Ottimizzazione della produzione e della logistica per il riuso di componenti obsolete nell'industria degli accessori moda

UNIVERSITÀ POLITECNICA DELLE MARCHE

Emanuele Frontoni, Roberto Rosetti, Mirco Sturari, Fabrizio Marinelli
Dipartimento di Ingegneria dell’Informazione
A case study in the sunglasses market

- ~ 93 M pz/year (sun + presc. glasses)
- more than 40 brands
- 12 manufacturing facilities
- 18 distribution center worldwide
- ~ 80% of market share

<table>
<thead>
<tr>
<th>16.3 parts per BOM (on average)</th>
<th>Some numbers</th>
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UNIVPM – Emanuele Frontoni e.frontoni@univpm.it
Supply chain network & Data

Distribution coverage:
• +7200 retail store
• distribution network over +150 countries

4 main plants / warehouses

Costs of stocked components according to component type and warehouse location

Component prices according to purchase location

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Challenges in fashion markets

- High demand variability
- High product turnover (out of fashion)
- Wrong forecast
- Obsolete products
- Overstock

Main drawbacks:
- *management costs*
- *potential losses*
Out of fashion products & obsolescences

First market

Outlets / 2\textsuperscript{nd} markets

\begin{itemize}
  \item \textbf{components related to out of fashion products}
  \item \textbf{Obsolescences}
  \item \textbf{Strategy}
  \item reuse \textbf{obsolescences in discounted products for outlets}
  \item \textbf{\~1000 different models}
  \item \textbf{\~3500 different components}
\end{itemize}
The Problem

- **Obsolete components overstocks** are useless for the first market.
- They can be used for 2\textsuperscript{nd} market products provided that new components are bought.

1. Find a *production plan* that maximize the *leverage* of obsolete components reusing
2. Learn to “buid” a “Frankenstein” glasses via AI/ML

- The problem is \textit{NP-hard}
- The problem is not plant-wise decomposable
- Can we use ML & DL?
DL Learning 3D models compatibility
Big Data Infrastructure

Optimal Component Reuse and Design Support System … LP & DL

**Input**
- Bills of Material (BOM)
- Obsolete components
- Budget for new orders
- Orders & production lot sizes
- Design info & 3D models

**Production Data**
- 3D model

**Output**
- Quantity and location of reused obsolete components
- Quantity and type of purchasing orders

Component reusing LP Model

Transfer Learning

CNN
Results (viable leverage of obsolete comp. reuse)

Instance: a “snapshot” from the company: ~ 1000 obsolete products, ~ 3500 comp., 4 warehouses.

Setting:
- No budget and production bounds \( (Q, H = \infty) \)
- No order min lot sizes \( (b_{ik} = 0) \)
- No production lot sizes \( (q_j = 0 \text{ and } Q_j = \infty) \)
- \( \mu \in \{1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, 0.1\} \)

Problem size: ~ 6000 vars, ~ 2000 const, ~ 20000 nonzeros

CPU/GPU times: 1.42 secs on average (max 10 secs)

Absolute gap: 31 € on average (max 59 €)
leverage of obsolete comp. reuse

\[ R = \text{tot revenue} \]
\[ P = \text{tot cost of bought comp.} \]
\[ C = \text{tot cost of used comp.} \]

\[
R / (P + C) \quad \text{used warehouse (% value)}
\]

<table>
<thead>
<tr>
<th>$\mu$</th>
<th>$R - P - C$ (M€)</th>
</tr>
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<tbody>
<tr>
<td>0.1</td>
<td>4.9</td>
</tr>
<tr>
<td>0.2</td>
<td>13.8</td>
</tr>
<tr>
<td>0.3</td>
<td>25.2</td>
</tr>
<tr>
<td>0.4</td>
<td>42.1</td>
</tr>
<tr>
<td>0.5</td>
<td>67.8</td>
</tr>
<tr>
<td>0.6</td>
<td>103.0</td>
</tr>
<tr>
<td>0.7</td>
<td>141.5</td>
</tr>
<tr>
<td>0.8</td>
<td>184.2</td>
</tr>
<tr>
<td>0.9</td>
<td>233.1</td>
</tr>
<tr>
<td>1</td>
<td>287.1</td>
</tr>
</tbody>
</table>

\[ R / P \text{ is always } > 270 \]
Assortment & production volumes

Too large assortment and too much small lots!
Results (viable leverage of obsolete comp. reuse)

Instance: a “snapshot” from the company: \(\sim 1000\) obsolete products, \(\sim 3500\) comp., 4 warehouses.

Setting:

- Production bounds \(Q = 100,000\)
- Order min lot sizes \(b_{ik} = 200\)
- Production min lot sizes \(q_j = 200\) and \(Q_j = \infty\)
- \(\mu \in \{1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, 0.1\}\)

Problem size: \(\sim 31000\) vars, \(\sim 33000\) const, \(\sim 107000\) nonzeros

CPU times: 18.2 secs on average (max 96 secs)

Absolute gap: 1.56 € on average (max 6.26 €)
Emanuele Frontoni e.frontoni@univpm.it @efrontoni
Dipartimento di Ingegneria dell’Informazione – Università Politecnica delle Marche