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NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

PERSPECTIVE ON AUTONOMOUS TRUCKING

THE 2024 INDY AUTONOMOUS CHALLENGE: ADVANCING AUTONOMOUS VEHICLE TECHNOLOGY AT HIGH SPEEDS

The Indy Autonomous Challenge is replacing drivers with cutting-edge AI to pave the way for the next frontier in both motorsports and technology.

"Racers, start your engines!" Except in this high-speed race, there were no human drivers in the Indy cars roaring around the racetrack at speeds in excess of 170 mph. On September 6, 2024, in the hallowed confines of the Indianapolis Motor Speedway (IMS), teams of talented and motivated university students from around the world, sponsored and partnered with leading-edge technology companies, gathered to compete in the 2024 Indy Autonomous Challenge (IAC) and race some of the highest tech autonomous Indy sports cars ever imagined.

The roar of engines, the screech of tires, and the thrill of the race have long been hallmarks of motorsport, but the IAC is pushing the boundaries of this tradition, replacing drivers with cutting-edge artificial intelligence (AI) to pave the way for the next frontier in both motorsports and technology.

Mike Roeth, NACFE's executive director, and I attended this year's festivities, which featured panels of experts, including several tech CEOs, deans from leading STEM programs, and government officials, discussing the latest innovations and challenges around autonomous racing and how that translates to commercial autonomous driving applications. Universities had booths and presented their autonomous engineering programs, and each team showed off its innovative car. The highlight was the afternoon races, which consisted of time trials and a high-speed, high-drama chase-and-pass competition for the six fastest qualifiers.

The official vehicle of this year's challenge was the IAC-built AV-24, which had been retrofitted with hardware and controls to enable automation. The chassis was a modified version of the Dallara Indy NXT, and each car was powered by a 4-piston Honda Racing Engine (K20C) with 488 hp@6500 RPM. Each vehicle had four Luminar Lidars, two Continental radars, six high-precision cameras, a GPS/INS system, networking gear, and an onboard edge computing system consisting of a dSpace Autera Autobox, Intel Xeon D-2166NT 3.00 GHz CPU, NVIDIA A5000 GPU, and 14TB of internal storage.

Yep, these cars are souped up and ready to rumble, with each vehicle costing more than $1M. Thank you to the sponsors, tech companies, and hardware manufacturers for their interest and investment.

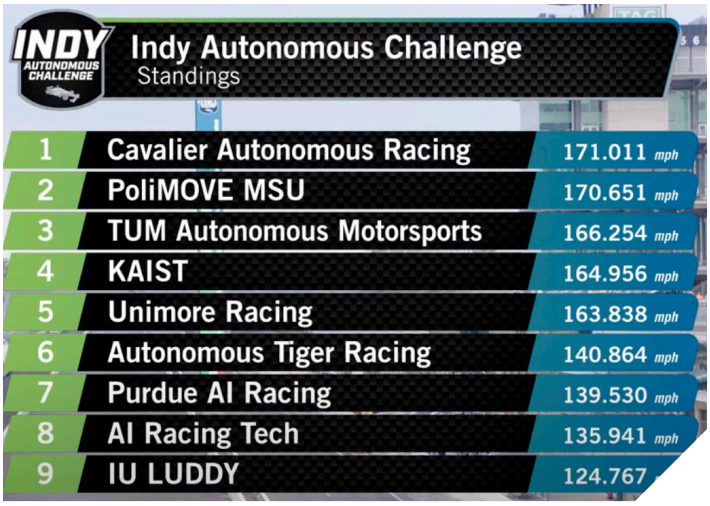
The primary objective in the IAC seems simple: race as fast as possible while maintaining safety and precision. However, the technical complexity behind achieving this is immense. These autonomous race cars must navigate the 2.5-mile IMS oval at speeds often exceeding 170 mph — without human intervention.

> "While the Indy Autonomous Challenge is rooted in motorsports, its implications reach far beyond the track.

This year, a new challenge was added: a high-speed, chase-and-pass maneuver that required the cars to navigate autonomously around a leading car at ever-increasing speeds. The true innovation lies in the software. Teams had to develop sophisticated algorithms that could:

- Interpret sensor data to understand the car's environment,
- Plan optimal racing lines and overtaking maneuvers,
- React to changing track conditions and competitor movements, and
- Maintain vehicle stability at high speeds.

The afternoon racing was exhilarating and inspiring. During the time trials, each team had five minutes to register the



IU Luddy – *the newest entrant to the race, completed two laps*

CalTech AI Racing Tech – *completed two laps; a GPS Issue caused an early exit*

KAIST – *rain delay in the middle of the run*

TUM Autonomous – *went low on turn four, lost traction, and hit the wall, ending the day*

fastest average lap speed. Among other inputs, sensors monitored tire pressure, temperature, and thread bite, and the speeds increased on each lap as tires warmed up and gained traction. When reviewing these results, remember that the average Indy 500 time-trial speed is around 230 mph, with the fastest ever recorded being 237.5 MPH set in 1995 by Arie Luyendyk.

The second phase, the attack-and-pass competition, featured the top six teams from the time trials and proved challenging for most teams. This phase tested sensing and navigating around other cars at high racing speeds, starting at 80 mph and increasing five miles per hour each lap until one team did not complete a pass during the allotted distance.

AI Racing Tech had a sensor or GPS issue and failed on the first pass attempt, running into the infield. The KAIST team could not complete the pass during the first lap. With a possible mechanical issue, the Cavalier team lost traction on a turn and spun out. The finals matched PoliMove and Unimore, with the teams reaching 155 mph on successful passes before PoliMove prevailed with a pass at 160 mph. This is an incredible accomplishment and shows the talent and ability of all the teams at this competition.

According to the organizers, beyond improving safety and vehicle performance, the IAC seeks to help overcome three prominent barriers to automated vehicle commercialization:

Solving “edge case” scenarios. Problems or situations that occur only at an extreme operating parameter, such as avoiding unanticipated obstacles at high speeds while maintaining vehicular control, need to be addressed to ensure safety across all operating environments.

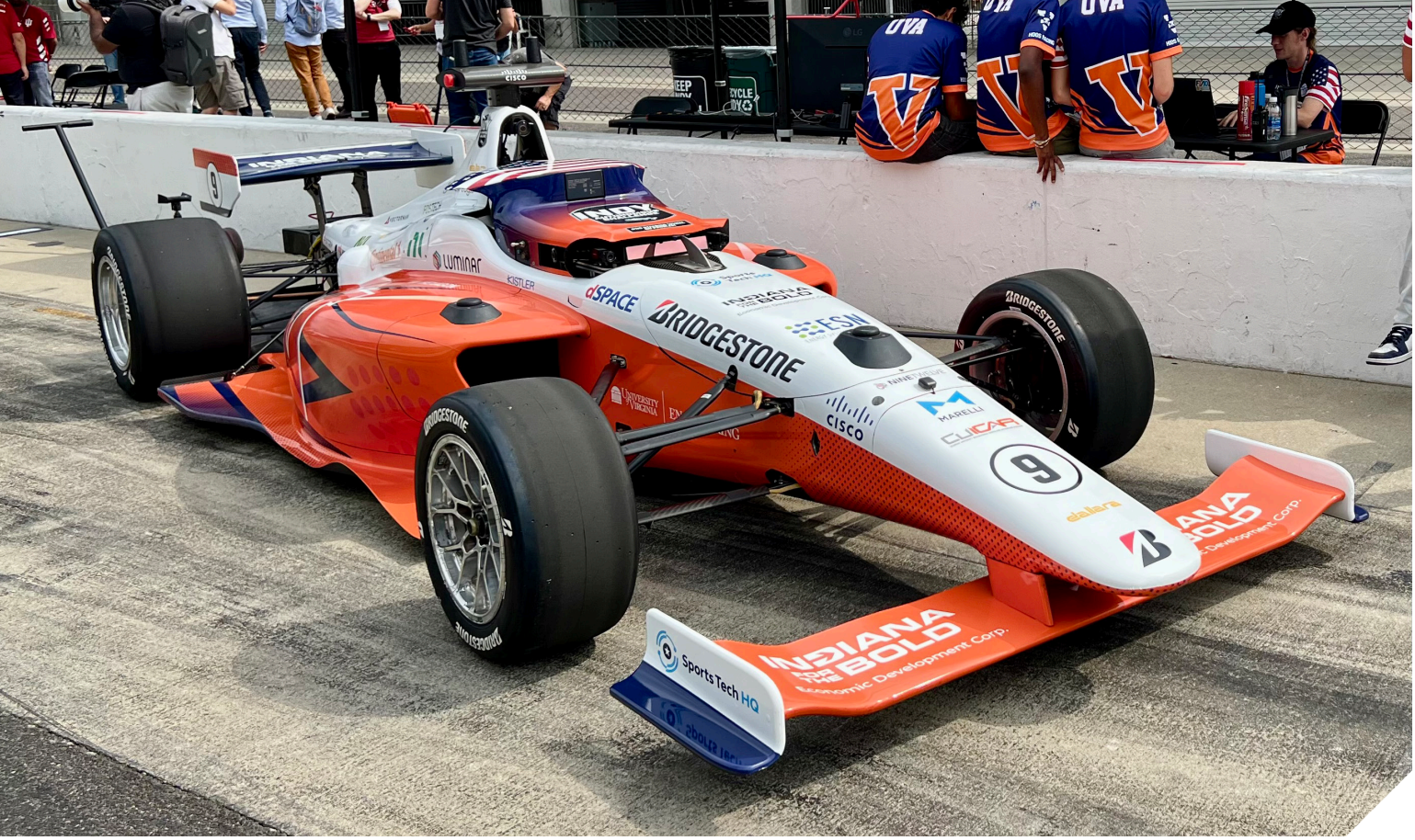
Catalyzing new AV technologies and innovators. Automated vehicles are too expensive for scaled commercial deployment, and automakers and tech companies are seeking sources of new intellectual property and qualified engineers and software developers.

Engaging the public to help ensure acceptance and use of AV technologies. Increased experience with and exposure to

The Teams: Global Collaboration and Competition

The IAC brings together some of the brightest minds from top universities and technology institutes worldwide, in collaboration and guidance from sponsor tech companies. In this year’s competition, several teams showcased their innovative approaches to autonomous racing:

1. **AI Racing Tech (ART)** — University of California, Berkeley, with University of Hawai’i, University of California, San Diego, and Carnegie Mellon
2. **Autonomous Tiger Racing (ATR)** – Auburn University
3. **Caltech Autonomous Systems and Technologies**
4. **Cavalier Autonomous Racing (CAR)** — University of Virginia
5. **IU Luddy** — Indiana University
6. **KAIST** — Korea Advanced Institute of Science and Technology
7. **PoliMOVE - MSU** — Politecnico di Milano, Michigan State, University of Alabama
8. **Purdue AI Racing** - Purdue University
9. **Unimore of Modena and Reggio Emilia** (Italy)
10. **TUM Autonomous Motorsport** — Technische Universität München



AVs can help facilitate an understanding of them and their potential.

While the IAC is rooted in motorsports, its implications reach far beyond the track. Autonomous vehicle technology has the potential to transform transportation systems globally. Whether improving road safety, reducing traffic congestion, or optimizing delivery systems, the advancements born from IAC can find applications in everyday life.

Moreover, potentially most significantly, the IAC is helping foster collaboration between universities, industries, and tech companies. By bringing together the brightest minds in AI, robotics, and engineering, the challenge is creating an ecosystem where innovation thrives. Not only are these teams solving immediate problems on the track, but they also are developing long-term solutions for the future of autonomous systems.

Beyond the race, the IAC continues to push the conversation on the role of AI in transportation. With major tech companies and partners like Cisco, Microsoft, and NVIDIA, the challenge is quickly becoming a launchpad for future advancements in autonomous technology.

The Indy Autonomous Challenge at IMS represents more than just a race; it symbolizes the evolution of technology and its integration into the world of motorsports and beyond. And it was so much fun to watch the events unfold. The best part was spending time with the students, who took great pride in their years of dedicated work to compete.

Sign me up; I'm ready to return to college and join the team!

About the Author: *Dr. Dean Bushey is NACFE's Senior Consultant and will focus on alternative fuels, fleet efficiencies, and advanced technologies in the trucking industry. Dean has more 30 years of business, academic, and military leadership experience in multi-modal transportation, energy, infrastructure, and mobility as a senior executive, educator, pilot, and autonomous systems expert. His most recent position was as a senior vice president at TravelCenters of America, focusing on low-carbon mobility and alternative fuels for the trucking industry. He has extensive experience in long-range mobility and complex and multi-modal transportation systems.*

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