Boarding Processes of Passenger Aircraft

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Introduction

Air travel is a widely used method of travel for getting from city to city. So air traffic optimisation is very important. One way to do this is to optimise the boarding time for passengers. Making this process more efficient is beneficial for both airlines and passengers. Faster boarding processes allow planes to spend less time at the airport and more time in the air, allowing airlines to schedule more flights in a day resulting in increased revenue. The shorter lines and less waiting make more efficient methods preferable to passengers.

In this report, we investigate numerous different methods for aircraft boarding processes and how they are impacted on by the time their tickets take to be processed at the gate. We look at a study done by van den Briel [2] and Lusmore and Lusmore [1]. These authors investigate this problem using a discrete model to simulate plane boarding times, using six different boarding strategies. These strategies include random, back to front, outside in, reverse pyramid, block and rotating zone boarding.

Model

Our model is based on a plane with 23 rows and one aisle. Each row of the plane has 6 seats, that is 3 seats either side of the aisle. We have created a simulation in MATLAB to model the progress of the passengers and the total time taken for the whole plane to be loaded with everybody in their seats, one unit of time is the amount of time that a passenger takes to move from one row to the next when there is no one in front of them.

Conditions that are taken into account in our model are the time between each passenger arriving at the plane, referred to as interarrival time, this is mainly the amount of time that it takes each passengers ticket to be processed, this time is variable in our model. It also takes into account the amount of time a passenger takes to put their baggage into their overhead locker and to take their seat, in our model this takes 15 units of time. Finally, we take into account the amount of time it takes to get past a passenger seated in their row, to a seat further away from the aisle. For example, the amount of time it takes for a passenger trying to get to the window seat to pass a passenger already seated in the aisle seat. This was allocated 8 units of time in our model.

In formulating our model we made a number of assumptions. These include that; all passengers walk at the same speed, each passenger takes the same amount of time to load their luggage and take their seat, that passengers do not enter the plane in groups (as families, groups of two or three friends) and also that the plane is always full and that every seat has one passenger assigned to it.

In our investigation, there were six different boarding schemes considered, the same as used by van den Briel [2] and Lusmore and Lusmore [1]. These schemes were; back to front boarding, random boarding, rotating zone boarding, block boarding, outside in boarding and reverse pyramid boarding. Details of these schemes can be seen in the following section.

Boarding Schemes

Back to Front boarding

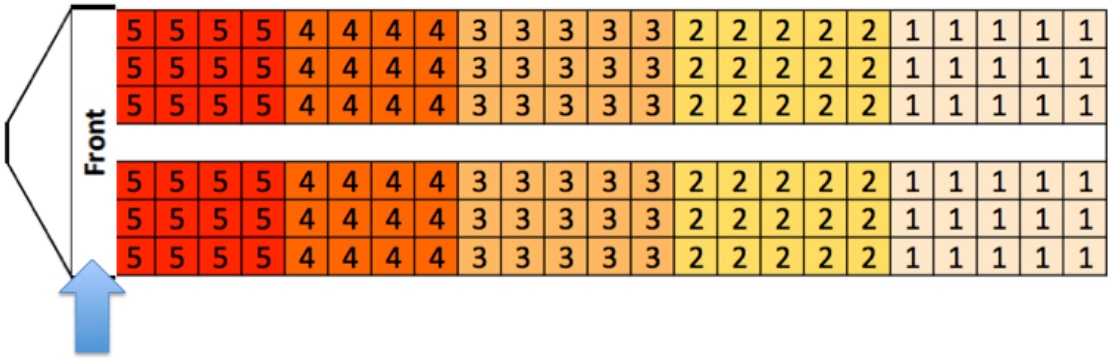

Figure 1 - Back to front boarding

The first boarding scheme proposed is back to front boarding. In this scheme the plane is divided up into five roughly evenly sized zones and numbered from back to front, as can be seen in figure 1. This is one of the common boarding schemes used by airlines, particularly on larger planes. However at each zone call there are about 30 people all trying to go to the same place, so this creates large queues in the aisle while people wait for those in front of them to take their seats, or pass somebody to get to their seat, with usually only one person able to do so at a time.

Random boarding

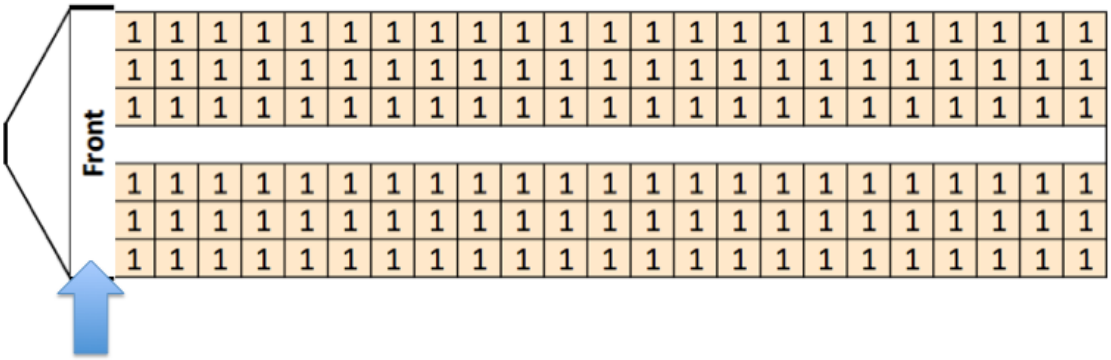

Figure 2 - Random boarding

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The second boarding scheme is that of random boarding. In this strategy, passengers are called to board the plane, and board in whatever order they reach the gate, as can be seen in figure 2. This is a simple boarding scheme and because of this, it is used by many airlines. This method has people boarding the plane all over the place and although there are queues there are often multiple people taking their seats at once, which speeds up the process.

Rotating Zone boarding

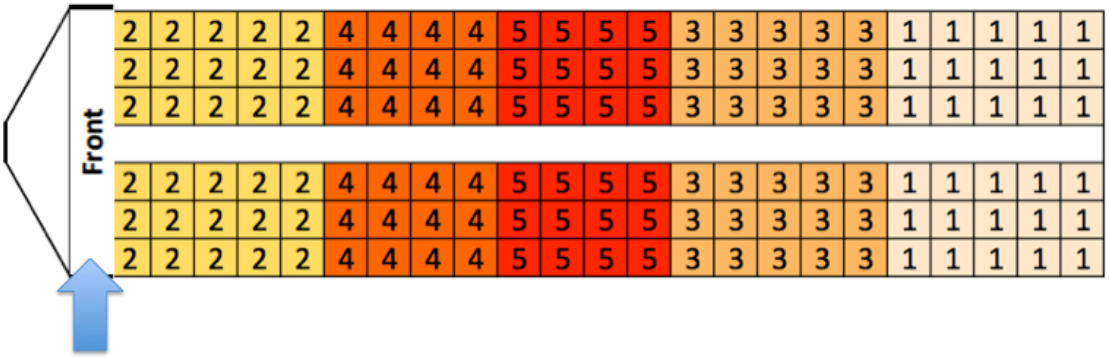

Figure 3 - Rotating zone boarding

The third boarding scheme is that of rotating zone. In this strategy the plane is broken up into roughly even zones, as with back to front boarding, however the zones are labelled alternatively between the back and front, as is displayed in figure 3. This scheme was aimed to correct the problem of queues that form in the back to front boarding, allowing passengers at the front to board while those at the back are still boarding. However, in doing this it creates the problem that every single passenger in zone 2 must be seated before those in zone 3 can make their way to their seats.

Block boarding

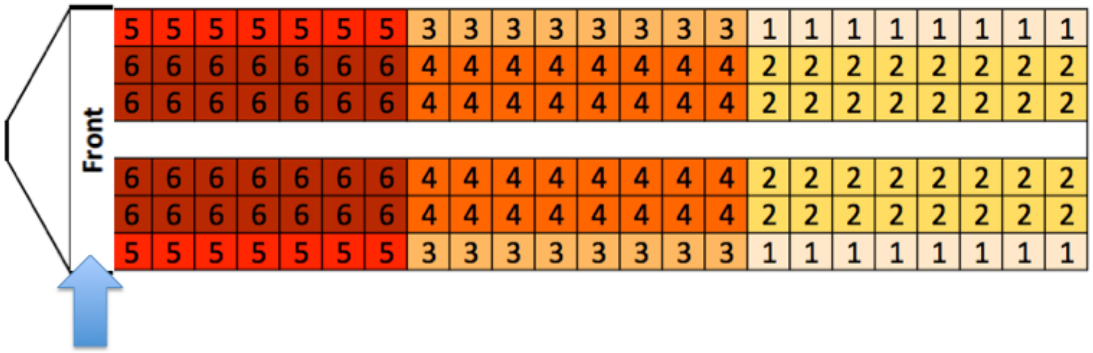

Figure 4 - Block boarding

The fourth boarding scheme is called block boarding. In this strategy the plane is broken up into three roughly even groups, with each group broken up into two uneven zones, as can be seen in figure 4. The boarding order is the window seats at the back of the plane, followed by the rest of the seats in those aisles and then in a similar fashion for the middle, then front of the plane. This method addresses the problem of having to swap seats with other passengers, however, it still suffers

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from the problem of queuing in the aisle, as with back to front and rotating zone boarding. This seating pattern is quite complicated, but could be used by simply creating a colour coding on boarding passes and calling passengers with a certain colour in the boarding calls.

Outside in boarding

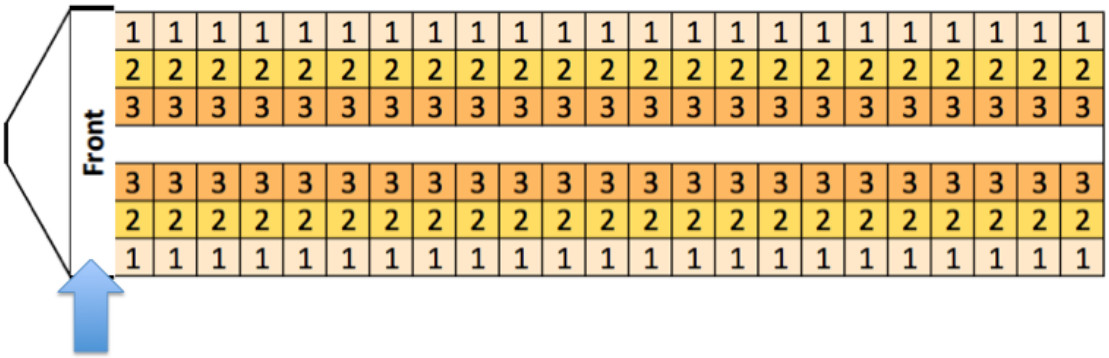

Figure 5 - Outside in boarding

The fifth boarding scheme is that of outside in boarding. This scheme divides the plane up into 3 zones relating to the kind of seat you have, as seen in figure 5. It boards the window seats, followed by the middle seats and lastly the aisle seats. This scheme removes the problem of having to swap seats altogether because of the way the plane is boarded. This scheme also reduces some of the queuing in the aisles, because everyone is trying to go to a different row and so multiple people can be taking their seat and putting their luggage up at once.

Reverse pyramid boarding

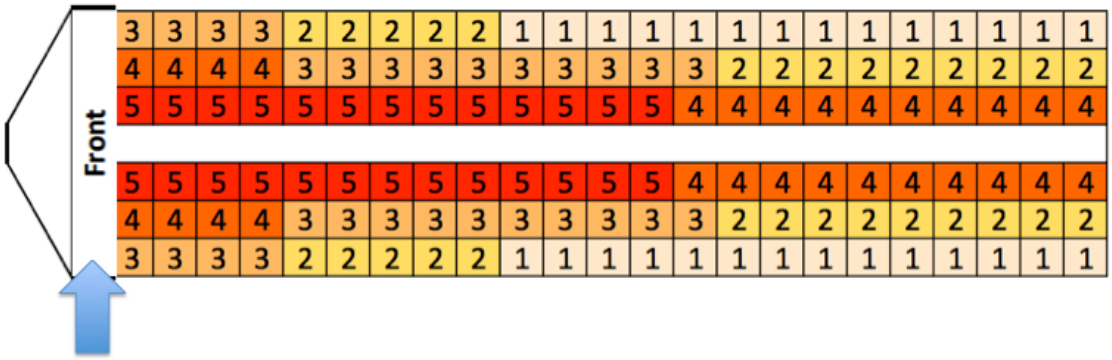

Figure 6 - Reverse pyramid boarding

The sixth and final boarding scheme is that of reverse pyramid boarding. This scheme is a combination of back to front boarding and outside in boarding. Passengers board the plane from the window seats at the back of the plane moving in a diagonally inward fashion towards the aisle seats at the front of the plane, as can be seen in figure 6. As with outside in boarding, this scheme also removes the problem of having to switch seats altogether. However, it does create some queuing in the aisles. This scheme would also need colour coding on tickets as with block boarding to help with calling the sections.

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Results

A comparison of the six different boarding schemes was done for multiple interarrival times. The results from this can be seen in figure 7. It can be seen that from our simulation that back to front boarding and rotating zone boarding were the slowest of the methods with similar average boarding times, also that the fastest methods were random boarding, reverse pyramid boarding and outside in boarding, and that these methods also had similar average boarding times.

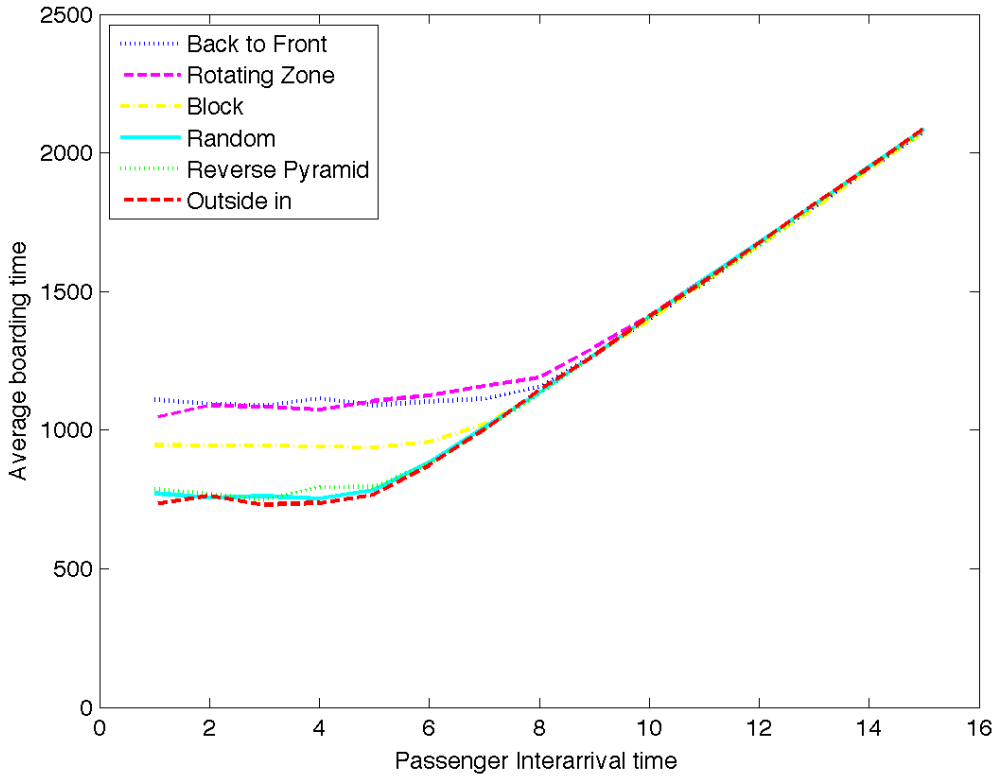

Figure 7 - Comparison of the six methods

In examination of how the methods are affected by different interarrival times, it can be seen that average boarding time of the faster methods (random, reverse pyramid and outside in) does not differ significantly for interarrival times of less than 5, similarly an interarrival time of less than 6 for block boarding and less than an interarrival time of 8 for the slower methods (back to front and rotating zone). This shows that there is no point hiring extra staff to get tickets processed at a rate faster than 5 units of time per passenger. It can also be seen that after an interarrival time of 8 there is little difference in the average boarding time of any of the methods.

Conclusions

Our aim was to look into different boarding schemes for passenger aircraft, looking to see which method took the least time to board the aircraft. This is important because a smaller boarding time could potentially create less time at airports, allowing more flights per day, beneficial to both airlines and passengers.

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It was found that random boarding, outside in boarding and reverse pyramid boarding were the fastest of the methods, not back to front boarding, which is commonly used by airlines. This would suggest that there is a need for airlines to reorganise how they board their planes. Our suggestion would be to use the schemes of outside in boarding or reverse pyramid boarding, this could be done by colour coding boarding passes and calling the colour to the gate.

This investigation made many assumptions; so further research can be done. Such research includes; including groups into the model, including disabled passengers and passengers with young children who board the plane first, include passengers that arrive late and do not board when their group is called and also include passengers boarding from both the front and the back of the plane at once. The model can also be extended to track the luggage in the luggage compartments and whether a passenger has to move to a different row to place their bag because the luggage compartment near their seat is full. Further work can also be done looking at different plane arrangements, such as bigger planes and different row arrangements, such as planes with 2 aisles (2 seats, 3 seats, 2 seats being the row configurations).

References

[1] Lusmore, C. and Lusmore, D. 2011. MAN764 Project Report. Queensland University of Technology, Brisbane.

[2] van den Briel, M. 2010. Airplane boarding. http://menkes76.com/projects/boarding/boarding.htm.

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