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USE OF VARIABLE SIZED ENTITIES TO MODEL AIRPORT PASSENGER FLOW WITH PEDESTRIAN DYNAMICS

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ABSTRACT

This paper describes the use of variable-sized entities within the framework of the InControl simulation software product Pedestrian Dynamics to rapidly model passenger flow and congestion for a series of check-in hall lobby designs for a US domestic airline terminal. Note that the airline and airport will remain anonymous for this presentation due to confidentiality.

1 PROBLEM STATEMENT

Because of the nature of unique passenger characteristics at the leisure-oriented airport (namely a higher than average passenger group size and bag per passenger values when compared to other airports), the airline desired a modeling solution that would be able to accurately model congested passenger flow in the corridors and processing areas of their check-in lobby quickly so that their design team could consider many potential evolving layouts. Many traditional simulation software programs (particularly those often used for airport passenger modeling) use standard sized simulation agents representing individual passengers. The airline specifically needed a solution that would consider the potential interactions of larger groups (both in terms of group size and physical space needed due to extra bags) than are typically encountered in an airport environment. It was also crucial to incorporate overflow queues in the model and capture the congestion and bottlenecks created because of these peak period queues. Modeling the dynamic nature of various queue disciplines was also important to detail the nuances of the actual operating conditions.

2 SOLUTION TECHNIQUE

Pedestrian Dynamics is an agent-based tool created by InControl - The Simulation Company (based in the Netherlands) and has been shown to be very convenient for realistically and quickly simulating congestion and movement of people in a variety of environments, including airports. In order to handle the group size and physical area differences of the typical passenger for the airline client, the modeling team decided to represent the passenger groups using variable-sized circles – known as 'Agent Footprint' that would represent the minimum physical space needed for each passenger in the group along with their carry-on and checked bags.

Based on data collected at the airport by the airline, the team assumed an area for each check-in and carry-on bag, along with a number of passengers resembling the airport/airline-specific group size distribution. These total areas were used to compute the Agent Footprint, a realistic minimum radius for the agents to be generated in the model. Each of these agents could now emulate a group with an accurate representation of number of passengers and bags that could now pass through the entrances and corridors, utilize queues and processers, and even dynamically reduce their size when checked bags were delivered into the baggage system at the counters. Their individual interactions with other variable sized groups as they transit the model would be based on detailed advanced collision avoidance behavior and pathfinding inherent in the Pedestrian Dynamics simulation software. The tool provided the ability to use its navigational mapping algorithm - known as the Explicit Corridor Map (ECM), to quickly evaluate different design options. The Indicative Route Method (IRM) used by the software enabled smooth movement of an agent from one step of the process to the next while also avoiding physical obstacles.

3 BENEFITS OF SOLUTION TO CLIENT

The team validated the simulation model by modelling current operating conditions and comparing the findings with actual data before evaluating proposed layout changes. By using the Pedestrian Dynamics software platform combined with the variable-sized entities, the modeling team was able to quickly construct and analyze several layout and design ideas proposed by the airline client (about 2-3 days per design layout).

The team reviewed peak hour wait time and queue length statistics with the airline. Heat maps of passenger behavior, including average density and frequency plots, were also analyzed as part of the study. The Density Maps were used to specify the average congestion (passengers per square meter) based on International Air Transport Association (IATA) Level of Service (LOS) criteria. The Frequency Maps helped to visualize the number of passengers transiting at any given point in the lobby during peak periods of activity. These visuals were key to guiding the quick evolution and development of the new lobby designs by the airline.