Boarding—Step by Step: A Cellular Automaton Approach to Optimising Aircraft Boarding Time

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Summary

We model the boarding time for the aircraft using a cellular automaton. We investigate possible solutions and present recommendations about effective implementation.

The cellular automaton model is implemented in three stages:

- Initialisation of the seating layout for a chosen aircraft type and assignment of seats to passengers
- The sorting of passengers according to various proposed boarding methods
- "Propagating" the passengers through the aisle(s) of the aircraft and seating them at their assigned places.

The rules governing the automaton take into account various factors. Among these are the load factor (percentage filled) of the craft, different walking speeds of passengers walking through the aisle, and time delays from stowing luggage and obstructions by other passengers during the seating process. The algorithm accommodates predefined aircraft layouts of common aircraft and also user-defined aircraft layouts.

We modeled and tested various boarding strategies for efficiency with regard to total boarding time and average boarding time per passenger. Thus, our approach focuses not only on optimisation of the process in favour of the airlines, but also yields information regarding convenience to passengers. Random boarding (where passengers with assigned seat numbers enter the plane in a random sequence) was used as a point of reference. Among other strategies tested were boarding the plane in groups from either end, boarding from seats farthest from the aisles toward the aisles, and combinations of these approaches.

We conclude that boarding strategies starting farthest away from the entrance or farthest away from the aisles yield shorter boarding times than random boarding. The most successful methods are combinations of these strategies, their detailed implementation depending on the exact layout/size of the aircraft. The method yielding the shortest total boarding time is not necessarily the one with shortest average boarding time per passenger. By considering standard deviations of total and individual boarding times over many iterations of the simulation, we can derive conclusions regarding the stability/consistency of the specific boarding strategies and how evenly the waiting time is distributed amongst the passengers.

By selecting appropriate strategies, time savings of 2–3 min for small and medium aircraft could be achieved. For a custom 800-seat aircraft with two aisles, more than 6 min could be saved compared to random boarding. Having compared our results to actual turnaround times quoted by airlines, we believe them to be realistic.

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