



Application of OR/MS At Schneider National

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Intermodal Dray Operations

Schneider Intermodal Services

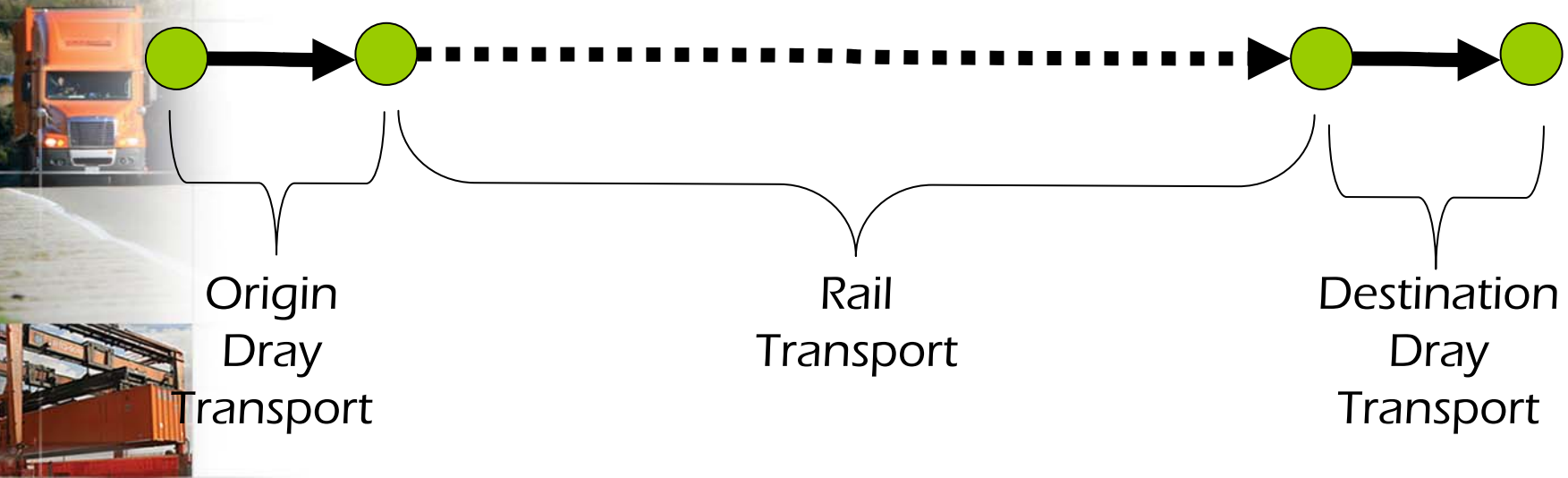
- Truckrail
 - COFC
 - 53' container allows for pinwheeling 25 pallets (10-15% more capacity than competitors)
- Truckrail Express
 - TOFC
 - 53' Schneider trailers
- Mexico Express
 - Priority access of up to 120 loads per day between U.S. and Mexico
- Dedicated Rail
 - Service between Marion, OH and Kansas City, MO
 - By avoiding Chicago, saves full day in transit time



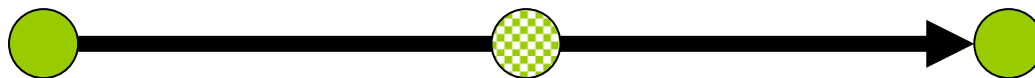
As The Name Implies, Truck/Rail Intermodal Transportation Utilizes A Combination Of Truck And Rail To Transport Freight.

Shipper Ramp

Ramp Consignee



Drays To Be Executed Can Be From Shipper To Ramp Or From Ramp To Consignee.



Shipper

- Time Window
 - Ready
 - Appointment
 - Open Hours
- Duration
- Live or Not

Stop-off (Optional)

- Time Window
 - Appointment
 - Open Hours
- Duration
- Live Load

Ramp

- Time Window
 - Cutoff
 - Open Hours
- Duration
- Drop Load

OR



Ramp

- Time Window
 - Available
 - Open Hours
- Duration
- Preloaded

Stop-off (Optional)

- Time Window
 - Appointment
 - Open Hours
- Duration
- Live Unload

Consignee

- Time Window
 - Appointment
 - Open Hours
- Duration
- Drop or Not



Available Capacity Can Include Schneider's Own Drivers As Well As Third Party Carriers.

Drivers

- Start At Park Location At Specified Time Without Trailer
- End At Park Location With or Without Trailer
- Routes Must Satisfy Department Of Transportation Hours Of Service Rules
 - Drive Time 11 Hours Or Less
 - Work Time 14 Hours Or Less



OR

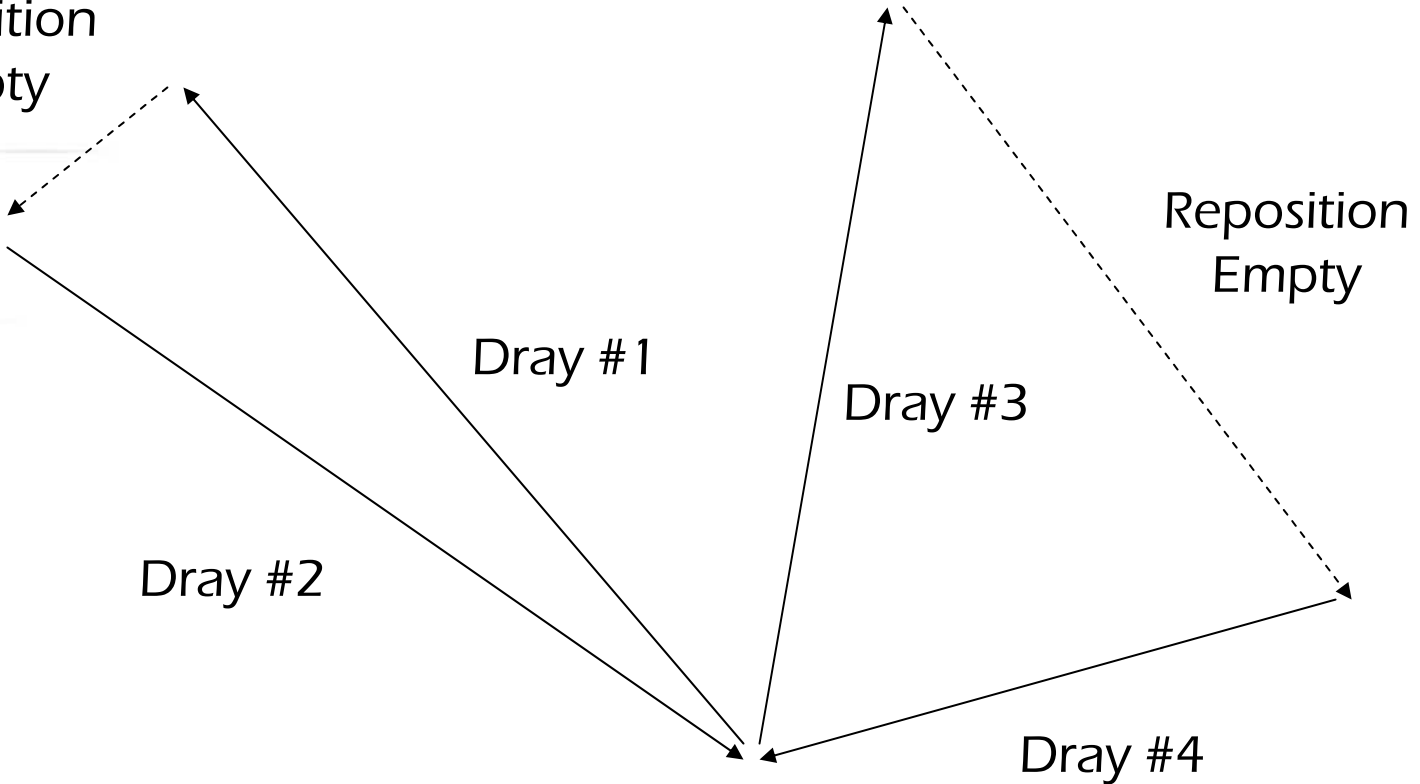
Third Party Carriers

- Routes Must Satisfy Hours Of Service Rules



Sample Route For Driver Or Carrier

Reposition
Empty



Route Covers Drays 1, 2, 3 And 4

Daily Dray Dispatch Planning Problem

- Cover drays
- At minimum cost
- With available capacity
- Respecting business rules

- Ileri, Bazaraa, Gifford, Nemhauser, Sokol, Wikum (Georgia Tech and Schneider), CEJOR
 - presents set-partitioning formulation
 - columns represent routes
 - solved using column generation



Example: Dallas

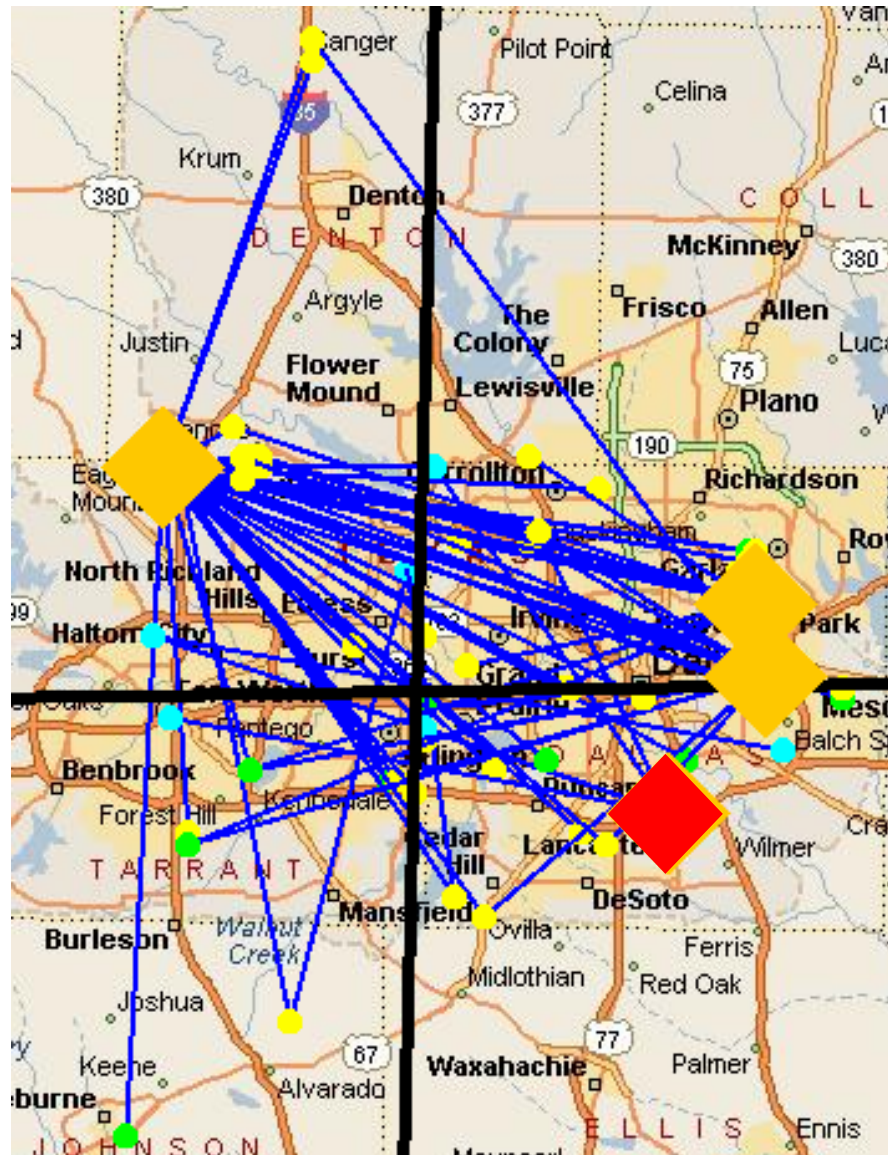
Haslet (BNSF)

(KCS)

Mesquite (UP)

Operating Center

Ramp to DL
PU to Ramp



How To Model?

- What Are Decisions To Be Made?
- How To Handle Time Windows?
- How To Handle Order Of Drays In Route For A Driver Or Carrier?
- How To Construct Constraints So As To Comply With Hours Of Service Rules?
- How To Model Per Hour And Tariff-Based Costs?

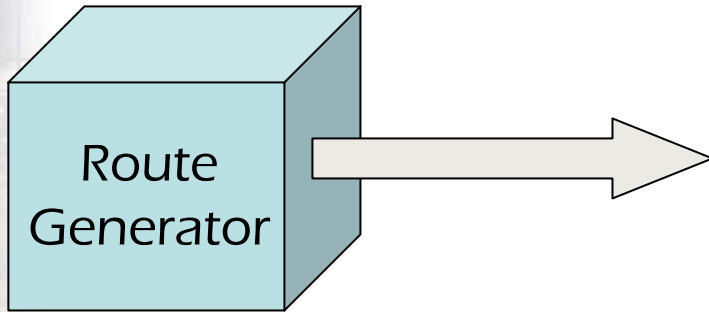


Observation

- Time Windows, Precedence Constraints, Hours Of Service Rules, And Costs Do Not Lend Themselves Well To Mathematical Programming
 - Awkward
 - Large Number Of Constraints
 - (Nearly) Impossible



Approach



- Handles Complexity
 - Feasibility Checking
 - Costing
- Provides For Each Route
 - Cost
 - Drays Covered
- Generate All Or Only Some

Minimize $[c_1 \quad c_2 \quad c_3 \quad \dots]$ Cost for each route

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \dots \end{bmatrix}$$

Subject To Drays covered by route

$$\begin{pmatrix} 1 & 0 & 1 & \dots \\ 0 & 1 & 1 & \dots \\ 0 & 1 & 0 & \dots \\ \dots & \dots & \dots & \dots \end{pmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \dots \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \\ \dots \end{bmatrix}$$

$$x_j \in \{0,1\}$$

- Hides Complexity
- Binary Integer Program