Proceedings of the 2014 Winter Simulation Conference
A. Tolk, S. Y. Diallo, I. O. Ryzhov, L. Yilmaz, S. Buckley, and J. A. Miller, eds.

A MULTIMODAL PORT FREIGHT TRANSPORTATION MODEL FOR ESTIMATING CONTAINER THROUGHPUT

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ABSTRACT

Past simulation studies of the multimodal freight transportation system have been unable to dynamically couple the various modes into one model; therefore, they are limited in their ability to inform on dynamic system level interactions. This paper presents a dynamically coupled multimodal transportation system operating at multiple spatial references and temporal scales. Specifically, this paper shows a dynamically coupled railroad network which closely follows major CSX railroads from Chicago, Washington DC, and Miami into the southern U.S. Ports of Savannah, Jacksonville, and Charleston. The models were developed using Arena® simulation software.

1 INTRODUCTION

Computer based simulation models have often been used to study the multimodal freight transportation system. But these simulation models have focused on isolated models of the component transportation modes to the neglect of dynamically coupled system interactions. A multimodal freight transportation system model, especially in areas surrounding container seaports, needs to be a dynamically coupled system of roads, connecting rails, and seaside activities all operating at multiple temporal scales and spatial references. Such a model can capture the impact of management policies on both the internal and external (landside access and environment) operations of the seaport and it may also demonstrate counter-intuitive behavior and/or nonlinear responses which might not be observable with simulation models that are not dynamically coupled.

This paper part of a larger research effort which attempts to dynamically couple railroad, seaport, and highway freight transportation models. It summarizes results on the development of couple railroad and seaport models. A full documentation on the development of the coupled railroad and seaport model (Gbologah 2010) and the development of the highway model (Wall 2010) is also available.

2 SCOPE OF PREVIOUS STUDIES

The literature on computer based simulations of the multimodal freight transportation system range in scope from maritime terminals simulations (Asperen et al 2003) to rail network simulations (Lu et al. 2004), inland terminal simulations (Rizzoli et al. 2002), to container scheduling (Kozan and Preston 1999).

3 METHODOLOGY

The modeled railroads and seaports were developed using Arena® simulation software and it comprises of three conceptual seaports (i.e. not fully reflective of the full range of characteristics of the actual ports) representing the Ports of Savannah, GA, Charleston, NC, and Jacksonville, FL and their adjacent CSX rail terminals. These ports are linked by five railroad lines which closely follow the CSX railroads originating from Chicago, IL, Washington, DC, and Miami, FL, to these southern U.S. Ports, in terms of track lengths, location of sidings, and speed limits.

These models were constructed using a nested modeling approach with nodes and links. The port model and the railroad model represent the two highest nodes and within these are nested sub modules such as dockside operations, inspections, and train stations. The links represent individual transportation facility links between either the nested sub modules or the high-level modules.

4 RESULTS AND DISCUSSIONS

The model was run for 26 continuous simulation days, generating 141 containership calls and a throughput of 28,738 containers for rail transport at the Port of Savannah. An analysis of train trajectories show that between 24-67 percent of travel time is spent idle on tracks. Likewise, the model results indicate that 85 percent of container residence time within the port is spent idle. Figure 1 shows a sample train trajectory (on left side) and speed profile (on right side) chart.

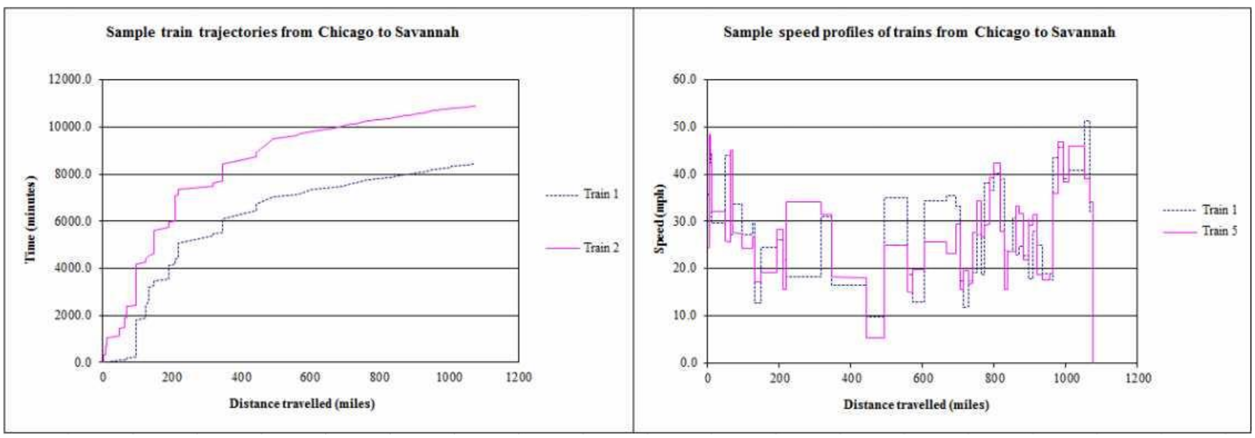

Figure 1 Sample Trajectory and Speed Profile of Two Trains

This research demonstrates that it is possible to dynamically couple the multimodal freight transportation system. In future the train movement logic can be improved to closely follow actual Direct Traffic Control (DTC) or Automatic Block Signal (ABS).

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