Snider Tire Optimizes Its Customers-Stores-Plants Transportation Network

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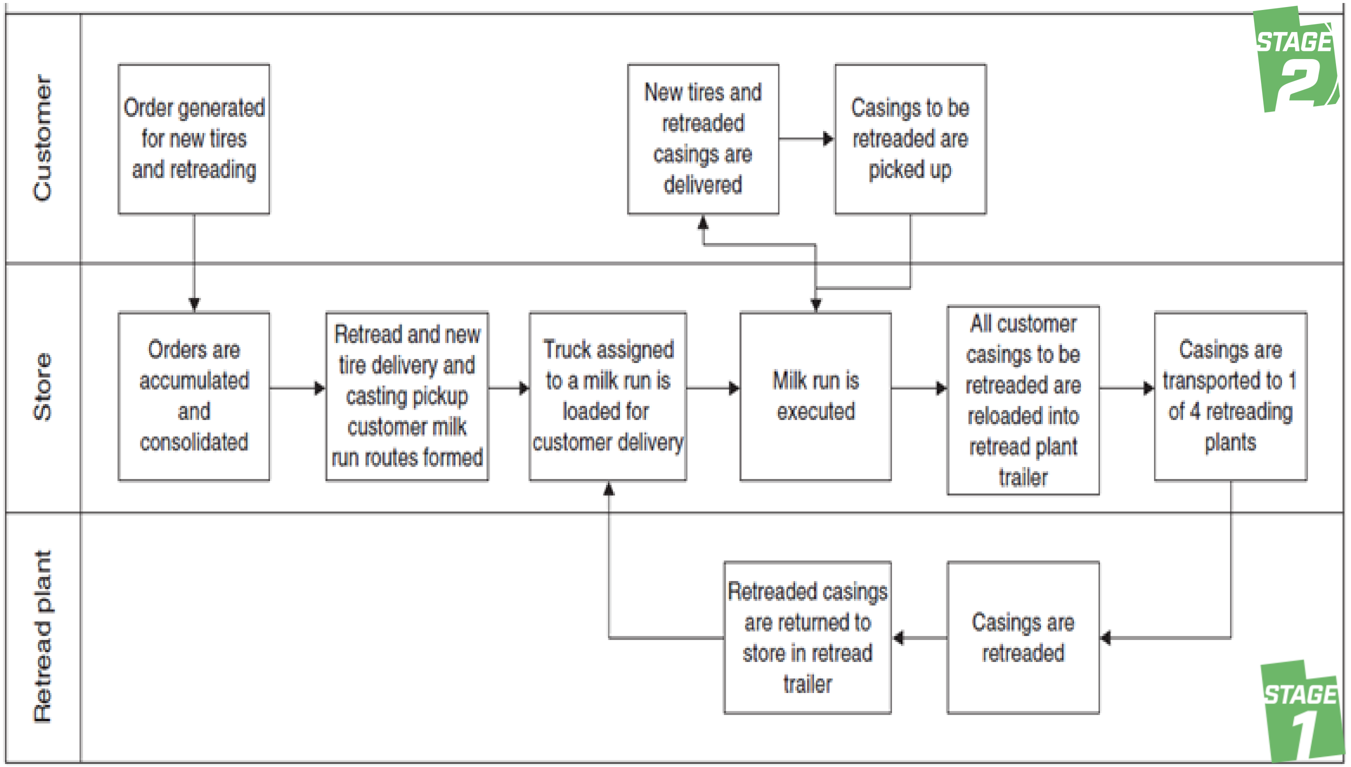
Introduction

- 1976 in Greensboro, North Carolina
- Variety of tire products to customers that use automobile, trucking, construction, and off-road vehicles
- By 2012, one of the largest commercial tire dealers and retreaders in the U.S
- In 2012, STI contacted with consultants to perform current-state analysis which includes
  - Identifying potential changes to transportation network
  - creating a standardized solution that could be transferred to other STI regions

Current Distribution Network

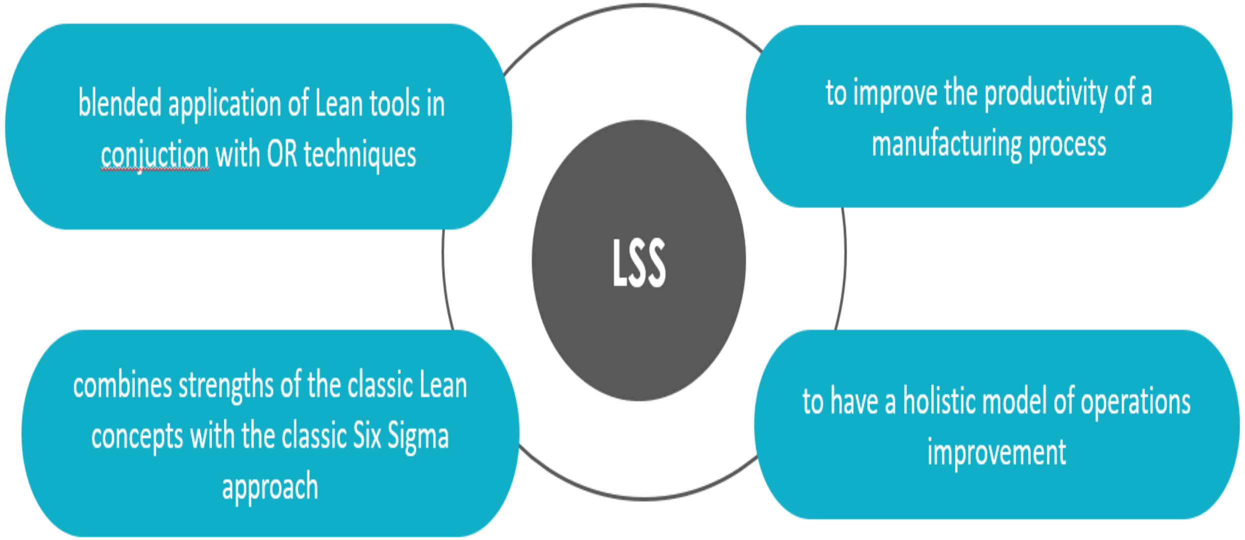


❗ Concerns about suboptimized transportation of tires, such as frequent crisscrossing of trucks and less-than-ideal utilization of its trucks.

- It shows the typical flow of a tire trough Snider's customer-store-plant network

The goal was to analyze the current network’s utilization of resources and recommend improvements that would generate savings of at least 10 percent in annual logistics costs through more effective logistics management.

To realize these benefits, Lean Six Sigma(LSS) approach was applied.



Project Scope

How efficiently the network utilizes the truck mix

How truck routes impact travel time and distance

Redesign STI's Southern and Eastern customer-store-plant network in two stages.

LSS (LEAN SIX SIGMA)

Logical and effective framework

Proactively manager engagement

$2M in annual cost savings

Reduced employee workload and increased employee morale

Superteam Organization

- Vice president of commercial operations, the director of purchasing, the manager of business development, the logistics and purchasing manager, and the director of manufacturing. Our consulting team included a Lean Six Sigma master black belt, a specialist professor in operations management, and six supply chain analysts. STI’s team, including supplier representatives, and the consulting team constituted the project’s 16-member superteam.

- Master Black Belts of companies work very closely to the top management, as leaders of the development and evolution of the organizations, and they learn, with a set of managerial, basic and project execution tools, how to ensure the sustainability of the philosophy as a way of life and work.

Project Goal

- Model and optimize the total production - distribution costs for the network (plants and stores)
- Reduce total transportation mileage between stores and end customers through reconfiguration of the customer routes

STAGE ONE

- Consist of improving the plant and store transportation network
- The goal of this stage is to minimize the total fixed and variable costs of transportation for the plants and transportation routes between plants and stores

STAGE TWO

- Consist of minimizing the total mileage traveled by milk-run trucks between customers and stores.
- The goal of this stage is to optimize the route times and maintaining customer service levels

*Milk run indicates a preplanned, round-trip routing in which several customers are visited to both pick up tire casings and deliver retreaded tires.

STAGE 1

STAGE ONE

Classic transhipment transportation-network model

Number of tires transported along each route

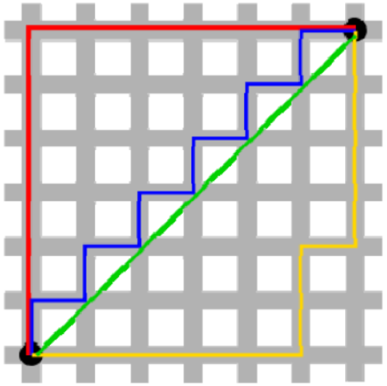
- Driving distances and driving times of each possible route is calculated by using google maps.
- Driver cost, fuel cost, truck utilization, plant capacity
- The current practice was within 99.5 per- cent of optimality . ($60,000 reduction)
- Stage 1 did not result with significant savings.

STAGE 2

- It focuses on reengineering the truck routes from customers to the stores using routing heuristics.
- The primary goal of this stage is minimization of the total distance (covering all customers with minimum number of drivers and routes) traveled by drivers between the stores and customers while optimizing the drive routes to a route length of either one operating day or two operating days, and meeting the customer service levels (in terms of order turnaround time) for customers based on their volume of demand.

Table 1. Reallocating Customers Across Stores and Optimizing Travel Routes Provide Substantial Savings in the Total Distances Traveled

	No. of customers allocated to each store			Total Euclidean distance for the network (miles)			Total rectilinear distance for the network (miles)		
	Current state	Future state	Change (%)	Current state	Future state	Change (%)	Current state	Future state	Change (%)
Store 1	122	64	−48	21,698	5,756	−73	28,135	7,495	−73
Store 2	19	61	221	1,088	5,315	389	1,377	6,871	399
Store 3	56	72	29	9,013	7,627	−15	12,118	8,636	−29
Total	197	197	—	31,799	18,698	−41	41,630	23,002	−45



Green line = Euclidean distance
Red, Blue, and Yellow lines = Rectilinear distance

- Based on a visual mapping of these stores and customers, a heuristic is used to allocate customers approximately equally to the three stores to create physically separate, nonoverlapping partitions ased on the geographical density ofcustomers served by.

➢ Resulted in a net 41 percent reduction in total Euclidian distance between the customers and their allocated store travelled across the network, and a 45 percent reduction in rectilinear distance.

- Once the partitions were derived, we conducted weekly milk run routing optimization analyses to iteratively derive routes consisting of customers visited by a truck on either a one-day drive time route or a two-day drive time route for meeting a week's demand for the customers served by the store.
- The superteam* defined a route as a specific path traversed by a milk-run truck, starting from the store and traversing selected customers in a specific sequence before returning to the store.
- Milk-run deliveries are a standard feature of just-in-time suppliers.

*Superteam: A team consists of STI professionals and consultants.

Optimization Problem in STI case

The mathematical optimization problem aimed at:

(1) identifying the span of feasible routes (that is, number of customers covered by a route) corresponding to each store.

(2) optimizing the sequencing along the identified set of customers on these routes.

➢ The second part became computationally intractable because of the large number of customers. Then a contemporary mapping software (Google Maps) is used in conjunction with the formulation of routing heuristics in addition to logical distance minimization and maximal material flow criteria to develop the optimal number of routes for each store.

Table 2. After Route Optimization is Accomplished Across All Three Stores, the Total Number of Miles Traveled Decreases by 41 Percent, Resulting in a Decrease of 24 Percent in Total Travel Time

	No. of routes			Total no. of miles traveled			Total route time (including travel and load-unload time) (hours)		
	Current state	Future state	Change (%)	Current state	Future state	Change (%)	Current state	Future state	Change (%)
Store 1	15	8	−47	10,216	2,364	−73	273	103	−62
Store 2	10	9	−10	1,088	2,787	389	81	113	40
Store 3	5	6	20	878	2,068	−15	38	83	118
Total	30	23	−23	12,182	7,219	−41	392	299	−24

- The goal of optimizing the milk runs for each store was to identify a minimum number of weekly driven routes that would cover all the customers' demands with as few trucks as possible. The revised routes were compared with current-state routes for each store in terms of number of routes (trucks) used to meet the demands and service levels for all customers of the store. For example, a current-state route with a total of 106 tires covers nine customers at a total of 264 miles. An improved route covers 12 customers with a total of 162 tires on the truck traveling a total of 216 miles. The new route clearly represents a great improvement over the current-state route. The new route is developed by using the nearest-neighbor heuristic.
- A representative analysis of current-state and future state routes for Store 1 shows that in the current state, 15 routes serve the customers allocated to Store 1. Of these, two are three-day routes, six are two-day routes, and seven are one-day routes, covering 10,216 miles in 273 hours (travel + load and unload times). The improved routings result in only eight routes; of these, only two are two-day routes and the remaining seven are one-day routes, covering 2,364 miles in 103 hours.

CONCLUSION

Save $2 million (16% reduction) in its annual transportation cost

Lss approach made project efforts efficient

Drivers morale has improved (human resource related benefit)

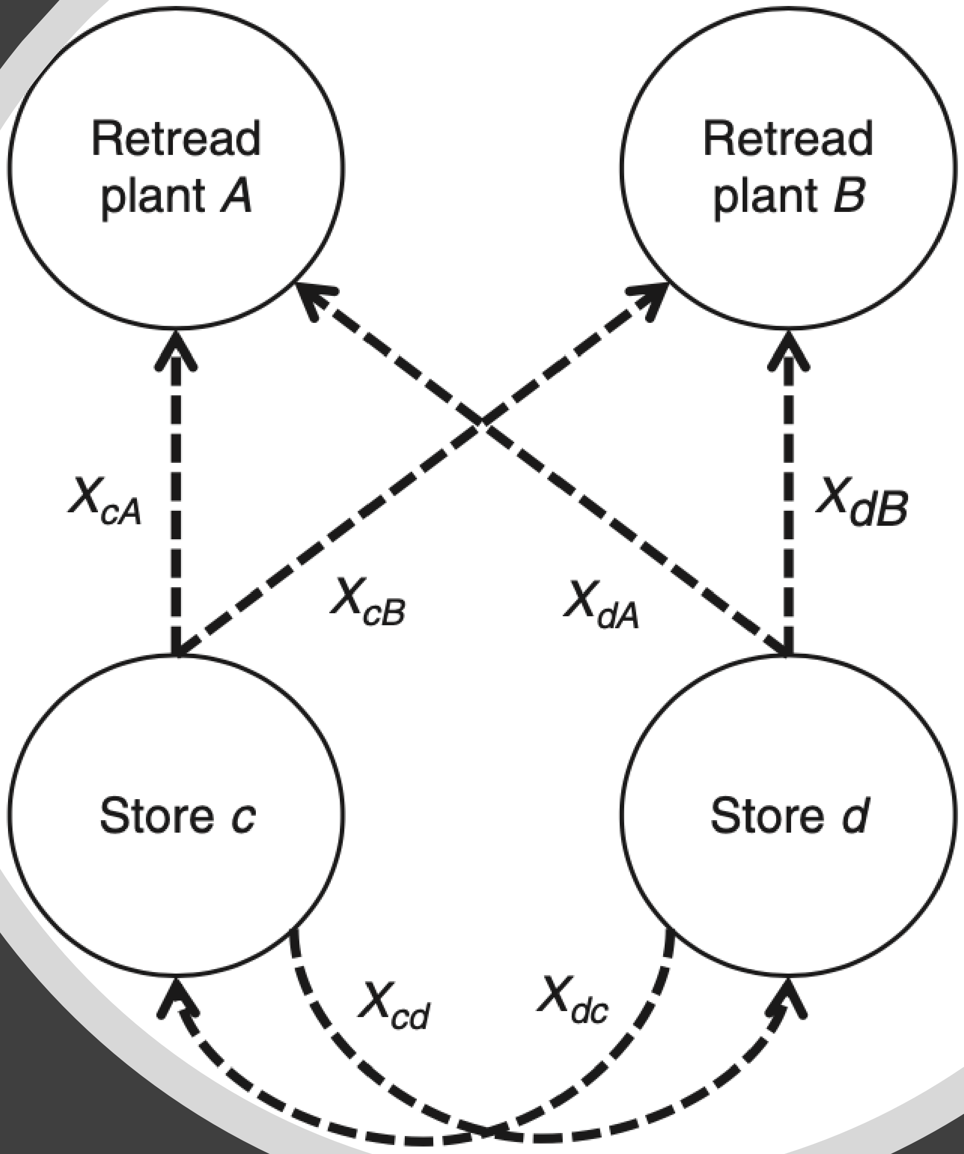
STI's mindset changed about how to manage transportation

SNIDER FLEET SOLUTIONS
Going The Distance

This LSS approach is an effective template for other small- medium scale firms

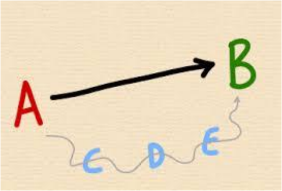
Truncated Example of the Linear Programming Transshipment Model

- **Dec. Variables X_{ij}** : the number of tires transported between locations *i* and *j*.
- **Parameters:**
- ***C_{cA}*:** (the one-way variable cost associated with transporting a tire from store *c* to plant *A*) + (the variable cost of retreading one tire at plant *A*);
- ***C_{cd}*:** the one-way variable cost associated with transporting a tire from store *c* to store *d*.
- **Obj:**
- Minimize $Z = C_{cA}.X_{cA} + C_{cB}.X_{cB} + C_{dA}.X_{dA} + C_{cB}.X_{cB} + C_{cd}.X_{cd} + C_{dc}.X_{dc}$
- **Constrains:**
- <u>Demand constraints</u>
$X_{cA} + X_{cB} + X_{cd} - X_{dc}$ = Demand for retreads at store *c*;
- $X_{dA} + X_{dB} + X_{dc} - X_{cd}$ = Demand for retreads at store *d*.
- <u>Minimum capacity constraints</u>
- $X_{cA} + X_{dA} \geq$ Minimum production at plant *A*;
- $X_{cB} + X_{dB} \geq$ Minimum production at plant *B*.
- <u>Maximum capacity constraints</u>
$X_{cA} + X_{dA} \leq$ Maximum production at plant *A*;
- $X_{cB} + X_{dB} \leq$ Maximum production at plant *B*.



The Nearest-Neighbor Heuristic Problem

The Nearest-Neighbor Heuristic



The Nearest-Neighbor Procedure

The procedure is as follows:

- [ ] 1. Choose one city as a starting (or depot) location.
- [ ] 2. Locate the city from all other cities which is cheapest, shortest, or quickest to link to the depot node.
- [ ] 3. From the cities not selected in steps 1 and 2, locate the city that is the cheapest, shortest, and (or) quickest to link to the city selected in step 2.
- [ ] 4. Repeat step 3 until all cities have been selected and linked.
- [ ] 5. Link the last city selected to the depot node to complete a tour.
- [ ] 6. Repeat steps 1–5 with each city in the collection serving as the depot node.

Advantages of the Nearest-Neighbor Procedure

- [ ] 1. Is easy to understand.
- [ ] 2.Is visual and there by easy to implement using mapping software.
- [ ] 3. Finds good ,but not necessarily optimal solutions.
- [ ] 4. Can solve large problems.

Disadvantages of the Nearest-Neighbor Procedure

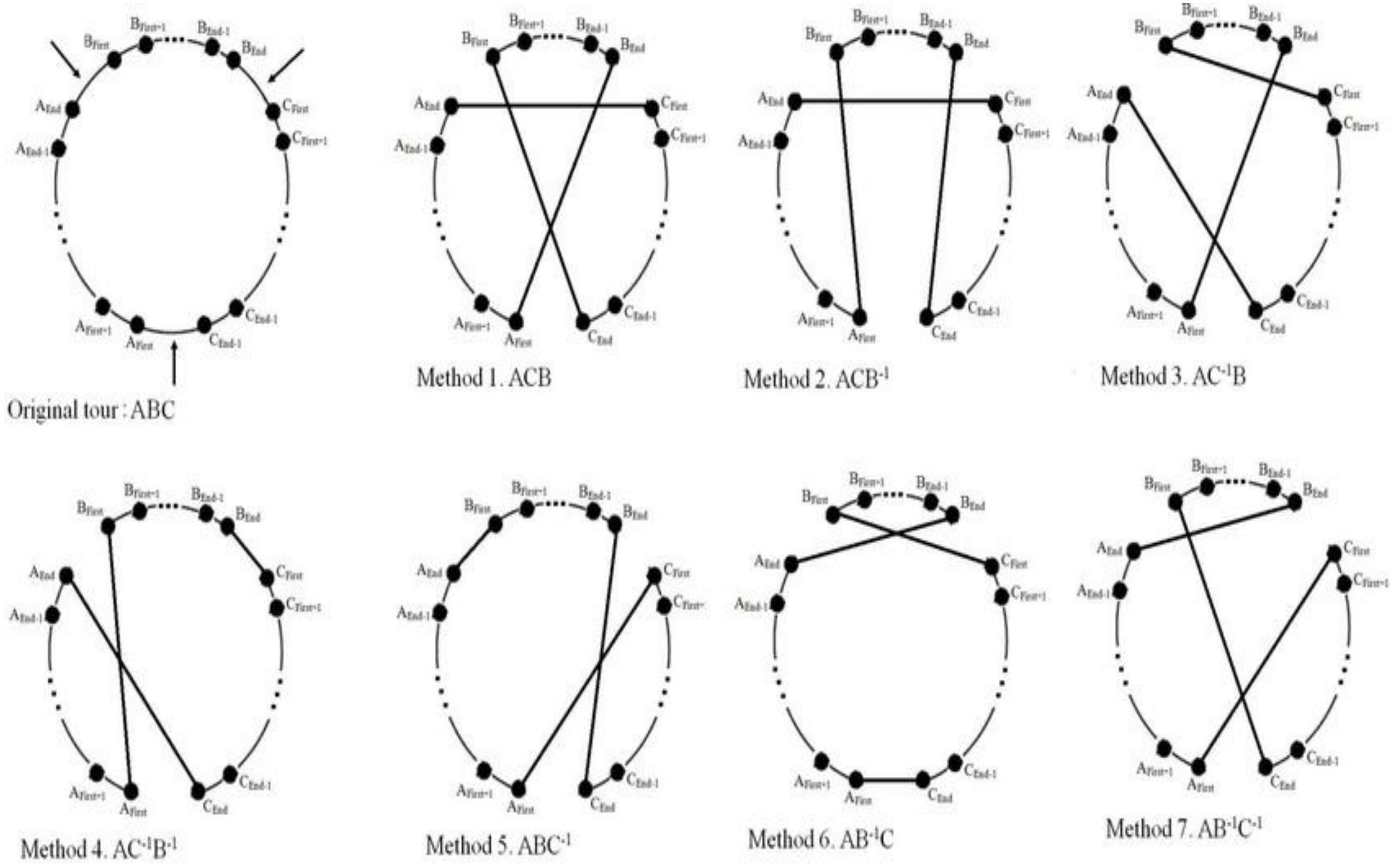
- [ ] 1. Cannot easily deal with nonsymmetric distances.
- [ ] 2. Requires a unique formulation for each problem.
- [ ] 3. Requires many trials per problem.

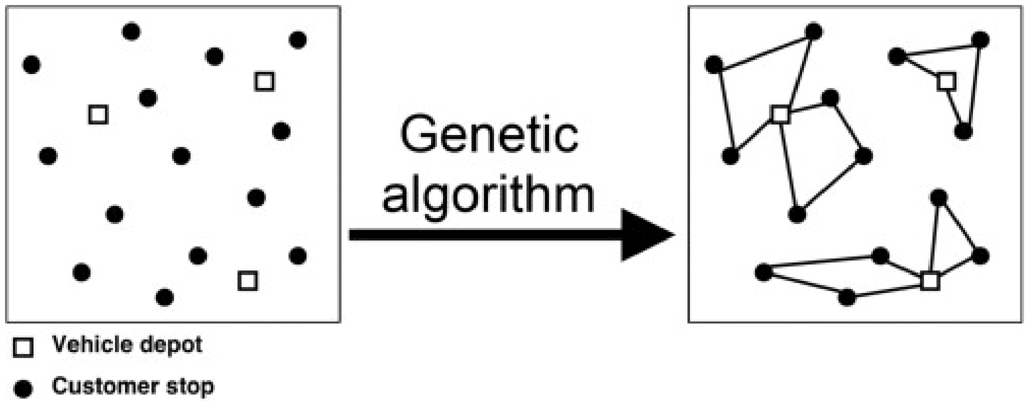
Constructive Heuristic
NN

Improvement Heuristic
N-opt

Bring you within 5% of the optimum.

Genetic Routing





Tactical Route Planning Decision Support System Design DHL Supply Chain

- Last year project.
- In project scope, using the operations research tools, a mathematical model has been developed, aimed at minimization. For the problem developed consists of three genetic algorithms that work together. And to determine the shipping method of orders in each algorithm clustering operations are carried out.

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THANK YOU