New study shows how to eliminate motion sickness on tilting trains

August 4 2011

An international team of researchers led by scientists at Mount Sinai School of Medicine have found that motion sickness on tilting trains can be essentially eliminated by adjusting the timing of when the cars tilt as they enter and leave the curves. They found that when the cars tilt just at the beginning of the curves instead of while they are making the turns, there was no motion sickness. The findings were published online Monday, July 25 in the Federation of American Societies for Experimental Biology (FASEB) Journal.

When a tilting train enters a curve, sensors on the front wheels of the train signal to the remaining cars when they should begin their tilt. In this reactive mode, since the sensors cannot be activated until the first car is in the curve, there is an inevitable delay in the onset of the tilt. In addition, the cars tilt more slowly. The researchers established that the late, slow rise in the velocity of the tilt during the curves coupled with the centrifugal force produced by the turn, causes motion sickness.

In contrast, when the curves were sensed from the geographic position of the train on the tracks, determined by a global positioning system (GPS), the tilts occurred earlier and were faster, and motion sickness was eliminated. In this predictive mode, lateral thrust was also reduced as the train rounded curves, making it much easier to walk in the aisles.

"This is a major breakthrough and a very practical solution to a problem affecting people's everyday lives," said Dr. Bernard Cohen, lead author of the study and Professor of Neurology at Mount Sinai School of

Medicine.

The Schweizerische Bundeshanen (SBB), the train system in Switzerland that requested this study, serviced 347 million passengers in 2010. The SBB wanted to order new trains that would maximize train speed and passenger comfort. Tilting trains are utilized world-wide to compensate for the centripetal acceleration during turns, allowing the trains to run faster. However, the tilting has also led to motion sickness.

"After seeing the results of the study, the SBB invested 3.2 billion Swiss francs for trains utilizing the results of the new technology that came from these experiments," said Dr. Cohen. "Hopefully we'll see this trend extend to other European and American markets as well."

During the study, the researchers placed angular velocity and lateral acceleration sensors on the front car in a seven-car train as well as on the heads of passengers. Over the course of about two months they used three control modes to evaluate the levels of motion sickness in 200 passengers: an untilted mode, a reactive mode based on the information from the front wheel set, and a predictive mode based on the information from the GPS. Passengers had no motion sickness in the untilted mode, showing that the lateral acceleration itself was not responsible for producing the discomfort. In this mode the train ran more slowly, however. The train ran equally fast in the predictive and reactive modes when it tilted, but passenger comfort was significantly better when the train tilted just at the onset and end of the curves in the predictive mode.

Provided by The Mount Sinai Hospital / Mount Sinai School of Medicine