Drive-Thru Loading Concept for In–Plant Milk Runs

Marco Dewitz
Stefan Galka

MHCL 2012
Belgrad
1. Motivation and Basics
2. Drive-Thru Loading concept
3. Benchmark of Automated Loading Concepts
4. Summary and Outlook
1. Motivation and Basics

2. Drive-Thru concept

3. Benchmark of Automated Loading Concepts

4. Summary and Outlook
Drive-Thru Loading Concept for In-Plant Milk Runs

Challenges of lean production supply systems

- reduction of stock
- JIT materials supply
- number of variants increases

Manageable only by high-frequency and synchronized material supply
Drive-Thru Loading Concept for In-Plant Milk Runs

High-frequency material supply by tugger trains

Benefits of tugger trains in comparison to forklifts

- Reduction of transport distances and therefore traffic volume
- Stabilization of material provision process and thus constant replenishment lead times
- Reduction of providing errors, thru sequencing material

Definition: tugger train for small load carriers

- Manually operated industrial trucks, which transport bins from one material sources to different destinations on one tour.
- Often several tugger trains are operated simultaneously, which use the same material source.
Drive-Thru Loading Concept for In-Plant Milk Runs

Challenge by providing small load carriers

- High number of bins per tour (search effort)
- High numbers of destinations
- High-frequency supply process
- Small material reach per bin

Manual handling of bins in the production
- Partially high weights per bin (15 kg)
- Different weights per bin

Tasks for the process design
- Efficient
- Ergonomic
- Speed
- Zero defects

- Automation of loading process for the tugger trains on the material source
- Automatically Sequencing of bins for reduction the search effort
Drive-Thru Loading Concept for In–Plant Milk Runs

1. Motivation and Basics

2. Drive-Thru concept

3. Benchmark of Automated Loading Concepts

4. Summary and Outlook
Drive-Thru Loading Concept for In–Plant Milk Runs

Concept
# Drive-Thru Loading Concept for In–Plant Milk Runs

## Technical Description

1. **Doubled capacity for decoupling between collection process and delivery process**
   - Collection of goods in station

2. **Automatic release by PLC**
   - Release of transfer depth

3. **Break rollers for smooth SLC transport**
   - Arrival of tugger train at station

4. **Clearance-free couplings**
   - Positioning of tugger train in station

5. **Restraint guided trailers**
   - Manual release and load transfer

6. **Centering devices**

7. **Laser mark for exact positioning**

8. **Direct visual contact to discover possible errors**

9. **Unrestricted grab area due to intended frames**
   - Start of tour and delivery

10. **Anti-squeeze protection**
Drive-Thru Loading Concept for In–Plant Milk Runs

1. Motivation and Basics
2. Drive-Thru concept
3. Benchmark of Automated Loading Concepts
4. Summary and Outlook
Description of Automated Loading Concepts

Available automated loading technologies

- ASRS-retrieval usually not restricted to SLC sequence
- Determined order of delivery established in ASRS prezone by conveyor technique or highly dynamic buffer

Concept 1

- Trailers are separated and combined in station
- Employee feeds loading station with trailers manually

Concept 2

- Transport shelves are taken of the trailers by fork lifter
- Automated feeding of transport shelves by conveyor technology

Available automated loading technologies

- ASRS-retrieval usually not restricted to SLC sequence
- Determined order of delivery established in ASRS prezone by conveyor technique or highly dynamic buffer

Concept 1

- Trailers are separated and combined in station
- Employee feeds loading station with trailers manually

Concept 2

- Transport shelves are taken of the trailers by fork lifter
- Automated feeding of transport shelves by conveyor technology

<table>
<thead>
<tr>
<th>Process step</th>
<th>Buffer time</th>
<th>Conveyor technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tugger train driver</td>
<td>Worker loading station</td>
<td>TS</td>
</tr>
</tbody>
</table>
Drive-Thru Loading Concept for In–Plant Milk Runs

Conclusions for the Replacement time

Technical lead time

- Time that is required by automated systems to prepare all goods for a specific tour
- Number of buffering stages and handling steps determines technical lead time
- The smaller the technical lead time, the longer orders for a specific tour can be accepted
  - Lower reorder levels
  - Lower stock at workstations
  - Lower stocks in transit
## Drive-Thru Loading Concept for In–Plant Milk Runs

| 1. | Motivation and Basics |
| 2. | Drive-Thru concept |
| 3. | Benchmark of Automated Loading Concepts |
| 4. | Summary and Outlook |
Drive-Thru Loading Concept for In–Plant Milk Runs

Summary

Challenges
• Increasing number of variants
• More flexible production equipment
• Smaller containers
• Greater amount of buy-in-items

Procurement Process

Aims
• High reactivity
• Cost- and space-effective
• Transparent processes
• Security of supply

→ Tugger trains can solve major problems of conventional procurement processes and are becoming an increasing trend, especially in automotive sector
→ Available loading concepts come with major disadvantages

Benefits of Drive-Thru concept:
• **Dynamic** procurement process
  … due to fewer handling steps and technical lead time
• **Economical** procurement process
  … due to smaller equipment investments and required floor space
• **Ergonomic** procurement process
  … since no additional physical stress is caused by loading tasks
• **Lean** procurement process
  … due to fewer handling steps and buffering stages
Outlook

June 2012
• Prototype of the system designed and tested at the Institute fml

October 2012
• Publication of empirical study with 15 automotive companies and suppliers
• Showing further fields of action regarding milk-run systems

July 2013
• Initial operation at a plant of an automotive supplier
Backup
Disambiguation

Definition: route

- A route describes a predefined track from one / several different sources to different destinations.
- The route comprises different destinations (e.g. Flow racks)

Definition: tour

- A tour is a trip of the tugger train on a route
- The tour can have a defined start time (tacted milk-runs), start immediately after the previous tour or start when the tugger trains has reached an appropriate load capacity (both untacted milk-runs)
Sequenced tugger loading reduces the search effort.

typical small parts tugger with free unloading sequence
Disambiguation

Definition: replenishment lead time (RLT)

- The RLT is the maximum time which passes between signaling the material requirement and provision of new materials
- The RLT depends on the process (Information process and physical process)
- The following factors influence the RLT:
  - Type of signaling material requirements (Bin-Kanban, eKanban, …)
  - Technical lead times (e.g. time for retrieval in an automatic storage)
  - Time for the physical delivery and provision of materials
- At the moment of signaling material requirements, the stock on the usage point must cover the material consumption during the whole RLT.
Challenges during the planning process

Devotions in demand, Layout, Type of bins, Replenishment lead times, Technology (Capacity), Process (Handling time), Lead times

Planning and dimensioning of milk-run systems

Parameters
- Tact
- Required service level

Output
- Number of milk-run trains and drivers

- No standardized planning method or tools (individual Excel-tools)
- Dimensioning based on average demand or worst case
- Reserves in capacity and process times to buffer deviations in demand
Why take deviations in demand into consideration?

Trade-off between under-utilization (waste) and over-utilization (bottleneck in provision process)
**Task**

- **Decision**
- **Plan process and technology**
- **Determine number of milk-run trains (procurement)**
- **Detailed planning (route)**
- **Implementation**

**Tasks**

- Calculate the number of milk-run trains to achieve a requested service level
- Define the tact time
- Verify whether number of routes / takt time is feasible
Input data for the calculations

- Process times
- Technology
- Demands

Model
Input data for the calculations

- **Process times**
- **Technology**
- **Demands**

**Model**

**Dependency of process times**

<table>
<thead>
<tr>
<th></th>
<th>number of bins</th>
<th>number of stops</th>
<th>distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_F$</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_B$</td>
<td>(X)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_E$</td>
<td>(X)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_S$</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend**

- $t_F = t_{F1} + t_{F2} + t_{F3} + t_{F4}$: Zeitanteil für Fahrt
- $t_B$: Zeitanteil für Beladung
- $t_E$: Zeitanteil für Entladung
- $t_S$: Zeitanteil für Stopp
- $t_H$: Zeitanteil für Handhabung
DIMENSIONING OF TACTED IN-PLANT MILK-RUN SYSTEMS

Input data for the calculations

- Process times
- Technology
- Demands

Model

- Number of trailers per train
- Number of bins per trailer
- Maximum capacity per milk-run train
DIMENSIONING OF TACTED IN-PLANT MILK-RUN SYSTEMS

Input data for the calculations

- Process times
- Technology
- Demands

Model

- Mean demand and standard deviation
- Assignment of materials and workstations (WS)
- Location of workstations (Layout)
Problem-solving approach

Combine individual demands at a single workstation

WS 1

Combine demands at workstations to one route

WS 2

Route 1

- Qualitative representation based on an empirical study
- Deviation of individual materials higher than deviations of amount combined on one route.
DIMENSIONING OF TACTED IN-PLANT MILK-RUN SYSTEMS

Problem-solving approach

Question
• How many/which workstations can be combined to one route?

Input data
• Demands (amount of bins) per workstation
• Sequence of workstations (Location in layout)
• Requested service level (95%)
• Maximum transport volume (time and capacity) 60 small load carriers

Variant 1

WS 1 + WS 2

• Service level of 95% achieved.
• Utilization 35/60 = 58%

Variant 2

WS 1 + WS 2 + WS 3

• Service level of 95% achieved.
• Utilization 40/60 = 67%

Variant 3

WS 1 + WS 2 + WS 3 + WS 4

• Service level of 95% not achieved.

best feasible solution
Case study

Task
• Planning of a new logistics concept
• Planning and dimensioning of structure
• Planning of milk-run processes
• **Determine the number of routes and milk-run TACT time**
• Definition of routes

**Focus of case study**
DIMENSIONING OF TACTED IN-PLANT MILK-RUN SYSTEMS

Case study

Material flow data
• 460 small load carriers/h (SLC)
• 34 large carriers/h

Challenge
• High demand deviations
Case study

- 7 SLC-routes, tact time 45 min
- Capacity 50 SLC/Tour
- Requested service level of 95%
- Mean utilization of 80%
DIMENSIONING OF TACTED IN-PLANT MILK-RUN SYSTEMS

Summary and outlook

• Increasing use of milk-run concepts
• Dimensioning based on experience
• Deviations only taken into account as a safety addition

• Solution approach explicitly considers deviations
• Higher planning reliability

• 2 research projects at our institute concerning milk-run systems

Drive-Thru-Loading concept