

# The Best Way to Board a Plane

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A Boeing 747 passenger plane.

Most airlines board passengers the same way, first filling the seats in the back of the plane, and then moving to the front. After a recent experience boarding a plane in this manner, Fermilab physicist Jason Steffen wondered if there might be a better way. So, in the midst of studying gravitation and axion-like particles, Steffen took a short break to investigate an optimal boarding method for airline passengers.

“I remember waiting in line to scan my ticket inside the terminal, I believe it was at the Seattle airport,” Steffen told *PhysOrg.com*. “I remember being quite disappointed when I saw how long the second line was – the one at the entrance to the airplane – and how slowly it moved. . . . That's when I thought that there had to be a better way to get people onto the airplane than the one that was being employed. I didn't have the time to work on it right then, so I brooded over it for almost 18 months.

Last year, I decided that I either needed to solve the problem or stop thinking about it.”

In his analysis, Steffen found that the worst method for boarding a plane is boarding from the front to the back, since passengers have to wait and step over each other to get to their seats. As he explains in a paper submitted to the *Journal of Air Transport Management*, conventional wisdom suggests that boarding in a manner opposite to the slowest method seems like it should be the fastest method. Quite unexpectedly, then, Steffen found that the common back-to-front boarding method is actually the second worst method possible, only slightly better than boarding front to back.

“I was certain that the worst way to load the airplane was from front to back, so I ran my simulation in that configuration first to set a baseline,” Steffen said. “I was also somewhat convinced that the optimal way would be from back to front or something like it. I half expected to find that back-to-front loading is several times faster than front-to-back. Had that been true, I was prepared to run the two simulations, see how much faster it was, be satisfied, and put it aside. When the results were almost identical, I first thought that there was a bug in my code. Once I was convinced that my code worked properly, I realized that the problem was more interesting than I had anticipated, and I got more serious about it.”

Using a combination of a Monte Carlo optimization algorithm and intuition, Steffen determined an optimal boarding method, which could make boarding go 4 to 10 times faster than the worst method, depending on the size of the plane. In the optimal method, passengers would board 10 at a time in every other row (since loading luggage requires about two aisles of space). This way, passengers could always be boarding luggage or sitting in their seats, rather than waiting in the aisle, as in the two previous methods.

However, Steffen also acknowledged that the optimal method might not be practical, since passengers who sit next to each other often travel together, and prefer to board together. He proposed a modified version, where passengers board in blocks of three consecutive seats on one side of the plane in every other row. In this strategy, there would be four boarding groups, with passengers in the same row on the same side boarding together. This method provided a decent middle ground, as it was twice as slow as the optimal method, but twice as fast as the conventional method. Although getting passengers to line up in their correct groups might sound challenging, Steffen noted that Southwest Airlines has been experimenting with having its passengers line up in numerical order – so the logistics wouldn't be inconceivable.

Steffen also identified several other boarding strategies with results superior to the conventional method. Contrary to our tendency for order, even completely random boarding proved to be a good alternative. In fact, random boarding was nearly as fast as the modified optimal method. Plus, by its very nature, it has the advantage of not requiring airline attendants to organize boarding passengers in any way. And the random result also shows that, when passengers board out of order in the other strategies, the results will still be better than the conventional boarding method.

The main advantage of the alternative boarding methods is that they allow several passengers to load their overhead luggage simultaneously, which Steffen identified as the largest factor in determining boarding time. By spreading the passengers throughout the airplane instead of concentrating them together, more passengers could load their luggage at once. Steffen noted that, although he has recently heard of other boarding optimization studies, his analysis uses a unique method and is the first to generate this specific optimization strategy.

“I think that the biggest challenge to implementing one of these methods

is cracking into the industry,” he said. “Right now, I have a model where the parameters need to be calibrated with data. But that would require an investment from an airline company or manufacturer. While I could be wrong, I doubt that when an airline company needs to study an issue like this one that their first thought is, "Let's go talk to a physicist" (followed by, "Look, here's one that's studied axions and extrasolar planets. He's our man.") The two fields just don't talk to each other enough to have that kind of understanding.”

Still, Steffen thinks that reducing the boarding time could benefit airlines in a number of ways, especially for short flights between nearby cities. In such cases, quicker boarding might allow an additional daily flight to be scheduled, or it could reduce the number of gates an airline requires, since each gate could be cleared more rapidly. With thousands of flights taking off around the globe every day, a few minutes could save a lot of people a lot of time.

More information: Steffen, Jason H. “Optimal boarding method for airline passengers.” ArXiv:0802.0733v1 [physics.soc-ph] 6 Feb 2008.

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