OPTIMIZATION IN RENAULT SUPPLY CHAIN AND MANUFACTURING

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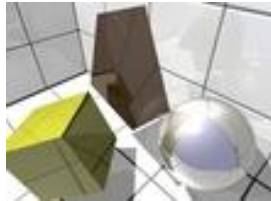
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Digital Transformation

Applied AI chapter
12 staff

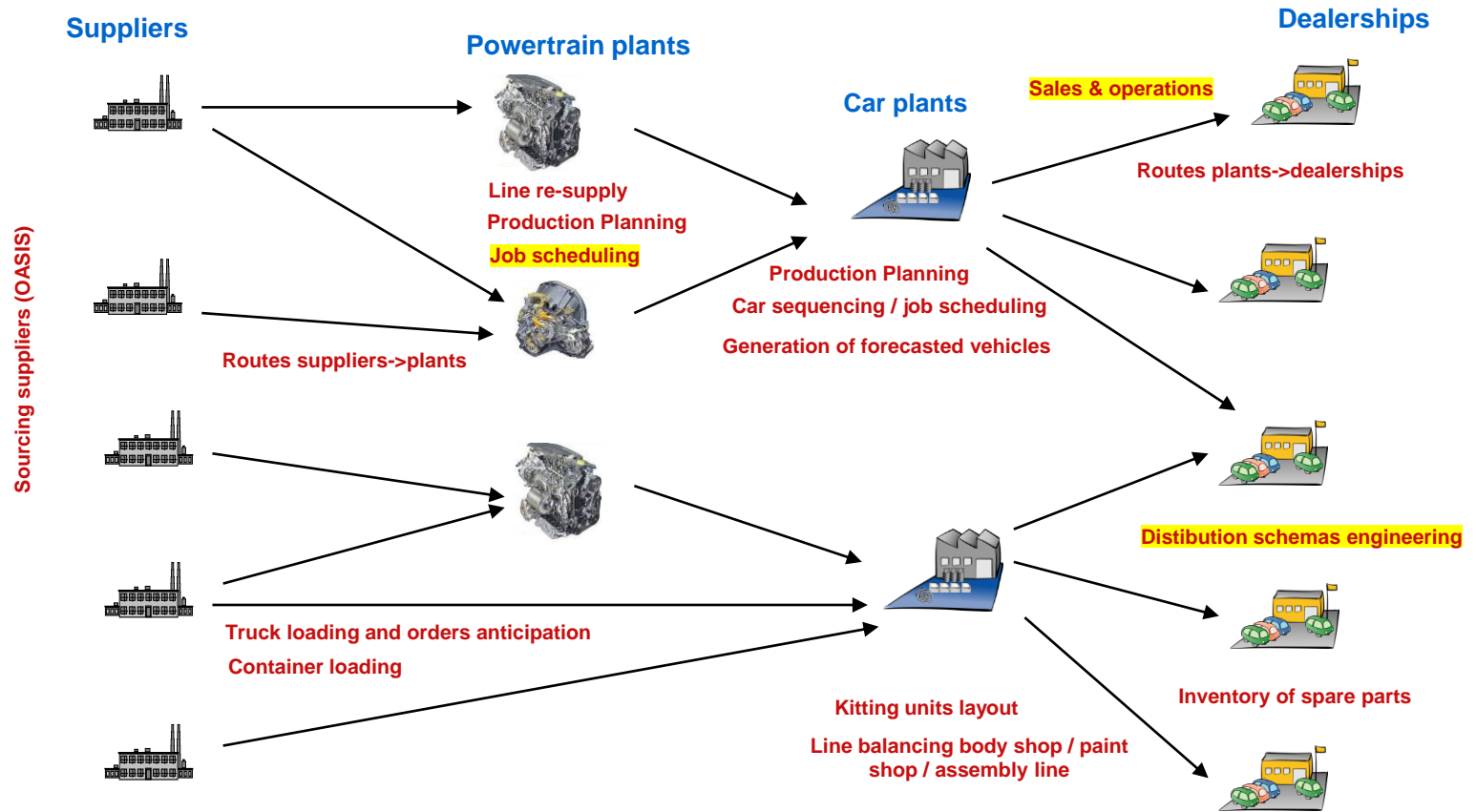**Product configuration Knowledge compilation**

Machine learning / Natural Language Processing

Operations Research (4 staff)

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OR applications in the supply chain

Suppliers

Powertrain plants

Car plants

Dealerships

Sales & operations

Sourcing suppliers (OASIS)

Line re-supply
Production Planning
Job scheduling

Routes suppliers->plants

Routes plants->dealerships

Production Planning
Car sequencing / job scheduling
Generation of forecasted vehicles

Truck loading and orders anticipation
Container loading

Distibution schemas engineering

Inventory of spare parts

Kitting units layout
Line balancing body shop / paint shop / assembly line

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Project vs serial life

Project

Serial life

Project | **engineering (strategic/tactical)** | **Day-to-day operations**

Routes suppliers->plants

Suppliers sourcing

Routes suppliers->plants

Line balancing (body shop, paint shop, assembly line)

Kitting layout

Distribution schemas engineering

Routes plants->dealerships

Inventory of spare parts

Empty packagings distribution

Line re-supply

Production planning

Car sequencing, Job scheduling

Trucks and containers loading

Sales & operations

Maintenance scheduling

EURO Special Interest Group on Cutting and Packing

And the winner is Olivier Briant & Denis Naddef (Grenoble-INP) !

Final rankings and results available. Congratulations to all the teams for their participation.

ESICUP is an EURO working group. It gathers practitioners, researchers and Operations Research educators with interests in the area of Cutting and Packing. The purpose of ESICUP is to improve communication among individuals working in this field. It organizes its first challenge with a subject proposed and sponsored by the automotive maker RENAULT and with the cooperation of the Operations Research team of the Bordeaux University. It is about container loading for logistics platforms. RENAULT is interested in algorithms for operational context (with short execution runtime of one hour for the whole set of instances) and also for simulation context (with longer execution runtime of 6 hours for the whole set of instances). Therefore 2 prizes (total of 14 000 euros) will be awarded for the 2 contexts.

A few examples of real-life loading configurations.

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Constraints for container loading

(C1) One or two possible orientations
(C2) Maximum total weight in the bin
(C3) Stacks non overlap
(C4) Stacks lie entirely into the bins
(C5) Each item is packed.
(C6) Maximum number of items that can be packed in the last bin.
(C7) Bin 0 is the one with the smallest volume
(C8) The height of a stack is the sum of the heights of its layer
(C9) Maximum total height.
(C10) Layers of almost equal dimensions in a stack.
(C11) The envelope of a stack is the envelop of the orthogonal projection of the layers it contains
(C12) Metal packages are packed together in stacks.
(C13) Maximum density for each stack.
(C14) The layers in a stack are sorted by decreasing weight.
(C15) Layers are composed of contiguous rows
(C16) Maximum number of rows in a layer.
(C17) Same sizes of rows in a layer.
(C18) All items in a layer have the same height.
(C19) Rows are justified in a layer
(C20) The dimension of a layer is the envelope of its rows.
(C21) Rows are composed of contiguous items
(C22) Maximum number of items in a row.
(C23) Same horizontal size of items in a row.
(C24) Items are justified in a row.
(C25) The dimension of a row is the envelope of its items.
(C26) Consecutive layers are contiguous in the vertical dimension
(C27) The top of a stack is the top of its highest layer
(C28) layers composed of metal packages can only contain one item
(C29) maximum weight on the base layer items

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Stacks building with CPLEX and 2D placement/bin packing with local search

The winners' algorithm re-written in java and rolled out at the French overseas crossdock

Winners : Denis Naddef – Olivier Briant (researchers from Grenoble)

3rd team : PhD students from Nagoya

3rd team : researchers from Valencia

2nd team : PhD students from Louvain

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Trucks loading

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Trucks loading and orders anticipation

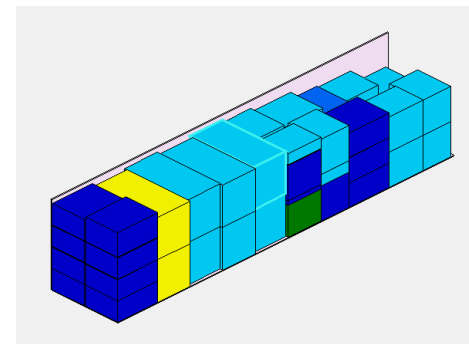**2D placement of items in the trucks with best fit heuristics**

Items to place

Lowest Gap

Rectangle placé
sur le bord droit
du Lowest Gap
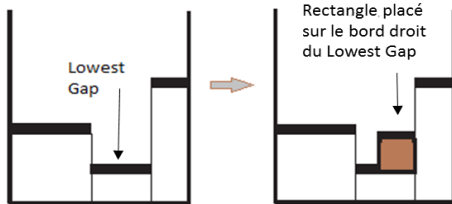
Build stacks and anticipate orders so as to maximize trucks filling rate
Construction heuristics + local search

D orders

D+1 orders

D+2 orders

Part A

Part B

Predefined trucks
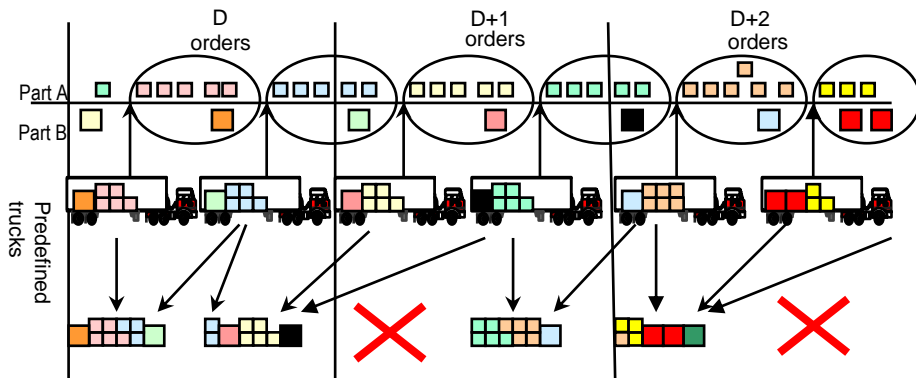
3000 trucks / week – 7 weeks horizon / GCP

Visualization of trucks

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Visualization of trucks loading plans
for suppliers and transporters : a major breakthrough !

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OR tools in car plants

Line balancing

Line balancing
Kitting layout
Production planning

Body shop

offline workstations

Paint shop

Assembly shop

car sequencing

Job scheduling
Line balancing
Workstations re-supply

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Line balancing in paint shop

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Operators' movements
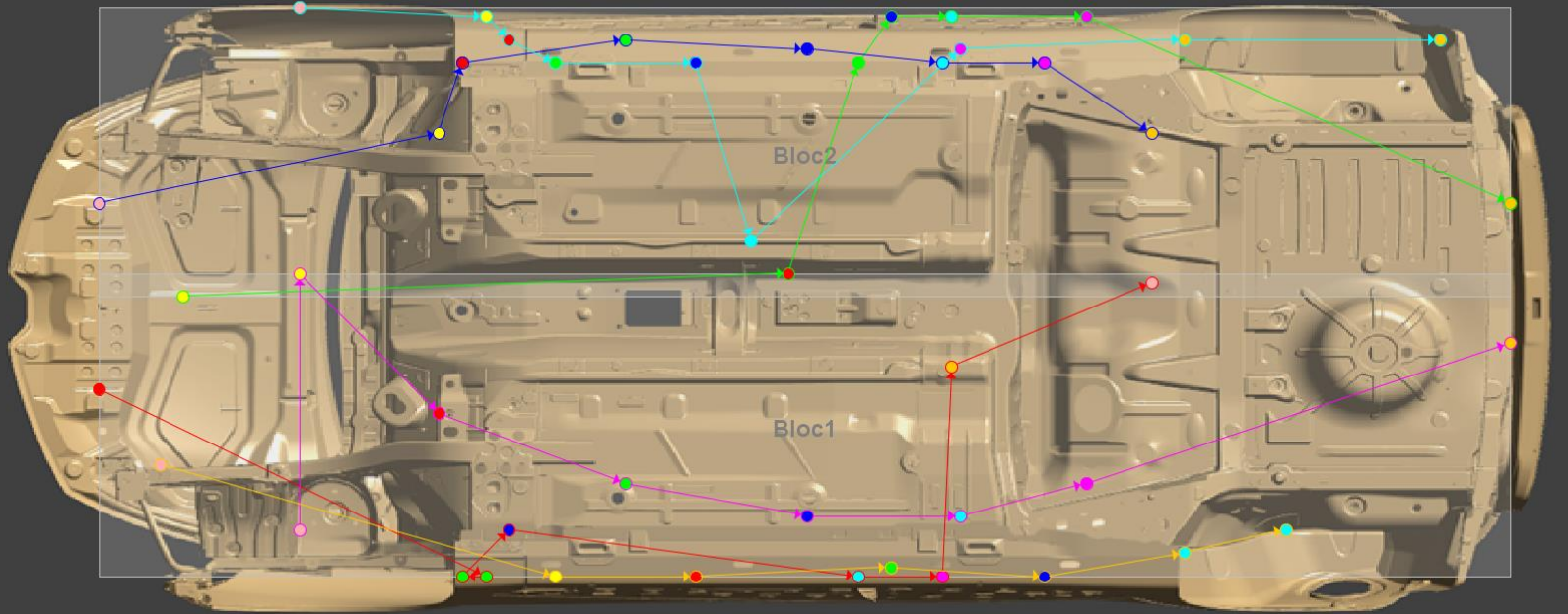
Opérateur	Couleur	Masquer
Operateur0		
Operateur1		
Operateur2		
Operateur3		
Operateur4		
Operateur5		

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Holes assignement to operators

	Operateur0	Operateur1	Operateur2	Operateur3	Operateur4	Operateur5
Temps total (cmin)	143,12	181,19	154,97	161,39	162,49	111,83
TEP FOS A (cmin)	35,00	29,50	36,50	40,50	36,00	29,50
MIO (cmin)	24,00	24,00	28,00	28,00	28,00	20,00
OA int blocs (cmin)	11,16	34,75	10,23	10,54	15,05	6,12
OA ext blocs (cmin)	65,63	82,15	70,89	73,19	73,55	51,21
nb blocs	1	1	1	1	1	1
nb buses	7	7	8	8	8	6
nb trous	8	7	8	9	8	7
table buses	(0.0,0.0)	(0.0,0.0)	(0.0,15.0)	(0.0,15.0)	(0.0,0.0)	(0.0,0.0)
Taux engagement	76,53	96,89	82,87	86,30	86,89	59,80
	Trou734 [Buse59 Bloc1]	Trou736 [Buse60 Bloc2]	Trou735 [Buse62 Bloc2]	Trou701 [Buse189 Bloc1]	Trou700 [Buse188 Bloc1]	Trou789 [Buse225 Bloc1]
	Trou710 [Buse136 Bloc1]	Trou748 [Buse101 Bloc2]	Trou707 [Buse30 Bloc2]	Trou711 [Buse83 Bloc2]	Trou747 [Buse102 Bloc1]	Trou318 [Buse178 Bloc1]
	Trou757 [Buse136 Bloc1]	Trou110 [Buse110 Bloc2]	Trou758 [Buse135 Bloc2]	Trou725 [Buse40 Bloc2]	Trou706 [Buse81 Bloc1]	Trou305 [Buse165 Bloc1]
	Trou724 [Buse35 Bloc1]	Trou122 [Buse85 Bloc2]	Trou729 [Buse41 Bloc2]	Trou319 [Buse179 Bloc2]	Trou728 [Buse36 Bloc1]	Trou121 [Buse84 Bloc1]
	Trou109 [Buse109 Bloc1]	Trou21 [Buse21 Bloc2]	Trou738 [Buse42 Bloc2]	Trou306 [Buse166 Bloc2]	Trou737 [Buse37 Bloc1]	Trou320 [Buse180 Bloc1]
	Trou323 [Buse183 Bloc1]	Trou79 [Buse79 Bloc2]	Trou324 [Buse184 Bloc2]	Trou58 [Buse58 Bloc2]	Trou739 [Buse39 Bloc1]	Trou732 [Buse100 Bloc1]
	Trou20 [Buse20 Bloc1]	Trou744 [Buse200 Bloc2]	Trou321 [Buse181 Bloc2]	Trou740 [Buse43 Bloc2]	Trou78 [Buse78 Bloc1]	Trou755 [Buse100 Bloc1]
	Trou22 [Buse22 Bloc1]		Trou24 [Buse24 Bloc2]	Trou733 [Buse170 Bloc2]	Trou743 [Buse201 Bloc1]	
				Trou756 [Buse170 Bloc2]		

Column generation method

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Line re-supply – plant of Motores

Bass moteur ligne 2 K9

Ligne 2 K9

Ligne 5 K9

Bass moteur ligne 5 K9

Ligne 6 Hxx

Kitting K9 (detail à la page suivante)

Kitting Hxx

TSP heuristics


```
2      3      4           5      6        7      8        9
3 HXI E02  3 HXI E03  3 HXI E04    3 HXI E05  3 HXI E06    3 HXI E07        3 HXI E09

           3 HXD E03  3 HXD E04    3 HXD E05                    3 HXI F08

                     3 HXD F05  3 HXD F06    3 HXD F07  3 HXD F08

3 KTH I01  3 KTH I02  3 KTH I03  3 KTH I04    3 KTH I05  3 KTH I06    3 KTH I07  3 KTH I08
```
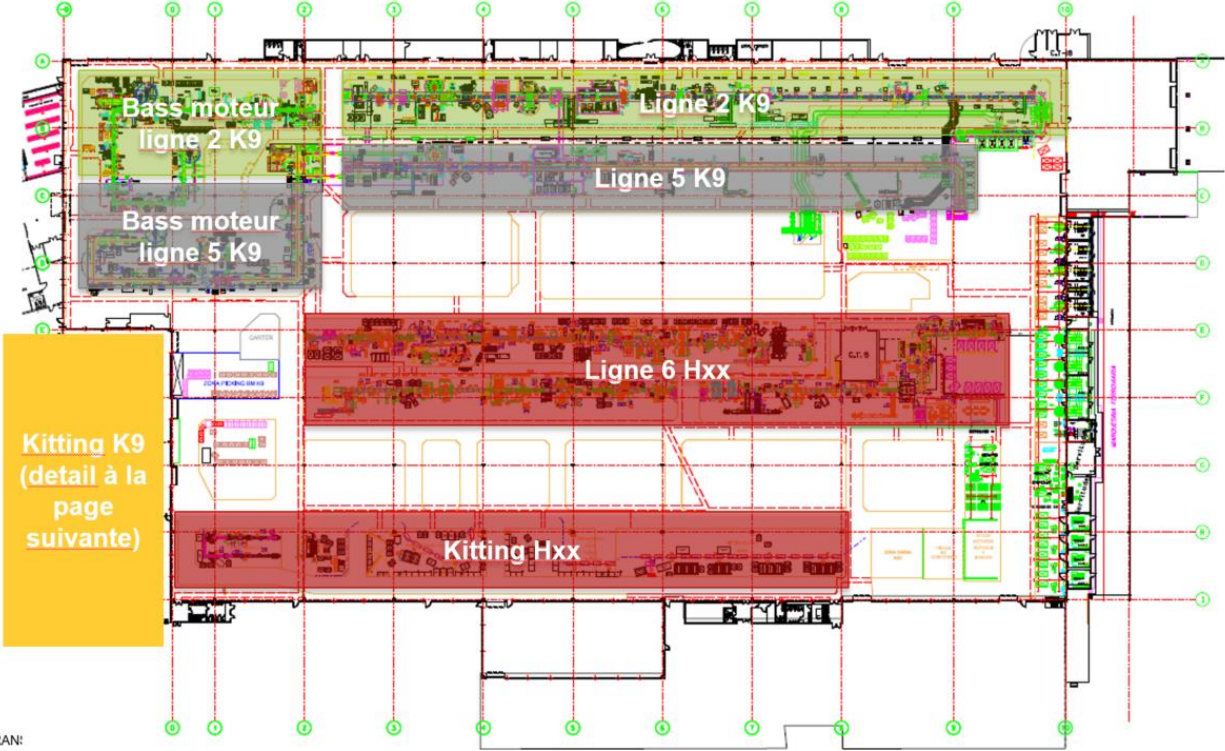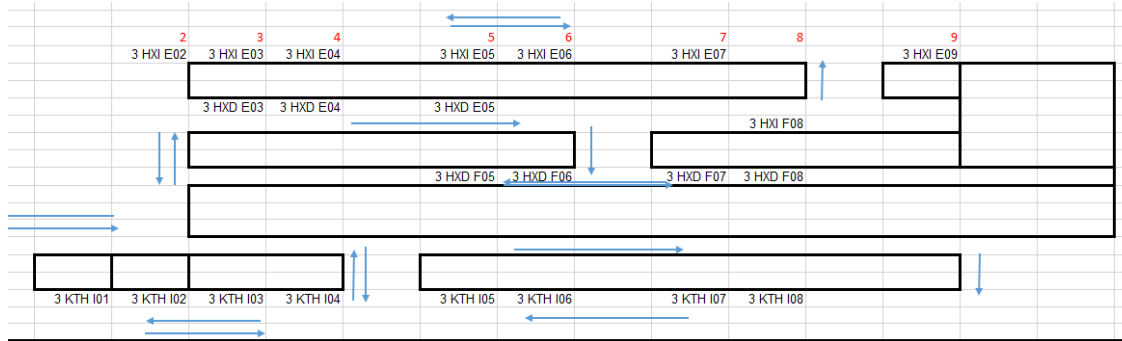
2D placement (best fit heuristics)

chariot 0001 *** conso min: 09/01/2018 -06:00:00 *** duree: 24,04 mn *** LINEA-2
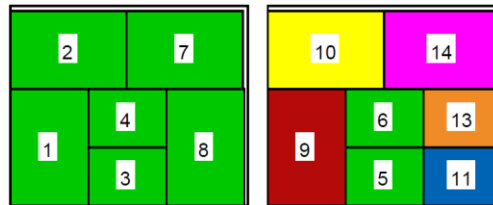
poteau	palette	pile	composant	point conso	UC	pas de temps min	nb Ucs
G-1	1	8	166714557R	G-1	BAC-O-6423	09/01/2018 -06:00:00	3
G-1	2	9	166714557R	G-1	BAC-O-6423	09/01/2018 -07:15:00	2
G-1	1	8	166714217R	G-1	BAC-O-6423	09/01/2018 -08:00:00	1
G-1	2	9	166714217R	G-1	BAC-O-6423	09/01/2018 -09:00:00	2
F-1	1	7	135630100R	F-1	BAC-O-6433	09/01/2018 -06:00:00	1

Inventory coverage

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Conclusion

➢ Lots of OR tools rolled out but many fields still unexplored

➢ Lack of « facilitators » between the OR team and the plants

➢ OR = a great alternative to investments

➢ To develop OR tools, an exciting job !

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Q & A

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