TU Clausthal

Container Terminal Simulation

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1. Introduction

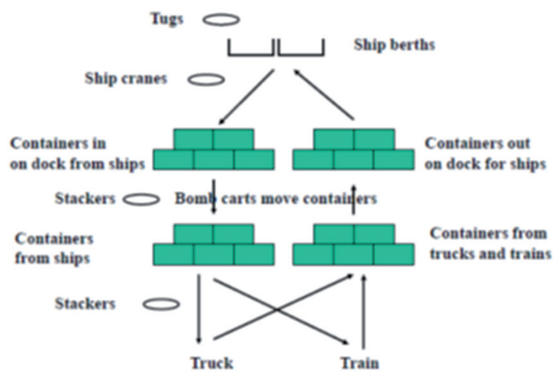
Modeling and simulation has a great potential for solving problems in the multimodal transportation systems sector. The power of modeling and simulation in multimodal transportation lies in the three Rs namely; reductionism, repeatability, and refutation. Reductionism recognizes that a transportation system can be decomposed into a set of components or compartments that mainly follow the laws of engineering. Repeatability or test-retest reliability is a test on the same item, the multimodal transportation system model, and under the same conditions. This means that the multimodal transportation system model under test can be said to be repeatable when its variation is smaller than an agreed upon boundary or target function. In that case, the multimodal transportation system model under test can be said to be validated by its repeatability; and one can make predictions with this model by refutation of the hypothesis. Against this background, while validation discovers that the chosen assumptions are true, a refutation does the opposite; and it proves something is false in the assumed prediction or hypothesis. The difficulty, but also the fascination of transportation analysis, modeling, and simulation, derives from the intrinsic complexity of the multimodal transportation systems sector. Therefore, simulation can be used as inexpensive insurance against costly mistakes.

2. Container Terminal

Over 90% of cargo currently transported worldwide is shipped as containerized cargo. As supply chains become more global and the use of containerized cargo increases, the ports throughout the U.S. are improving operations and undergoing major expansions. The Alabama State Port Authority is currently enhancing container and intermodal operations at the Alabama State Docks in Mobile, Alabama. The Figure is an overview of the Mobile Container Terminal and intermodal container handling facility. The shipping terminal will include 92 acres with 2,000 feet of berthing space dredged to a depth of 45 feet for two berths. A grade-separated roadway will connect the container terminal with an intermodal terminal and value-added warehousing and distribution area). The container operation will consist of 57 acres and will be able to accommodate unit container trains that will pick up or off load containers from the terminal warehousing and value-added areas. Trains up to 8,000 feet in length will be able to serve the facility without blocking rail traffic on the main line.

3. Container Terminal Model

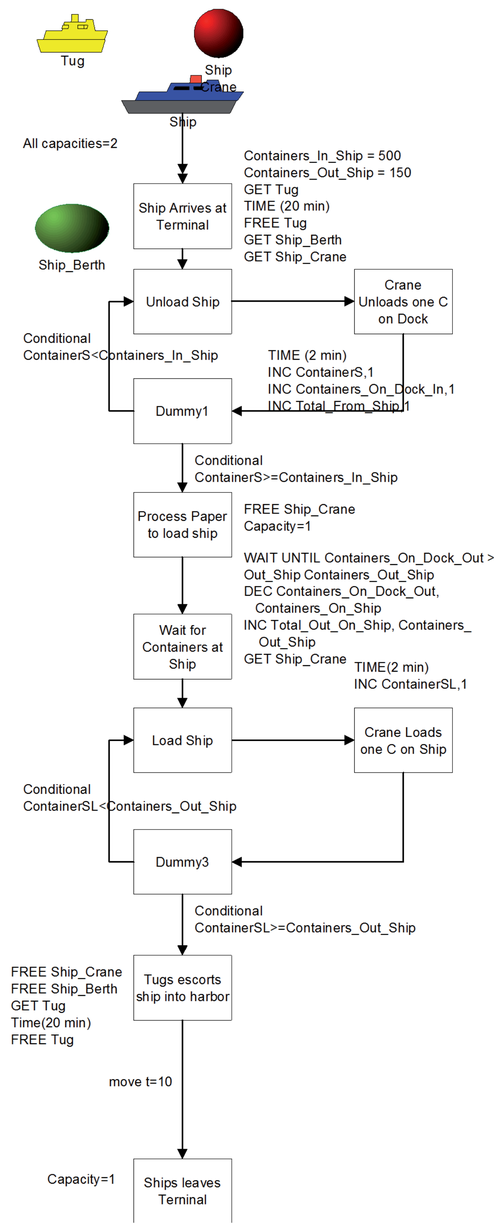
The conceptual framework of the container terminal model is shown in the next Figure.



The model has five submodels:
1. Ship unloading and loading of containers
2. Train unloading and loading of containers
3. Truck unloading and loading of containers
4. Movement of containers from ship dock to container yard
5. Movement of containers from container yard to ship dock

The terminal model has two container inventory locations: 1) the storage of containers from ships that are to be loaded onto trains and trucks and 2) the storage of containers from trains and trucks that are to be loaded onto ships.

The ProModel logic for the ship unloading and loading of containers is shown in the following Figure.



Many of the activities have considerable logic in the action section. The action logic for the activity Ship_Arrives_At_Terminal is assumed to be as follows:

- Containers_In_Ship = 500 Set container in count
- Containers_Out_Ship = 150 Set container out count
- GET Tug Get resource
- TIME (20 min) Time for tug to position ship
- FREE Tug Free resource
- GET Ship_Berth Occupy resource
- GET Ship_Crane Get resource

The action logic for activity Crane_Unloads_One_C_On_Dock is:
- TIME (2 min) Time to unload one container
- INC ContainerS,1 Increase counter by 1
- INC Containers_On_Dock_In,1 Increase counter by 1
- INC Total_From_Ship,1 Increase counter by 1

The branching for the two routings at activity Dummy1 is:
- Conditional: ContainerS>=Containers_In_Ship All containers have been unloaded
- Conditional; ContainerS<Containers_In_Ship Not all containers unloaded; continue to loop

At the routing from Unload_Ship to Crane_Unloads_One_C_On_Dock, the entity Ship is changed to the entity Container. The graphic for the container is a yellow rectangle. The entity continues to loop until all containers have been unloaded. After activity Dummy1, the entity Container is changed back to the entity Ship.

4. Verification and Validation

The model was verified by removing all of the variability and using only constants. In addition, ProModel has a "label block" option that displays data from the global variables during the simulation. By reducing the simulation speed, it is possible to observe these values as entities move through the simulation. The values of these labels after running the model for 1,440 hours, or 60 days, were:

Containers	Values
Unloaded from ships	10,000
Unloaded from trains	6,000
Unloaded from trucks	1,440
Loaded onto ships	3,000
Loaded onto trains	6,000
Loaded onto trucks	1,440
On dock unloaded from ships	0
On dock waiting to be loaded onto ships	4,400
In container yard from ships	250
In container yard from trains and trucks	0

Containers	Values (tons)	Containers	Values (tons)
Unloaded from ships	10,000	Unloaded from trains	6,000
Loaded onto trains	-6,000	Unloaded from trucks	1,440
Loaded onto trucks	-1,440	Loaded onto ships	-3,000
On dock unloaded from ships	-0	On dock waiting to be loaded onto ships	-4,440
In yard from ships	2,560	In yard from trains and trucks	0

Model validation was not possible since the Mobile Container Terminal is still under construction. However, it was possible to use data from the existing container facility for the service times and to visually observe the operations of the terminal during the simulation.