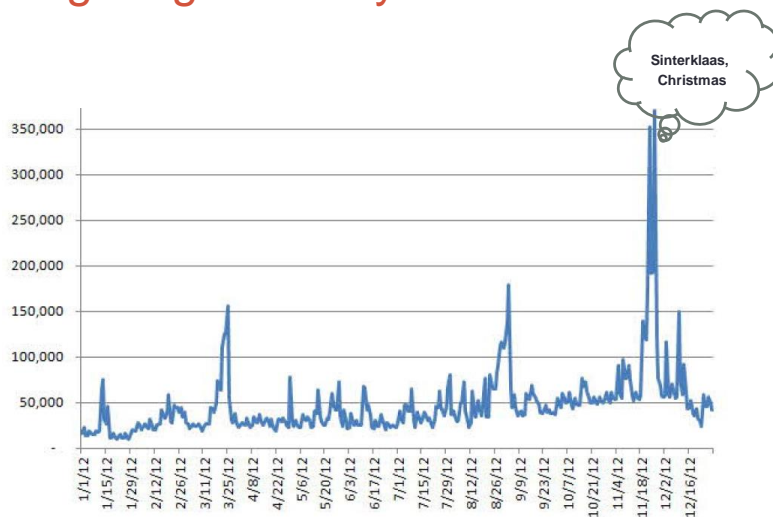
# amazon

Guaranteed  
1-Day Delivery 

Fulfilled 



## In Addition: Manage High Volatility in Customer Orders



Source: [www.mwpl.com/html/kiva\\_systems.html](http://www.mwpl.com/html/kiva_systems.html)

## Typical eCommerce Requirements

### Provider

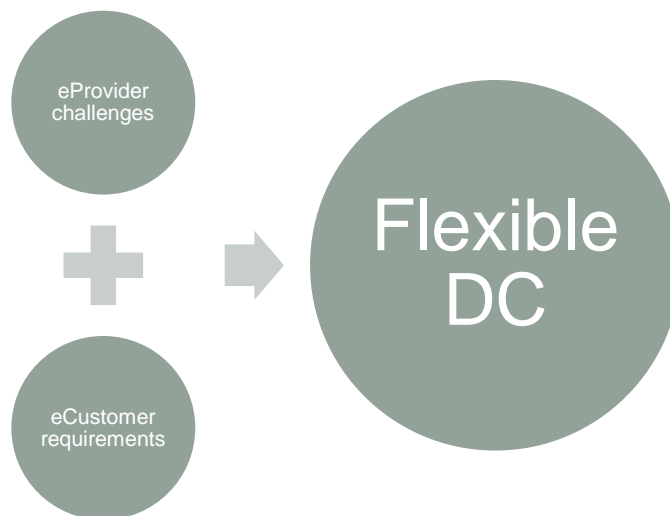
- Cope with uncertainty of geographical success
- The capacity and scale is unknown
- Need quick start, deployment
- Need to adapt with the SKU selection
- Order accuracy

### Customer

- Mobile-site ordering capability
- Wide selection of SKU offerings
- Fast and free delivery and
- Free returns (also the time available to free returns)

***The store for a eCustomer is the DC***

## How to Address the Need of the Hour?



## The Building Blocks of a Mobile Shelves-based Order Pick System



Drive Units

Pick from

Cartons



Totes



Inventory Pods

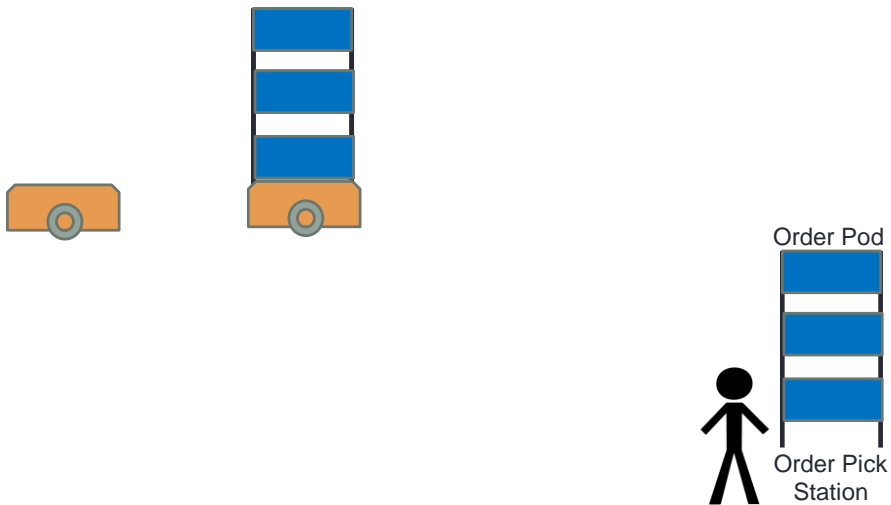
Pallets



## Mobile Shelves-based Order Pick System

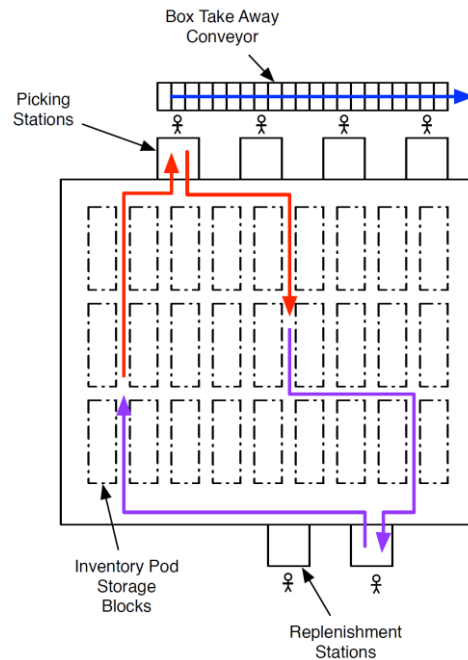


## The Robot on a Mission



## Mobile Shelves-based Order Pick System

## Order Pick and Replenishment Cycles

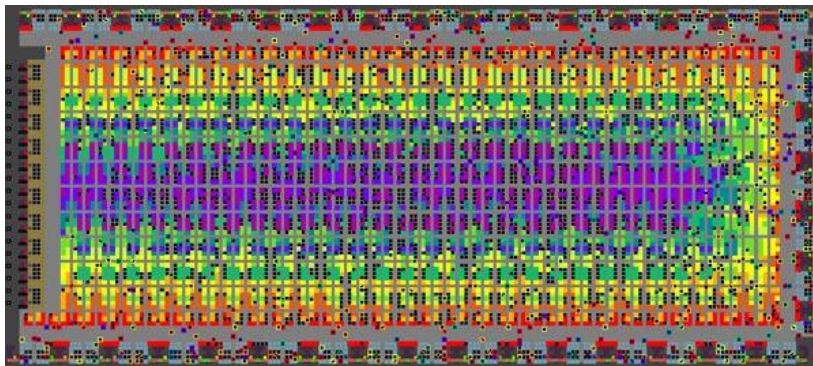


## Key Advantages

- Can handle odd-shaped products
- Picker productivity increased by 2-3 times
- Improves worker conditions
- Reduces order pick accuracies and order cancellation percentages/ returns
- Automation within an existing building and rapid deployment



## Self Organizing Layouts



*Shelves with fast-selling items are indicated in red.  
Blue squares show slow-selling items.*

Source: wired.com



## How can we get Maximum Benefit from the Order Pick System?

- Outputs?
  - Picker productivity, order throughput times
- Inputs?
  - Design Parameters such as number of pods, workstations (order pick and replenishment), drive units/ robots

## Goal (Cost vs. Responsiveness)

- Reduce the number of robots
- Increase system responsiveness
- Strike a balance between inventory on pods vs. stockouts

# DECISION AREAS

Algorithms and Models

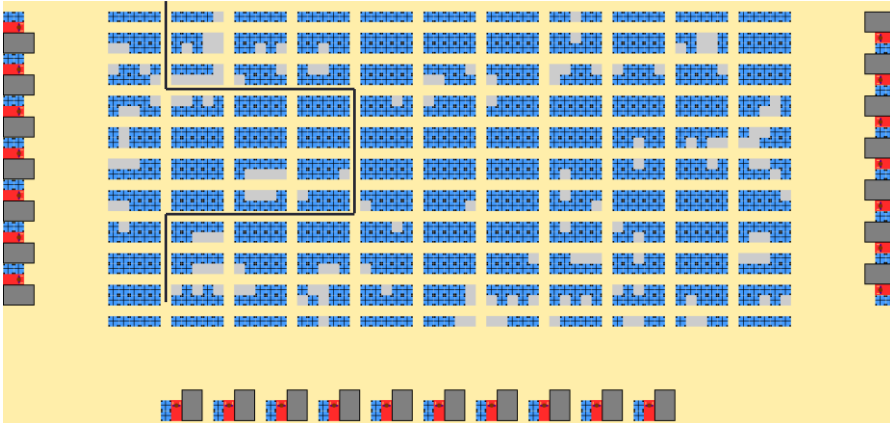
## Inventory Pod Selection Problem

- Like the pod to cover maximum open lines in the pick stations
  - Amortize the cost to travel from storage location to pick station and back
  - But this may introduce additional delay
- Trade-off between delay at pick stations vs travel time of the pod



## Inventory Pod Storage Problem

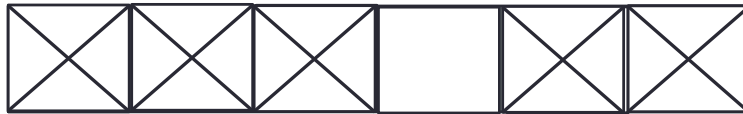
- Pod Storage policies
  - Class-based zones
  - Within an aisle?



## The Storage Process Resembles a Book Shelf



## Where to Store the Pod within an Aisle?



Pod Storage Strategies:

- ✓ Random open location
- ✓ Closest open location
- ✓ Closest open location near retrieval

How should the open locations be distributed in the storage area?

## Order Allocation Problem

New Order  
requires A,B,  
where should we  
allocate it?



Fulfilling orders with  
items A,B,C



Fulfilling orders with  
items X,Y,Z

## Replenishment Allocation Problem

- How many replenishment workstations?
- How many bins should be maintain per product?
- At what level should the bin be stored in the pod?

If customers frequently order Ketchup and Mustard sauce together



*Ensure product synergies within the pod*

## Robot Allocation Problem

- Which robot to which pod?
- Some pick stations are handling difficult products
- Some pick stations are far off from inventory pods
- Pick times may be variable
- Pickers should not starve
- Dynamic Travelling Salesman Problem

## Other Design Questions

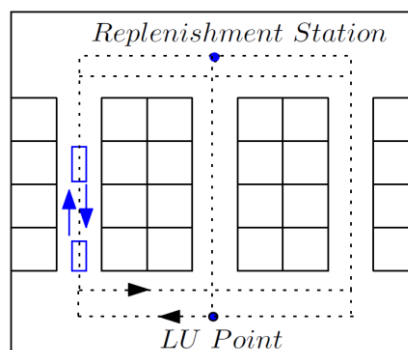
- Dedicated vs pooled robot system
- Optimal number of pick and replenishment stations
- Optimal location of stations
- Optimal shape (Depth to width ratio)
- Optimal shape of the storage blocks

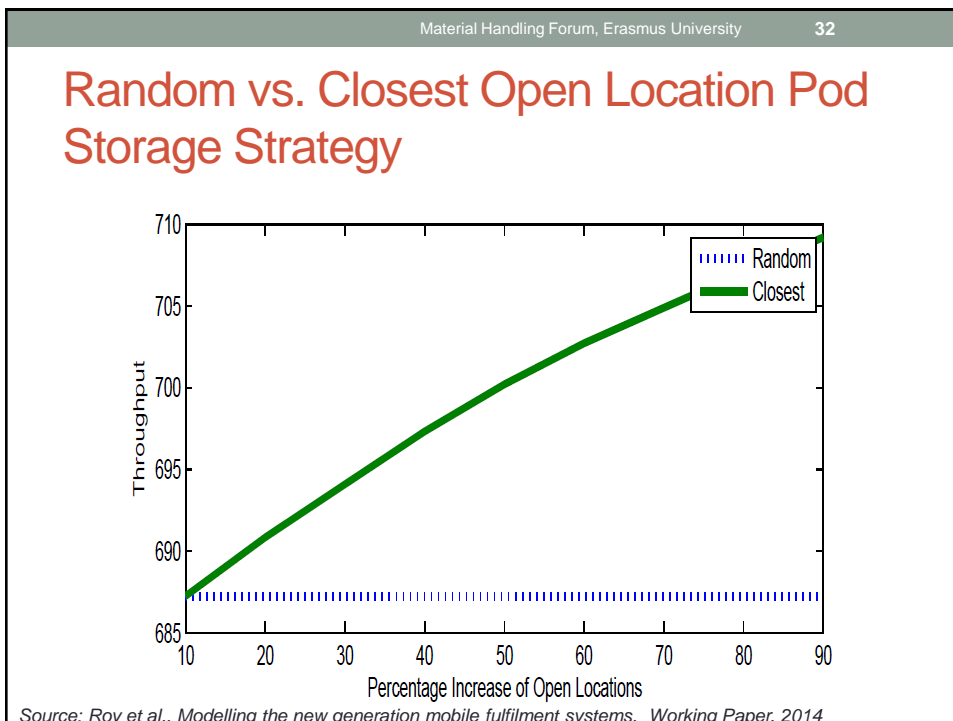
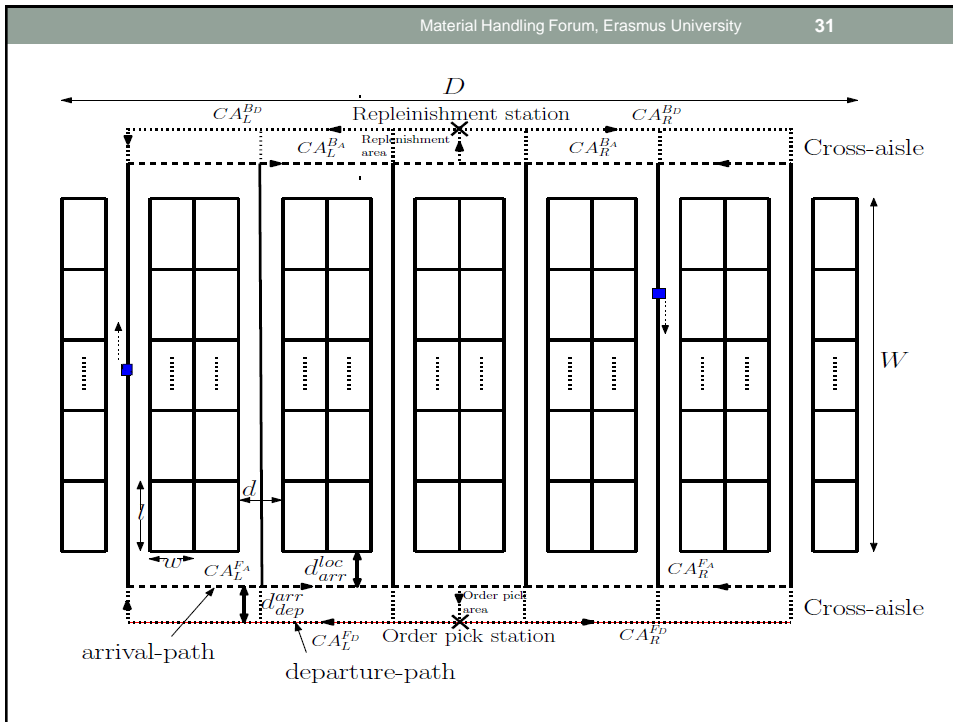
# ANALYTICAL MODELS

Answering design questions

## Challenges in Modelling

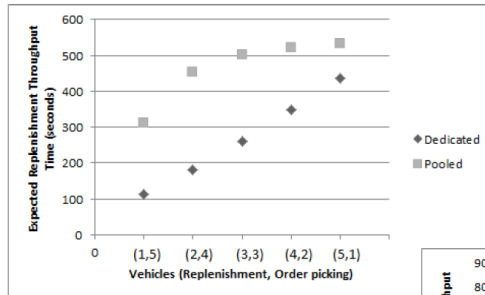
- Blocking, collision avoidance
- Rectilinear but underneath movement possible
- Finite waiting space



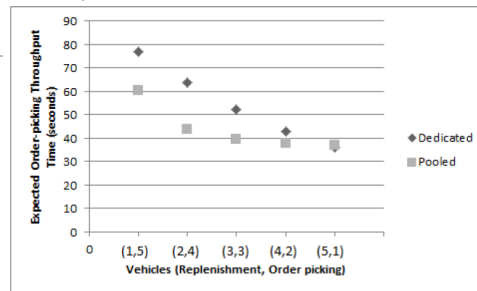




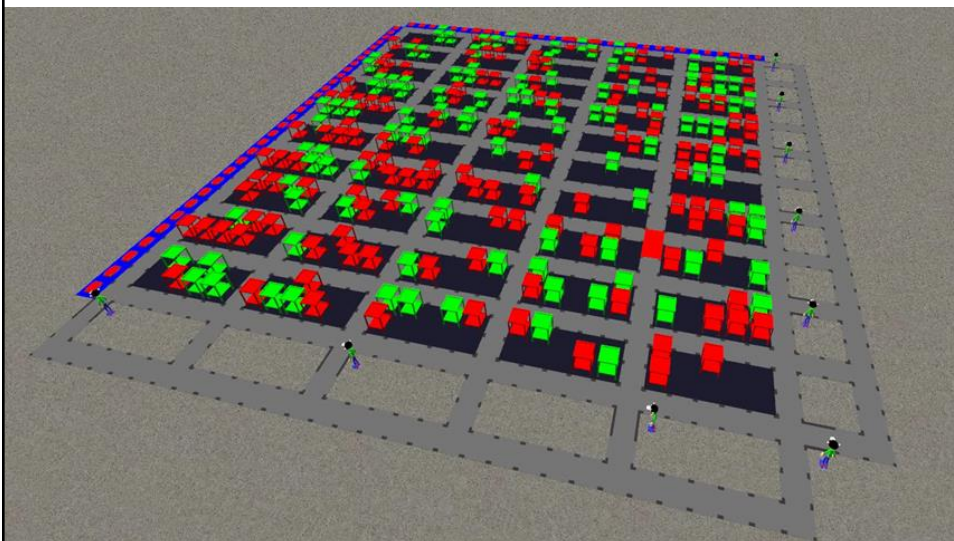
## Dedicated vs. Pooled Robots



Pooled robots benefits order picking but affects the replenishment process



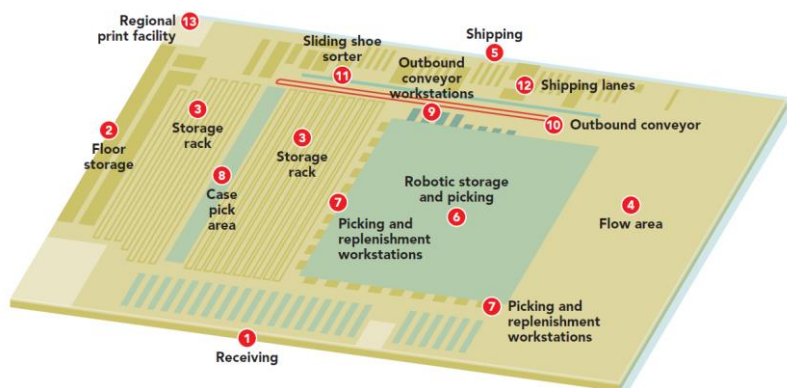
## Simulation Model Developed at RSM (Jelmer van der Gaast, Ph.D. Student)



# IMPLEMENTATION

## OfficeDepot.com

- 600,000 sq ft DC in Newville, Pa., USA
- 100,000 sq ft (Robot pick area)
- 60,000 lines per day
- 300 robots



Source: Modern System Report, Flexible Automation, August 2010, Bob Trebilcock, Modern Materials Handling

## Rapid Deployment



One growing eCommerce pure-play created a world-class Kiva-enabled fulfillment center in 7.5 weeks. They started with a dilapidated warehouse that had been abandoned for over 20 years and were picking orders less than 2 months later at a pace that allowed them to process in one day what used to take a full week the old way.

Source: Creating a Distribution Powerhouse:  
Why Rapid Deployment Matters, White Paper, Kiva Systems

## Other Benefits

- Rapid relocation (one weekend)
- Saves costs for air-conditioning and lighting
- Ergonomically better
- Increases order pick productivity
- High throughput flexibility
- Less training hours
- .....

## Open Questions?

Thank you!!

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