# Judges' Commentary: The Fusaro Award Airplane Seating Paper

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The Ben Fusaro Award for the 2007 Airplane Seating Problem went to a team from Rowan University in Glassboro, New Jersey. Their paper was designated Meritorious; it fell just short of the Outstanding designation due to an error in one of their equations and some questionable results. However, this paper exemplified some outstanding characteristics:

- it presented a high-quality application of the complete modeling process;
- it demonstrated noteworthy originality and creativity in their modeling effort; and
- it was well written, in a clear expository style, making it a pleasure to read.

The students were asked to devise and compare procedures for boarding and deboarding planes with varying numbers of passengers. They were also asked to prepare an executive summary for an audience of airline executives, gate agents, and flight crews, in which they explained their findings.

Addressing real-world problems involves formulating a mathematical description of the problem, solving the mathematical model, interpreting the mathematical solution, and critically evaluating the model.

Before a team could formulate a mathematical description of the problem, it was necessary to do research to estimate reasonable values for parameters to be

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used. The Rowan University team began by looking at current boarding procedures and came up with a detailed list of sources of boarding delays, including the storing of carry-on luggage. Based on their assumptions, it was clear that the team members had considered many issues associated with the boarding process, and that they justified each assumption. Certain assumptions, for example, in terms of the implication on boarding time "random seating and assignment seating can be thought to be equivalent," might be questionable. However, as long as they used this assumption consistently in their simulation models, it was considered allowable. It should be mentioned that such assumptions help to distinguish Outstanding papers from Meritorious papers. In setting up their simulation model, the Rowan University team considered

- the time that it takes passengers to walk to their seats;
- the service time, which includes time for stowing luggage, based on the size and quantity of luggage; and
- seating time.

The rather important detail of distinguishing separate times for these activities was overlooked by many other teams. The Rowan team determined walking speed using an accelerometer and included the results in their model, using a uniformly-distributed random variable, together with a factor that allowed for a decrease in walking speed as the number of passengers increased. They used a uniform distribution over the interval 11.5 to 14.5 seconds to estimate stowing time for luggage. The number of passengers with carry-on luggage was estimated with a log function of a uniformly distributed random variable. Seating time was a function of which column (window, middle, aisle) passengers were in. Although the level of mathematics used in this model may not have been as high as some, the team utilized it very well. Overall, the Rowan model was quite simple, but the description of parameters used was very clearly spelled out. This is what judges look for when simulations are done.

Their simulation models consisted of four different seating methods:

- open seating, where passengers are lined up randomly;
- back-to-front seating;
- outside-in Seating (WilMA); and
- modified reverse-pyramid seating, in which the outer columns are seated first, followed by open seating of the rest of the plane.

To test the efficiency of their model, the team used Matlab simulations with several types of small, medium, and large aircraft. Reports were given for the mean, median, and variance of the simulated results for each type of seating on each type of plane. Frequency histograms were also given for each category. This type of reporting clearly demonstrated the results of their simulations.

However, the judges did not feel that all the results were reasonable, and this was a reason for the Meritorious designation rather than Outstanding. If the team had acknowledged the unreasonableness of some of their results, that would have been more acceptable. Nevertheless, this paper is a very good example of mathematical modeling. The team is to be congratulated for using mathematics to create their own model to solve the problem at hand, in a clear and solid example of the modeling process.

# About the Authors

Marie Vanisko has retired from Cal State Stanislaus and moved back to Montana, where she taught for 31 years at Carroll College and was a visiting professor at the U.S. Military Academy at West Point. She chairs a College Board committee for the SAT Subject Tests in Mathematics and serves on a national joint committee of the National Council of Teachers of Mathematics and the Mathematical Association of America (MAA). For each of the past two years, Marie has co-directed an MAA Tensor Foundation grant project for high school girls, entitled Preparing Women for Mathematical Modeling, with the hope of encouraging more young women to select careers that involve mathematics. She serves as a judge for the COMAP MCM and HiMCM has also been active in the MAA PMET (Preparing Mathematicians to Educate Teachers) project.