



# Container Terminal Simulation with Flexsim CT

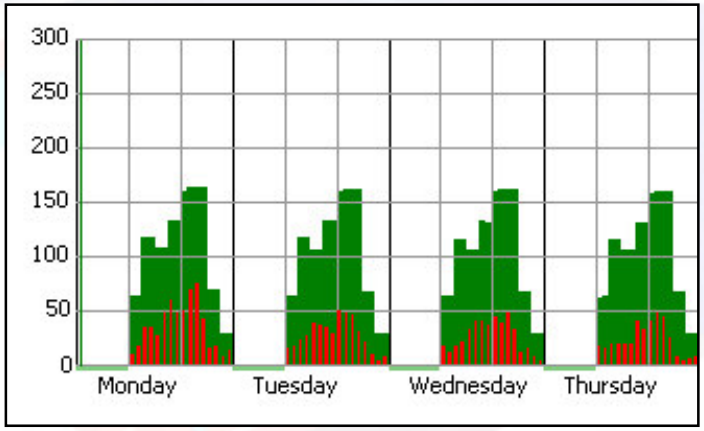
2007

# Planning Example

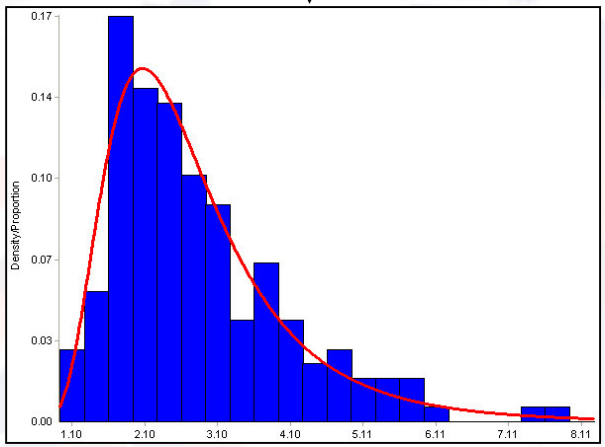
| | |
|---|---|
| Trucks/week | 10.000 |
| Trucks/day | 1.428 |
| Trucks/hour | 60 |
| Interarrival time | 1 min |

**Static**
**Deterministic**
*(Excel, Queuing Theory)*

| | |
|---|---|
| Service time per lane | 3 min |
| Productivity per lane | 20 trucks/h |
| Required lanes | 3 |




**Dynamic**
**Stochastic**
*(Computer Simulation)*




Trucks never come one by one every minute
Interarrival time changes every hour
Demand has peaks and valleys

Only a small percent of the time service times are close to the average

**How can you find the maximum queue size?**
**what about the waiting times?**

# Complex Systems

- Container terminals, like most real world systems, are too complex to allow realistic models to be evaluated analytically. These systems handle a huge amount of information from different independent processes which are stochastic and dynamic.

- With discrete-event simulation we can use a computer to evaluate a complex model numerically, and then gather data to estimate the performance of the real system under different scenarios.

# Container Terminal Efficiency

***(-) Ship Operation Time***

***(+) Quay Cranes Moves/Hour***

***(+) Trucks Cycles/Hour***

***Yard***

Containers locations within the stack
Resources availability
Internal traffic
(+) Yard cranes moves/hour

***Yard Planning, Resource Allocation and System Design***

# Existing Types of Simulation Projects

- Exclusive in-house projects:
  - *15 man years in development.*
  - *High development cost.*
  - *Used for a specific project.*
- Small software tools to simulate only few aspects of the system.
- Consulting services (final user is not allowed to buy the software).
- 3D Animations (not really simulation).

***None of the existing commercial packages from the big discrete-event simulation companies (Automod, Arena, Promodel, Witness, etc) are flexible enough for container terminals.***

# Project Participants (Steering Committee)

- Flexsim – Developers (Utah)
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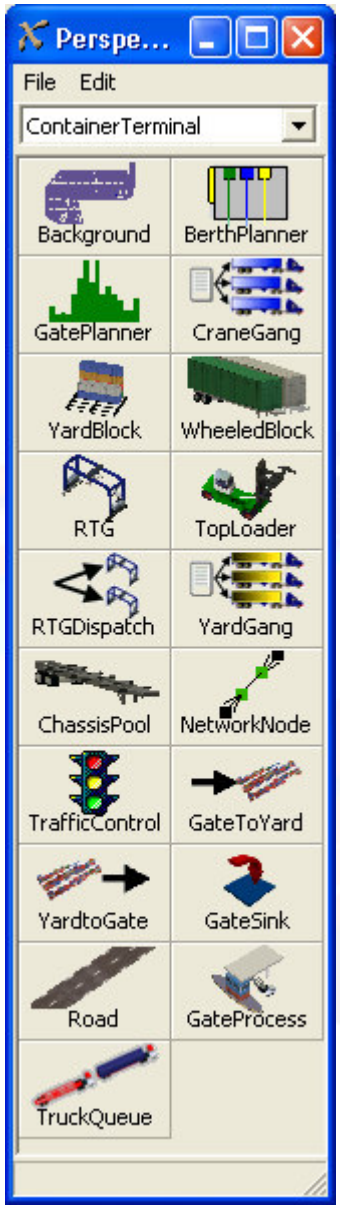
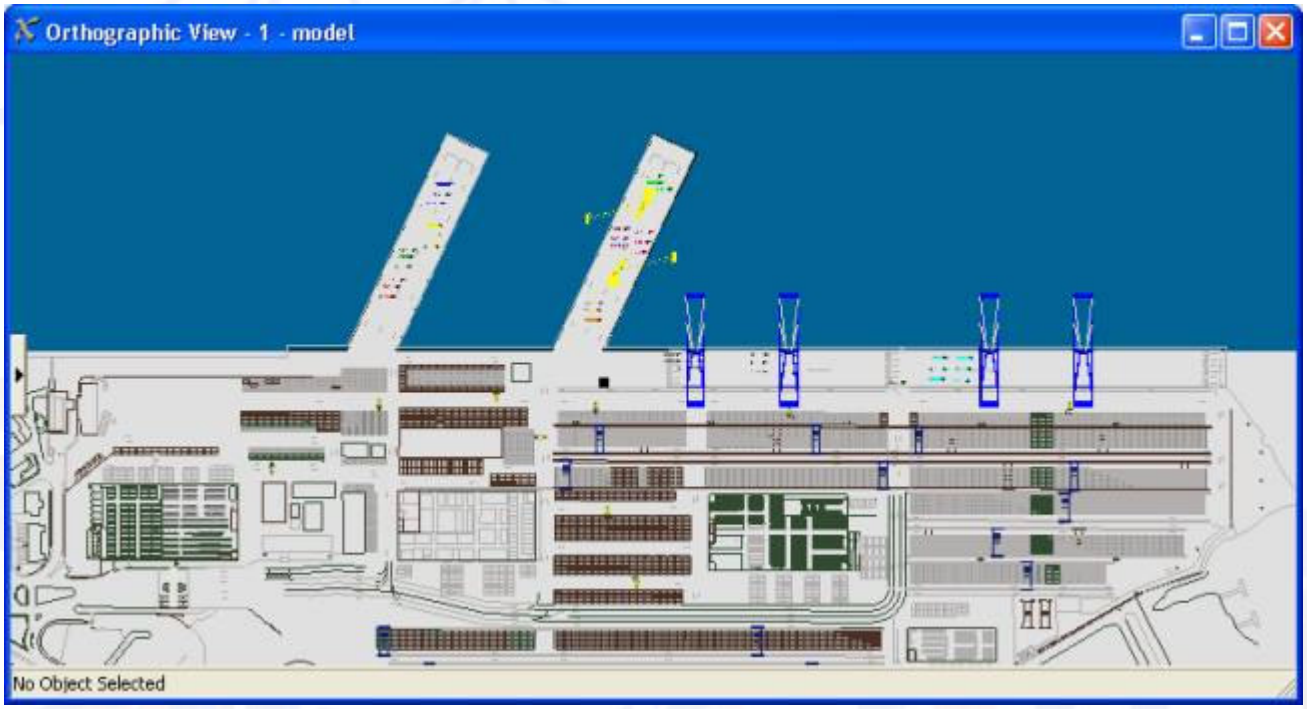
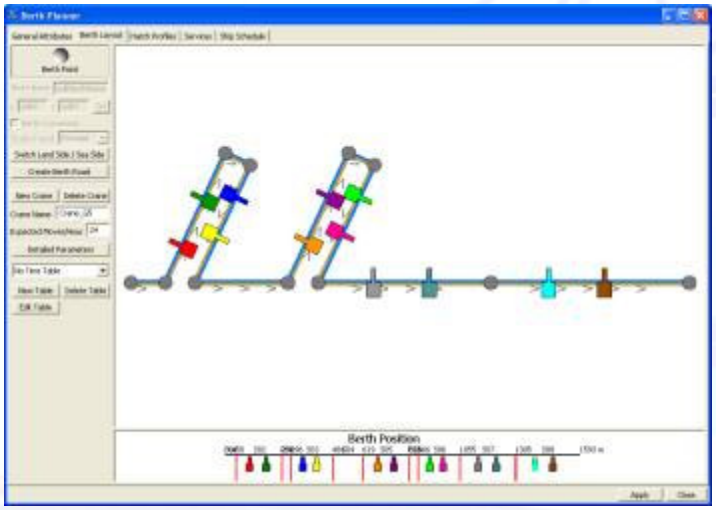
# Simulator Features



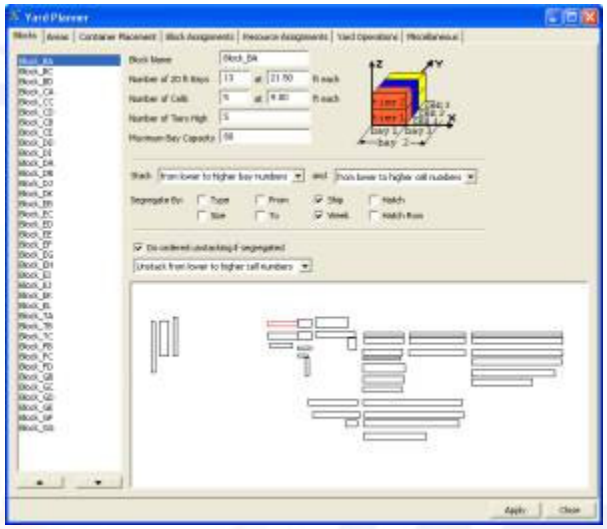




- First commercial “off the shelf” container terminal simulator.
- Drag and drop objects, fast model construction (less than 6 hours).
- User friendly, 3D Graphics.
- Programmable, flexible, adaptable to any terminal.
- Statistically correct.  Built-in ExpertFit and Optimiser (OptQuest).
- Open technology (sockets, odbc, c++, excel, xml).

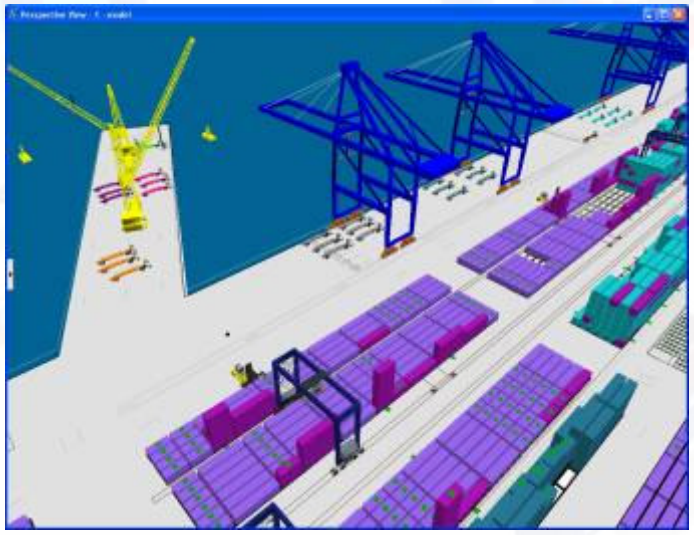
# Simulation Inputs: Terminal Infrastructure




*Berth Layout*



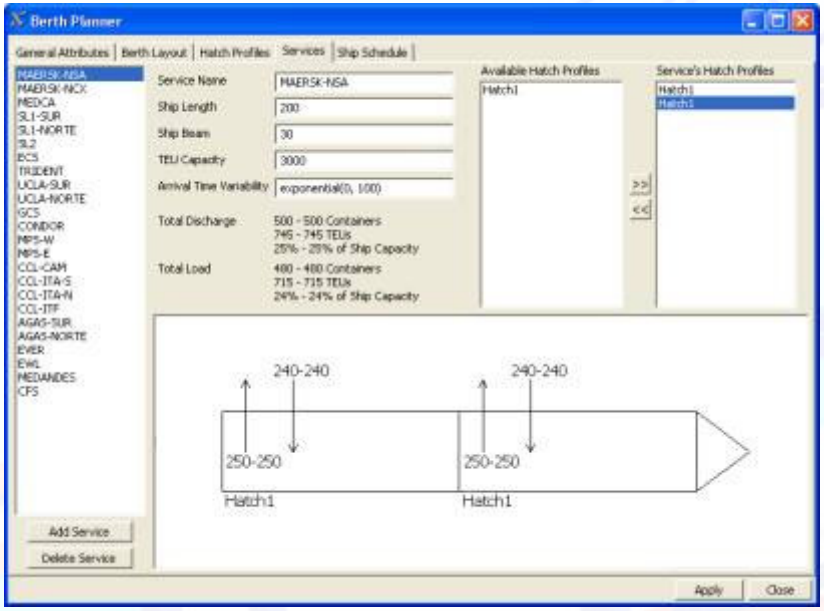
*Storage Blocks*



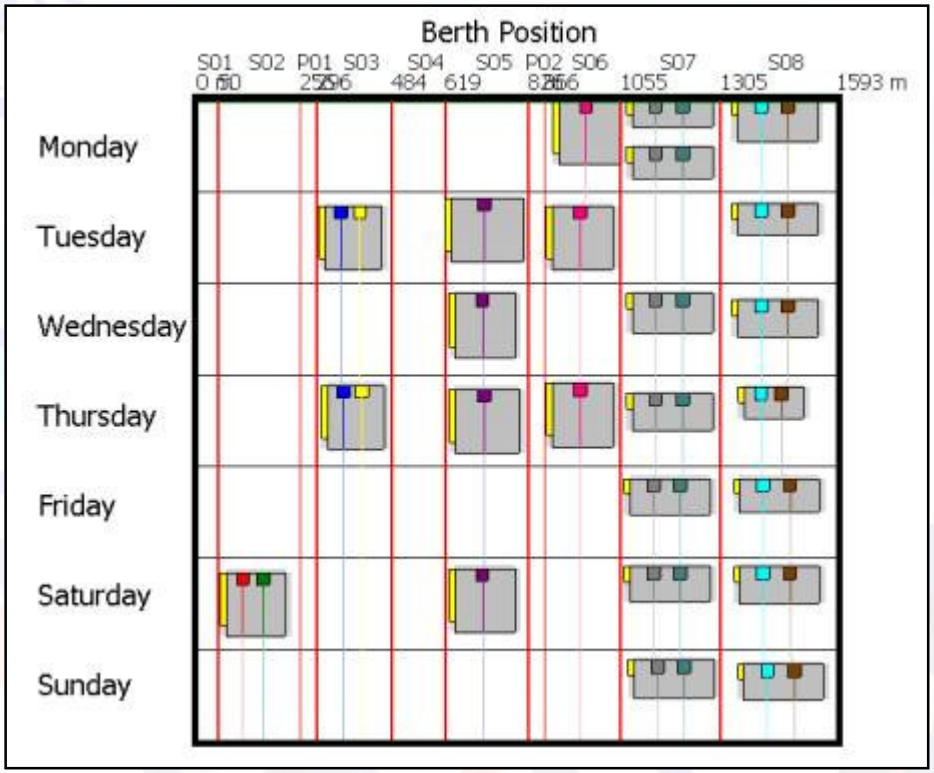
*Cranes and Trucks*
*(travel speeds, productivity, MTBF, MTTR)*

*Gate Layout, Inner Roads*
*and Traffic Constraints*

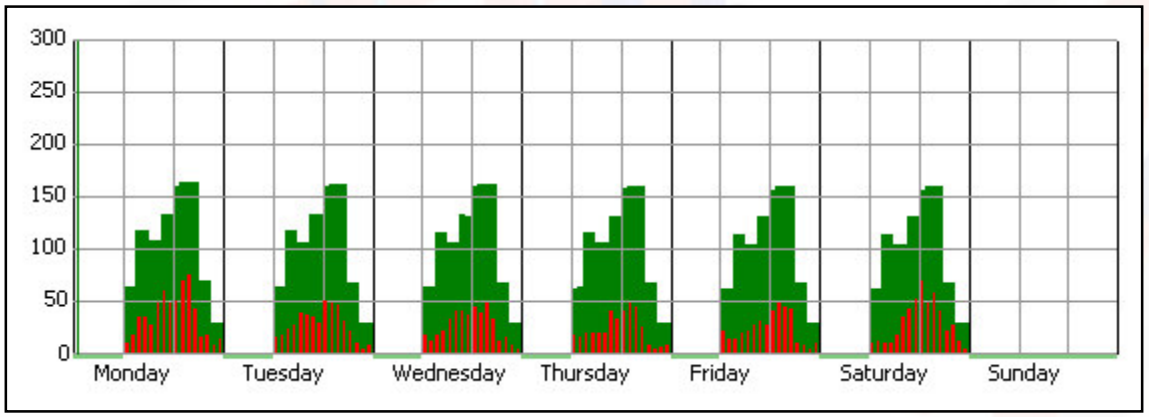
# Simulation Inputs: Cargo Volumes




***Detailed Vessel Movements and Cargo Dwell Time***




***Vessel Schedule and Berth/Crane Assignment***




***Truck Arrivals from Gate***

# Simulation Inputs: Operational Policies

## Yard cranes assignment

| Block / Area | Operation | Container Type | Size | From | To | Ship | Segregation | Custom | Resource * |
|---|---|---|---|---|---|---|---|---|---|
| Block_EL | | | | | | | | | RTG_T1 |
| Block_EK | | | | | | | | | RTG_T2 |
| Block_DK | | | | | | | | | RTG_T16 |
| Block_EJ | | | | | | | | | RTG_T3 |

## Yard stacking filters and segregation policies

| Container Type | Size | From | To | Ship Service | Custom | Block / Area / Table* | Placement Strategy |
|---|---|---|---|---|---|---|---|
| Impo | | | | | | AreaImpo | ImpoStrategy |
| Expo | | | | | | AreaExpoAndTransit | ExpoStrategy |
| Transit | | | | | | AreaExpoAndTransit | TransitStrategy |
| Empty | | | | | | AreaEmpty | ExpoStrategy |

Stack: from lower to higher bay numbers and from lower to higher cell numbers

Segregate By: ☐ Type ☐ From ☑ Ship ☐ Hatch ☐ Size ☐ To ☑ Week ☐ Hatch Row

## Yard stacking strategies

Name: Weighted - Imports

Weight Values | Other

| | Block | Bay | Cell |
|---|---|---|---|
| Segregated | | 0.00 | 0.00 |
| Empty | | 0.00 | 100.00 |
| Filling | | 0.00 | 0.00 |
| Number of Containers | | 0.00 | -200.00 |
| Stacking Trucks in Transit To | 0.00 | 0.00 | -200.00 |
| Unstacking Trucks in Transit To | 0.00 | 0.00 | -6500.00 |
| Truck Travel Distance | 0.00 | | |
| Covered Dwell Time (Days) | | | 0.00 |
| Yard Resource Travel Distance | | -0.01 | |
| Yard Resource Task Queue Content | -200.00 | | |

## Equipment Failures (MTBF, MTTR)

Members | Functions | Breakdowns

First Failure Time: Statistical Distribution: exponential(0,1000,1)

MTBF: Statistical Distribution: exponential(0,1000,1)

MTTR: Statistical Distribution: uniform(50,100,1)

Down Function: Stop object Execute stopobject(). ID: 1 Priority: 0

Resume Function: Resume object Execute resumeobject(). ID: 1 The resumeobject() c

OnBreakDown

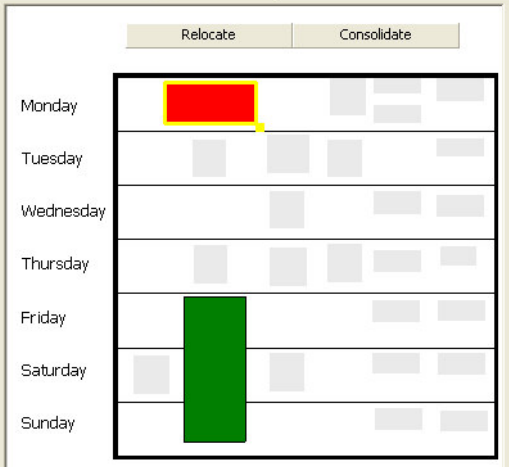
OnRepair

## Housekeeping jobs

From Time: Monday 2 AM
Until Time: Monday 8 PM
Transport Resource: Default Stacking Resource
Unstacking Resource: Default Unstacking Resource
Stacking Resource: Default Stacking Resource

Relocate Container Operation

Type: All Size: All
From: All To: All
From Block: Block_BD
To Block: Block_CC
Placement: Default Strategy



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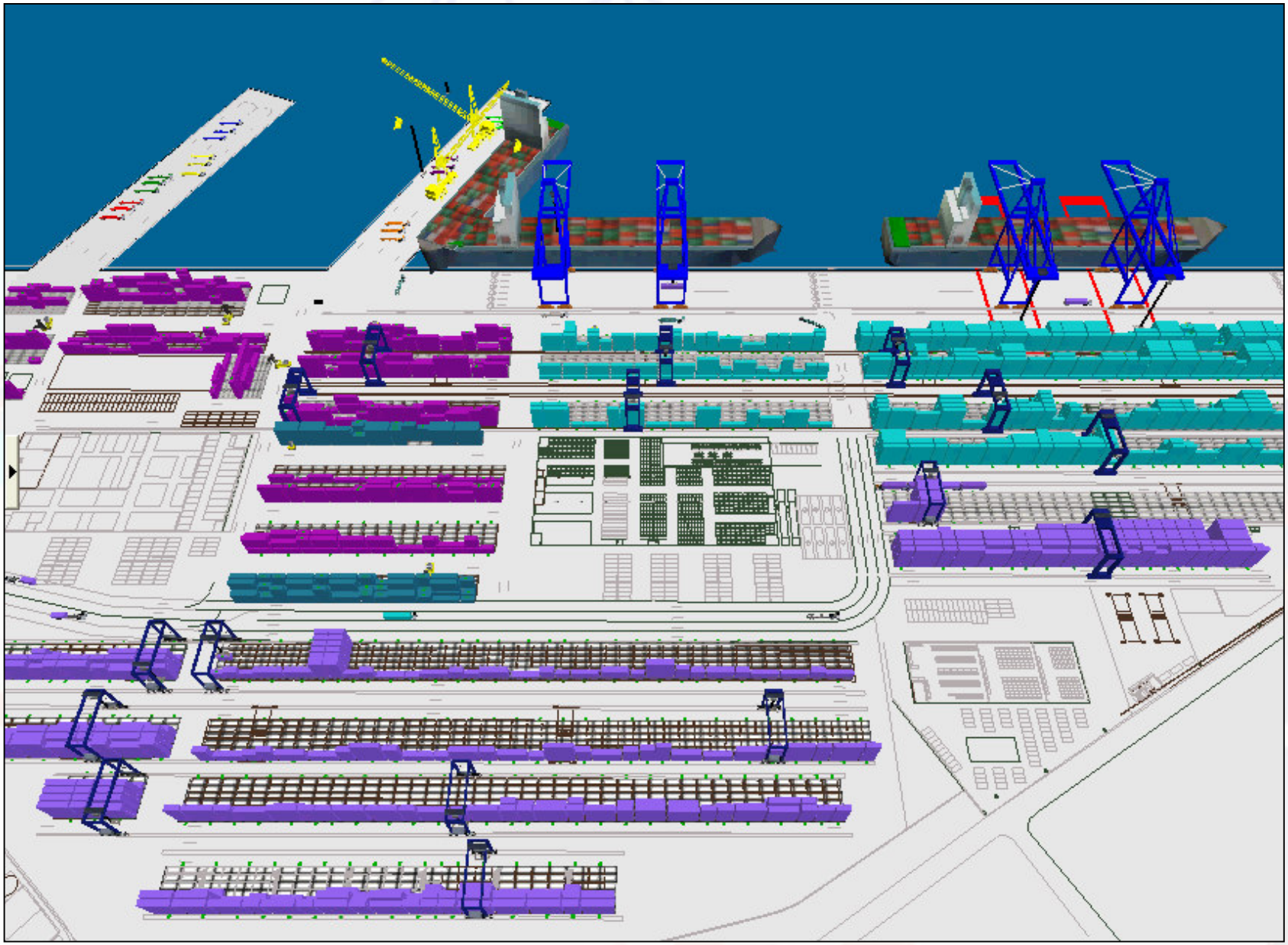
PUERTO DE CARTAGENA

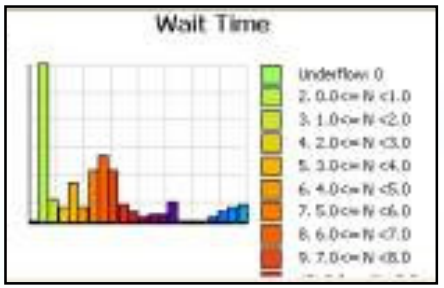
# Simulation Run in 3D Graphics for Face Validation

FlexSim



# Simulator Outputs

***Service Levels***
Productivities
Waiting Times
Queues



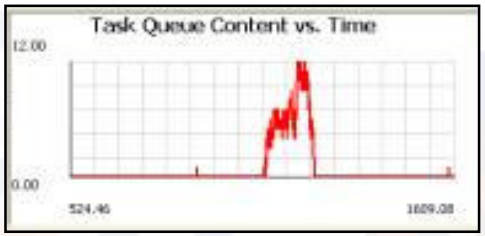

***Infrastructure***

***Cargo Volumes***

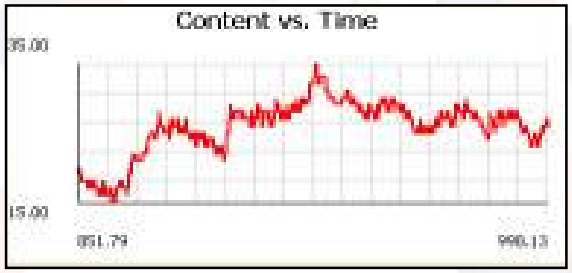
***Operational Policies***

***Flexsim CT***

***Resource Utilization***
Berth Occupation
Inventories
Capacities




***Operational Costs***
Distances Travelled
Fuel Consumption
Yard Rehandles



# Simulation Uses

- Increase throughput
- Improve equipment utilization
- Reduce waiting time and queue sizes
- Reduce bottlenecks
- Balance workload allocating resources efficiently
- Optimise prioritisation and dispatching logic for goods and services
- Study alternative investment ideas
- Justify capital expenditures
- Study cost reduction plans
- Demonstrate new tool design and capabilities
- Train operators in overall system behaviour and job related performance
- Process automation