Chapter 35
Supporting Automated Container Terminal Design Processes with 3D Virtual Environments

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ABSTRACT

Recent trends in container terminal design favor automation above manual labor. Automatic container terminals outperform their manual counterparts in terms of twenty-foot equivalent units per year, and they are economically more effective as well. Due to the use of modern technologies, it is not always clear for actors which consequences every decision has on the design. Although technical design drawings are understandable by engineers, they could lack clarity for others, such as business analysts. To overcome this issue, 3D visualizations have often been employed to present future container terminals. However, constructing such visualizations is often time-consuming, expensive, and lacks the flexibility needed through a design process. In this chapter, we present a solution that allows designers to quickly generate 3D environments from technical design drawings. The environment, which is called the "Virtual Terminal," consists of an AutoCAD plug-in that communicates with a 3D virtual environment. Whenever an updated visualization is needed throughout the design process, this can be realized with minor efforts. The Virtual Terminal has already been used in design processes of major future container terminals, which allowed us to evaluate its usability, usefulness, and usage. The evaluation has been performed both quantitatively (for assessing the usability) and qualitatively (for assessing usefulness and usage).

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INTRODUCTION

Container terminals play an important role in modern logistics by providing a cost and time efficient solution for connecting maritime and land transportation modes. From the mid fifties onwards, container terminals have become the main hub for transshipment (from one ship to another) and transloading (from a ship to other forms of transportation): containers arrive and depart on vessels, trucks, and trains. Due to the growing demand during the last couple of decades, container terminal operators have been steadily increasing the capacity of container terminals by employing larger vessels and transforming small terminals into more efficient larger ones (Vis & de Koster, 2003). Advancement in modern technology has decreased the speed and costs required to perform the connection between maritime and land transportation modes e.g. standardization of equipment and containers, employing more efficient equipment and process optimization. A major shift has taken place in recent years by substituting manual labor (e.g. crane operators) by automated controls. Modern Terminal Operating Systems (TOS) are able to control a large amount of equipment to unload containers, transport them to storage stacks and retrieve them when needed. The types of equipment that are currently best suited for automated controls are the one for horizontal transportation and the container stacks. Equipment used in horizontal transportation transports containers between the yard and the quay. Equipment in charge for the stacks, pile containers in specified areas for storage and retrieve the containers when needed. According to Versteegt (2004) and Saanen (2004), this shift from manual to automated labor brings numerous advantages such as lower life cycle costs, improved safety (humans are less likely to be involved in accidents), reduced damage to containers and equipment (automated equipment has a higher precision during operations), and increasing service levels (automated equipment can run almost without any breaks). Thanks to these advantages, an increasing number of newly developed container terminals are automated. Table 1 contains the current status of automated container terminals around the world.

Although many advantages are gained by using automation in container terminal development, they can only be obtained as a result of well-planned design process. The design process of automated container terminals is particularly challenging due to:

- the limited experience in designing automated container terminals (there are not that many developed around the world yet);
- the advanced equipment that is used in automated container terminals which is complicated and challenging to integrate in the overall system;
- the larger solution space that designers have to explore compared to manual container terminals;

Table 1. Current automated container terminals worldwide

Terminal	Year	Automated technology
ECT (Rotterdam)	1989-1993	Rail Mounted Gantries (RMG) Automated Guided Vehicles (AGV)
Thamesport (UK)	1982 - 1990	RMG
HHLA-CTA (Hamburg)	2003	RMG and AGV
Euromax (Rotterdam)	2007	RMG and AGV