Latest Automated Storage & Retrieval System (AS/RS) Technology – Two Cranes, One Aisle

Sponsored by:
DAIFUKU WEBB

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Two Cranes / One Aisle

Dual Mini Load AS/RS

Dual Mini Load
Topics Covered

Mini Load – What is the Load?
Typical Mini Load Automation
  – Crane in Aisle
  – Shuttle
  – Dual
Dual Mini Load
Sequencing
Kitting
Summary
Cartons

Can store end down aisle

Can even work with good cartons

Can store side down aisle
Loads

Totes

Corrugated Plastic Tote

ESD Plastic Tote

Corrugated Carton used as Tote
Crane in Aisle Mini Load

Storage Retrieval Machine (SRM)

Single Aisle ASRS
Crane in Aisle
Mini Load

Mini-Load AS/RS

- **Load weight capacity:** 220 lbs.
- **Machine height:** 33 ft.
- **Horizontal speed:** 650 ft./min.
- **Vertical speed:** 260 / 330 ft./min. Full / MT
- **2 extractors per machine**
- **Side belt extractors**

Proven Technology
1000s of installations
Shuttle Type Mini Load
Shuttle Type Mini Load

- P&D Conveyor
- Tote
- Lift Conveyor
- Shuttle
Shuttle Type Mini Load
Rate vs. Storage

<table>
<thead>
<tr>
<th>Locations</th>
<th>Totes per Hour</th>
</tr>
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<tbody>
<tr>
<td>Manual</td>
<td>Manual</td>
</tr>
<tr>
<td>Carousels</td>
<td>Carousels</td>
</tr>
<tr>
<td>Dual Mini Load</td>
<td>Dual Mini Load</td>
</tr>
<tr>
<td>Crane-In-Aisle Mini Load &amp; Shuttle</td>
<td>Crane-In-Aisle Mini Load &amp; Shuttle</td>
</tr>
</tbody>
</table>
Dual Mini Load
What’s different about Dual Mini Loads
Typical Dual Mini Load

Level 1

Level 2

Upper Guide Rail

Post & Beam Rack

Travel Rail

SR Machine
Specifications

- **300 m/min**  Horizontal speed
- **3.5 m/s²**  Horizontal acceleration
- **80 m/min**  Vertical speed
- **3.5 m/s²**  Vertical acceleration
- **2 s**  Average transfer time
- **30 kg 66 lbs**  Maximum load weight
## Heritage of High Speed Mini load

<table>
<thead>
<tr>
<th>Year</th>
<th>Concept</th>
<th>Throughput</th>
<th>Acceleration</th>
<th>Travel Speed</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>High Speed</td>
<td>220C/H</td>
<td>0.1G</td>
<td>200m/min</td>
<td>Single Motor Drive</td>
</tr>
<tr>
<td>2002</td>
<td>High Acceleration</td>
<td>330C/H</td>
<td>0.3G</td>
<td>200m/min</td>
<td>Twin Motor Drive</td>
</tr>
<tr>
<td>2004</td>
<td>Fastest ML In the world</td>
<td>500C/H</td>
<td>0.5G</td>
<td>500m/min</td>
<td>Synchronous Motor control 2 wheels &amp; 4 motors High Traction Drive Anti Mast Sway</td>
</tr>
<tr>
<td>2006</td>
<td>Responsive System</td>
<td>800C/H</td>
<td>0.6G</td>
<td>400m/min</td>
<td>Lightweight (CFRP Mast) 2 SRM per Aisle Single CPU-Off-Board Ctrl</td>
</tr>
<tr>
<td>2008</td>
<td>High System Throughput</td>
<td>2200C/H</td>
<td>0.4G</td>
<td>350m/min</td>
<td>Multi Layer - Double Decker 2 SRM per Aisle &amp; By-Pass Ctrl Offset Frame</td>
</tr>
</tbody>
</table>

Throughput above is based on best case scenario  
Base Condition : Travel Stroke 20m, Clear Height 6m
Features of Dual Mini Load

High Throughput
- Two cranes work in the same aisle
- Cranes pass each other without interference

Non-Stop System (Redundancy)
- When one crane stops
- Second crane continues working
- Accessing all locations

Ecology System
- Lightweight design saves electricity
- Regenerative braking creates electrical power that is sent to the other crane through a regenerative converter
- One SRMs is inactive during low utilization

High Maintainability
- One crane can be in maintained while the other is working
- Maintenance can be systematically implemented by controlling the numbers of active SRMs.
Synchronous Control

2 cranes works in one aisle moving past each other without interference

- I can access any carton in both left and right shelves across entire aisle.

- I can by-pass crane #2 to go to the station because #2 is still in transfer process.

Crane #1 working zone

Crane #2 working zone
Simultaneous Transfer

Unloading and loading transfer at the conveyor

Non-stop Transfer
No idle time
2 SRM do unloading and loading at the same time!

*1: Not applicable to fork extractor alone.

Patent pending
Crane 1 works, with load error on crane 2

e.g. load size error

- Carton accessible by crane #1
- Carton not accessible by crane #1
Non-Stop System

- One crane encounters a bad case
- Other crane can by-pass and continues to operate
High Maintainability

System remains in operation while maintenance is performed on one SRM. Maintenance can be systematically implemented by controlling the numbers of operations of individual SRM.

I keep working alone until my partner is back from maintenance.
Non-Stop System

- One crane can be maintained
- While other crane continues to operate
Ecology System

Example 600 cases/hr

Conventional Miniload
- Model R-P1
- x 3 aisle 3SRM
- Without regenerative converter

15.4 [kWh]

Model Dual Mini Load
- x 1 aisle 2SRM
- With regenerative converter

Weight Savings 30%
Regen Savings 38%
Accel adder 20%

Energy Saving 48%

8.1 [kWh]

Horizontal: 200m/min 0.1G
Vertical: 40m/min 0.15G

Horizontal: 350m/min 0.4G
Vertical: 40m/min 0.3G

Horizontal: 200m/min 0.1G
Vertical: 40m/min 0.15G
Collision Proof Technology

Single CPU controls two cranes.

High Speed Motion Control

Off-Board Controller

Motion Controller

C-Language Controller

Dual Feed Back Control

Laser distance sensor

Motor axis encoder [PLG]

Accurate position control

Off-Board Controller

Speed Command

Position Feedback

Ethernet

SRM-1

On-Board

Carriage

Lower Frame

Extractor

Vertical

Horizontal

SRM-2

On-Board

Carriage

Lower Frame

Extractor

Horizontal

Vertical

Laser Scale

On-board

Accurate position control
Verification of Collision Proof

Simulation Test
- 10 years of duty cycles on software.
- Simulation software incorporating all logic proved no collision or deadlock.

Real Machine Test
- 700,000 cycles tested by prototype
- Installed 3 test sites
- Many cranes installed
- Over 100,000,000 cycles, no collisions
Benefits

- Speed
- Rack Side Delivery
- Multiple Level Output for Sorting
- Flexibility in Load Size
- Simultaneous Transfer
- Reliable
- Save
- Proven Technology
Case Study
Order Sequencing
Order Sequencing System
3D Sorter for Shipping

Dual Mini Load changes the conventional “Sorter + Chute buffering” solution to new “3D Buffering & Sorting” solution, allowing your shipment to be prepared in exact sequence in a shorter period in less space.

horizontal space is cut by 50%
Distributed Sequencing
Case Study
Rack Side Picking
Overall System
ML feeds Dual Mini Load
Plan of Dual Mini Load
Rack Side Picking
Work Flow
Dual Mini Load
Summary

- Dual Mini Load is a NEW Application
- AS/RS as “Vertical Sorter”
- Not a New Technology
- Dual Mini Load was developed based on Field Proven AS/RS Components
- High Speed Evolution
  - Intensively pursuing High Speed, High Throughput SR Machines since 2000
  - Dual Mini Load Speed Evolution is Field Proven
- Added features
  - Ecology, Redundancy, and Maintainability
- Dual Mini Load is one part of Automated Storage
  - Can be combined in system depending on application
- Collision Proof Software is proven with over 100,000,000 cycles
- Dual Mini Load was developed aiming at high speed sequencing and picking systems
For More Information:

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