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Plane Geometry: Scientists Help Speed Boarding of Aircraft

America West Saves Minutes With 'Reverse Pyramid'; Link to Relativity Theory

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Several years ago Menkes van den Briel, an industrial engineer at Arizona State University, tackled a "nonlinear assignment problem with quadratic and cubic terms in the objective function."

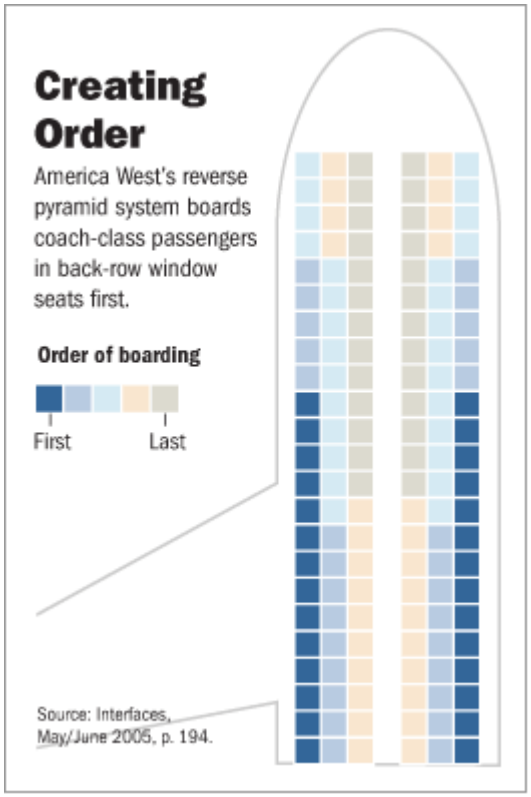
Menkes van den Briel

In other words, he wanted to stop people from bumping into each other when they board an airplane.

Mr. van den Briel's research has led to an innovative boarding system at America West Airlines called "reverse pyramid." The first economy-class passengers to get on the plane are those with window seats in the middle and rear of the plane. Then America West gradually fills out the plane, giving priority to those with window or rear seats, until it finally boards those seated along aisles in the front.

Anthony V. Mulé, senior vice president for customer services, says the system, introduced in 2003, has saved at least two minutes in boarding time. "This is a great illustration of how science helped improve both efficiency and customer service," says Mr. Mulé.

Mr. van den Briel is one of a small cadre of experts in the science of airline boarding. Their research has upset much of the conventional wisdom about how to get people quickly into their seats. Boarding from the rear to the front, still standard practice at many American airlines, is almost certainly not the fastest way, these scientists say. Among the faster methods may be letting everyone board randomly or calling out each individual seat number.



Airlines have long looked for marginal improvements to save money. In the 1980s, Eastern Airlines stripped paint off its jets to reduce the load on each plane by a few hundred pounds. Trans World Airlines once introduced "Project Skinny," in which it cut the number of pillows and blankets on board.

Boarding time is one of several variables affecting how quickly airlines can turn their planes around and get them back in the sky. Others include luggage loading and refueling. Every extra minute the plane sits on the ground means lost revenue. "It can add up to tens of millions of dollars," says Andrew Miller, chief executive of the Centre for Asia Pacific Aviation, an aviation consultancy based in Sydney.

America West, which after a recent merger is now part of US Airways Group, isn't the only airline to focus on boarding. On Oct. 1, United Airlines introduced a new boarding system -- dubbed WilMA, for window, middle, aisle, the order in which the seats are called -- to save time and money. By boarding window passengers first, United hopes they won't have to climb over their fellow passengers to make it into their seats.

A United spokeswoman says the new system was selected from five candidates because it triumphed in time trials at the United hub in Denver and elsewhere. United expects WilMA to shave four to five minutes off the average boarding time and save $1 million annually.

The time it takes for passengers to board has more than doubled since 1970, according to studies by Boeing Co. One study in the mid-1960s found that 20 passengers boarded the plane per minute. Today that figure is down to nine per minute, as passengers bring along heftier carry-on luggage. Both Boeing and Airbus, the two top commercial-aircraft makers, are working on improving boarding time as a selling point to airlines.

Willy-Pierre Dupont, an Airbus cabin engineer, believes national differences can affect boarding time. A few years back, he watched some 560 passengers on a Japan Airlines domestic flight in Japan disembark in six minutes flat. A new group of travelers was completely boarded and seated within an additional 25 minutes. The same turnaround in the U.S. or Europe could take as long as an hour and a half, Mr. Dupont says.

"It was razor-smooth," he says. "We have a lot to learn about their behavior."

NOW BOARDING

[1] **Cranky Consumer tests**[2] some of the new boarding methods.

Eitan Bachmat, a lecturer in computer science at Ben-Gurion University in Israel, considered the topic in a paper titled "Airplane boarding, polynuclear growth, disk I/O scheduling and space-time geometry." (The paper, in expanded form, was submitted for publication this year.) He asserted that the boarding problem raises some of the same issues addressed by Lorentzian geometry, the branch of mathematics developed to deal with Einstein's theory of relativity.

Willy-Pierre Dupont

Because no information can move faster than the speed of light, two events in different parts of the universe may be unable to affect each other. Other events, meanwhile, may be close enough in space and time to affect each other. Likewise, two events on an airplane being boarded also may or may not influence each other, depending on time and distance. "As far as I know, this is the first application of this theory outside physics," Dr. Bachmat says.

The model he developed suggests that boarding a plane back to front is slower than simply letting people file on at random. According to the professor, people stowing carry-on luggage in the overhead bin or pausing to check the magazine rack still tend to block the aisles and cause boarding backups. "If people were cardboard thin, this would be a great idea," he says.

When America West wanted help on its boarding strategy in the summer of 2002, it turned to Arizona State University. There, a group of engineers including Mr. van den Briel, a graduate student, took on the project.

Mr. van den Briel flew to Los Angeles International Airport to film passengers. He took the tapes back to the university and played them over and over again, timing how long it took people to walk, sit and stow their luggage. He and his colleagues identified a variable called the "pass ratio" -- the proportion of people who successfully squeeze by someone putting their luggage in the overhead compartment. The pass ratio was just one in 10.

The team published its findings this summer in the operations-research journal Interfaces, showing that the reverse pyramid boarding can reduce boarding time by as much as 39% and reduce congestion caused by luggage loaders. Mr. van den Briel is now writing a dissertation on artificial intelligence, hoping to develop techniques that could help robot explorers on Mars operate by themselves.

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