Trevor Evans Award

Stan Wagon

“Resolving the Fuel Economy Singularity,” *Math Horizons*, 26:1, 5–9, 10.1080/10724117.2018.1460120.

Combining the subtleties of an everyday phenomenon with a dash of exposé, the author makes a strong case for considering fuel economy in gallons per 100 miles (GPM) rather than the traditional miles per gallon (MPG). He begins with two counterintuitive results. First, a person considering trading in a car that gets 40 MPG for a car that gets better gas mileage could never save as much gas as would someone trading in a 10-MPG vehicle for a 14-MPG one. Second, a policy of the government’s Corporate Average Fuel Economy (CAFE) program, intended to fine an automotive manufacturer for failing to meet minimum average fuel economy standards, may cause a manufacturer to incur an increased fine upon adding a new, fuel-efficient car to their fleet.

The discussion continues with the fuel efficiency of hybrid and electric vehicles, which can similarly be measured in kilowatt-hours per 100 miles (similar to GPM) or miles per kWh (similar to MPG). The first measure is displayed on the dashboards of Teslas, while the second is used by Chevrolet. As the article neatly explains, the use of miles per kWh has led to ugly hacks and bizarre results. These issues are subtle enough that they have made it into production, but significant enough that engineers from the Chevrolet Bolt team were willing to listen to the author’s suggestions.

The article is illuminating and accessible. The author proposes a better display that fixes the issues he raises regarding fuel efficiency calculations and displays, without completely discarding the familiar MPG method. The subject is topical and draws attention to the need for revisiting common fuel economy measures, in addition to our collective need to change our understanding of them.

Response

Mathematically inclined runners quickly learn how to relate the harmonic mean to their sport. To get overall speed from the speeds on two halves of a route, one must use a harmonic mean. The same principle applies to the measurement of energy usage. What was shocking about my investigation into measures of economy in gasoline and electric vehicles is that serious errors can arise even when the developers (of vehicles, or government regulation) understand how the harmonic mean applies. An easy-to-grasp measure, such as miles-per-gallon, is deeply ingrained in American car culture and is obviously very useful. But it can lead to serious misunderstandings. For a mathematician, an electric car is a rich source of investigations into issues of measurement, both from a technical point of view, but also in terms of how language and common phrases can affect understanding by the general public. The use of mathematics in real-world problems is important at all levels and I am grateful to *Math Horizons* for its ongoing effort to publish realistic applications at an accessible level.

Biographical Sketch

Stan Wagon attended McGill University as an undergraduate, and then Dartmouth College, where he earned a PhD in set theory in 1975. He taught at Smith College for 15 years and then at Macalester College for 23 years. He is known for a certain inefficient method of transportation: a bike with square wheels. But he has always been interested in efficient transportation, having run many marathons and ultramarathons (up to 100 miles), both on foot and on skis. He is a founding editor of *Ultrarunning* magazine and the author of many books and papers, including most recently a second edition of *The Banach–Tarski Paradox*.