# Bridging the gap between theory and practice

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# Facts & Figures

## Wide Scope

| | |
|---|---|
| **FOUNDATION** | 2003 |
| **NUMBER OF EMPLOYEES** | 50 |
| **HQ LOCATION** | Lisbon, Portugal |
| **DISTRIBUTOR LOCATIONS** | Australia, Turkey, Singapore, UK, France, Cyprus, China, India |
| **FOUNDING PARTNERS** | Filipe Carvalho and Ana Sofia Pereira |

# Products

## Meet Routyn

*Routyn* is a vehicle routing system that automatically plans a fleet's routes, sequencing visits to locations while saving fuel consumptions and driving costs.

What has been distinguishing *Routyn* from other similar products is its ability to solve tactical, operational and respond planning optimization problems with its unique advanced algorithms.

# WE ARE SPECIALIZED IN REDUCING TRANSPORTATION AND LOGISTICS COSTS

# Customers

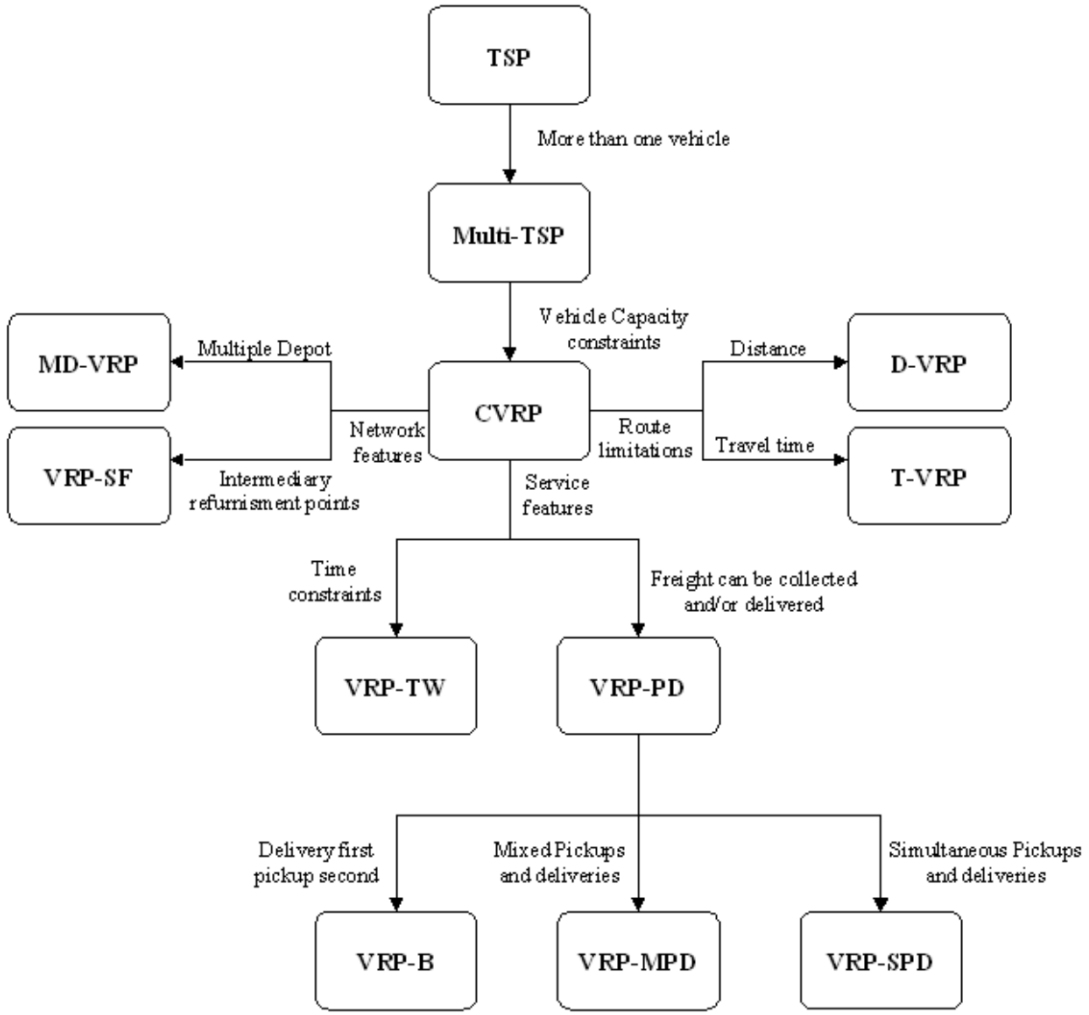
## Routyn implementations


## Quick Facts

- There's a 70% chance you get your food from a supermarket in Portugal replenished by trucks following routes designed by Routyn.
- And if you go to a restaurant, hotel or caffé, it goes up to 95%.

# Theory

## Vehicle Routing Problems






Models and Methods for the City Logistics: The Two-Echelon Capacitated Vehicle Routing Problem - Jesus Gonzalez-Feliu

# Capacitated vehicle routing problem with time windows

- 2D Matrix of travel times $t_{i,j}$
- Customers have one time window $[e_i, l_i]$
- Vehicles have a known capacity $Q_k$

The decision variables are specified as follows:

$$x_{ijk} = \begin{cases} 1, & \text{if arc } (i,j) \text{ is used by vehicle } k \\ 0, & \text{otherwise} \end{cases}$$

$$w_{ik} = \begin{cases} \text{service start time, if customer } i \text{ appears in the route of vehicle } k \\ 0, \quad \text{otherwise} \end{cases}$$

(CVRPTW):

$$min \sum_{k \in K} \sum_{(i,j) \in A} c_{ij} x_{ijk} \tag{1}$$

Subject to:

$$\sum_{k \in K} \sum_{j \in \Delta^+(i)} x_{ijk} = 1 \quad \forall i \in V, \tag{2}$$

$$\sum_{j \in \Delta^+(0)} x_{0jk} = 1 \quad \forall k \in K, \tag{3}$$

$$\sum_{i \in \Delta^-(n+1)} x_{i,n+1,k} = 1 \quad \forall k \in K, \tag{4}$$

$$\sum_{i \in \Delta^-(j)} x_{ijk} - \sum_{i \in \Delta^+(k)} x_{jik} = 0 \quad \forall k \in K, j \in V \tag{5}$$

$$x_{ijk}(w_{ik} + s_i + t_{ij} - w_{jk}) \leq 0 \quad \forall k \in K, (i,j) \in A, \tag{6}$$

$$e_i \sum_{j \in \Delta^+(i)} x_{ijk} \leq w_{ik} \quad \forall k \in K, i \in V, \tag{7}$$

$$l_i \sum_{j \in \Delta^+(i)} x_{ijk} \geq w_{ik} \quad \forall k \in K, i \in V, \tag{8}$$

$$w_{0k} \geq E \quad \forall k \in K, \tag{9}$$

$$w_{n+1,k} \leq L \quad \forall k \in K, \tag{10}$$

$$\sum_{i \in V} q_i \sum_{j \in \Delta^+(i)} x_{ijk} \leq Q \quad \forall k \in K, \tag{11}$$

$$x_{ijk} \in \{0,1\} \quad \forall k \in K, (i,j) \in A. \tag{12}$$


Expectation
Reality

# Expectation

2D Matrix of travel times $t_{i,j}$ vary with

- Origin i
- Destination j


# REALITY

Travel times vary with

- Origin i
- Destination j
- Vehicle type
- Departing time of the day (15 mins slots)
- Day of week
- Holiday

# Expectation

Customers have one time window $[e_i, l_i]$

# REALITY

“Deliver up to 33 pallets between 07:00 and 09:00.”

“Antecipate up to 12 pallets on the previous day between 22:00 and 23:30, as long as it’s a small truck.”

“Deliver any remaining pallets between 14:00 and 18:00.”

# Expectation

- Vehicles have a known capacity $Q_k$

# REALITY

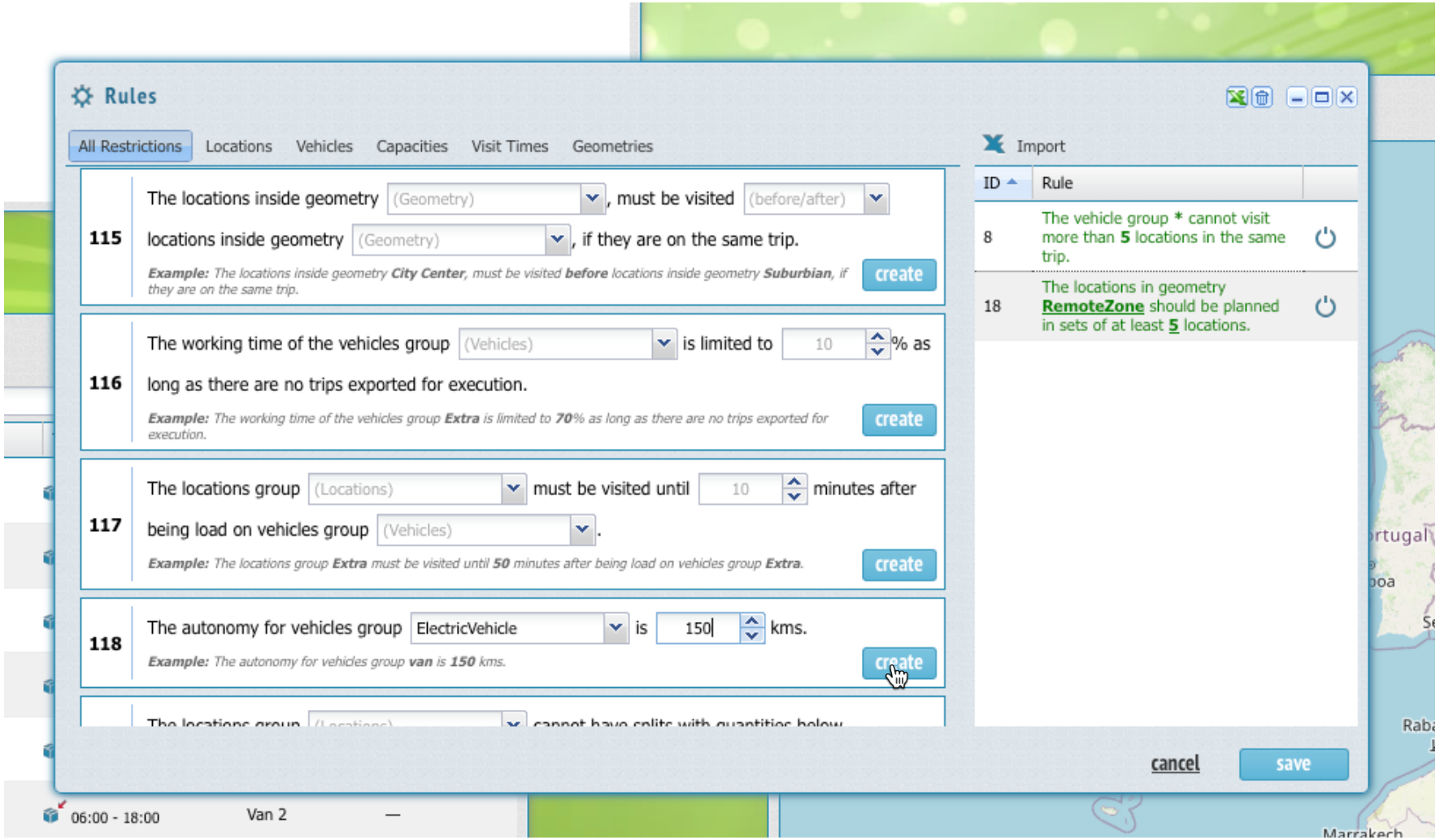


- Trucks support up to 3 different temperature chambers: Frozen, Chilled, Ambient
- Min volume per temperature: 6 pals
- Additions of 3 pals (1 row).

Example: A 33-pals truck cannot carry 1 Frozen + 28 Ambient

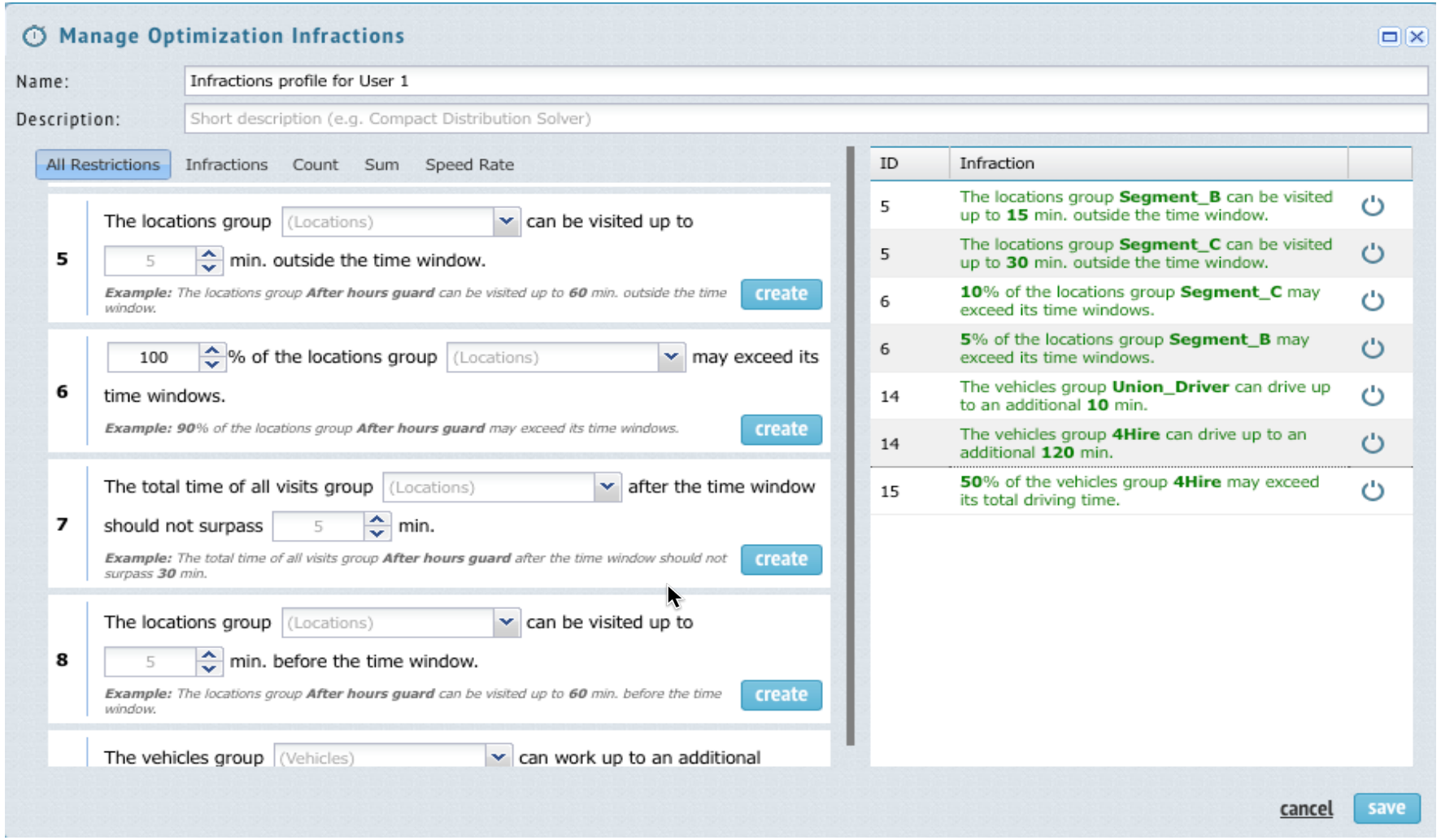
# Rules

## Building a logistics model



# Infractions

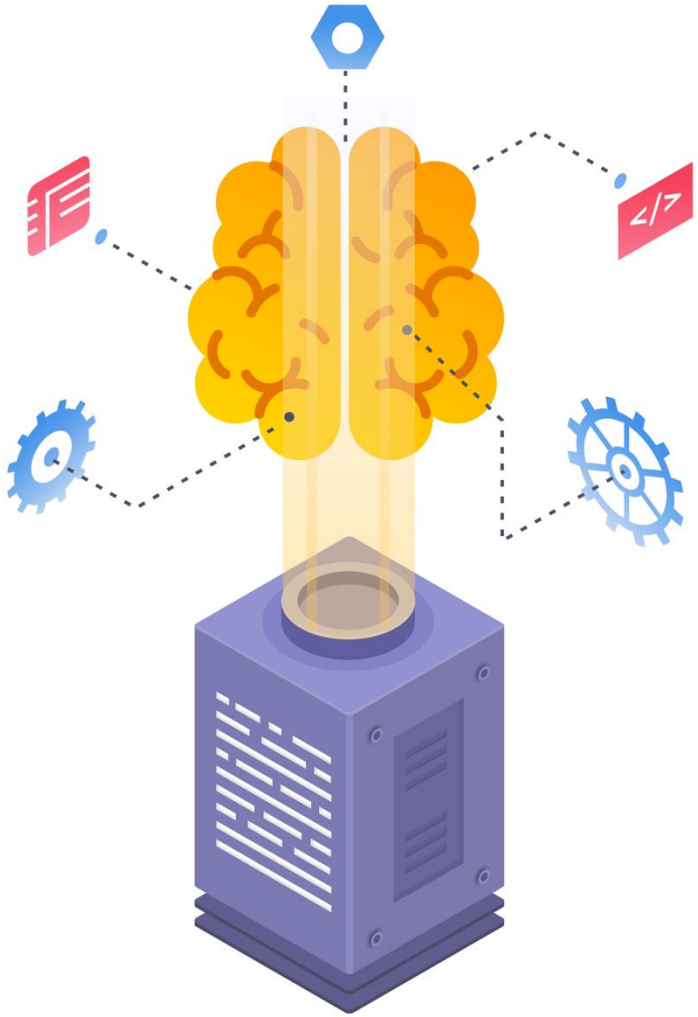
## Real-life touch of realism



# Algorithms

## Application examples

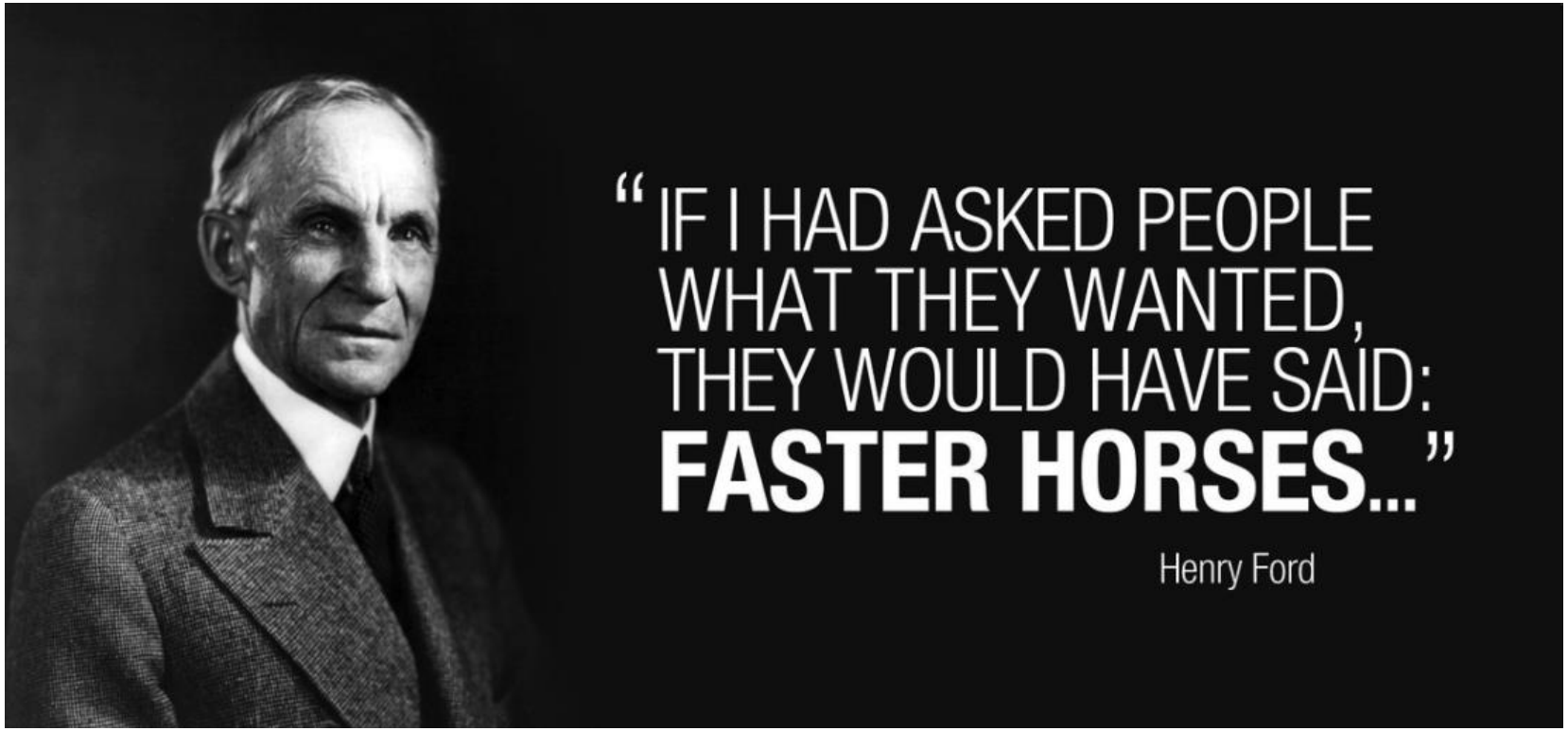
- Meta-heuristics
  - Domain-specific local search
- Mixed Integer Programming
  - Split and Merge
- Constraint programming
  - Dock Smoothing



# Keys to success

Modelling, implementation and adherence

- Data quality
- Change management



# Use case

ALDI testimony

# Electric vehicles

## Current work

- Limited number of filling stations in the warehouse for simultaneous loads
- The battery autonomy is not only measured in kms,  depends if the cold engine is used or not, if the lifting platform is necessary, if the road has ups and downs, etc.
- Charging batteries for second trips considering only the required energy
- And many more constraints…

# Thank you!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