

Simulation for Bulk Material Handling:

A compilation of successful case studies

Felipe Gana - fgana@moffattnichol.com

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moffatt & nichol

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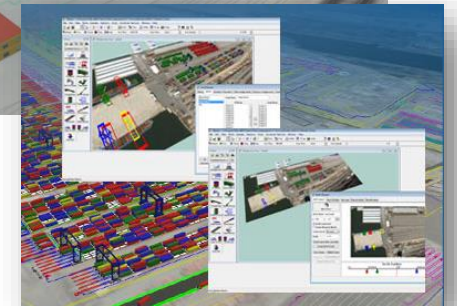
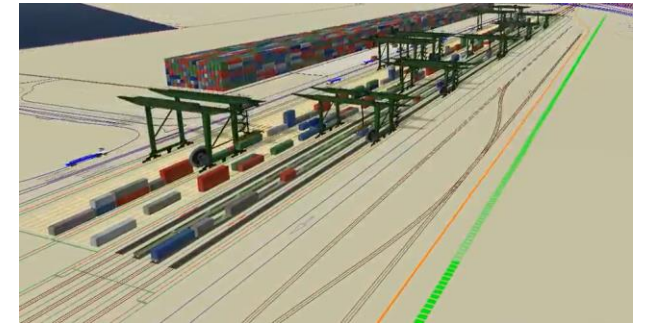
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Discrete Event Simulation



Discrete Event Simulation (DES)

- › DES is one of the most powerful and widely used tools in operations research to analyze complex real-world systems. DES involves representing a real-world system within a virtual environment, incorporating simplifications and assumptions to mimic the real-world system behavior, aiming to answer specific questions and allowing valuable lessons learned from the simulation to be applied to existing or planned systems.
- › Components of the Model:
 - › **The Dynamic Model:** A simplified yet representative version of real-world processes.
 - › **Input Data:** Parameters and initial conditions loaded into the model. This includes loading probability distributions for random variables, which account for variability and provide more realistic results.
 - › **Time Management:** The advancement of time within the model, which can be continuous or in discrete steps.
 - › **Outputs:** Key performance indicators (KPIs) that are obtained from the simulation model runs. These outputs are critical for making informed decisions about the scenarios and questions posed, with the intent of applying findings to the real-world system.



What is FlexTerm?



What is FlexTerm?

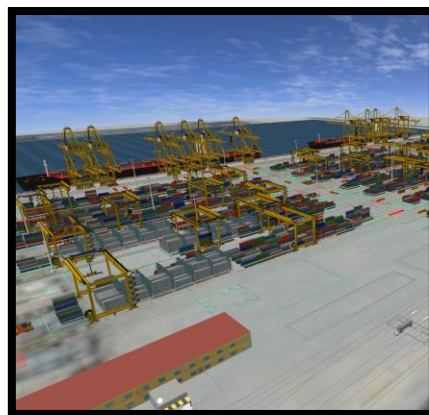
FlexTerm Software Tool

Domain Knowledge



Technical Knowledge

FlexTerm Model



Inputs

e.g. CAD Layout,
Planning / Operation
Parameters



› FlexTerm is a proprietary software tool developed and owned by M&N

› Robust platform used to deliver on simulation and emulation projects

› Actively developing new features

› Actively maintaining the software with regular updates

› Can license to customers for their own applications

› FlexTerm combines **domain knowledge** and **technical knowledge** to create a digital model that is representative of a real-world system

› Simulation is cost-effective to study a system

› FlexTerm becomes the solution to the problem

› Extensively used for container ports and terminal

› Actively used in other domains such as:

› Dry Bulk Terminals;

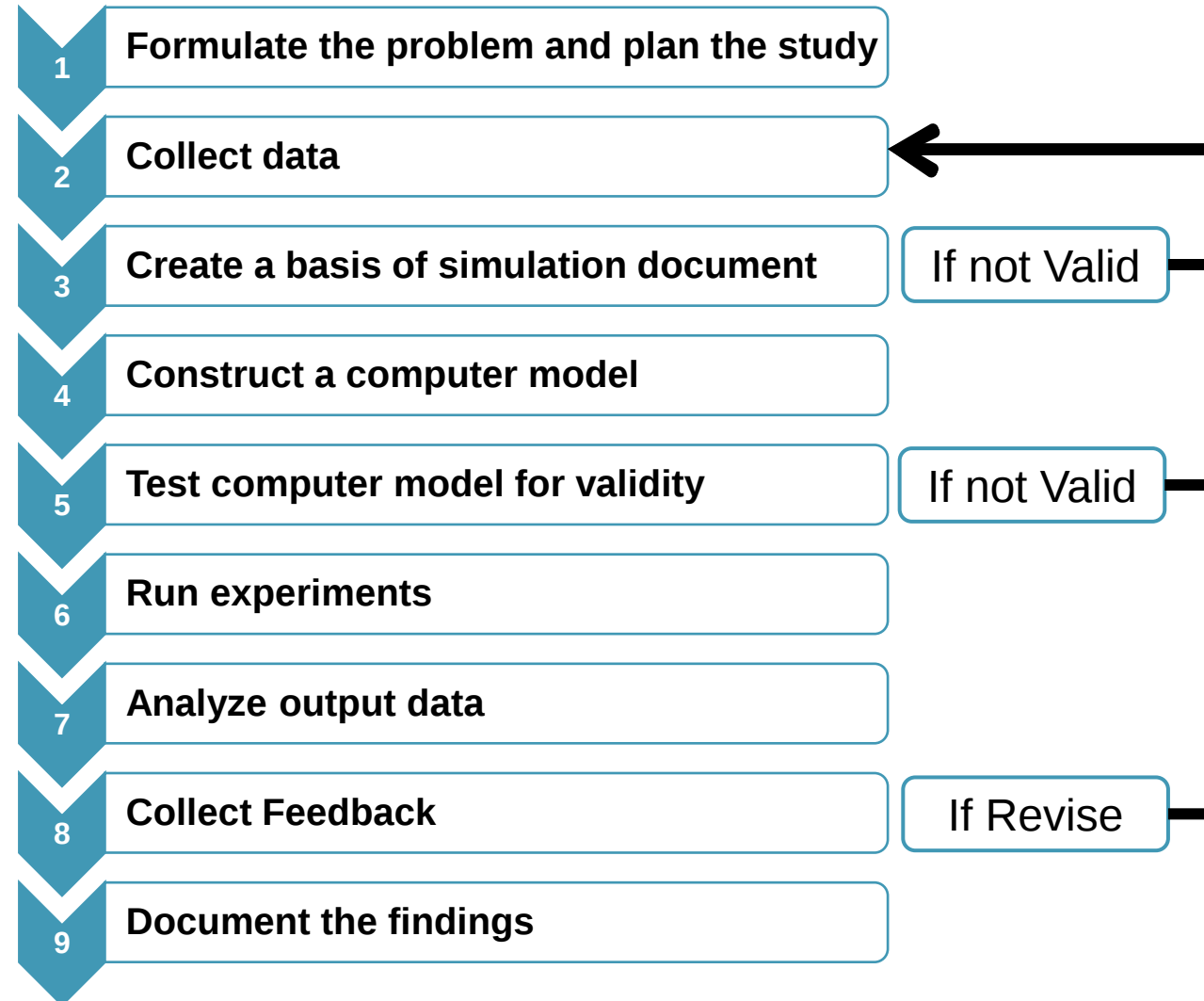
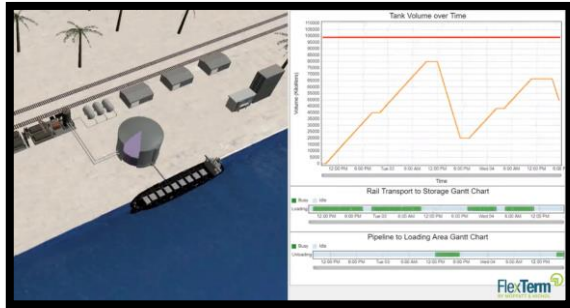
› Oil and Gas Terminals;

› Offshore Wind Terminals

› Passenger Cruise Terminals;

How to use FlexTerm to Solve Problems?

Simplified Process



FlexTerm Applications

Capacity Evaluation

- What is the throughput capacity of the terminal?
 - Storage capacity? Berth? Gate? Rail?
 - Peak or average?

Equipment Analysis

- What are loading/unloading equipment productivities?
- How many and what kind of loading/unloading equipment?
- What kind of horizontal transport?
How many units?

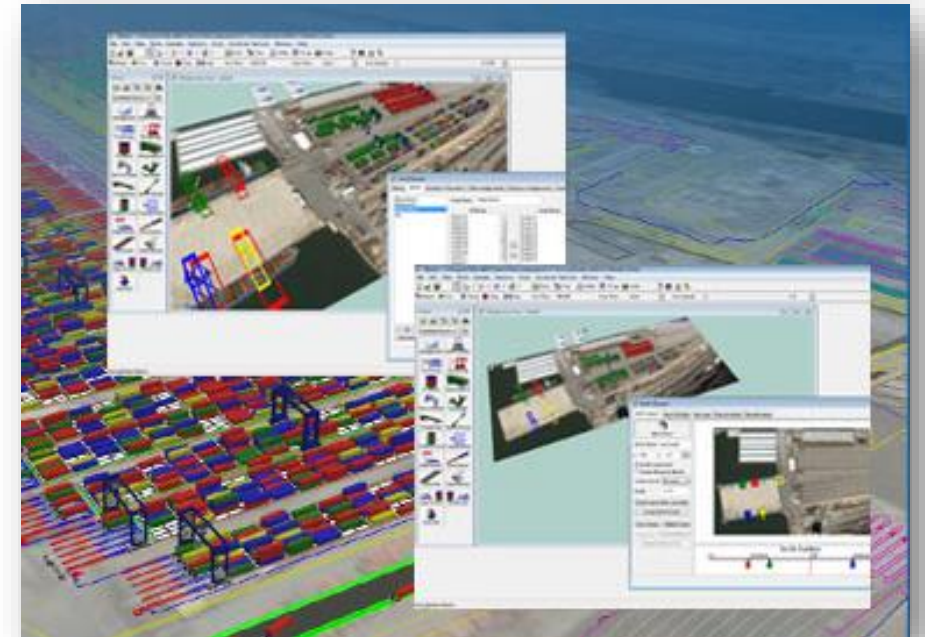
Financial Analysis

- What is my capital/labor/energy/maintenance cost?
- Total cost per lift?

Reliability Analysis

- What if the equipment is down?
- How will a security escalation impact my terminal operation?

Any Process can be modeled!



Bulk Handling Simulation



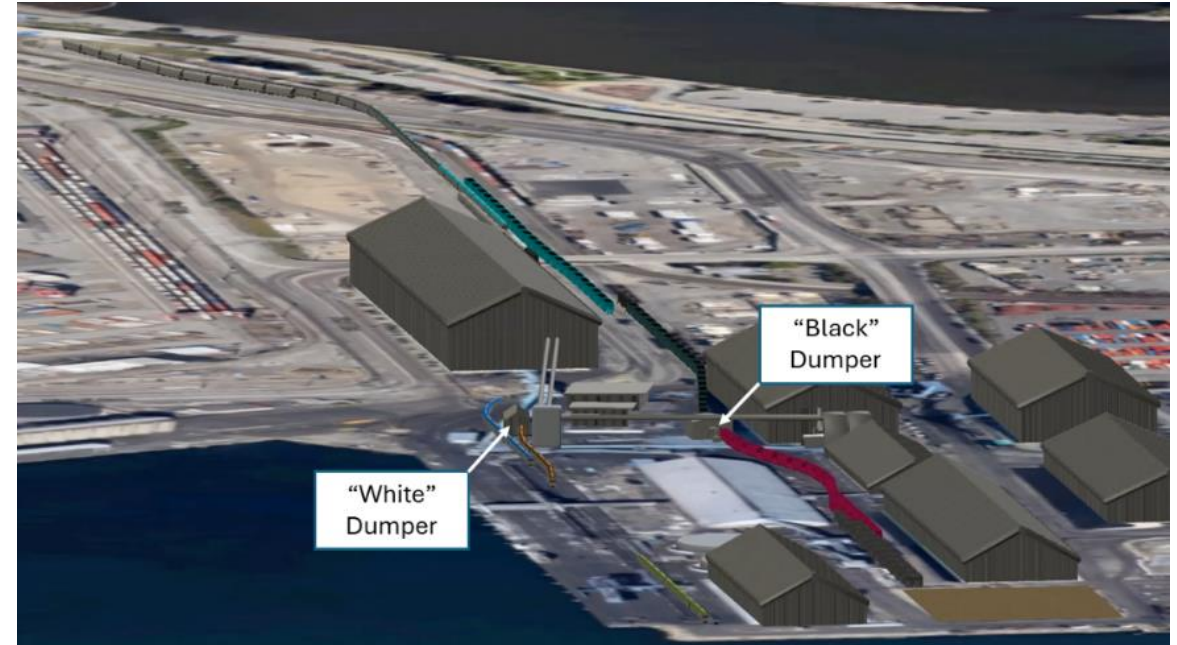
Bulk Handling Simulation

FlexTerm empowers us to simulate a wide array of solid and liquid bulk-related activities

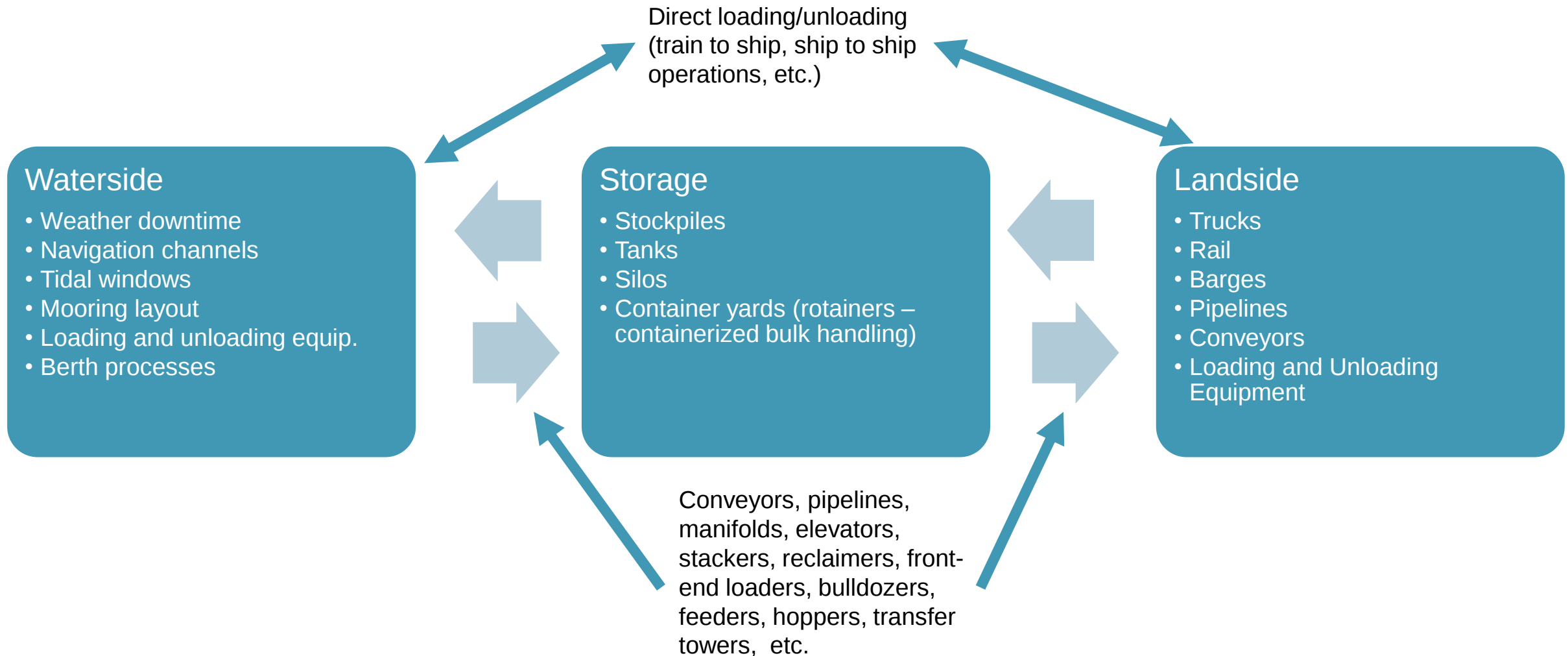
Provides critical insight into optimal procedures and configurations

Key benefits and capabilities include:

- Enhancing operational planning
- Resource utilization evaluation
- Process bottleneck identification
- Vessel queue and wait time reduction
- Impact analysis
- Trade-off analysis
- Sensitivity analysis
- Optimize train working sequences



Bulk Material Handling Processes



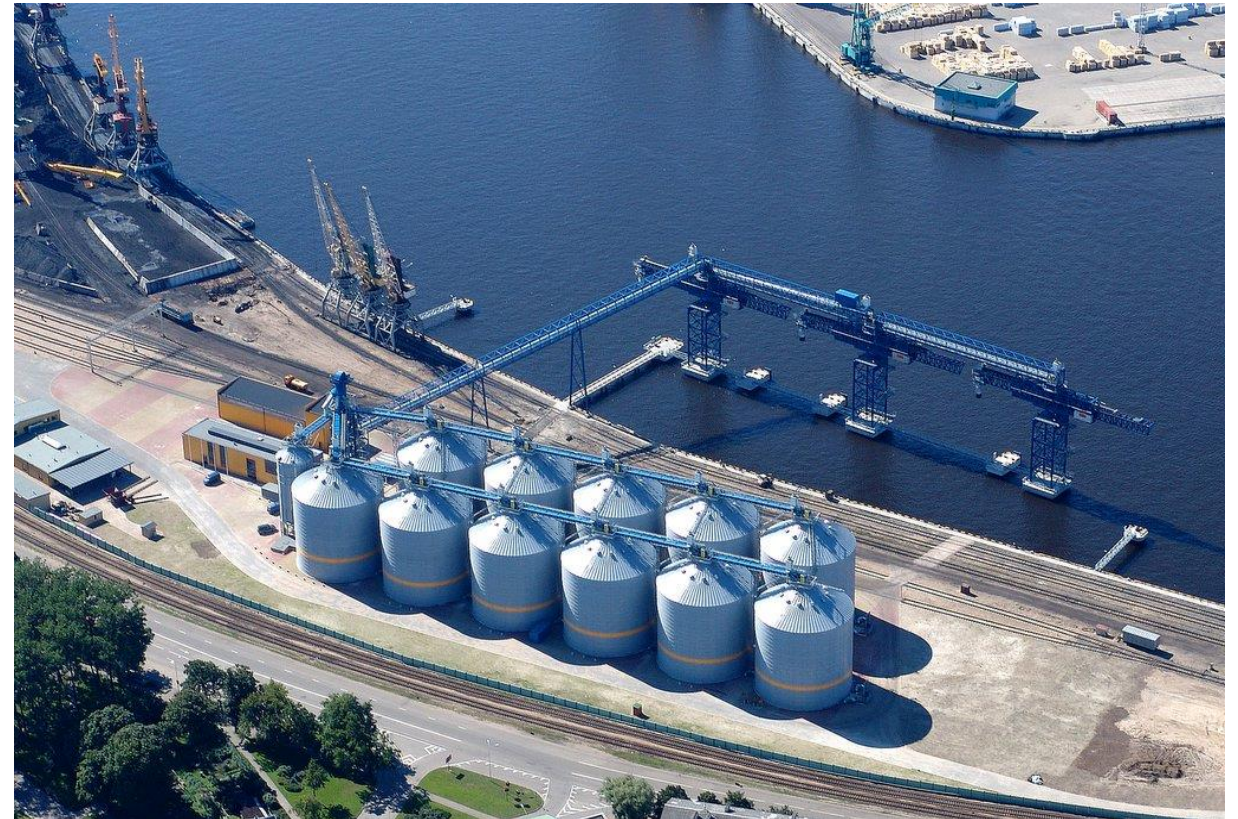
What Questions can FlexTerm Answer?

- Throughput analysis, check maximum throughput on existing facilities, check required facilities to increase throughput.
- Demurrage calculations.
- Stockpile sizing (sensible to downtime when this is high).
- Port stockpile optimization or reduction (through direct loading/ remote stockpiling)
- Feasibility of handling new products.
- Trade-offs between shiploader types (traveler, radial, etc.), mooring arrangements, breakwater requirement, etc.
- Optimize depth of navigation channels.
- Trade-offs between barge transshipment options.



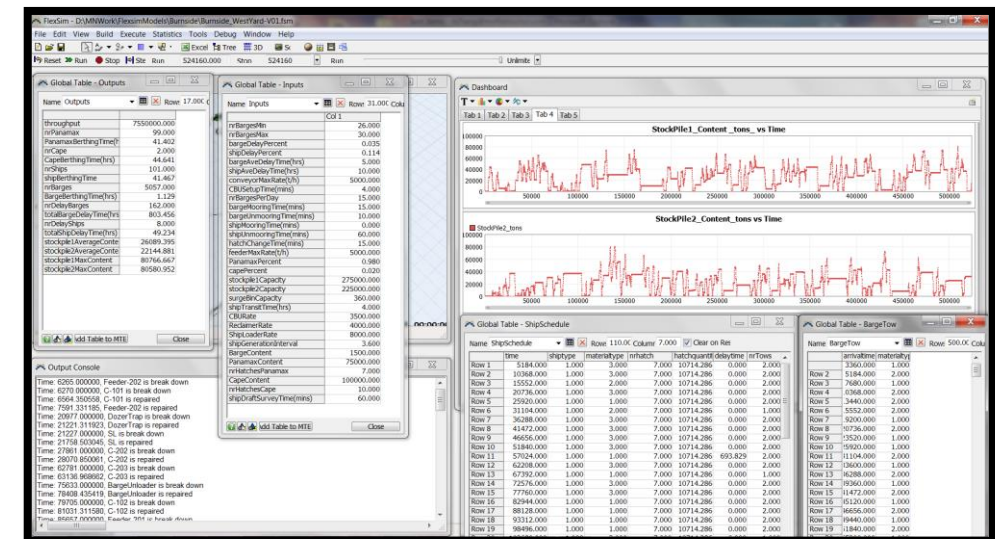
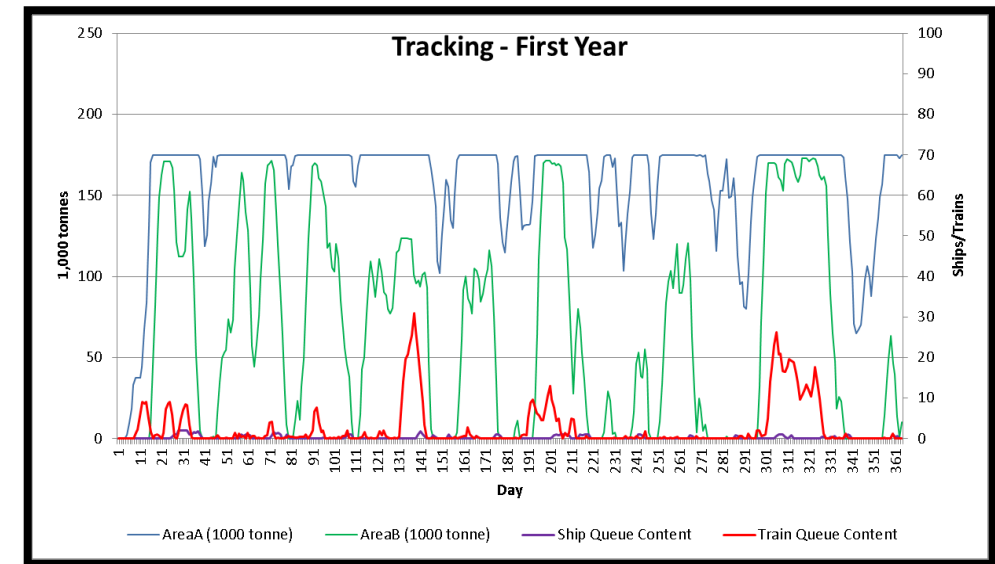
Critical Considerations for Bulk Simulation

- Usually at least one year simulation to analyze properly the inventory variations.
- Multi-year simulation can be performed to include year variations in weather downtime, simulate the production variations, etc.
- Vessel, rail and truck arrivals can be inventory driven. Multiple load sizes and products can be simulated.
- Scheduled maintenance and reliability logic (failures) can be included in the model.
- Multiple replications can be performed to produce multiple samples and better estimate of mean and variability of the KPIs (Monte-Carlo analysis).



Typical Simulation Outputs

- Throughput tonnage finished
- Stockpile and tank contents, average and maximum, changes over time
- Unloading and loading rate, net and gross
- Equipment utilization
- Berth occupancy
- Berth time, port time, and waiting time for ship, train, and barge
- Etc.

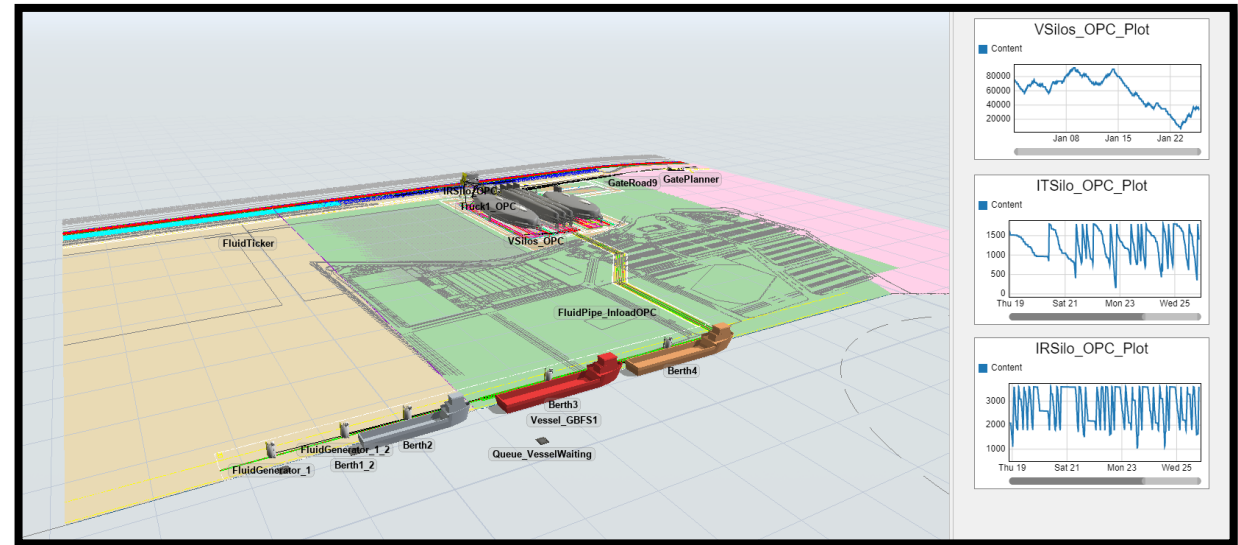


Case Studies



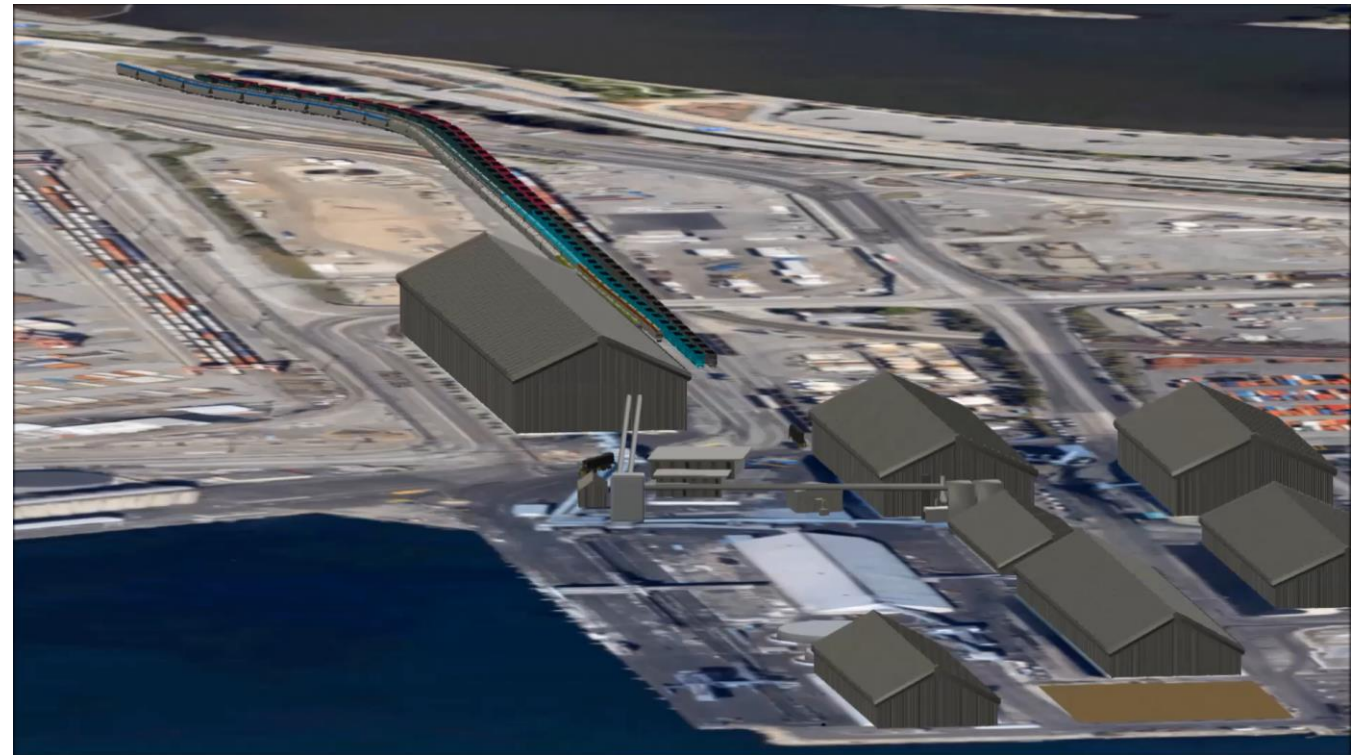
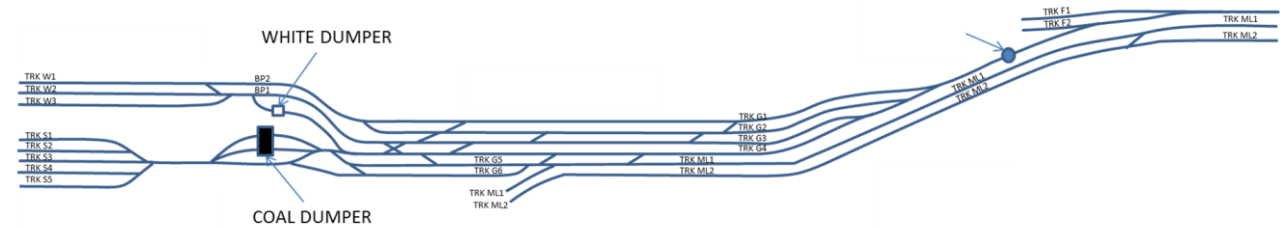
Case Study: Cement Facility

- › **Objective:** Perform a capacity analysis for the master plan and conceptual engineering project for a cement port in Asia. The facility considers the import of five types of cementitious products.
- › **Approach:** Capacity verification and equipment and storage sizing through dynamic simulation with FlexTerm.
- › **Outcome:** A simulation was programmed which included berth operations, conveyors, storage, loading truck and train stations. With the results of the simulation, port planners could analyze bottlenecks and improvements to the facility.



Case Study: Coal Terminal

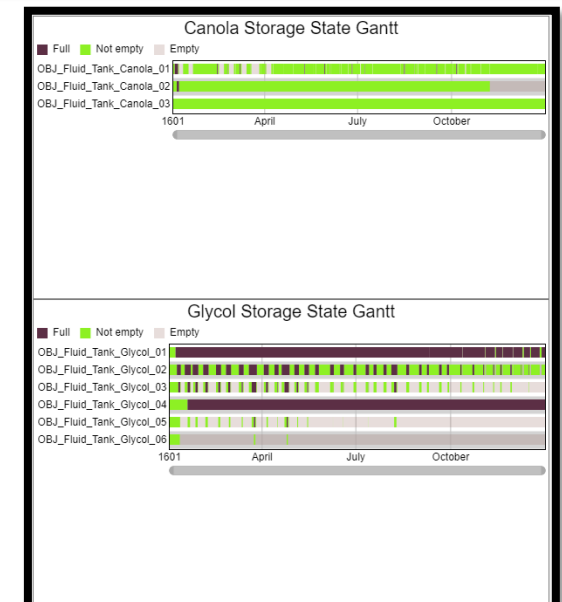
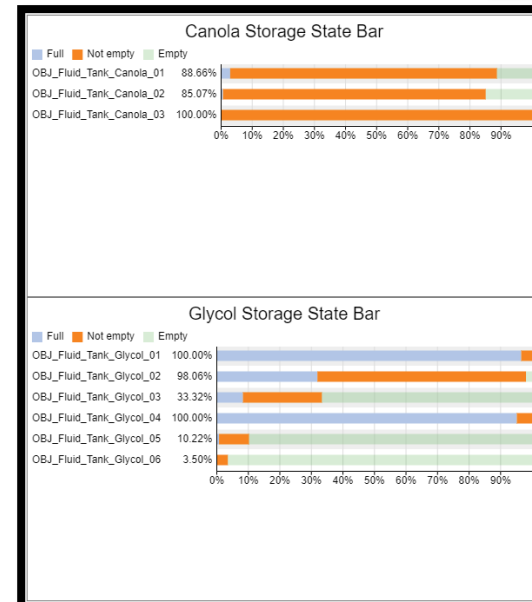
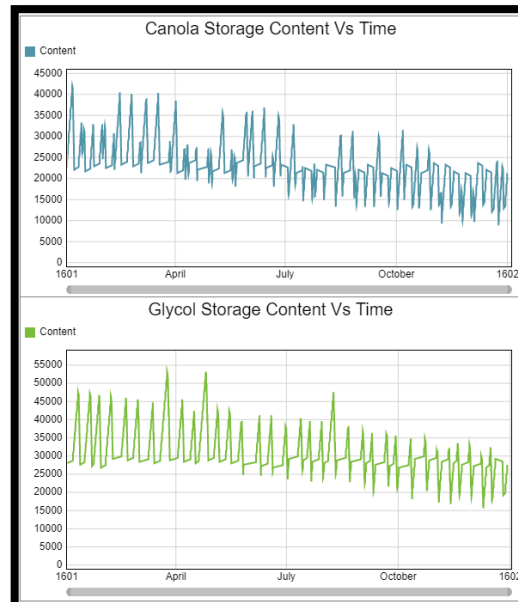
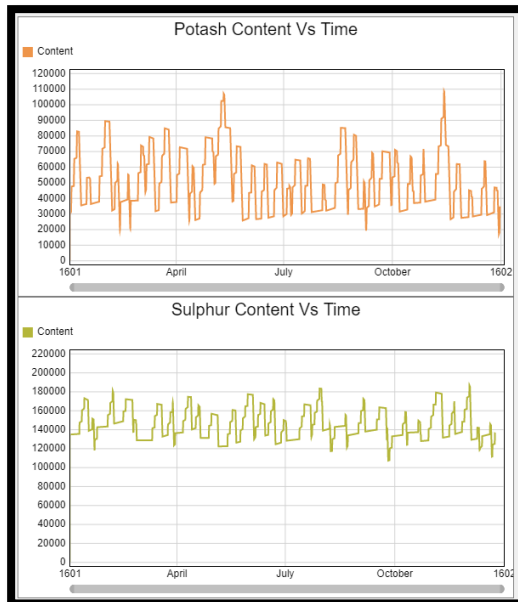
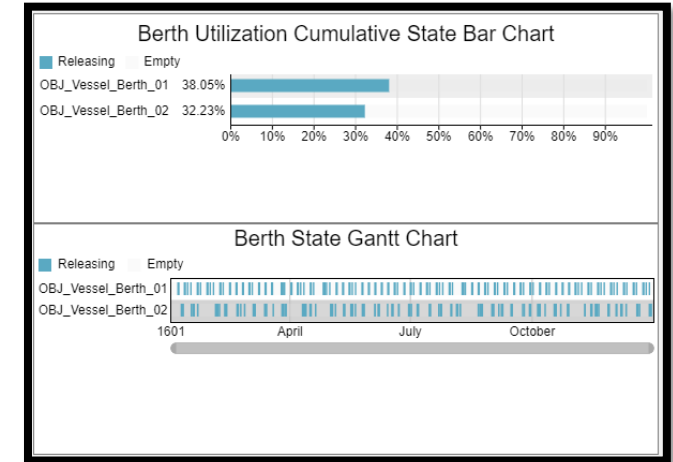
- › **Objective:** Evaluate capacity and efficiency of the terminal under various proposed changes, including increased dumper speeds and additional tracks, to identify bottlenecks and propose effective mitigation measures.
- › **Approach:** Simulated the bulk handling operation for both black and white materials using a shared rail yard and tracks, ensuring comprehensive and holistic analysis.
- › **Outcome:** The optimized train handling sequence resulted in an improved rail track design, increased terminal capacity, more flexible operation, and significant cost reductions.



Case Study: Dry Bulk and Liquid Terminal

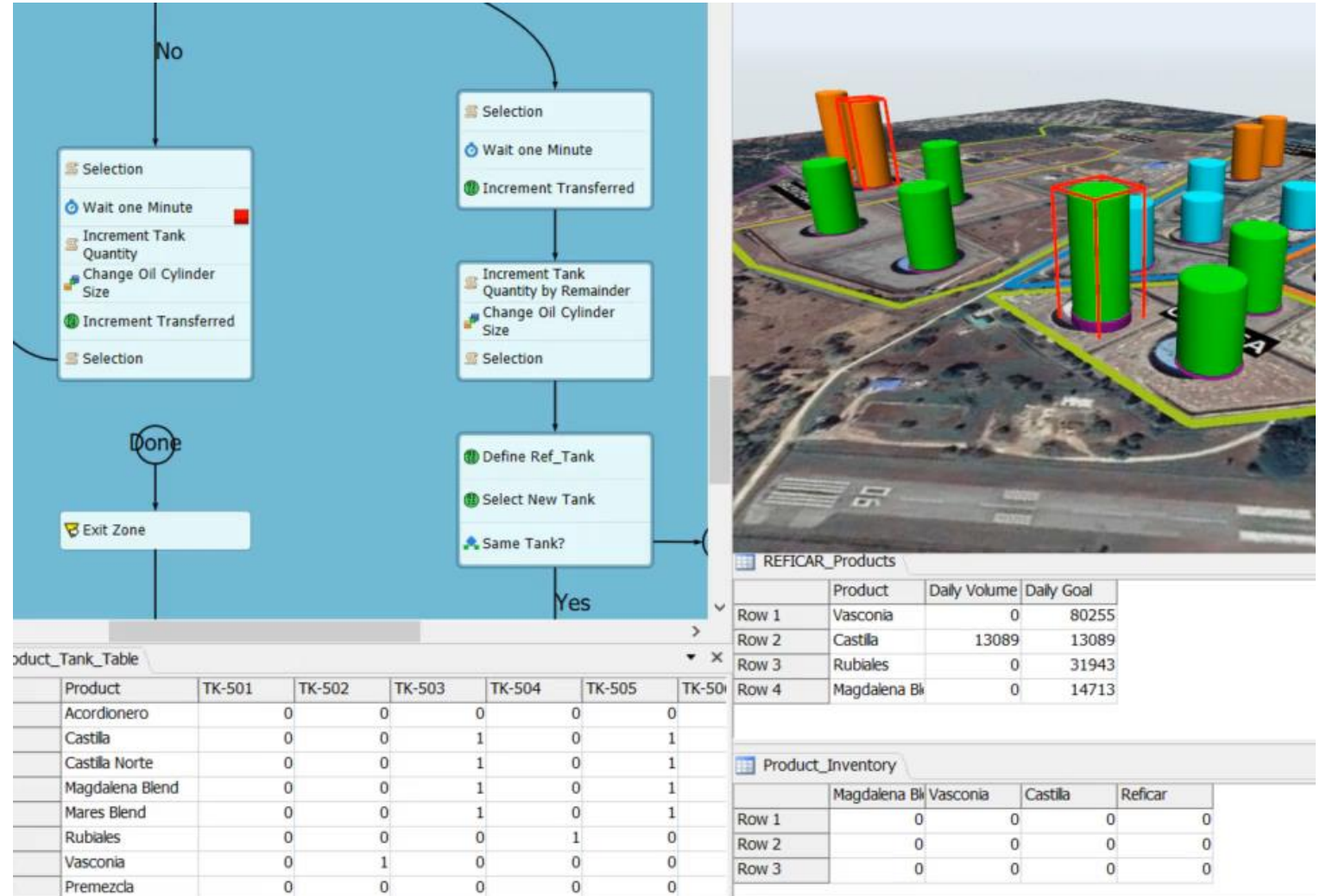
Outputs that were used for planning are stockpile and tank contents, percentage of direct hits, berth utilization, berth state, unloading and loading equipment states and utilization.

Parameter	Simulated Value
Berth 1 Occupancy (Liquids)	38.1%
Berth 2 Occupancy (Bulk)	32.2%
Sulphur direct hits	6.5%
Potash direct hits	12.5%

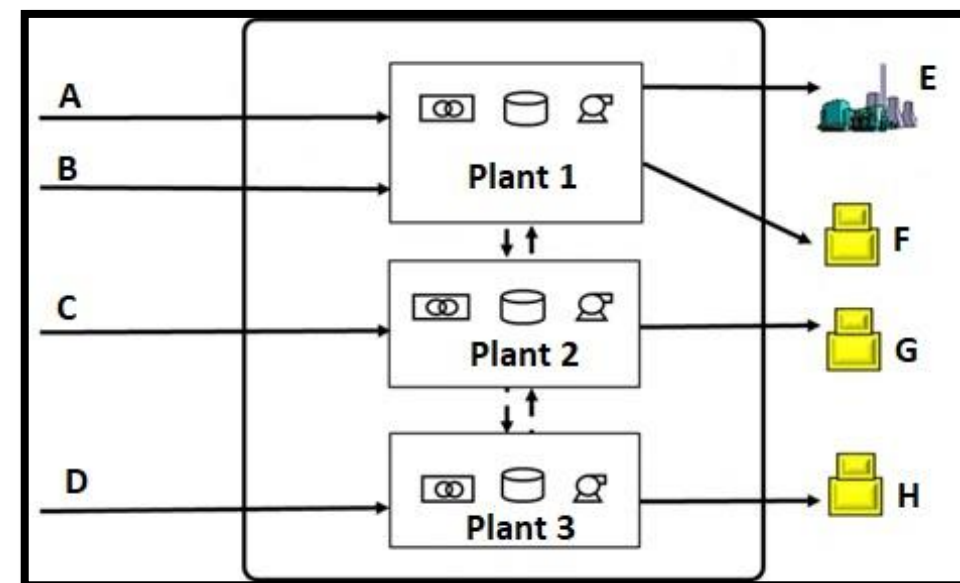
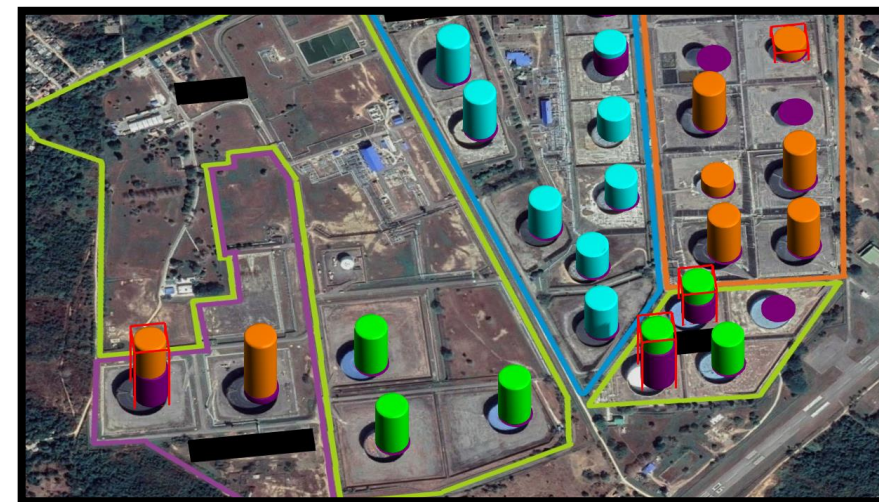
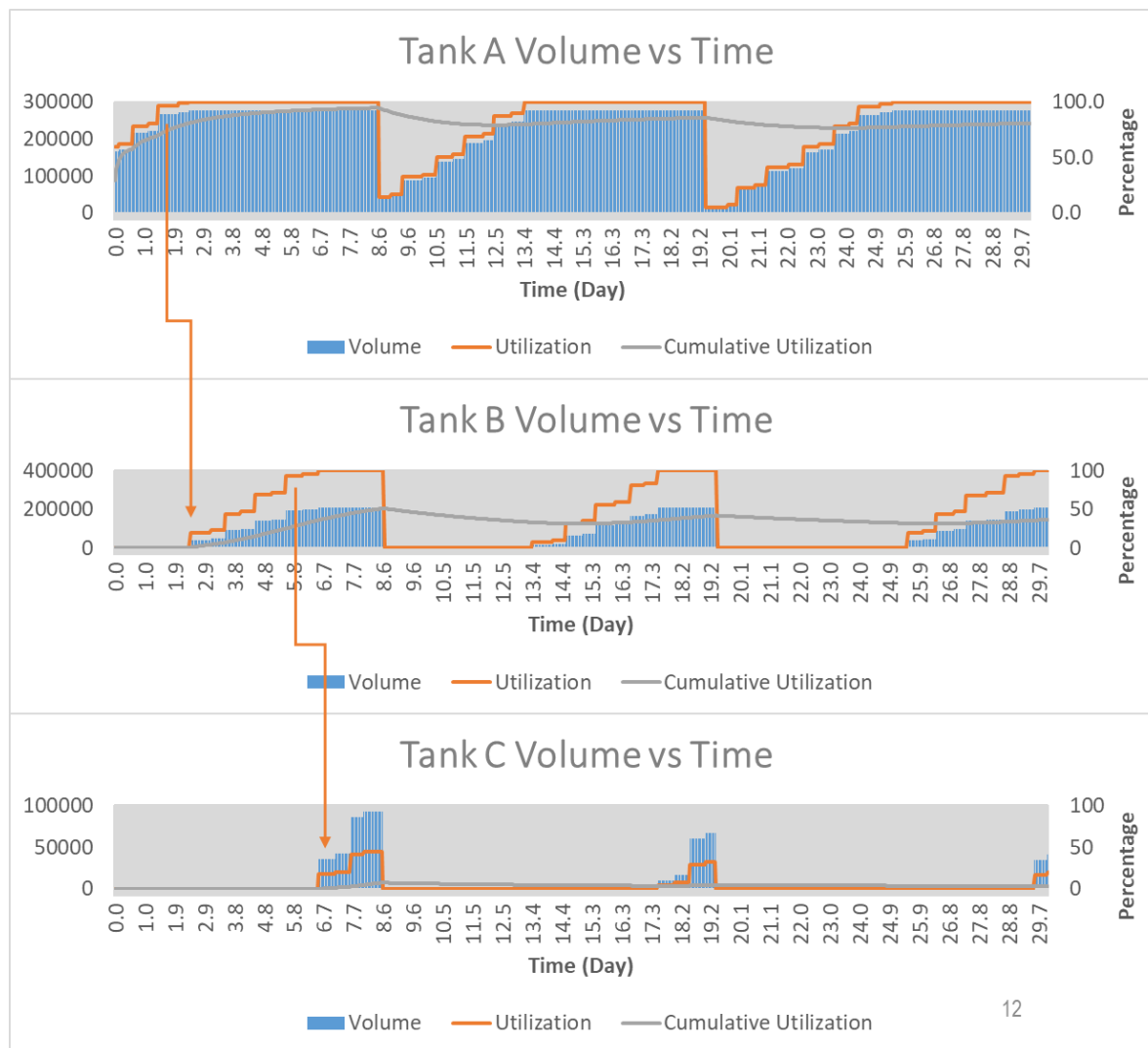


Case Study: Oil Facility

- › **Objective:** The project considers an oil export terminal that wanted to identify tanks that are not utilized over the course of operation which represents additional capacity that can be used for economic benefits. Some of the challenges include multiple oil products, multiple source of inputs, multiple stakeholders, multiple tanks and interactions between stakeholders and multiple outputs.
- › **Approach:** Simulate and model the oil terminal including all the oil products, inputs, stakeholders, interactions and outputs.
- › **Outcome:** After the evaluation with the simulation, M&N helped with the proposal of different tank selection strategies and optimization of the oil terminal.



Case Study: Oil Facility

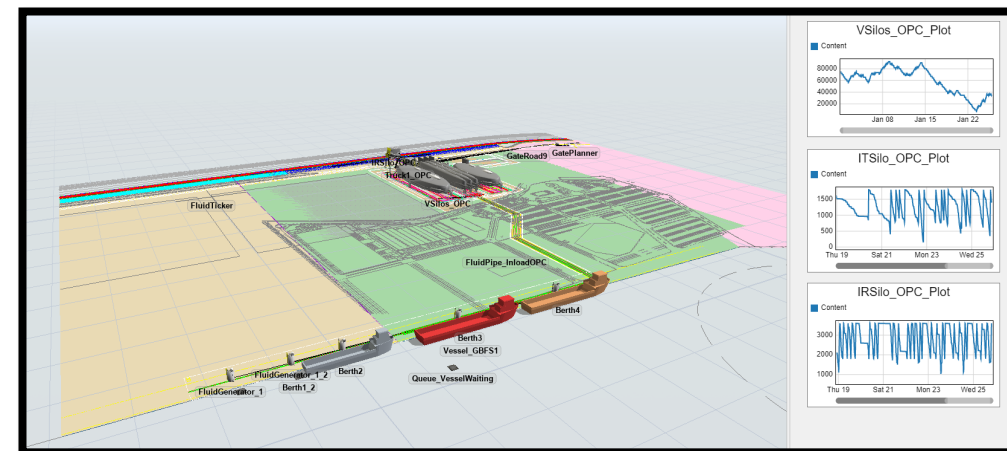


Conclusion: FlexTerm Advantages



FlexTerm Advantages

- FlexTerm is trusted by clients worldwide
- Support decision making for key stakeholders
- Provide a cost-effective solution to assess and evaluate before deployment
- Our clients can make informed decisions that enhance operational efficiency, reduce cost, increase throughput, and optimize resources
- Run tests virtually that would otherwise be too expensive to run in the real world
- Reduce risks and save money early in the process
- Backed by world-class experts



Thank you