



# NASA's 17th Annual Great Moonbuggy Race:

Innovative Engineering Solutions From Tomorrow's Space-Age Pioneers



**A pair of racers representing the Huntsville Center for Technology in Huntsville, Ala., speed toward the 2009 high school division trophy in NASA's 16th annual Great Moonbuggy Race. The school tied for first place in 2009 with Erie High School Team 2 from Erie, Kan. (NASA/MSFC)**

NASA's 17th annual Great Moonbuggy Race is set for April 9–10 at the U.S. Space & Rocket Center in Huntsville, Ala. There, as many as 106 student teams from 88 high schools, vocational schools, colleges and universities around the world will propel wheeled rovers of their own design around a simulated alien landscape — perhaps launching their future careers as next-generation engineers, scientists and space explorers.

More than 1,000 students from 20 states and Puerto Rico, Bangladesh, Canada, Germany, India, Romania and Serbia are expected to compete in the 2010 race. An unprecedented 35 international teams signed up for this year's competition, including 27 from India alone. Nearly half of all race teams are racing in the event for the first time this year.

Each team — which can include up to six students and a teacher/mentor — spent much of the preceding fall and winter designing, building and testing its lightweight moonbuggy. All the rovers are based on NASA's original lunar vehicles, first driven on the moon's surface during the Apollo 15 moon mission in 1971.

Eight college teams participated in NASA's first Great Moonbuggy Race in Huntsville in 1994. That event commemorated the 25th anniversary of the Apollo 11 lunar landing. The race was expanded in 1996 to include high school teams, and student participation has swelled each year since.

The competition opens Oct. 1 each year. NASA challenges high school, college and university students around the globe to begin designing

**NASAfacts**

## Participating 2010 High School Teams

*A.I. Prince Technical High School, Hartford, Conn.*  
*Altamont High School, Birmingham, Ala.*  
*Arab High School (two teams), Arab, Ala.*  
*Autauga County Technology Center (two teams), Prattville, Ala.*  
*Bob Jones High School, Madison, Ala.*  
*Calloway County High School, Murray, Kan.*  
*Cape Girardeau Career Technology Center, Cape Girardeau, Mo.*  
*Carlisle County High School, Bardwell, Ky.*  
*Cookeville High School, Cookeville, Tenn.*  
*East Chicago Central High School, East Chicago, Ind.*  
*East Limestone High School, Athens, Ala.*  
*Elk Valley High School, Longton, Kan.*  
*Erie High School (two teams), Erie, Kan.*  
*Escuela Superior Santiago Iglesia Pantin, Ceiba, Puerto Rico*  
*Escuela Superior Urbana, Patillas, Puerto Rico*  
*Fairhope High School (two teams), Fairhope, Ala.*  
*Fajardo Vocational High School, Humacao, Puerto Rico*  
*Huntsville Center for Technology (two teams), Huntsville, Ala.*  
*International Space Education Institute, Leipzig, Germany*  
*I.S. Dev Samaj School, Chandigarh, India*  
*Isidro Sanchez High School, Luquillo, Puerto Rico*  
*Jupiter High School, Jupiter, Fla.*  
*Lima Senior High School (two teams), Lima, Ohio*  
*Madison County Career Technical Center (two teams), Huntsville, Ala.*  
*Manuel Mediavilla Negron, Humacao, Puerto Rico*  
*Murray High School, Chatsworth, Ga.*  
*New Britain High School, New Britain, Conn.*  
*Pana High School (two teams), Pana, Ill.*  
*Scotlandville Magnet High School, Baton Rouge, La.*  
*Sunshine Grammar School & College, Chittagong, Bangladesh*  
*Teodoro Aguilar Mora Vocational High School (two teams), Yabucoa, Puerto Rico*  
*Tudor Vianu National High School of Computer Science (two teams), Bucharest, Romania*  
*Velammal Matriculation Higher Secondary School, Madurai, India*  
*Wellpinit School District, Wellpinit, Mass.*

a sturdy, collapsible vehicle that addresses engineering problems similar to hurdles overcome by the original lunar rover development team at NASA's Marshall Space Flight Center in Huntsville in the late 1960s.

The Great Moonbuggy Race is organized annually by the Marshall Center, and has been hosted by the U.S. Space & Rocket Center since 1996. The race is sponsored by NASA's Space Operations Mission Directorate in Washington, with corporate sponsorship by Lockheed Martin Corp., The Boeing Company, Northrop Grumman Corp. and Jacobs Engineering Science Technical Service Group, all of Huntsville.

Other corporate and institutional contributors include ATK Launch Systems, Inc.; Davidson Technology; Teledyne Brown Engineering; Science Applications International Corp.; the American Institute of Aeronautics and Astronautics; Industrial Fabrication Company; the Tennessee Valley chapter of the System Safety Society Inc.; and Stanley Associates.

NASA's Great Moonbuggy Race is one of dozens of educational programs and initiatives the Marshall Center leads each year to help attract and inspire America's next generation of scientists, engineers and explorers — those who will carry on the nation's mission of exploration in the decades to come.

## Participating 2010 college/university teams

*Alabama A&M University, Huntsville, Ala.*  
*Amity University (two teams), Noida, India*  
*Amity School of Engineering & Technology, New Delhi, India*  
*Bevill State Community College (two teams), Sumiton, Ala.*  
*Cameron University, Lawton, Okla.*  
*Carleton University, Ottawa, Ontario, Canada*  
*Central Connecticut State University, New Britain, Conn.*  
*Christian Brothers University, Memphis, Tenn.*  
*Colorado School of Mines, Golden, Colo.*  
*CT Institute of Engineering, Management & Technology, Jalandhar, India*  
*Delhi Technological University, New Delhi, India*  
*Dronacharya College of Engineering, Greater Noida, India*  
*GGs College, Chandigarh, India*  
*Government Edward College, Pabna, Bangladesh*  
*Guru Gobind Singh Indraprastha University, Delhi, India*  
*Guru Tegh Bahadur Institute of Technology, New Delhi, India*  
*JSS Academy of Technical Education, Noida, India*  
*Kali Charan Nigam Institute of Technology, Banda, India*  
*Kirorimal College, New Delhi, India*  
*Krishna Engineering College, Ghaziabad, India*  
*Mahakal Institute of Technology, Ujjain, India*  
*Middle Tennessee State University (two teams), Murfreesboro, Tenn.*  
*Mukesh Patel School of Technology, Management & Engineering, Mumbai, India*  
*Netaji Subhas Institute of Technology, New Delhi, India*  
*Noida Institute of Engineering & Technology (two teams), Greater Noida, India*  
*North Florida Community College, Madison, Fla.*  
*Ohio State University, Columbus, Ohio*  
*PEC University of Technology, Chandigarh, India*  
*Pittsburg State University (two teams), Pittsburg, Kan.*  
*Punjab Engineering College, Chandigarh, India*  
*Purdue University Calumet (two teams), Hammond, Ind.*  
*R.B.S. College, Agra, India*  
*Rajiv Gandhi Technical University, Bhopal, India*  
*Rhode Island School of Design, Providence, R.I.*  
*Ryerson University, Toronto, Ontario, Canada*  
*Southern Illinois University at Carbondale*  
*Southern University (two teams), Baton Rouge, La.*  
*Tallahassee Community College, Tallahassee, Fla.*  
*Tennessee Technological University (two teams), Cookeville, Tenn.*  
*University of Alabama in Huntsville, Huntsville, Ala.*  
*University of Belgrade, Belgrade, Serbia*  
*University of Central Florida, Orlando, Fla.*  
*University of Delhi (two teams), New Delhi, India*  
*University of Evansville, Evansville, Ind.*  
*University of Puerto Rico, Humacao, Puerto Rico*  
*University of Utah, Salt Lake City, Utah*  
*University of Vermont, Burlington, Vt.*  
*University of Wyoming, Laramie, Wyo.*  
*Uttar Pradesh Technical University, Uttar Pradesh, India*  
*Virginia Commonwealth University, Richmond, Va.*  
*Wright State University, Dayton, Ohio*  
*Youngstown State University, Youngstown, Ohio*

## The rules

Teams selected as winners for the top three positions in both the high school and college divisions are judged based on the shortest total time to assemble their moonbuggies and complete the lunar obstacle course. Each team is permitted two runs of the course. The shortest course time, combined with assembly time, results in each team's final score.

Each vehicle must be solely human powered and piloted by two students, one female and one male, over the half-mile course. Every vehicle is required to have a specific set of parts — fenders, a flag and simulated mission hardware including batteries, a communications antenna, radio and TV camera.



**Student racers from the University of Evansville in Evansville, Ind., speed to victory in the college division of NASA's 15th annual Great Moonbuggy Race, held April 4–5, 2008, at the U.S. Space & Rocket Center in Huntsville, Ala. The team outraced 23 other college teams from around the United States, Puerto Rico, Canada, Germany and India. (NASA/MSFC)**

To start, teams first must demonstrate that their unassembled moonbuggies will fit into a 4-foot-by-4-foot-by-4-foot cubic container, similar to transport conditions experienced by the original lunar rovers during their journeys from Earth to the moon. Folded moonbuggies then are carried by hand to the prequalification line, where they are assembled and readied for the course by the drivers, and evaluated for safety by the judges.

The buggies race against the clock, rather than side-by-side. Judges mark their progress, assessing penalty points if the drivers' feet touch the ground, or if buggies lose their on-board equipment. The drivers push hard to conquer each obstacle without overturning the rover or exceeding the 10-minute time limit on the course.

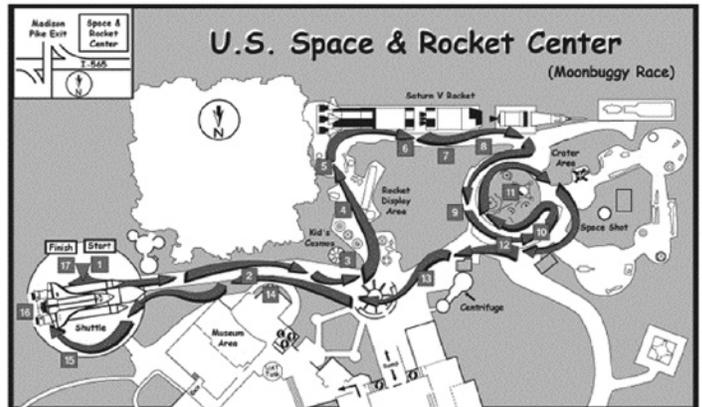
Some 350 members of the Marshall Center work force volunteer each year to assist with the moonbuggy race, serving as timekeepers, vehicle inspectors, obstacle judges and crossing guards, maintaining safety at numerous busy spots on the race course, among other capacities.

### The course

A crew of construction workers at the U.S. Space & Rocket Center spends two weeks prior to each year's competition laying the simulated lunar course. It covers approximately a half-mile of pathways that wind around the exterior of the popular Huntsville space museum and NASA Visitor Center, twining through an atmospheric backdrop of famous American rockets and space vehicles.

The course includes 17 unique obstacles built of plywood, aluminum and discarded tires. The obstacles and other portions of the course are covered with approximately 20 tons of gravel and 5 tons of sand. The material is carefully shaped into craters, basins and other obstacles simulating the harsh landscape of alien worlds.

The unearthly landscape of the current course was designed in 1993 by Dr. Larry Taylor, a lunar geologist and professor at



### Course map

The Great Moonbuggy Race course and specific obstacles vary in detail from year to year. This outline gives participants a general idea of the course layout.

- The starting line is located under the space shuttle, near the "Pits" Area where moonbuggies are inspected and repaired. **Obstacle 1** is under the space shuttle.
- Next, the course slopes up slightly on a paved path that leads over a hill toward **Obstacle 2**, then travels downhill again to **Obstacle 3**.
- A sharp turn to the left leads through the U.S. Space & Rocket Center's rocket display area to **Obstacle 4** and **Obstacle 5**.
- The course turns sharply to the right, remaining on asphalt and moving uphill to **Obstacle 6**, **Obstacle 7** and **Obstacle 8**.
- At the end of this straight section, a wide right turn brings participants to **Obstacle 9** and **Obstacle 10**, on the circular downhill path leading to the lunar crater area.
- Entering the crater area, the course veers left. Racers must take a complete 360-degree clockwise path across the lunar terrain. The largest crater is **Obstacle 11**, with its challenging 18-inch uphill grade.
- Exiting the crater area, moonbuggies turn right toward **Obstacle 12**, **Obstacle 13** and **Obstacle 14**, on a path that starts flat, then slopes uphill. At the last of these obstacles, it slopes downward again. Speed bumps help slow descent.
- Finally, the course takes a left turn as racers enter the shuttle area and tackle **Obstacle 15**, **Obstacle 16** and **Obstacle 17** to conclude their runs.



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the University of Tennessee at Knoxville; Dr. J.M. Wersinger, a physics professor at Auburn University in Auburn, Ala.; and the Marshall Center's Dr. Frank Six, now Marshall's university affairs officer supporting the annual race.

Over the years, the challenging course has been made as safe as possible. Every driver is required to wear a seatbelt during the race, and more than 175 hay bales line the drive path to protect speeding drivers and spectators alike.

### **The repairs tent**

Student "pit crews" make use of NASA's repairs tent throughout race day, welding snapped struts, replacing bent wheels and installing new chains and sprockets. The tent includes work tables and benches, equipment and material supplies for pit crews working on up to six moonbuggies at a time. Team members make their own repairs, with oversight and guidance provided by Marshall Center engineers. All pit crew members are required to wear safety glasses in the work area, and welds are supervised by trained professionals.

Repair tent equipment, provided by the Metals Engineering Branch of Marshall's Engineering Directorate, includes a variety of welding machines, hand tools, electric tools, duct tape and epoxy, and a salvageable pile of scrap metal to replace or strengthen damaged vehicle parts. They also keep on hand detailed maps of local bicycle shops and area hardware stores, in case repairs require additional tools or parts.

### **National Aeronautics and Space Administration**

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### **The prizes**

Top prizes are awarded to the three teams in the high school division and three in the college division that post the best assembly-and-race times.

In the high school division, the first-place team receives a trophy from the Marshall Center and a one-week trip to the Advanced Space Academy at the Space & Rocket Center, courtesy of ATK Launch Systems. In the college and university division, the first-place team receives a trophy from the Marshall Center and \$5,700 in cash from Northrop Grumman, Inc., to support a trip to experience a space shuttle launch.

Marshall also gives commemorative plaques to the second- and third-place teams in the high school and college divisions, and presents each team member of the top three teams in both divisions a medallion and certificate.

All participating moonbuggy teams receive a plaque from Science Applications International Corp.

The Marshall Center's Engineering Directorate each year presents the Frank Joe Sexton Memorial Pit Crew Award plaque to the team whose engineering ingenuity, resourcefulness and teamwork most successfully overcomes race-day obstacles. Sexton, a NASA machinist, worked on the original lunar rover and numerous other space vehicles until his death in 2000. NASA also presents plaques for "Best Team Spirit" and "Featherweight." The latter, a new award in 2010, recognizes the team that designs the lightest, fastest buggy on the track.

Additional prizes for each division include a \$1,000 cash award from the American Institute of Aeronautics and Astronautics for best moonbuggy design; an award for most improved team from Jacobs Engineering; and an award for fastest rookie team of the year from Northrop Grumman Corp. The American Institute of Aeronautics and Astronautics also awards a "Crash and Burn" plaque and cash prize to one college or university team that faces and resolves the most dramatic vehicle breakdown of the day's race.

For more information, visit: <http://moonbuggy.msfc.nasa.gov>

For information about other NASA education programs, visit: <http://education.nasa.gov>

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