Drum Buffer Rope Application at Intel Warehousing

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A case study about how a team from Intel Corporation was able to improve performance in a finished goods warehouse operation by applying Theory of Constraints Drum-Buffer-Rope

CUSTOMER FULFILLMENT
Planning and Logistics Group
Organizations everywhere encounter challenges to improve their performance.
Process improvement professionals must apply effective concepts to improve performance
Organizations are reluctant to change or try new things.
You want your organization’s performance to improve
Apply **key concepts** from my experience in implementing DBR in a warehouse operation to dramatically improve performance.
Key Concepts

1. **Timely** and accurate **data**

2. **Utilize** existing **continuous improvement** programs & methods

3. **Training** through “**Game**” exercises
Intel’s Supply Chain

- Supplier
- Factory
- Fab
- Shipment Delivery
- Customer

Warehouse Operations
Warehouse Operation

- Receiving
- Inventory Storage
- Placement
- Order Pick
- Order Staging
- Processing Line
- Partial/Combine
- Pack
- Label

FACTORY

Shipment Delivery

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1. Data

Provide a timely and accurate measurement system to assess performance
Demonstrate **immediate** impact

**Date=08/16/2006**

**Cycle time / Hour**

<table>
<thead>
<tr>
<th>Hour</th>
<th>Mean(CT)</th>
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<tbody>
<tr>
<td>-5</td>
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<tr>
<td>0</td>
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<tr>
<td>10</td>
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<td>15</td>
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<tr>
<td>20</td>
<td></td>
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<td>25</td>
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</table>
SPC and Buffer Reports

Cycle Time Control Chart

Buffer Report
2. Continuous improvement

Utilize existing process improvement methods already in place or more fully understood, use the data
“Lean” (VSM, Waste elimination)
DMAIC

D – Identify constraint
M – Set baseline
A – Determine key variable that impact constraint
I – Apply DBR, reduce variability
C – Sustain performance (SPC)
3. Games

Use “Game” or simulation training methods to introduce power of DBR and turn skeptics into believers
Drum – Buffer – Rope

Process step: A → B → C → D → E

Rate (e.g. orders per hour)

*Non Constraint* 45* → *Non Constraint* 75 → *Constraint* 25 → *Near Constraint* 30 → *Non Constraint* 50

Drumbeat

Rope

Buffer

WIP

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18
Simulation Set Up

7 Players:
1 Ground Controller
5 MS (1 per process)
1 Flow Control Monitor
Simulation Example

Flow Time Histogram

With DBR
# Immediate Implementation

## Buffer Calculation Tool

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Buffer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station Output X</td>
<td>Minimum 0 to A Orders</td>
</tr>
<tr>
<td>Avg O/Hr/Line Y</td>
<td>Target A to B Orders</td>
</tr>
<tr>
<td># Stations Y</td>
<td></td>
</tr>
<tr>
<td>Total Output X*Y</td>
<td>Maximum B to C Orders</td>
</tr>
<tr>
<td>Avg O/Hr</td>
<td></td>
</tr>
<tr>
<td>Max Buffer time Z</td>
<td>Hrs</td>
</tr>
</tbody>
</table>
Results
Order Processing Cycle Time Improvement

Oneway Analysis of Cycle Time (hours) By Implementation

Oneway Analysis of REPACKFINISH By Implementation / Demand

Means and Std Deviations

Means and Std Deviations

Avg Cycle Time (pick to repack finish) reduction ~43% (~61% St dev)
Avg Hourly Throughput Increase (DNs/hour) ~10%
Total Warehouse Cycle Time Improvement

**OPD Weekly Average Cycle Time (DN Create to AGID)**

- **Cycle Time (Days):**
  - Before OIM: 4.5, 4.0, 3.5, 3.0, 2.5, 2.0, 1.5, 1.0, 0.5
  - OIM: 4.5, 4.0, 3.5, 3.0, 2.5, 2.0, 1.5, 1.0, 0.5

**Analysis of Variance**

- **Source:**
  - Implementation: 1
  - Error: 30

- **Sum of Squares:**
  - Implementation: 32.1509
  - Error: 10.1754

- **Mean Square:**
  - Implementation: 32.1509
  - Error: 10.1754

- **F Ratio:**
  - 32.1509

- **Prob > F:**
  - <0.001

**Means and Std Deviations**

- **Level:**
  - Before: 33
  - After: 8

- **Mear:**
  - Before: 2.65403
  - After: 1.39694

- **Std Dev:**
  - Before: 0.575306
  - After: 0.500250

- **Lower 95%:**
  - Before: 2.4500
  - After: 0.9787

- **Upper 95%:**
  - Before: 2.85
  - After: 1.81

**Without additional expense**

- **Avg Cycle Time reduction ~48% (~14% St dev)**
- **~1.25 day total reduction in inventory**
- **Increased Inventory availability**
- **Cycle time stable**
Additional Warehouse Example

Warehouse Throughput

Constraint elevated this time

33% increase in throughput

<table>
<thead>
<tr>
<th>Implementation</th>
<th>Student's t</th>
<th>0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Before</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) After</td>
<td></td>
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</table>
Qualitative Results of DBR

BEFORE
• Operations metrics were not directly effected by daily activity
• Large unexplainable difference in cycle time from Site to site
• Difficult Order prioritization
• Each operation/station was focused on only their process

AFTER
• Clear link between operations performance and metrics
• Site to site differences are small and can be explained
• Easy order prioritization
• Simplified DC Management
• Increase in site team work
Additional Key Learnings

• Robust production solutions are portable from manufacturing to warehousing

• Step function improvements don’t have to be complex or expensive

• The proper motivation can cause culture change quickly

• Don’t break the constraint, make it the operational focus
Successful DBR Implementation possible through:

1. **Timely** and accurate **data**

2. **Utilization** of existing **continuous improvement** programs & methods

3. **Training** through “**Game**” exercises
Questions?

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