Warehouse Simulation: Quick and Effective
Alain de Norman et d’Audenhove
Rob Bateman

About the Authors

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  – Director of Graduate and Executive Programs
  – Previously VP-Technical Services at ProModel Corp.
  – Consulted or taught simulation courses in 60+ countries
About the Authors

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  – Mechanical Engineer from USP-University of Sao Paulo
  – Post graduated at ULB-University of Brussels/Belgium
  – 28 years of professional experience on planning and I.T. at Mercedes-Benz and Siemens. Founder and CEO at BELGE
  – Coordinated the implementation of logistics computer simulation at: VW, Fiat, GM, Delphi, Honda, Eaton, Scania, Michelin, Ryder, Arcelor Mittal, Siemens, Ericsson, Bosch, Dell, ThyssenKrupp, ABInBev, Coca-Cola, Danone, Nestle, Stihl, Basf, Repsol, Petrobras, Guardian, P&G, Unilever, Colgate, Avon, …

Agenda

- Discrete Event Simulation (DES)
- Warehouses & DES
- Case Unilever
- Case Coca-Cola
- Conclusions
- New trends / tools
- Questions
Discrete Event Simulation (DES)

- In DES, the operation of a system is represented as a chronological sequence of events.
- Each event occurs at a point in time and changes the state of the system.
- In contrast to optimization, DES allows incorporation of stochastic processes.
- From ‘what-if’ scenarios to optimization: simulation with optimization (incorporates genetic algorithms).
- Common commercial applications: manufacturing and logistics (warehouses, ports, transports…)

Distribution Centers (DCs) and Warehouses

Warehouse’s basic flow
Static Analysis vs DES - ‘Simultaneity’

• How could a static spreadsheet (MS Excel) consider the fact that a forklift cannot do several things at once if it does not simulate the operation over time?

Static Analysis vs DES – ‘Variability’

• How long does it take to unload a pallet from a rack?
• Spreadsheets consider average time
• Simulation allows us to consider lift time variability due to different numbers of levels per rack.
Static Analysis vs DES

<table>
<thead>
<tr>
<th>Static Analysis</th>
<th>Dynamic Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations sequencing</td>
<td>Does not consider</td>
</tr>
<tr>
<td>Simultaneous request of the same resource</td>
<td>Does not consider</td>
</tr>
<tr>
<td>Variability in operational times, speeds, demands and breakdowns</td>
<td>Does not consider</td>
</tr>
<tr>
<td>Productivity indexes (e.g., pallets/hour, qty in picking and load assembly)</td>
<td>It is an input, which can cause error. It is a mistake to use these values as a premise, since it is influenced by several factors such as: resource qty, processing times, arrivals and departure sequence, etc.</td>
</tr>
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Productivity Index (PI)

**Static Analysis: PI is input data**
- The previous productivity index was X boxes/hour
- Assumes that with the new method, the productivity will be increased to Y boxes/hour
- Scales the number of operators and equipments with the assumed productivity

**Dynamic analysis: PI is output data**
- The previous productivity index was X boxes/hour
- According to the new times, resources quantity and the new method, the productivity index will be Y boxes/hour
- Evaluates the productivity (meets or not) according on the amount of resources and process times

Eg.: New picking system
Simulation applied to Warehouses or DCs

- Warehouse environments include:
  - Complexity
  - High level of processes interdependency
  - Variability

When to simulate?

Warehouse Management Systems (WMS) vs Warehouse Simulation

- WMS:
  - Excellent for managing operations, but not as suitable for planning
  - No ability to test layouts, experiment with different process alternatives, determine the right number of transport and human resources or forecast the impact of different demand levels.
Case: Unilever

Objective:

- Audit 3 different logistics operation proposals and help Unilever to decide which 3PL would operate their new (and biggest) DC in South America
- Joint Warehouse (Foods and HPC / SP) – almost 60% of Unilever Revenue (Brazil) comes from this DC

Interactive analysis to define the number of required resources:

- Inbound and outbound results X targets

Eliminating bottlenecks and reducing resource idleness
Case: Unilever

Results:

- Defined the minimum number of necessary resources (we detected oversizing and undersizing)
- Costs were reduced by US$ 130,000 / month (reducing operators and forklifts)
- Identified and eliminated bottlenecks. Otherwise the DC would have a backlog of almost 35% on peak days
- Guarantee ability to attain the level of service required. Start-up operations ran very well
Case: Coca-Cola (Bottlers)

Case: Coca-Cola

- **Objective:**
  - Optimize the layout, flows and storage of the new DC area in Taguatinga do Sul city (BRASAL).
  - Consider the storage area expansion and verify operational restrictions in the system. Example: Idleness level of each resource in each shift.
Case: Coca-Cola

• Scope
  – The model considered the following processes:
    • Storage Area;
    • Picking Area;
    • Loading/Unloading Tunnel;
    • Receiving and Expediting of Product.

Case: Coca-Cola

Previous Layout

Production Lines

Idle space

“Docks” – 16 loading points

Storage area

Picking area was not working

Staging

Picking
Case: Coca-Cola

**New Proposed Layout**

- **Production Lines**
- **Storage area**
- **Loading points (8)**
- **Picking**
- **Staging area (new concept)**
- **Replenishment Picking**

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Case: Coca-Cola

6 a.m.: all trucks must be loaded

**Baseline:** several trucks loaded after the deadline

**Layout proposed**

**Staging area required**
Case: Coca-Cola

1. Picking: Baseline
   - Decrease of 1.5 min/pallet

2. Picking: New Layout

3. New product positions

Example: Loading Time – Vehicle “Mercado”

Baseline
Mean time ➔ 1.6 HR

Reduction: 12.5%

Layout Proposed
Mean time ➔ 1.4 HR
Success Case: Coca-Cola

Case: Coca-Cola

Results:
- Bottlenecks and operational problems were identified, and the DC breakpoint in the current situation;
- A new layout was proposed, improving storage capacity by 20%;
- The operation strategy of the DC was changed, reducing vehicle loading times by almost 26%;
- A new picking configuration was proposed, reducing picking time and inspection in the stages.
# Case: Coca-Cola

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Results</th>
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<tbody>
<tr>
<td>Optimize flows and movements</td>
<td>Increase the storage area utilization by 8.9%</td>
</tr>
<tr>
<td>Space optimization</td>
<td>Decrease of 18% in vehicles service times</td>
</tr>
<tr>
<td>Determine the number of resources required for out years</td>
<td>Correct quantity of required resources</td>
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### Vonpar

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## Case: Coca-Cola

### Objectives

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<tr>
<td>Set the best layout for future and increasing demands</td>
<td>Obtained the optimized layout for the DC</td>
</tr>
<tr>
<td>Set the best operation strategy</td>
<td>Charging system dramatically modified</td>
</tr>
<tr>
<td>Set the best layout for increasing volumes</td>
<td>20% increase in availability in warehouse area</td>
</tr>
<tr>
<td>Define the picking and staging area</td>
<td>Truck loading time reduced by 40%</td>
</tr>
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<td>Improvement in the picking area</td>
<td>Definition of a new layout for picking area</td>
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Case: Coca-Cola

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<td>Define the best layout for a new DC</td>
<td>Defined warehouse area, restaurant, parking area, etc</td>
</tr>
<tr>
<td>Identify investments required in future years</td>
<td>Investment plan per year</td>
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<tr>
<td>Define the number of resources</td>
<td>Minimum number of human resources and equipment defined</td>
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<td>Define the best layout for a new DC</td>
<td>Increase of 45% in warehousing capacity when compared with the original proposed layout</td>
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<tr>
<td>Flow optimization</td>
<td>Defined the picking method, type of storage structures, staging areas and set the best regions for each SKU</td>
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<tr>
<td>Size the number of resources</td>
<td>Defined the minimum qty of resources</td>
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</table>

Wrap-up

- Simulation is helping several companies to avoid typical sizing errors (compared to simple MSExcel usage)

Differences between simulation and spreadsheets in resource sizing
Wrap-up

- Observing the usage of DES at DCs, we can point to some significant improvements, such as:
  - Up to 40% increase in outbound capacity, made possible through the identification and modification of system bottlenecks
  - Minimized start-up errors in new and modified DCs
  - Up to a 30% reduction in human resource requirements during peak days
  - Operational cost reductions of up to 35%

New trends: Specific Warehouse Simulators

- **FROM** Generic simulation software (AutoMod, ProModel)
  - Flexible to model any logistics, manufacturing or service industry
  - Requires extensive programming effort for DC complexities

- **TO** Warehouse or DC (Distribution Center) Simulators:
Trends: More use of simulation

• Dynamic analysis
  – Resource planning

• Variability
  – Demand, supply

• Visualization
  – Globalization

• Flexibility
  – Scenarios
  – Experimentation

Questions ???

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+1 801 983 4978