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CMU F1Tenth Autonomous Racing Capstone Course Support

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16. Abstract

This project enabled the purchase of equipment for an F1Tenth Autonomous Racing Course that was offered at Carnegie Mellon University in Spring 2026. Earlier UTC funding had assisted in equipment purchases for the University in Fall 2023, Spring 2024, and Spring 2025. The course was developed by fellow Safety21 UTC member Prof. Rahul Mangharam and team at the University of Pennsylvania, and adapted for CMU by the PI, Prof. John M. Dolan. It gives students a strong foundation in the full autonomous driving software stack and stresses safe maneuvering at high speeds among multiple surrounding vehicles. Participants in and graduates from the course at Penn and other universities have competed in F1Tenth race competitions at major robotics and transportation conferences including ICRA, IROS, and the IEEE Intelligent Vehicles Symposium and gone on to jobs in the intelligent transportation industry. The course therefore has high impact in the area of intelligent transportation workforce development. Furthermore, the technologies and techniques learned for maneuvering safely at high speeds have application to safety at the typically lower speeds of highway and city driving, and to the quick reactions needed to respond safely to emergency situations in conventional driving. This report describes the equipment purchased and other activities supported by the award.

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1. Executive Summary

This project enabled the purchase of equipment for an F1Tenth Autonomous Racing Course that was offered at Carnegie Mellon University in Spring 2026. Earlier UTC funding had assisted in equipment purchases for the University in Fall 2023, Spring 2024, and Spring 2025. The course was developed by fellow Safety21 UTC member Prof. Rahul Mangharam and team at the University of Pennsylvania, and adapted for CMU by the PI, Prof. John M. Dolan. It gives students a strong foundation in the full autonomous driving software stack and stresses safe maneuvering at high speeds among multiple surrounding vehicles. Participants in and graduates from the course at Penn and other universities have competed in F1Tenth race competitions at major robotics and transportation conferences including ICRA, IROS, and the IEEE Intelligent Vehicles Symposium and gone on to jobs in the intelligent transportation industry. The course therefore has high impact in the area of intelligent transportation workforce development. Furthermore, the technologies and techniques learned for maneuvering safely at high speeds have application to safety at the typically lower speeds of highway and city driving, and to the quick reactions needed to respond safely to emergency situations in conventional driving. This report describes the equipment purchased and other activities supported by the award.

2. Introduction

F1Tenth vehicles (Figure 1) are 1/10-size autonomous cars based on off-the-shelf R/C vehicles available from the company Traxxas or possibly other vendors, but retrofitted for autonomous operation. They have been used for several years now as the basis for university courses on autonomous racing. The F1Tenth Autonomous Racing course (16-663) in CMU's Robotics Institute gives students a strong foundation in the full autonomous driving software stack and stresses safe maneuvering at high speeds among multiple surrounding vehicles. Participants in and graduates from the course at Penn and other universities have competed in F1Tenth race competitions at major robotics and transportation conferences including ICRA, IROS, and the IEEE Intelligent Vehicles Symposium and gone on to jobs in the intelligent transportation industry. The course therefore has high impact in the area



Figure 1. F1Tenth Autonomous Vehicle

of intelligent transportation workforce development. Furthermore, the technologies and techniques learned for maneuvering safely at high speeds have application to safety at the

typically lower speeds of highway and city driving, and to the quick reactions needed to respond safely to emergency situations in conventional driving.

3. Platform

A suitable Ultimate or Platinum Traxxas chassis (

Figure 2) currently costs about \$500. The addition of appropriate computing, sensing, power, and other miscellaneous items brings the total cost of an F1Tenth autonomous vehicle platform to a little less than \$3,000 (see **Error! Reference source not found.**). In the Spring 2026 semester, the UTC award allowed us to buy 4 platforms to add to the 11 platforms we had bought with past UTC funding. Due to wear and tear, the total number of fully autonomy-retrofitted platforms at the end of the semester was 13, with two partially outfitted platforms available for current cannibalization if needed and future reconstitution.



Figure 2. Traxxas Ultimate R/C Car

Given a desired student team size of 4, we now have enough platforms for a class size of about 48 students. The number of students in Spring 2026 was 33, a significant increase over our Spring 2025 enrollment of 14, and we expect to be able to continue to grow the class.

4. Results (Supported Activities)

The UTC award funding allowed us to do the following things:

1. Buy 4 F1Tenth autonomous car platforms and key replacement parts.
2. Offer the 16-663 F1Tenth Autonomous Racing course at Carnegie Mellon University for the fourth time in Spring 2026.
3. Support the participation of a subset of the Spring 2026 16-663 students in a Race Day held at the University of Pennsylvania in early May 2026.

4.1 Purchase of F1Tenth Platforms

We were able to purchase four F1Tenth cars (see **Error! Reference source not found.**) for use in the Spring 2026 offering of the 16-663 F1Tenth Autonomous Racing course. Students gained experience in mechatronic fabrication and assembly by adding the autonomy retrofit components to the base Traxxas chassis.

4.2 F1Tenth Course

We taught the 16-663 F1Tenth Autonomous Racing for the fourth time in Spring 2026. The two TAs had taken the class earlier. The course will continue to be taught in the spring semester each year.



Figure 3 and



Figure 4 respectively show the CMU Spring 2026 set-up for Race 2 and two vehicles competing in Race 3.



Figure 3. Track set-up and single car participating in Race 2 in the Spring 2026 offering of the CMU F1Tenth Autonomous Racing course. Whereas Race 1 required only reactive maneuvering, Race 2 required mapping and localization.



Figure 4. Vehicles competing in the April 2026 Race 3 in the Spring 2026 offering of the 16-663 F1Tenth Autonomous Racing course at CMU

4.3 Penn Race Day

A Race Day was held at the University of Pennsylvania in early May 2026 with participation by students in the F1Tenth Autonomous Racing classes being taught simultaneously at Penn, Carnegie Mellon University (CMU), and other universities. CMU sent 10 students to participate in the Race Day, and about \$2000 of the UTC funding was used to defray logistics costs for the trip.

5. Future Work

This project has continued to support the following activities:

1. Teaching the 16-663 F1Tenth Autonomous Racing course at CMU each spring semester.
2. Participation in an annual multi-university Race Day at Penn, CMU, or elsewhere at the end of the spring semester.

3. Continuing to augment the fleet of F1Tenth vehicles at CMU in order to support greater numbers of students in the 16-663 course.
4. Supporting purchase of back-up/replacement parts and design alterations for the existing F1Tenth vehicles.