

## MathWorks Math Modeling Challenge (M3 Challenge) 2023

### Ride Like the Wind Without Getting Winded: The Growth of E-bike Use

While there is a lot of discussion in the news about the growth of the electric car market, it turns out the most in-demand electric vehicle on the market in 2021 in the US, after a 70% increase in annual sales, is the electric bicycle, or e-bike. In many cases, e-bikes provide people with a fast, reliable transportation option that comes without the worry of timing public transit, the nuisance of parking, or the stress of traffic congestion. E-bikes have also revolutionized some businesses that rely on them for delivery of food and other goods. Policy makers are observing these changes with interest and wondering if e-bikes are likely to become part of a more sustainable energy plan by getting more cars off the roads. These issues were all part of this year's MathWorks Math Modeling Challenge. Over a long weekend in early March, 650 teams composed of almost 3,000 students worked on solution papers of up to 20 pages, competing for \$100,000 in scholarships in [MathWorks Math Modeling Challenge \(M3C\), a program of SIAM](#).<sup>1</sup>

M3 Challenge is a unique, internet-based math competition that provides a transformative, real-world experience for high school students in the United States and sixth form students in the United Kingdom, giving them the opportunity to demonstrate how the math they learn in class can be used to solve real problems. Now in its 18th year, M3 Challenge has awarded more than \$1.85 million in scholarships since its launch in 2006.

A program of Society for Industrial and Applied Mathematics (SIAM) and sponsored by leading software developer MathWorks, M3 Challenge seeks to make math relatable to everyday life and to inspire students to study and pursue careers in applied math, computational and data sciences, and technical computing. Free of any entrance or participation fees, M3 Challenge has drawn the participation of more than 50,000 students (one third female), 4,000+ high schools, 6,000+ teachers, and 400+ Ph.D.-level judges. It has been endorsed by the National Association of Secondary School Principals (NASSP) since 2010.

Working in teams of three to five members under a 14-hour time constraint, participants use the mathematical modeling process, as well as other skills and experiences, to understand and define a particular problem, gather data and information, document their assumptions, and devise a math model to make predictions and provide insight for decisions about the issue before submitting their solution via online upload. The specific real-world problem that is posed each year is unknown to participants until they log in during Challenge weekend. Teams may opt to use technical computing to advance a model or better reveal its implications, and extra credit awards exist for outstanding work in that area.

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<sup>1</sup> Please see the 2023 M3 Challenge [problem statement](#) for what teams downloaded on Challenge weekend.

After three rounds of rigorous judging by more than 120 professional applied mathematicians over the eight weeks immediately following Challenge weekend, six finalist teams and three technical computing awardees are selected to present their solutions to a panel of mathematical experts in New York City on the last Monday in April. The 2023 presentations are [viewable on YouTube](#). 37 teams were recognized with scholarship prizes starting at \$1,000; the Champion team received \$20,000.

**The following is the Champion team's paper from the MathWorks Math Modeling Challenge 2023.** Note that this is the team's original, unedited work as was submitted after just 14 hours. As such, there may be typos and other errors.

Complete information about MathWorks Math Modeling Challenge, including an archive with problems, solutions, and judge perspectives from each Challenge year, is available at <http://m3challenge.siam.org>.

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A program of Society for Industrial and Applied Mathematics