Intermodal Freight Transportation and Railroads
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Definition

- Intermodal shipment: a freight shipment that moves between origin and destination using two or more modes of transportation

- Types of intermodalism:
  - unitized
  - bulk

- Growth of unitized intermodal shipments has been a spectacular trend in transportation
Intermodal Operations

● Service marketed by railroad, motor carrier, steamship line, or third party

● Roles of modes
  - Motor carriers perform pick-up and delivery
  - Railroads perform land-side line-haul
  - Steamship lines perform intercontinental movement

● Terminal facilities provided by port, steamship line, railroad, customer, or third party
Types of Service

- Railroad intermodal transportation is typically described as either:
  - Trailer on flatcar (TOFC)
  - Container on flatcar (COFC)
- These categories no longer cover all types of service (e.g., RoadRailer)
- Current intermodal rail cars don’t necessarily resemble flatcars.
(Above) TOFC Train, Union Pacific RR, Austin TX

(Right) Double stack COFC, Norfolk Southern Ry, Greeneville, TN
Rail Intermodal Traffic Growth

• Railroads began offering TOFC service in the late 1950s
  - many small, non-mechanized terminals
  - service in general freight trains
• Trailer Train Corporation (now TTX) was formed to handle equipment pool
• COFC service paralleled the rise of marine containers
• Rise of global trade propelled COFC growth during 1980s
The economic recession has affected recent intermodal trends, in common with all freight movement.
Recent Traffic Trends

2006-2010 Yearly Traffic Totals
By Month

Millions


Source: IANA Intermodal Market Trends and Statistics
## Intermodal Truck/Rail Comparison

<table>
<thead>
<tr>
<th>Source: BNSF Railway</th>
<th>Truck</th>
<th>Intermodal Train</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit of Shipment</td>
<td>1 truckload</td>
<td>1 train (250 truckloads)</td>
</tr>
<tr>
<td>Labor (2000 mile trip)</td>
<td>1 person</td>
<td>26 people (1 train)</td>
</tr>
<tr>
<td>Frequency of Service</td>
<td>Daily / Hourly</td>
<td>Daily (if volume warrants) Often less than daily</td>
</tr>
<tr>
<td>Annual Volume Required for Daily Service</td>
<td>365</td>
<td>91,250</td>
</tr>
<tr>
<td>Transit</td>
<td>Mile/day: 500 Average MPH: 50 Operates: 10 hrs/day</td>
<td>Mile/day: 500 Average MPH: 21 Operates: 24 hrs/day</td>
</tr>
<tr>
<td>Route Infrastructure</td>
<td>Unlimited use of Federal and State road system</td>
<td>Use of privately owned rail network with limited use of alternate networks</td>
</tr>
<tr>
<td>Route Options</td>
<td>Virtually unlimited: many route options between origin and destination</td>
<td>Normally just one viable route between origin and destination</td>
</tr>
</tbody>
</table>
Relative Costs

DeBoer provided the following cost indices for a 1,000 mile haul:

- 89’ railcar with TOFC: 0.55
- 89’ railcar with COFC: 0.53
- Double stack railcar: 0.41
- RoadRailer: 0.57
- Truck: 1.00
Intermodal Containers

- Allow unitized movement of goods
- Domestic and international versions
- Configurations include box, tank, flatbed
- Stackable
- Dimensions
  - length
    - 20 ft, 40 ft, 45 ft for international use
    - 48 ft, 53 ft for domestic use
  - width = 96” international, 102” domestic
  - height = 4’, 8’, 8’-6”, 9-6”
40' x 9'6" Steel Dry Freight High Cube Refurbished

<table>
<thead>
<tr>
<th>Sea Box, Inc. Container Types</th>
<th>Length</th>
<th>Height</th>
<th>Width</th>
<th>Door Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exterior</td>
<td>Interior</td>
<td>Exterior</td>
<td>Interior</td>
</tr>
<tr>
<td>40' DRY FREIGHT</td>
<td>40'0&quot;</td>
<td>39'5 1/2&quot;</td>
<td>9'6&quot;</td>
<td>8'9 7/8&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sea Box, Inc. Container Types</th>
<th>Tare Weight in pounds</th>
<th>Payload in pounds</th>
<th>Gross Weight in pounds</th>
<th>Cubic Capacity in cubic feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>40' DRY FREIGHT</td>
<td>8,930</td>
<td>58,270</td>
<td>67,200</td>
<td>2,681</td>
</tr>
</tbody>
</table>

© Sea Box, Inc.
Chassis are normally used for movement of containers over the highway, although flatbed trailers can be used.
Intermodal Trailers

- Common lengths are 28 ft, 48 ft, 53 ft; width is 102 in max.
- 80,000 lb GVW with tractor
- Modified construction to withstand railroad service loads
  - reinforced doors
  - lift rails
- All configurations used; dry van and refrigerator most common
Trailer and Container Use Trends

- High volume of import/export trade drives container growth
- Domestic container traffic is small, but growing
- TOFC service focused on domestic market
- TOFC growth limited by
  - availability of compatible trailers
  - need for long-haul (>750 miles); 88% of truck traffic is less than 500 miles

Source: IANA
The Maxi-Stack IV car is the mainstay of the United States domestic double-stack car fleet because it provides the optimum balance between tare weight and capacity. It is a three-unit articulated double-stack car that can handle containers from 20' to 53' long in the well and containers from 40' to 57' in the top position. The Maxi-Stack IV utilizes 70-ton end trucks and 125-ton intermediate trucks. It has a capacity of 116,800 pounds per well.
53' All-Purpose Double-Stack Car

The 53’ All-Purpose (AP53) double-stack well car is a single unit designed to maximize flexibility. It can carry either containers or trailers. The AP53 has a 53’ well to accommodate containers from 20’ to 53’ long. It can handle containers from 40’ to 53’ long in the top position. The AP53 can also accommodate two 28’ pup trailers or one long trailer up to 57’ long. Each car is capable of carrying nose-mounted containers or trailer refrigeration units. The AP53 has 166,000 pounds of capacity per car to handle heavy loads. It can also be configured as a 3-unit drawbar car.
Mechanized Loading Technology

- **Gantry crane**
  - transfer only
  - rail or rubber tired
  - 25–50 ton lift capacity
  - span 32–76 ft
  - 5–8 container lift height

- **Straddle loader**
  - transfer/storage
  - rubber tired
  - 50 ton capacity
  - span 15–20 feet
  - turning radius 35 ft outside
  - 2–5 container lift height

- **Side loader**
  - transfer/storage
  - rubber tired
  - 22–45 ton lift capacity
  - turning radius 20 ft to 52 ft requires aisles 30 ft min to 75 ft ideal
  - 2–3 container lift height

- **Reach loader**
  - transfer/storage
  - rubber tired
  - 50 ton lift capacity
  - 5–8 container lift height
Marine Gantry Cranes
Rubber Tired Straddle Loader
Side Loader
Reach Loader

Image from Mi-Jack Products, Inc.
Lift Spreader Assembly
Carless Technologies

The RoadRailer® may be handled over the highway like any conventional semitrailer
Or coupled in trains of up to 125 units
1. Hostler trailer positions trailer.
2. Trailer air suspension lifts rear of trailer, tractor backs trailer onto rail bogie.
3. Trailer air suspension is vented. Steel coil springs lift tires clear of rail.
4. Tractor backs trailer to coupling with balance of train.
5. Tractor leaves leading trailer on landing gear. Air lines are connected and landing gear is raised on second trailer.
6. Rail locomotive backs CouplerMate® to trailer. Air lines are connected and landing gear is raised on all trailers.

Source: Wabash National Corporation
Intermodal Terminal Elements

• Provision for loading/unloading railcars
• Box storage (long term or temporary)
• Vehicle storage (railcars/trailers/chassis)
• Check-in/check-out control
• Vehicle and box servicing/repair
• Security and lighting
• Office and administration
• Information systems
• Vehicle scales
Roberts Bank, BC Marine Terminal

Area: 160 acres
Marine berths: 2 (2,198 ft)
Daily truck trips: 1,800
Other trips: 2,100
Annual TEU capacity: 900,000
Ground storage: 24,000 TEUs
7 Post Panamax gantry cranes

Image from GoogleEarth
Marion, AR Intermodal Terminal

Annual box capacity: 375,000
Ground storage: 2,600 boxes
Ramp track capacity: 326 cars
Storage track capacity: 748 cars
Length shown ≈ 2 mi
Parcel width ≈ 960 ft

Image from GoogleEarth

Union Pacific Mainline
Storage Tracks (8)
Ramp Tracks (4)
Access Road
Truck Gates 8 lanes
Factors in Terminal Location

- Access to railroad and highway system
- Area, configuration, and topography of site
- Cost to acquire site and provide infrastructure
- Adjacent land uses
- Proximity to customer base
- Ability to accommodate future growth
- Local support
Terminal Design

- **Low volume (<100,000 annual lifts)**
  - side loader operation
  - rail loading tracks of 500–1000 ft length
  - 110 feet separation between tracks
  - separate parking areas for road vehicles
  - one way highway traffic circulation

- **Medium volume (100,000-500,000 annual lifts)**
  - rail loading tracks 1,000–3,000 ft stubbed or flow-through
  - side loader or straddle loader operation

- **High volume (>500,000 annual lifts)**
  - rail unloading tracks 3,000 to 8,000 ft, flow through preferred
  - straddle loader or gantry operation

- **In all cases, a linear design is preferable**
Future Issues for Intermodalism

- **Improving the railroad system**
  - adding capacity to handle more business
  - matching truck service characteristics
  - increasing efficiency of intermodal equipment

- **Funding needed improvements**
  - private sector
  - public sector
  - public–private partnerships

- **Developing a short-haul intermodal system**
  - currently, intermodal is competitive for shipments >750 mi
  - 88% of truck trips are 500 mi or less
Intermodal Trains and Railway Infrastructure

- **Intermodal trains must be service competitive with trucks**
  - maximum speeds of 50–70 mph typical; such speeds
    - consume track capacity
    - require appropriate control system
    - require high train power/weight ratio
    - require higher track and alignment standards
  - schedule requirements provide operating challenge

- **Train lengths to 7,500 ft routine; may reach 10,000 ft if conditions permit**
  - adequate passing siding length needed on single track lines
  - multiple main track provides better capacity and operational flexibility, at higher cost
  - careful terminal design needed to avoid conflict with mainline operations

- **Double stack trains need adequate clearances (20’ 3” min)**
The Railroad Capacity Issue

1998 (Actual)

2018 (Forecast)

1998 Railroad Flows
- 0 to 1000000 GT
- 1000000 to 5000000 GT
- 5000000 to 10000000 GT
- 10000000 to 20000000 GT
- 20000000 to 30000000 GT
- 30000000 to 50000000 GT
- 50000000 to 100000000 GT
- > 100000000 GT

2018 Railroad Flows
- 0 to 1000000 GT
- 1000000 to 5000000 GT
- 5000000 to 10000000 GT
- 10000000 to 20000000 GT
- 20000000 to 30000000 GT
- 30000000 to 50000000 GT
- 50000000 to 100000000 GT
- > 100000000 GT

Miles
Intermodal Corridors
RAIL – SAFER, FASTER, CHEAPER, CLEANER

• Rail and spot highway infrastructure upgrades
• Traffic management and enforcement options for quick-fix safety improvements

At a Glance

I-81 Existing Highway: 4 lanes

I-81 At Trouble Spots: 6 lanes

Higher-speed Intermodal Rails
Roughly Near I-81

Higher-Speed 2-Way Intermodal Rails
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