eurystic

Tire Factory Simulation for resource capacity, schedules and investments analysis

September, 23

Agenda

01.

Stakeholders

02.

Project introduction

03.

The model

04.

Implementation

05.

Results and potential

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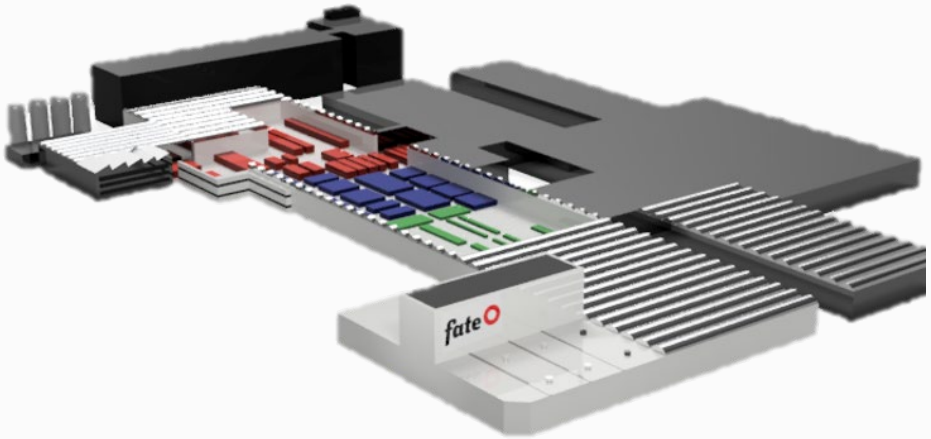
¿How?
Robust Quantitative Support
Modeling & Simulation
Optimization Algorithms
Artificial Intelligence
Agile Methodologies
We deliver high impact solutions to complex problems, through the application of quantitative based methodologies and tools
Supply Chain
Strategy
Planning
Operations
¿Where?
¿What?
Tailor-made Solutions
Consulting
Products
SaaS
Software as a service

Description of FATE

- Leading Argentinean company in **tire manufacturing and export**.
- The FATE tire industrial plant is the **largest and most modern in Argentina**, with a production capacity that exceeds five million tires per year.



+2000 employees

1.7M square feet

+5M per year

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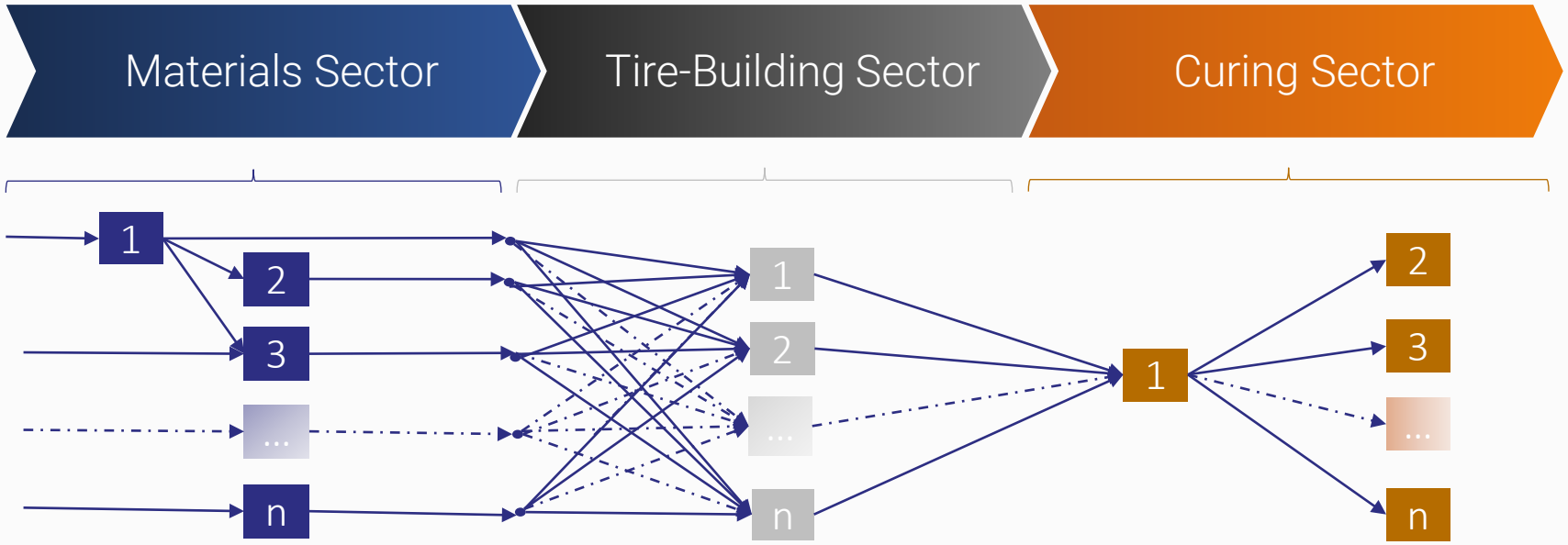
Project introduction

- **More than 200 machines of 16 machine types**, each with its own scheduling logics and particular behaviors.



- **More than 250 Storage areas** associated to each machine and product type, including storage logics.
- Great diversity of **movement equipment, vehicles and conveyors**, and its logics to transport products.
- **Staff allocation to machines and transport operations (Truckers)**

Business challenge

CONTEXT:

- FATE was **transitioning a transformation process** to reach improvements and higher efficiency in all its production processes.
- FATE sought a tool to analyze its internal logistics and production scheduling.

OBJECTIVE

- Develop a **flexible tool** that allows to analyze different scenarios.

CHALLENGE:

- **Highly complex system**, hard to model, sets a challenge for the team leading the industrial planning.

QUANTITATIVE ANALYSIS:

- Analyze different production schedules, manpower, tooling, etc.
- Anticipate Production Planning completion.
- Workforce requirement and utilization.
- Resource capacity and efficiency.
- Material stocks evolution and flow.
- Bottleneck detection and potential investments.

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Why simulations & anylogic

- The factory is a highly complex and interconnected. It involves hundreds of workstations to manufacture all the components of a tire.
- Flexibility in the UI design and potential.
- Time dependent processes.
- Variability of the system.
- AnyLogic provides a great development experience, and reduces the time and effort required to develop the simulation model.

Methodology and simulation

INPUTS

Scenario A

Scenario B

Scena

Scenario D

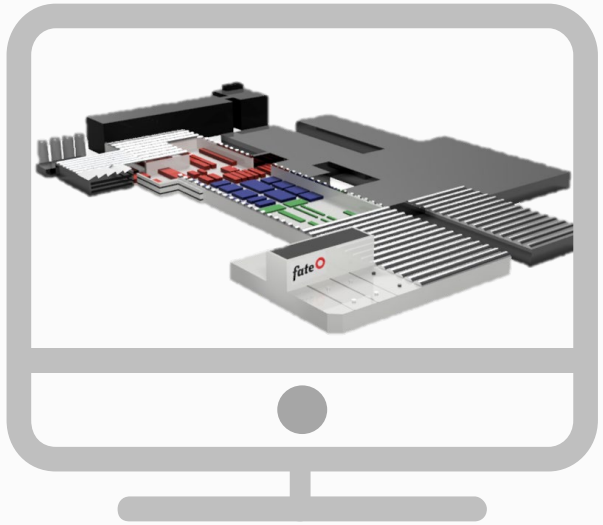
Program
Shifts
Equipment
.....

Scena

Scenario F

...

Digital representation of the production system through simulation to analyze how the system evolves under different conditions.



OUTPUTS

Agent-Based

Discrete Event

Model

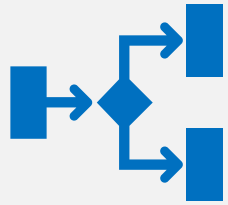
Agent-Based

Applied to model most of the components, from machines and workers, to vehicles and buffers.

This approach was preferred to represent behaviors and complex interactions using:

- Statecharts
- Messages and functions to react to external events
- Actioncharts for complex logics

Discrete Event



Discrete event modeling was applied for the factory's conveyor belts.

This simulation modeling paradigm was favored because it allows to rapidly model components that have a limited number of interaction areas with other components, and also a clear unidirectional flow.

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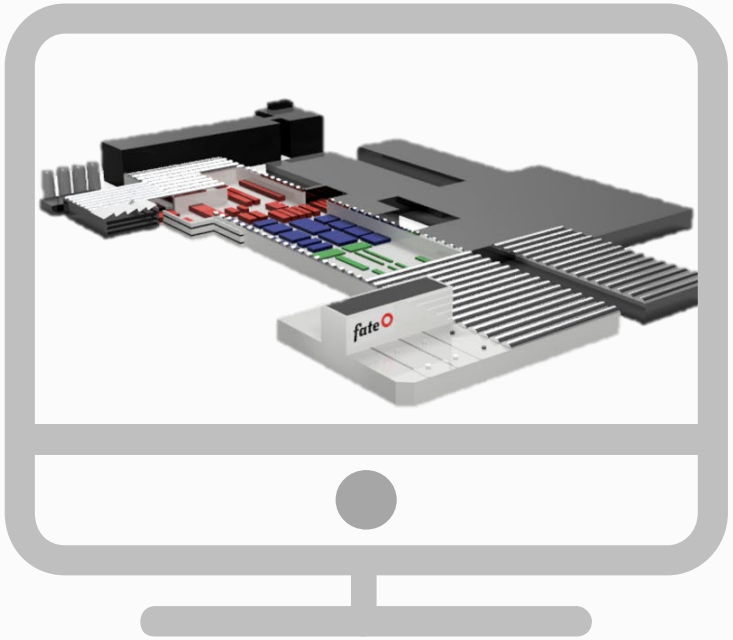
The model



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Eurystic Digital Twin
FATE Radial car and pick up

Fake Scenario 1

Summary
Real time status
KPIs Acum

Summary

Alerts

Fast mode
Simulation ended

Saturday | 1/5/2021
06 : 00 : 00 | Shift 1

01/05/2021 06:00
01/05/2021 06:00

Export

Plan compliance 60%

Green tires

Total production
126,489 UN

Daily production
4,216 U./Day

Tires vulca

Total production

Simulated	Program
128,945	213,244

Daily production

Simulated	Programada
4,298	7,108

Tons vulca

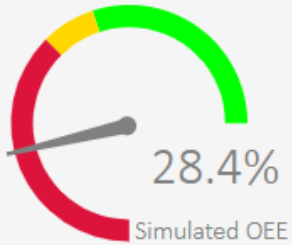
Total production

Simulated	Program
1,037.1	1,737.3

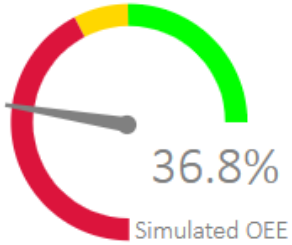
Daily production

Simulated	Program
34.6	57.9

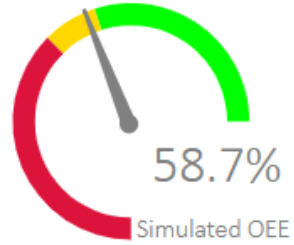
Sector 1



Sector 2



Sector 3



Sector KPI

	OEE Sim.	OEE INPUT	Gap
MAC51	6.5	60	-53.5 ▼
MAC54	18.1	60	-41.9 ▼
MAC57	4.1	60	-55.9 ▼
MAC60	13.1	60	-46.9 ▼
MAC63	5.3	60	-54.7 ▼
MAC66	17.2	60	-42.8 ▼
MAC69	42	60	-18 ▼
MAC72	0	60	-60 ▼
MAC75	72.8	60	12.8 ▲
MAC78	72.2	60	12.2 ▲
MAC81	72.8	60	12.8 ▲
MAC84	67.6	60	7.6 ▲
MAC87	61.1	60	1.1 ▲
MAC90	60.8	60	0.8 ▲
MAC93	45.8	60	-14.2 ▼
MAC96	18.8	60	-41.2 ▼
MAC99	26.4	60	-33.6 ▼
MAC102	30.1	60	-29.9 ▼

Global system indicators

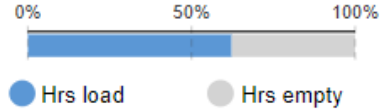
Required staff

Group	Staff	utilization [%] Avg.	Max.	Min.
G63	18	25.6	100	9.1
G69	13	22.6	80.9	10.8
G66	25	25.6	46.2	10
G57	57	13.3	36.9	4.7
G68	31	13.9	56.5	0.7
G72	8	28.3	100	0
G77	39	15.7	54.1	0

Truckers

Average Utilization 37.2%

Equivalent staff 2.2 by shift



Containers

	Utiliz.
CONT 50	67.6%
CONT 9	69.7%
CONT 0	30.5%
CONT 8	96.5%
CONT 66	26.0%
CONT 35	NaN%
CONT 44	97.1%
CONT 69	0.0%
CONT 69	71.7%
CONT 40	84.7%
CONT 5	78.6%
CONT 49	66.0%

Vulca

Available
20
Active
68

Stock Area

	Sat.
Sector 1	88.4%
Sector 2	86.6%
Sector 3	92.2%
Sector 4	78.2%

Transport Units

	Utiliz.
UT 64	63.2%
UT 68	63.0%
UT 62	55.1%
UT 61	18.3%
UT 43	5.9%
UT 6	1.8%

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06 : 00 : 00 | Shift 1

01/05/2021 06:00
01/05/2021 06:00

Cause of efficiency loss

Waiting material

Element type	Events	Hours
Element 0	3,132	11,015.9
Element 1	240	967.6
Element 2	340	591.1
Element 3	125	232.4
Element 4	74	122.1
Element 5	55	61.7
Element 6	271	15.5
Element 7	163	12.3

Waiting container

Container	Events	Hours
Container 0	3,748	452.8
Container 1	328	365.3
Container 2	262	295.2
Container 3	491	240.8
Container 4	467	229.2
Container 5	216	204.5
Container 6	242	101.5
Container 7	74	54.6

Machines

Id	Events	Hours
MAC15	64	234.3
MAC33	124	179
MAC30	119	164.3
MAC42	5	3.9
MAC9	9	3.8
MAC36	7	3.8
MAC48	4	1.7
MAC24	2	0.1
MAC21	2	0.1

Id	Events	Hours
MAC552	1,715	115
MAC39	96	82.2
MAC549	885	65.3
MAC21	267	34
MAC48	162	33.9
MAC42	77	27.6
MAC24	180	24.9
MAC45	164	22.8
MAC9	86	18.9

Restrictions and alarms

Staff

Group	# Shifts >80%	# Shifts <20%
G63: DESC G63	6	20
G69: DESC G69	1	38
G66: DESC G66	0	8
G57: DESC G57	0	70
G68: DESC G68	0	71
G72: DESC G72	9	39
G77: DESC G77	0	68
G52: DESC G52	0	4
G65: DESC G65	0	56
G90: DESC G90	0	41
G62: DESC G62	1	22
G81: DESC G81	0	11
G86: DESC G86	0	0
G73: DESC G73	0	86
G85: DESC G85	0	11

Absenteeism

Extra hours by absenteeism	40
Idle time as extra hours	19,792

Stock Area

Sector	# Stock Area Utiliz >100%
Sector 1	22
Sector 2	87
Sector 3	1
Sector 4	3

Production mix

Sector 2	# SKUs 50
Sector 3	# Tires models 71

Tooling alert

Sector 2	Sector 3	
# Events 0	Die 2	
	Container 0	

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Fake Scenario 1

Summary | Real time status | KPIs Acum

Productivity | Staff | Transport Units | Truckers
Program | absenteeism | Tooling | Vehicles
Stock areas | Containers | Conveyors | Scrap

Fast mode
Simulation ended

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01/05/2021 06:00

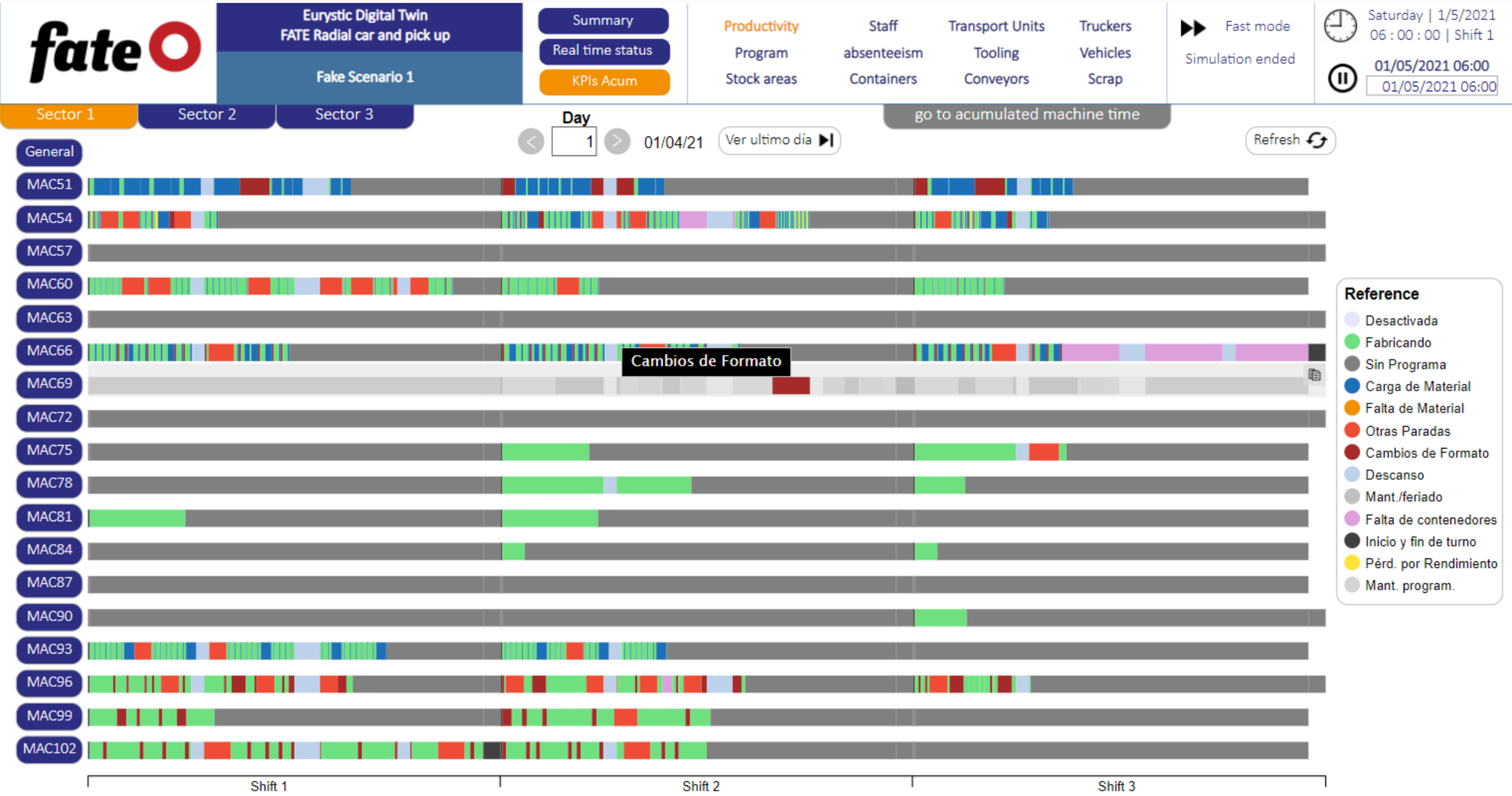
Sector 1 | Sector 2 | Sector 3

Go to machine state history

* Not explained by the model.

General | MAC51 | MAC54 | MAC57 | MAC60 | MAC63 | MAC66 | MAC69 | MAC72 | MAC75 | MAC78 | MAC81 | MAC84 | MAC87 | MAC90 | MAC93 | MAC96 | MAC99 | MAC102

	MAC51	MAC54	MAC57	MAC60	MAC63	MAC66	MAC69	MAC72	MAC75	MAC78	MAC81	MAC84	MAC87	MAC90	MAC93	MAC96	MAC99	MAC102
Calendar time (hs)	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
Anual maintenance (hs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shift (hs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No program (hs)	407.6	108.1	458.8	240.7	702.6	176.8	432.9	712	581.4	443.6	554	657.9	683.4	623.9	537.9	143.4	183.2	240.6
Available time (hs)	312.4	611.9	261.2	479.3	17.4	543.2	287.1	8	138.6	276.4	166	62.1	36.6	96.1	182.1	576.6	536.8	479.4
Programed maintenance (hs)	8	0	8	8	16	8	8	8	8	8	8	8	8	8	8	0	0	8
Absenteeism (hs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start/End of shift (hs)	3.6	21.3	10.8	18.4	0	18.3	5.3	0	1.9	2.7	2.6	1.7	0.4	1.6	3	19.7	19.6	18.5
Break (hs)	31.8	77.3	31.5	56.5	0	64.3	35	0	10.3	28.8	12	1	2.5	7.5	16.5	72.5	0	59.5
Set up (hs)	66.1	17.2	1.2	1.5	0.2	20.9	78.5	0	0	0	0	2	0	3.5	0	61.2	33.1	34
Loading material (hs)	161.4	87.9	1.2	8.2	0.3	66.4	0	0	0.5	2.2	2.4	0.9	0.4	0.5	44.1	0	0	0
Waiting material (hs)	0	0.4	0	0.2	0	0.1	0	0	0	0	1.3	0	0	7.8	1.3	0	0	0
Waiting container (hs)	0	183.7	165.2	257.3	0	206.5	0	0	0.2	4.8	0.1	0	0	0	9.5	229.2	295.2	156.1
Other stops (hs) *	21.3	107.1	32.6	66.4	0	65.5	39.6	0	16.9	30.3	18.7	6.4	2.9	8.7	16.3	85.4	47	59.1
Operative time (hs)	20.2	117	10.7	62.8	0.9	93.2	120.7	0	100.8	199.6	120.9	42	22.4	58.5	83.5	108.7	141.9	144.2
Performance loss (hs) *	0	6.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross operative time (hs)	20.2	110.6	10.7	62.8	0.9	93.2	120.7	0	100.8	199.6	120.9	42	22.4	58.5	83.5	108.7	141.9	144.2
% Availability	6.5	19.1	4.1	13.1	5.3	17.2	42	0	72.8	72.2	72.8	67.6	61.1	60.8	45.8	18.8	26.4	30.1
% Performance	100	94.5	100	100	100	100	100	0	100	100	100	100	100	100	100	100	100	100
% Quality	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
% Simulated OEE	6.5	18.1	4.1	13.1	5.3	17.2	42	0	72.8	72.2	72.8	67.6	61.1	60.8	45.8	18.8	26.4	30.1
% OEE INPUT	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Units produced	796,960	414,744	7,320	58,858	582	178,991	291,144	0	54,492	98,160	59,964	20,652	10,560	24,360	2,998,800	162,381	145,169	375,310
Production (UM/Turno)	8,855	4,608	81	654	6	1,989	3,235	0	605	1,091	666	229	117	271	33,320	1,804	1,613	4,170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Fake Scenario 1
Summary
Real time status
KPIs Acum
Productivity
Program
Stock areas
Staff
absenteeism
Containers
Transport Units
Tooling
Conveyors
Truckers
Vehicles
Scrap
Fast mode
Simulation ended
Saturday | 1/5/2021
06 : 00 : 00 | Shift 1
01/05/2021 06:00
01/05/2021 06:00
Sector 1
Sector 2
Sector 3
Day
1
01/04/21
Ver ultimo día
go to acumulated machine time
Refresh
General
MAC51
MAC54
MAC57
MAC60
MAC63
MAC66
MAC69
MAC72
MAC75
MAC78
MAC81
MAC84
MAC87
MAC90
MAC93
MAC96
MAC99
MAC102
Cambios de Formato
Reference
Desactivada
Fabricando
Sin Programa
Carga de Material
Falta de Material
Otras Paradas
Cambios de Formato
Descanso
Mant./feriado
Falta de contenedores
Inicio y fin de turno
Pérd. por Rendimiento
Mant. program.
Shift 1
Shift 2
Shift 3

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FATE Radial car and pick up

Fake Scenario 1

Summary | Real time status | KPIs Acum

Productivity | Program | Stock areas | Staff | absenteeism | Containers | Transport Units | Tooling | Conveyors | Truckers | Vehicles | Scrap

Fast mode
Simulation ended

Saturday | 1/5/2021
06 : 00 : 00 | Shift 1
01/05/2021 06:00
01/05/2021 06:00

Sector 1 | Sector 2 | Sector 3

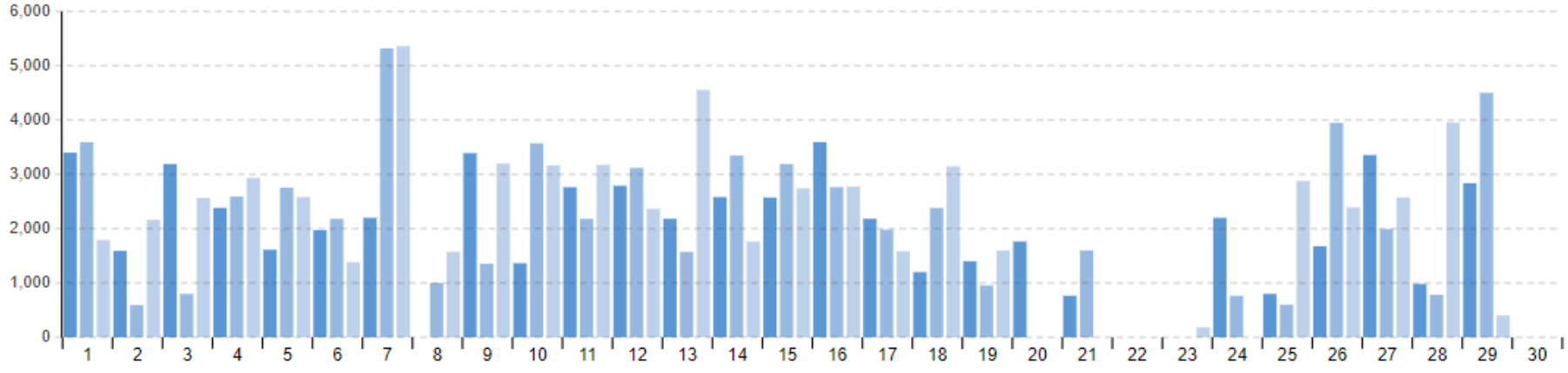
* Conceptos que no son explicados por el modelo.

General | MAC51 | MAC54 | MAC57 | MAC60 | MAC63 | MAC66 | MAC69 | MAC72 | MAC75 | MAC78 | MAC81 | MAC84 | MAC87 | MAC90 | MAC93 | MAC96 | MAC99 | MAC102

☐ Seleccionar todos ☐ Seleccion multiple

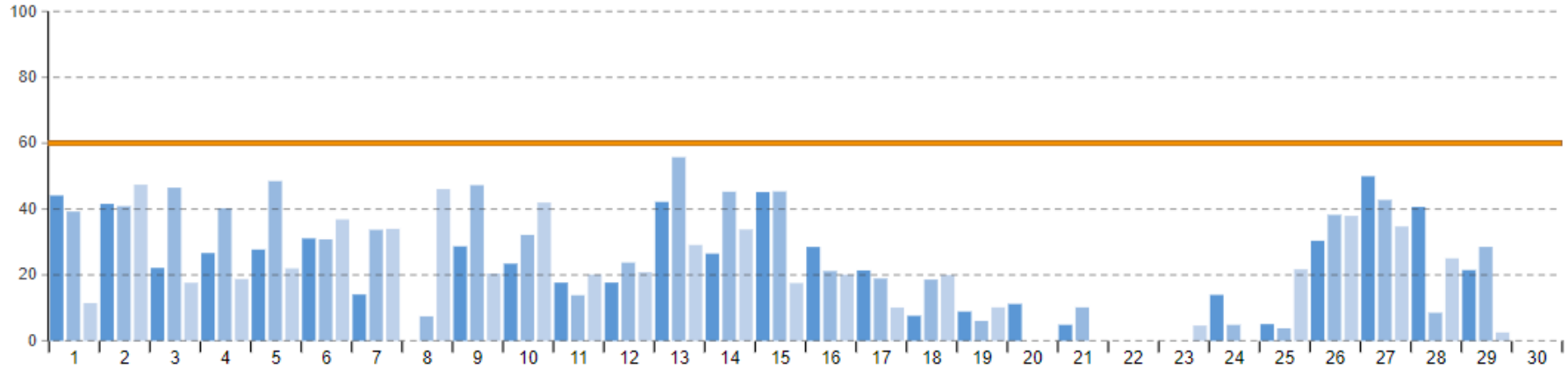
Calendar time (hs)	720
Anual maintenance (hs)	0
Shift (hs)	0
No program (hs)	176.8
Available time (hs)	543.2
Programed maintenance (hs)	8
Absenteeism(hs)	0
Start/End of shift (hs)	18.3
Break (hs)	64.3
Set up (hs)	20.9
Loading material (hs)	66.4
Waiting material (hs)	0.1
Waiting container (hs)	206.5
Other stops (hs) *	65.5
Operative time (hs)	93.2
Performance loss (hs) *	0
Gross operative time (hs)	93.2
% Availability	17.2
% Performance	100
% Quality	100
% Simulated OEE	17.2
% OEE INPUT	60
Units produced	178,991
Production (UM/Shift)	1,988

[Meters] Produced by Shift Day



Simulated OEE — OEE INPUT

[%]



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Sector 1 | Sector 2 | Sector 3

Machines

MAC51
MAC54
MAC57
MAC60
MAC63
MAC66
MAC69
MAC72
MAC75
MAC78
MAC81
MAC84
MAC87
MAC90
MAC93
MAC96
MAC99
MAC102

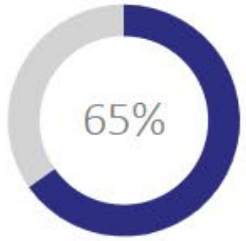
Stock area saturation

MAC69 - BUF 354

Stock A.	Capacity	Average Saturation	Maximum Saturation
BUF 63	17	51.95%	76.47%
BUF 113	3	12.48%	33.33%
BUF 354	15	65.22%	86.67%
BUF 193	50	3.13%	10.0%

Stock area utilization

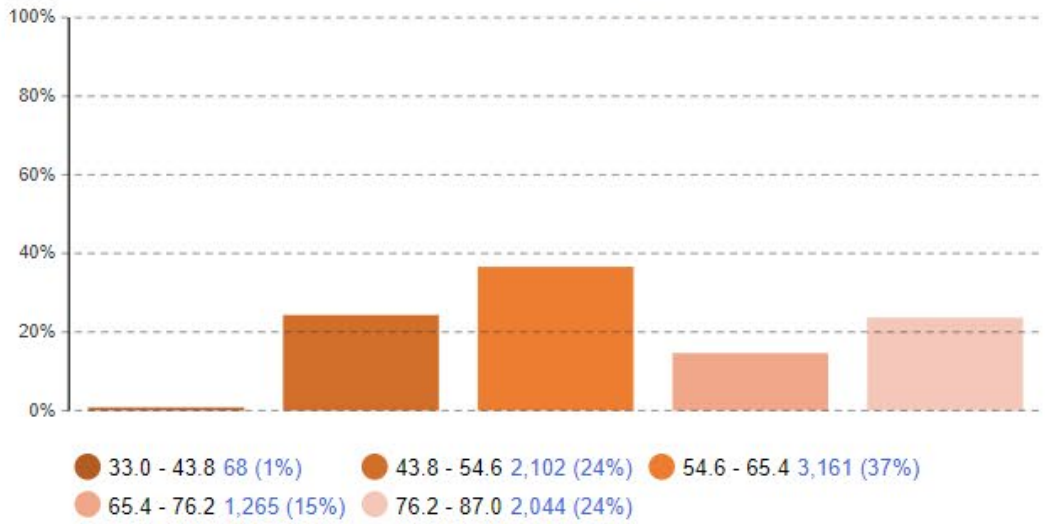
Average utilization



Stored elements

N-P

Saturation histogram



utilization evolution

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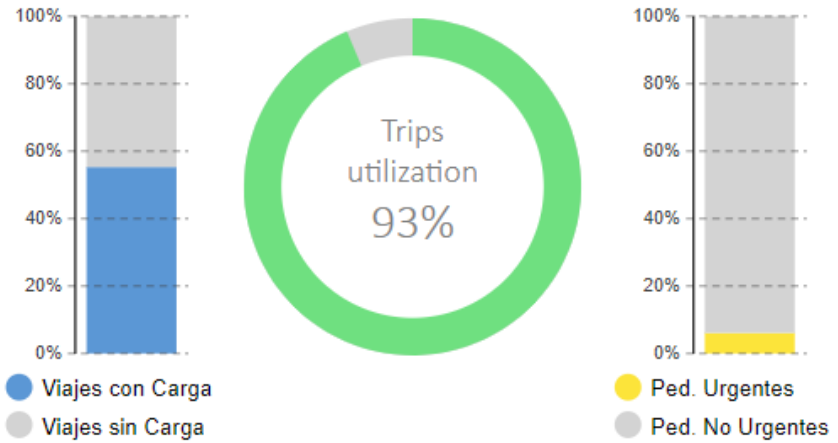
01/05/2021 06:00
01/05/2021 06:00

Utilization of truckers by staff group

Group	Number of task	Average utilization	Maximum utilization	Minimum utilization
G66	1.1	18.2	18.4	17.7
G57	73	36	54.7	18.2
G68	58	16.5	34.8	2.8
G52	46.3	21	39.1	10
G65	11.8	97.9	100	17.9
G90	33	58.3	75.4	35.6
G62	22.3	62.5	72.9	35.4
G81	494	30.2	69.2	5.6
G73	10	18.7	20.6	17.8
G85	101.4	26.8	41.4	17.7

Trucker group G57: DESC G57

Trips done

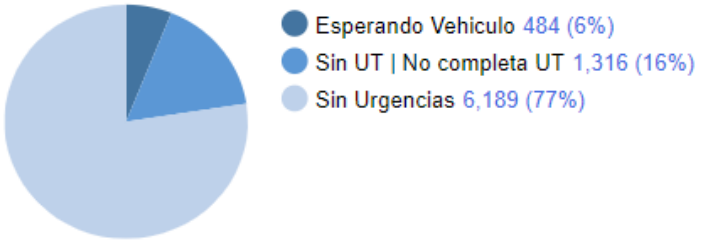


Traveling with load / Traveling empty 61.1%

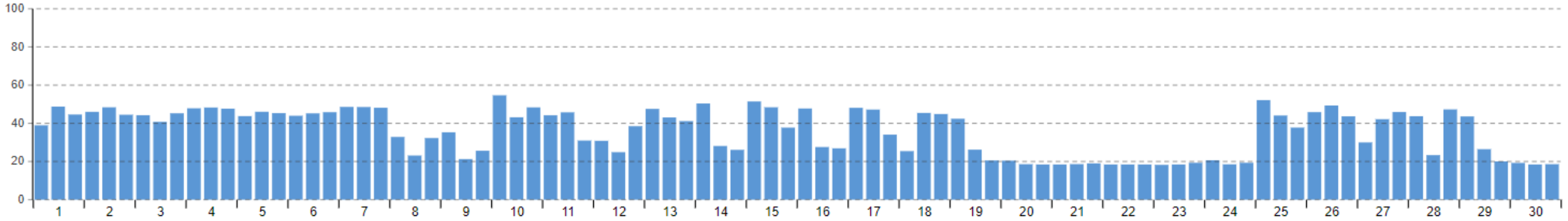
Utilization

HH Trucker available	1,738.8
HH Working (Moving|Adjusting)	109.1|11.0
HH Emergency truckers available	298.8

Free truckers reasons



utilization over time




fate
Eurystic Digital Twin
FATE Radial car and pick up
Fake Scenario 1
Summary
Real time status
KPIs Acum
3D animation
Machines
Conveyors
Staff
Absenteeism
Stock areas
Truckers
Cont. / TU / Vehicles
Fast mode
Simulation ended
Thursday | 1/4/2021
06 : 03 : 23 | Shift 1
01/05/2021 06:00
01/05/2021 06:00
Run
x1
Paused

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Inputs and parameters

Machines

Maintenance
Setup
Required workforce
Efficiency
Stops

Workforce

Available workforce by shift
Workforce segmentation
Task assignments
Work schedules

Production Schedule

Production target by product type

Transportation Resources

Material handling
- Vehicles
- Containers

Products

Bill of materials (BOM)
Production route and productivities

Storage

Storage by product type
Capacity and position

Other Parameters

Initial stock by product
Scrap generation by product type
Tooling availability
Conveyor parameters
Time horizon
Tunning parameters

KPIs and output

PERFORMANCE

- Gross production and plan compliance.
- Machine scheduling.
- Stock and scrap evolution in time.

RESOURCES

- Human resources utilization.
- Equipment performance (OEE, GLY).
- In-Process materials stock
- Occupation of buffers.
- Tooling utilization.

ANIMATION

- Allow the evaluation of the factory status and understanding of system dynamics
- Helps in the model validation.
- Real time indicator to study very specific moments during the simulation.

OUTPUT

- Export tailor made results to further analysis using third party software(e.g. PowerBI).

Agenda

01.
Stakeholders

02.
Project introduction

03.
The model

04.
Implementation

05.
Results and potential

Challenges along the road

Process survey

- High volume of input data to be collected.
- Organizing and **standardizing data** in the process.
- Processing and validating data.

Production scheduling

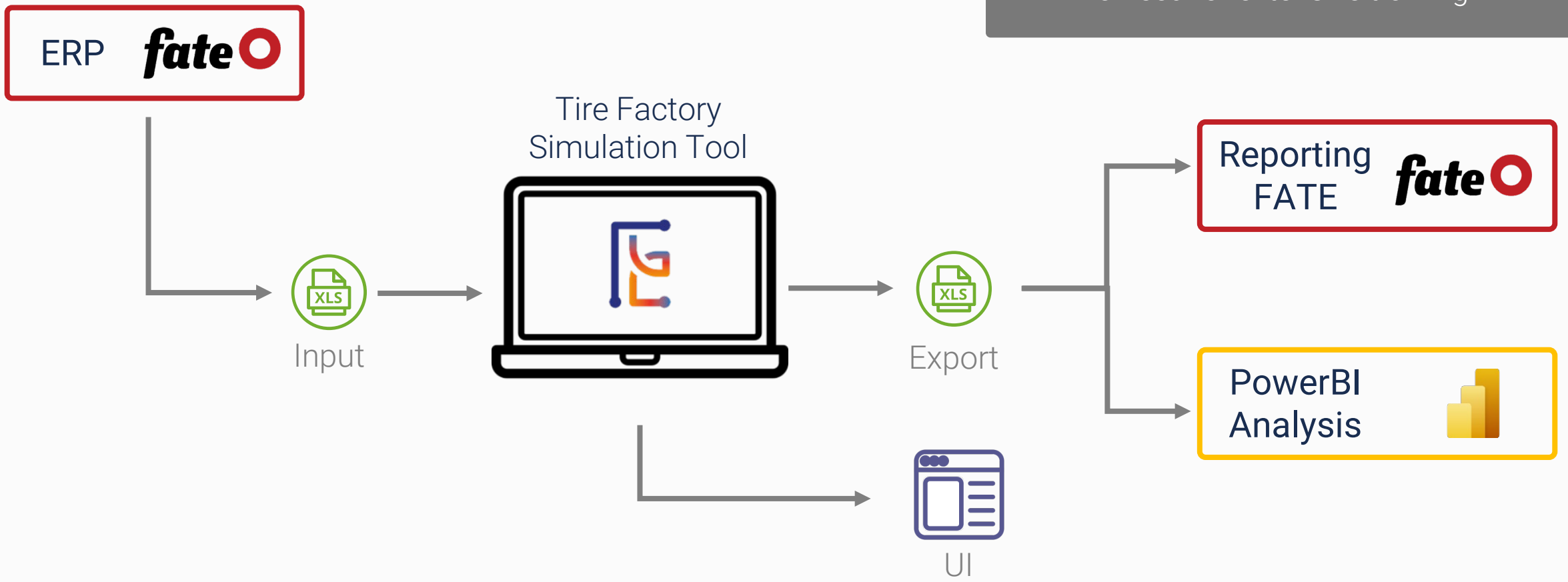
- Many particularities according to the machine type.
- Need for **normalize and unify criteria**.
- Large number of possible scenarios.

Transport staff logic

- Wide range of scenarios and possible elements to transport.
- **Unify rules** and standardize.

Model - Integration

- Flexible to deploy in any environment
- Adaptable to a wide range of systems
- No need for extensive training



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Results and potential

Predict **Production Planning completion**.

Visualize **bottlenecks** and system constraints.

Determine **plant capacity** with given resources.

Evaluate possible **human resources allocations** .

Evaluate the overall **impact of bottleneck improvements**

Evaluate investment viability in **improving bottlenecks**

Optimize **plant configuration** (parameters).

Optimize **internal logistics**.

Test **unification** of materials and components.

Test different strategies and asses their impact on production and plan adherence.

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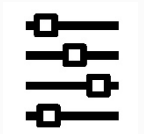

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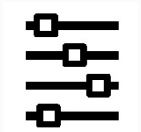

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Any questions?

Thank you

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www.eurystic.com.ar