

Bulk Cement Supply Simulation Model for Eastern Caribbean Cementos Argos S.A.

9/29/2021



¿Who are we?

- Founded in 1934
- Cement and ready-mix market leader in Colombia
- Fourth largest cement producer in the United States
- \$3 Billion USD Revenue
- Over 8.000 employees
- Operating across 16 countries.
- 13 Cement plants, 9 grinding facilities, 340 concrete plants, 33 ports & terminals



Cement



Concrete



Aggregates

¿What do we do?

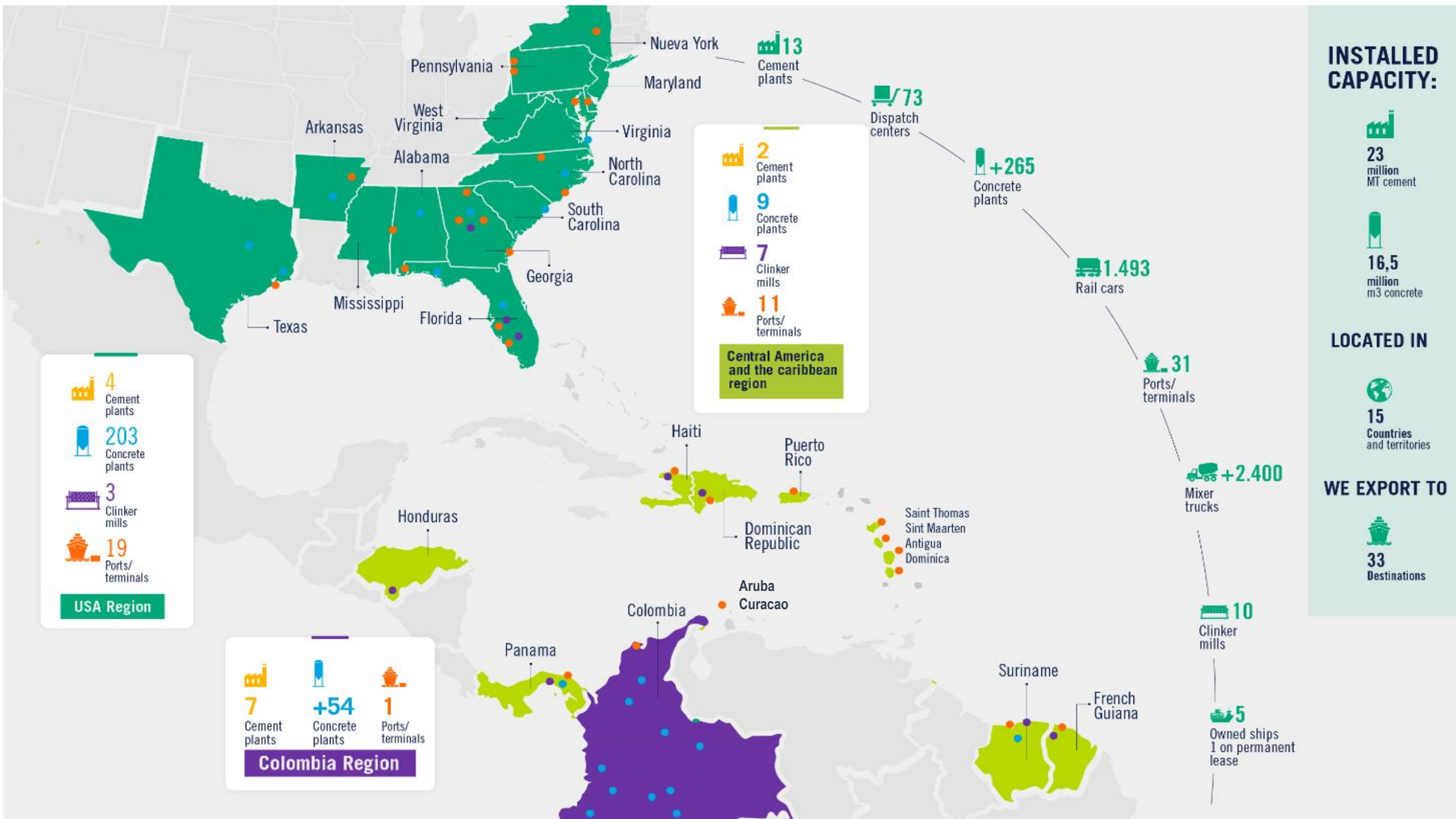
- We create value through innovative products, solutions, and logistics synergies.
- We lay the foundations for development in a sustainable manner.
- We take on major challenges that allow us to carve out new paths, shape realities and transcend boundaries.

Our higher purpose

To build dreams that boost development and transform lives.

¿What makes us different?

- We support our customers in the development of their businesses, being an ally in the materialization of their dreams and projects through which we built a future and multiply growth opportunities together.
- We attract the best talent and we are committed to delivering extraordinary solutions for customers.
- We build relationships of trust based on ethics and transparency.
- We are a company committed to creating value.



USA Region

- 4 Cement plants
- 203 Concrete plants
- 3 Clinker mills
- 19 Ports/terminals

Central America and the Caribbean region

- 2 Cement plants
- 9 Concrete plants
- 7 Clinker mills
- 11 Ports/terminals

Colombia Region

- 7 Cement plants
- +54 Concrete plants
- 1 Ports/terminals

13 Cement plants

73 Dispatch centers

+265 Concrete plants

1.493 Rail cars

31 Ports/terminals

+2.400 Mixer trucks

10 Clinker mills

5 Owned ships
1 on permanent lease

INSTALLED CAPACITY:

23 million MT cement

16,5 million m3 concrete

LOCATED IN

15 Countries and territories

WE EXPORT TO

33 Destinations

Business Case - Bulk Cement Supply Simulation



General Objective:

- Develop and evaluate a simulation model for the supply of bulk cement to the Eastern Caribbean terminals using Anylogic.

Specific Objectives:

- Avoid cement shortages in each market.
- Use 100% capacity for each of the vessels.
- Optimize discharge times to avoid rotation delays or demurrage.

To be reviewed in the business case:

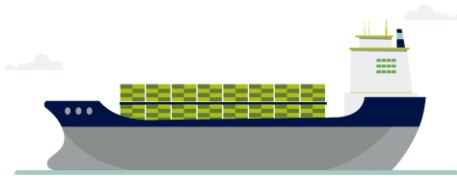
- Description of previous supply model.
- Description of the Anylogic simulation model.
- Results with simulation indicators.
- Benefits and Restrictions of the Anylogic Simulation model.
- Annexes.

Supply Chain Management

Model description

Port of Origin: Cartagena, Colombia

Bulk Carriers



- MV Cymbidium: 7.300 MT
- MV NACC Panarea: 5.300 MT

We act as wholesalers in each market, providing cement for both the industrial and retail segments (Concrete producers and Hardware stores respectively).

	Silo Storage Capacity (MT)	Draft Restrictions	Port Restrictions	Terminal Operation
Aruba	3.700	-	-	Only Bulk
Curacao	5.000	Cymb: 5.800 MT NACC: 3.800 MT	-	Local Production
St. Maarten	3.600	-	Weekends	Local Production
St. Thomas	4.000	-	Weekends	Only Bulk
Dominica	1.900	Cymb: 4.400 MT NACC: 3.000 MT	-	Local Production
Antigua	2.400	Cymb: 3.000 MT NACC: 2.000 MT	-	Local Production

Supply Chain Management

Model description



First stop: Aruba, St. Thomas or St. Maarten

- No draft restrictions

Last stop: usually Antigua – lowest draft.

Local demands determine the frequency of shipments and cement volume per terminal.

Products Presentations:

- Bulk
- Small Bags (47 lb) – local production
- Big Bags (1.5 MT) – local production

Previous Model Description



Sales and production update

- Download and update Excel reports for each terminal.
- OCS, Daily Sales, Inventory Report, Inventory Planning.
- Report contrast and correction.
- Generate consumption projections.

Excel (4 different files)



Vessel Programming

- Estimation of tentative dates of arrival at the port of origin.
- Review of next cycle based on analysis in Inventory planning report.
- Confirm product availability in Cartagena.
- Manual build up of the supply program, considering the system constraints.
- Construction and revision of different scenarios.
- Confirmation of the best option.

Excel



Monitoring of Vessel program

- Monitoring of operations prior to product loading.
- Adjustments to the initial program if necessary, updating sales and production.

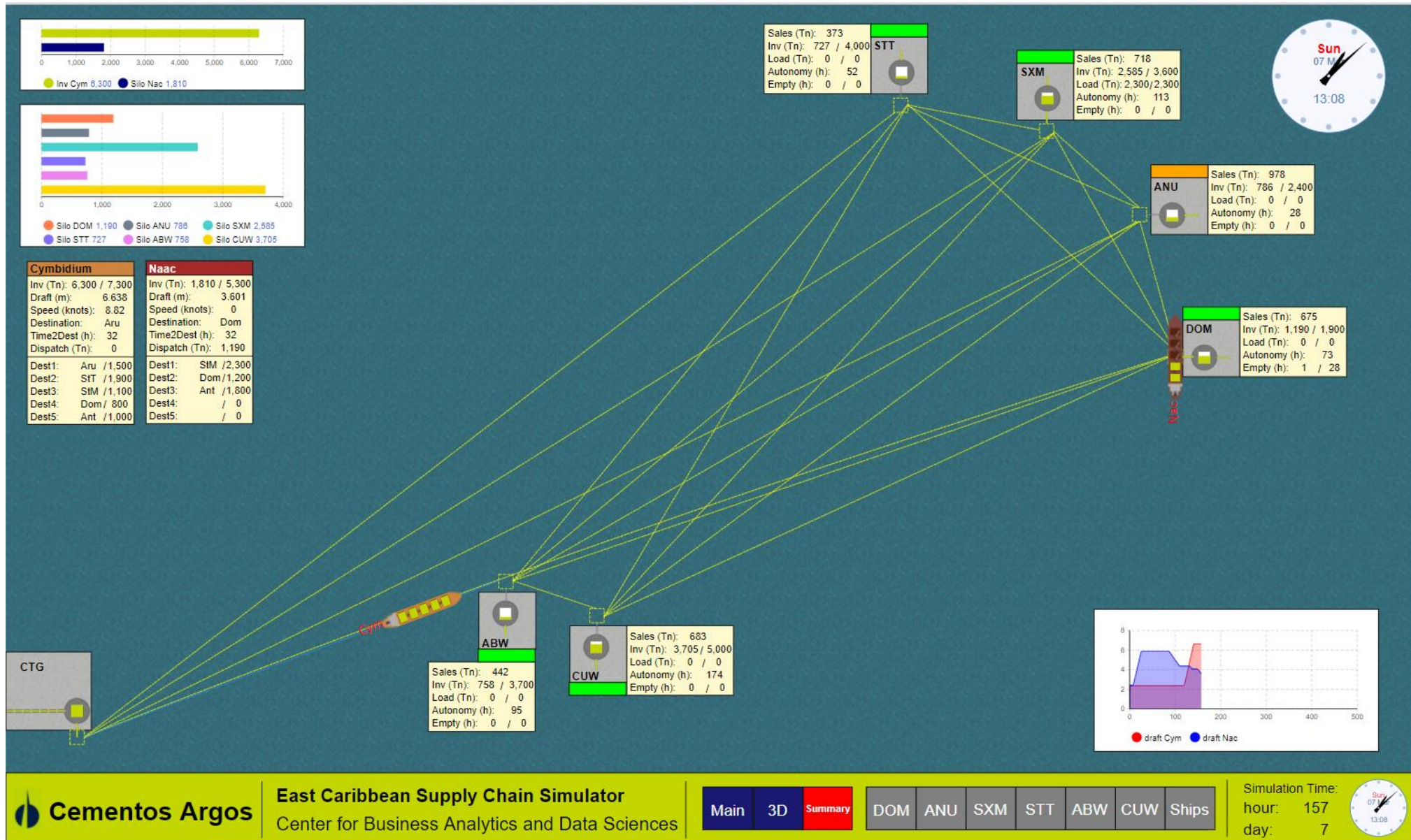
Excel

Visibility: 15 days

Process carried out on a weekly basis and/or on demand

Anylogic Model Description

Agent based simulation with deployment through a Java executable file.



Anylogic Model Description



Input Data

Terminal

- Terminal variables: Initial inventories and projected demand for each product in each market.
- Terminal parameters: storage capacities, packing rates, working hours.

Vessels

- Vessel variables: assigned route to each vessel, proposed volume split, ship speed ranges, departure delays.
- Vessel parameters: Vessel capacity, vessel loading and unloading rates.
- The input data of the model can be read from an Excel template and the results of the model are exported to the same Excel file.

East-Caribbean Supply Chain Simulator




East-Caribbean Supply Chain Simulator



Terminals	Initial Inventory (Tn)	Demand (TPD)	Packing Rate
Dominica	Initial Inv. Silo: 1040.0 Initial Inv. Sacks: 320.0 Initial Inv. BBags: 230.0	Min: 0.0, Mode: 40.0, Max: 46.0 Sack: 60.0, 85.0, 100.0 BBag: 0.0, 30.0, 45.0	Sack (sack/hr): 600.0 BBag (Tn/hr): 15.0
Antigua	Initial Inv. Silo: 1660.0 Initial Inv. Sacks: 200.0 Initial Inv. BBags: 200.0	Bulk: 90.0, 150.0, 200.0 Sack: 30.0, 70.0, 90.0 BBag: 0.0, 25.0, 44.0	Sack (sack/hr): 550.0 BBag (Tn/hr): 15.0
Aruba	Initial Inv. Silo: 1200.0	Bulk: 0.0, 60.0, 150.0	
St. Marteen	Initial Inv. Silo: 1200.0 Initial Inv. Sacks: 200.0 Initial Inv. BBags: 300.0	Min: 62.0, Mode: 105.0, Max: 125.0 Sack: 10.0, 60.0, 105.0 BBag: 0.0, 12.0, 35.0	
Curacao	Initial Inv. Silo: 5000.0 Initial Inv. Sacks: 200.0 Initial Inv. BBags: 400.0	Bulk: 25.0, 71.0, 125.0 Sack: 0.0, 60.0, 100.0 BBag: 0.0, 30.0, 80.0	
St. Thomas	Initial Inv. Silo: 1100.0	Bulk: 40.0, 92.0, 128.0	

Ships	Operation Mode:	Draft Constraint:
Cymbidium <input checked="" type="checkbox"/> selected Speed: Min 8.0, Mode 10.0, Max 11.0	<input checked="" type="radio"/> Manual <input type="radio"/> Auto	<input type="checkbox"/> selected
Nacc <input checked="" type="checkbox"/> selected Speed: Min 7.0, Mode 9.0, Max 10.0		Initial Delay (hr): 0
Route 1 Total Load (Tn): 6300 Loading Delay (hr): 120 Dest. Number: 5 Split Destination 1: Aru 1500 Destination 2: SIT 1900 Destination 3: SIM 1100 Destination 4: Dom 800 Destination 5: Ant 1000	Route 2 <input checked="" type="checkbox"/> selected Total Load (Tn): 7300 Loading Delay (hr): 48 Dest. Number: 5 Split Destination 1: SIT 1900 Destination 2: SIM 2000 Destination 3: Dom 1000 Destination 4: Ant 1500 Destination 5: Cur 900	Route 1 Total Load (Tn): 5300 Loading Delay (hr): 8 Dest. Number: 3 Split Destination 1: SIM 2300 Destination 2: Dom 1200 Destination 3: Ant 1800

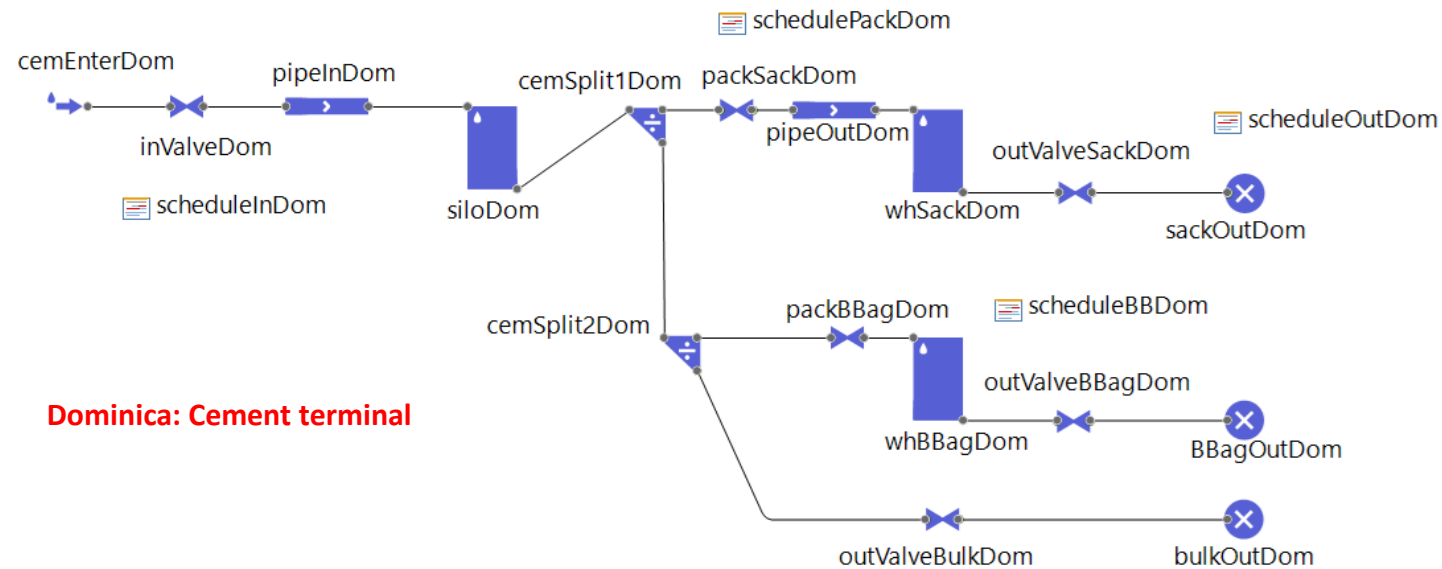
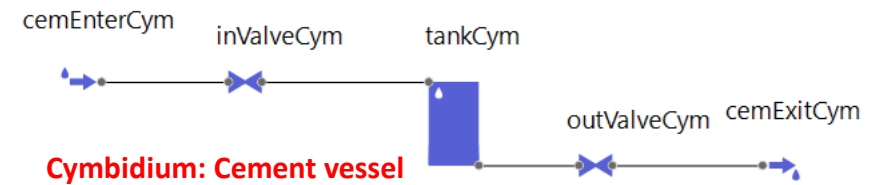
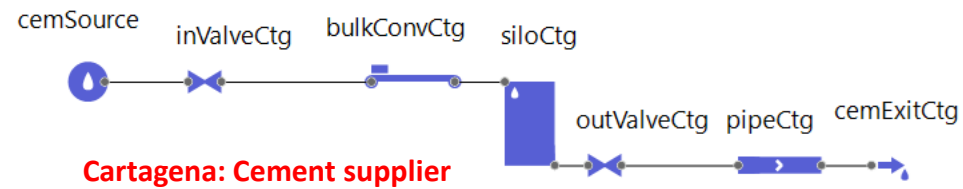


Anylogic Model Description



Modeling approach

- Extensive use of fluid library for the simulation of loading and unloading process of vessels and storage, packing and dispatch of cement in the terminals.
- Use of schedule elements for simulate working hours in the process for each terminal.

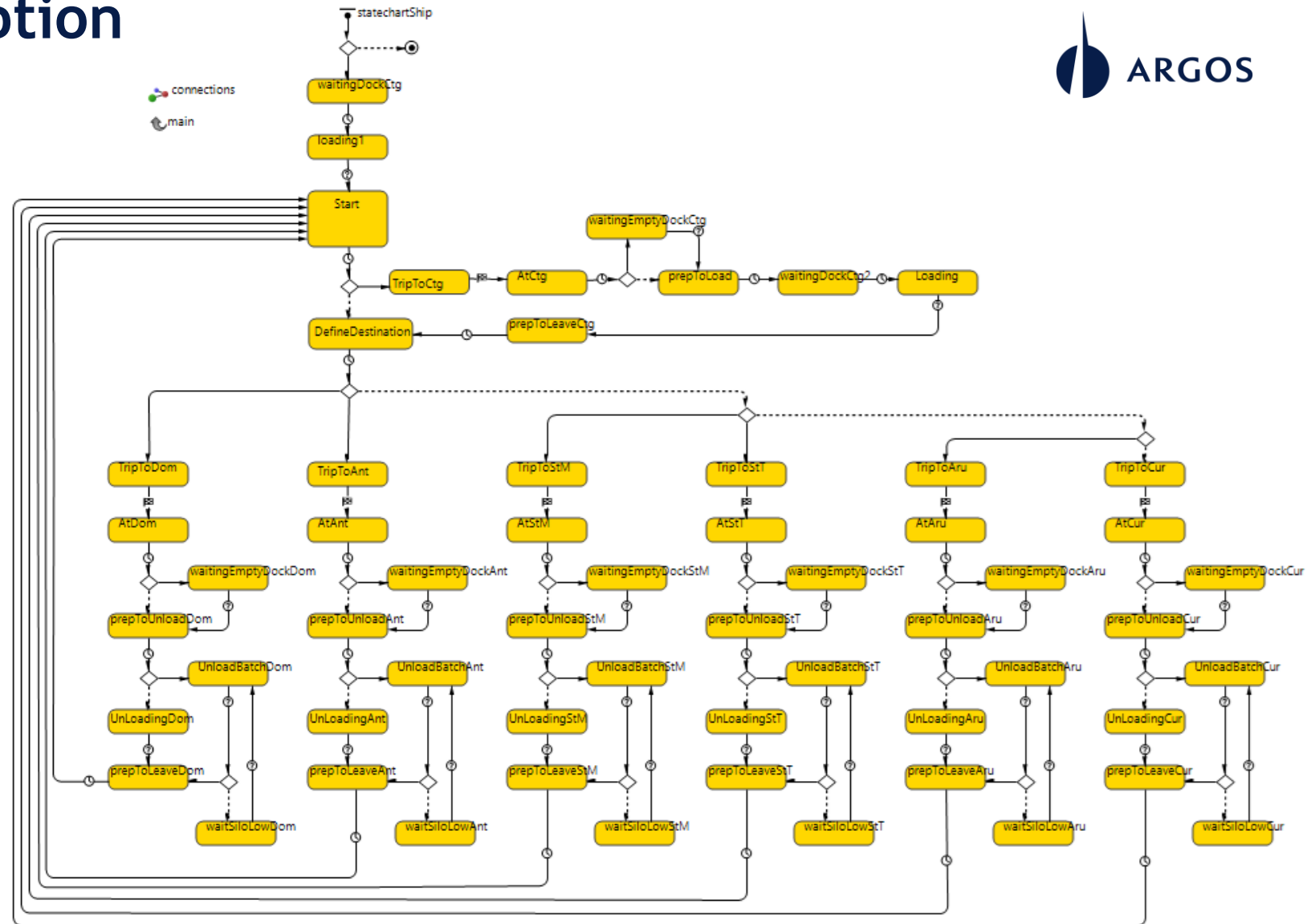


Anylogic Model Description



Modeling approach

- Agent based simulation approach for the vessels with use of statecharts for programming the behavior of the vessels.
- Simulation of stochastic parameters (vessel speed, cement demand, etc) using built-in probability distributions or custom distributions.
- Extensive use of functions, events, datasets, parameters, variables and collections elements.
- User have control of simulation starting date and simulation time (hours)



Destination Definition Function and Variables

- | | | |
|---------------|---------------------|------------------------|
| shipPathArray | shipNextDestination | getRectangleVisibleCym |
| shipLoadArray | shipNextLoad | shipTimeInArray |
| fillRoute1Cym | shipIndexArrays | shipTimeOutArray |
| fillRoute2Cym | shipInitialAmount | shipDateInArray |
| | shipNumDestination | shipDateOutArray |
| | | shipIndexArrays1 |

Filling Silo Conditions and Variables

- | | | |
|----------------------|--------------|--------------|
| shipEventSiloFilling | loadCym | draftCym |
| shipCondDom1 | shipCondAnt1 | shipCondStM1 |
| shipCondDom2 | shipCondAnt2 | shipCondStM2 |
| shipCondDom3 | shipCondAnt3 | shipCondStM3 |
| | | shipCondStT1 |
| | | shipCondStT2 |
| | | shipCondStT3 |
| | | shipCondAru1 |
| | | shipCondAru2 |
| | | shipCondAru3 |
| | | shipCondCur1 |
| | | shipCondCur2 |
| | | shipCondCur3 |

Anylogic Model Description



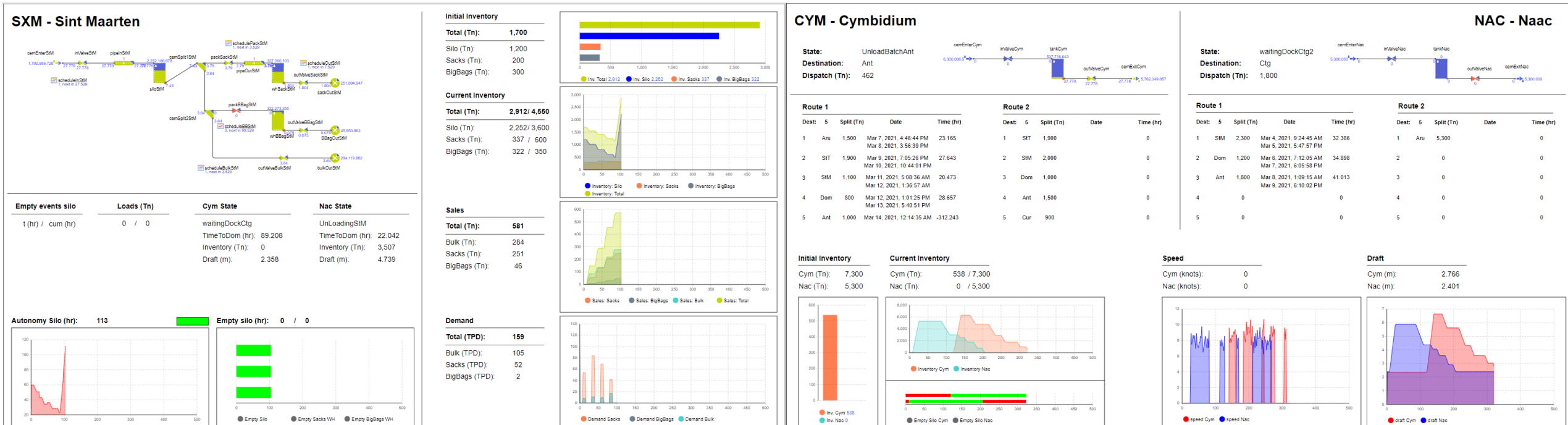
Output approach

Terminal

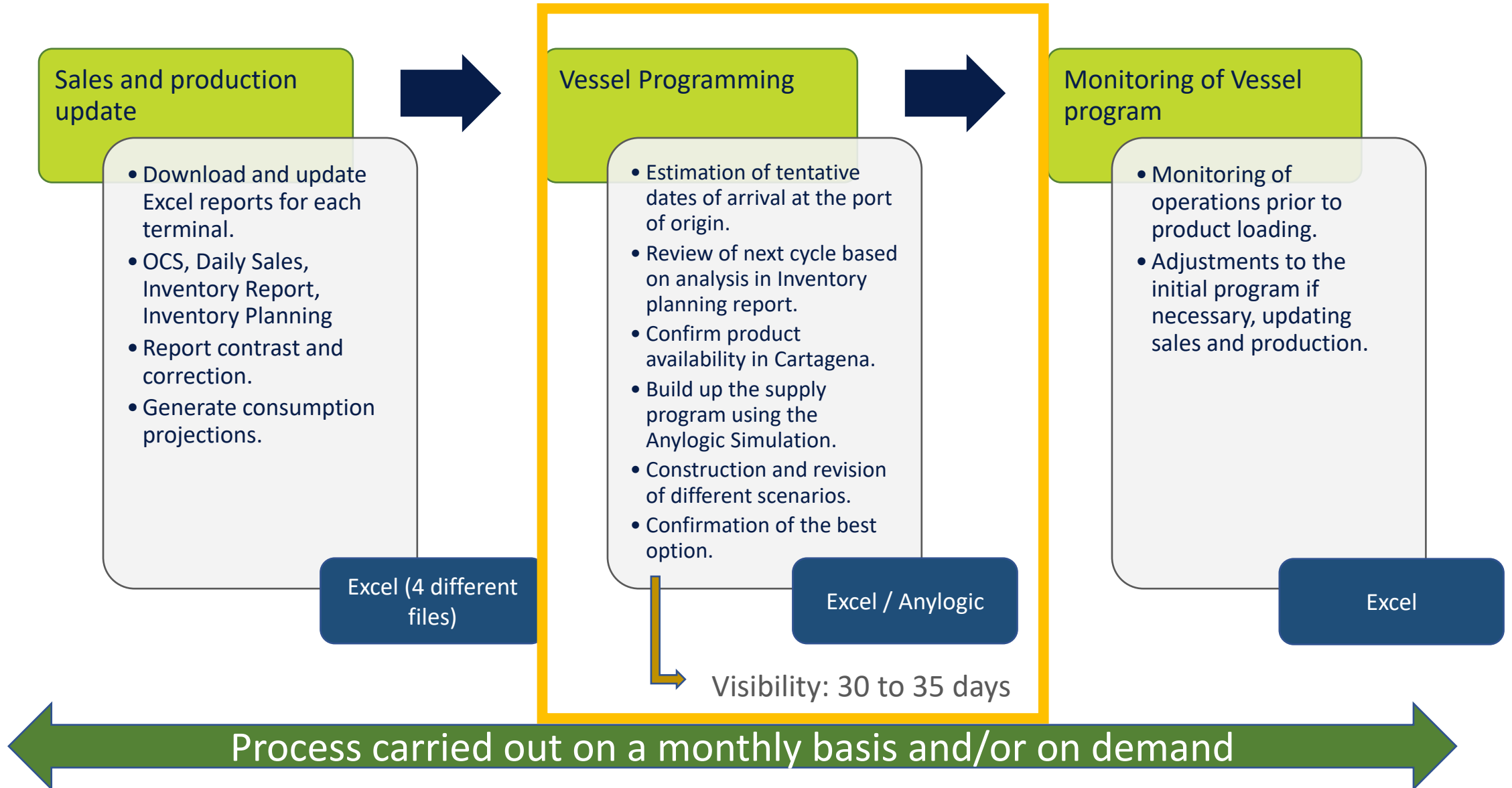
- Inventory shortage events and accumulated time without inventory.
- Final inventory projected for each product (silos and WH).
- Monthly sales per terminal.
- Daily demand per product.

Vessels

- Arrival and departure times for each vessel
- Time of permanence
- Cement inventory report
- Speed profile
- Draft monitoring



Anylogic Model Description



Simulation KPI's



To measure the simulator's performance and assertiveness in the generated plans, the following indicators were created:

KPI	Measurement Unit	Calculation	Level	Frequency	Minimum value	Source
Cement Inventory breakdown	# days without inventory	# events without inventory	Per terminal, Total cement	Monthly	0	International Sales Rep.
Loss of income for days of breakdown	\$ Income	Average MT per day * Sales Price	When the event occurs	Monthly	0	International Sales Rep.
Vessel capacity utilization	% utilization	Total MT Loaded/ Vessel Capacity	Per Vessel (Nacc & Cymbidium)	Monthly	90%	Trading
Fulfillment of Supply program	%	Terminals serviced on schedule, order of sequence, MT supplied.	Per vessel, per terminal	Monthly	80%	Everyone

The KPI corresponding to “Fulfilling of Supply Program” (Perfect Delivery) assigns a weight to the following variables that intervene in the supply plan:

- Date of departure from origin
- Date of arrival to each terminal
- Vessel assignment
- Stop Sequence
- Assigned volume.

Results with simulation indicators

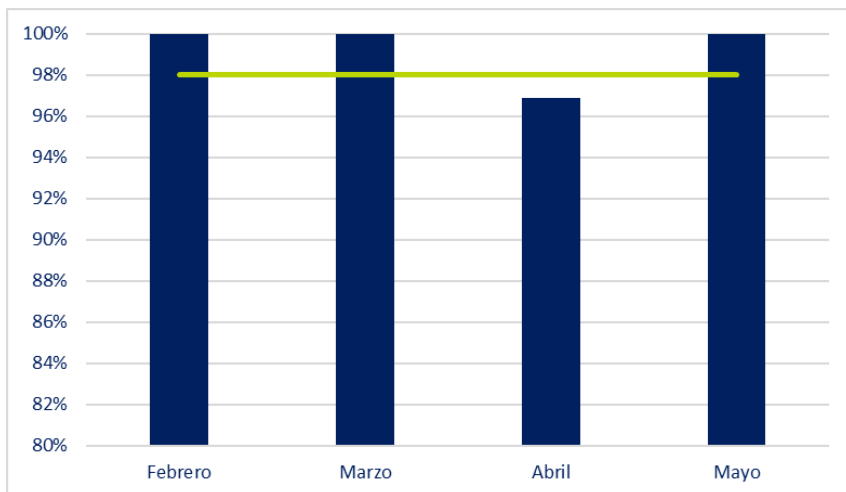


Below are the indicators designed to measure the performance of the simulation exercises carried out between February and May 2021:

1. Inventory Breakdown: No inventory breakdowns in the period under review. **Fulfilling** ✓

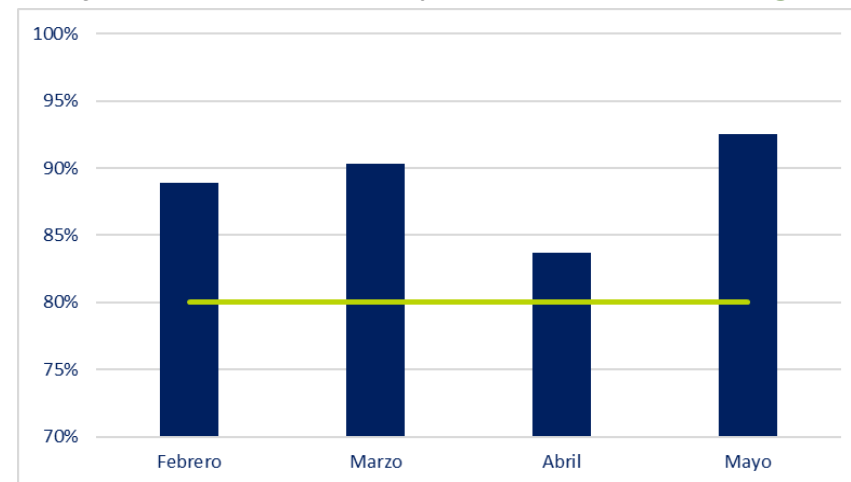
There has been an increase in inventory levels at the terminals during the test period (Annexes by terminal).

3. Vessel Capacity utilization
Objective= 98%, Accomplished= 99%. **Fulfilling**. ✓



2. Loss of income: No loss of income, resulting from no cement breakdown. **Fulfilling** ✓

4. Supply Program:
Objective= 80%, Accomplished= 84%. **Fulfilling** ✓



Benefits of the simulation model



- Greater visibility of operations, having a broader horizon, identifying possible risks such as inventory shortages, adjustment to the production program, delays in shipments, among others.
- Time reduction in the supply scheduling process. Decrease in split changes.
- Review of the system bottle necks in a systemic and integrated way.
- Improved product availability in real time, placing inventory where it is required.
- Lower labor costs and overtime. Higher volumes sold in 2021, with a unitary cost equal to 2020.
- Fleet use optimization.
- Ease of knowledge transfer. (the simulator will provide the basis for beginner users).
- Ease of scenario development, freeing network restrictions.

Improvement opportunities - Next Steps

- Heuristic model for autonomous destination definition by vessel
- Reinforce learning applied on agents (vessels) behavior



Thank you!

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