2011 Official Rules

Andy Ogden ©

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Overview

The Formula E (elastic) challenge aka. M3 Racer Project, aka "*The Rubber Racer"* has been held annually during the month of August since 2006 in Art Center College of Design's Graduate Industrial Design Department.

The 14 Week long design project culminates with student teams competing in a variety of events with their uniquely designed remote controlled race vehicles propelled by energy stored in 16 feet of rubber band.

The event takes place on the smooth paved sidewalks of the Art Center *sculpture garden* and includes a road course, a drag race, and a hill climb, In addition there are awards for a beauty contest, and for the team that wins the most other events: a best in show award.

For 2011 the teams were additionally challenged to find a charitable local organization and to use their creativity to generate donations for the charity through their race activity.

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Overview (continued)

Formula e vehicles are designed and developed utilizing scratch-build fabrication techniques as well as with computers and rapid prototyping tools, advanced materials and mechanisms that regularly produce sophisticated design solutions that rapidly accelerate to speeds over 25mph.

The Grad ID classes involved with the project are designed to teach lessons in strategy, product development, science, engineering, design, fabrication, branding, communications, and event planning through a fun and real world product development experience.

In the process students learn about competition, working in teams, setting goals, making plans and then implementing them with various measures of success despite surprises and adversity.

The rules and specifications for formula E racing evolve slowly. Each generation of Formula E vehicles has evolved in regard to design sophistication by innovative thinking that furthers advancements made by teams in prior years.

There are 5 contests in the formula e challenge. They are designed to challenge the teams to build strategies that select superior performance and competitive advantage in specific contests- with a likely outcome that in pursuing success in all contests – it will necessarily require compromises in having advantages in any one of them.

formula e ©

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THE CONTESTS

The *Eckles* build design and approach trophy

This Concours d'Elegance **-** like event is judged by a blue ribbon panel that will determine award of the trophy for best design aesthetics, craftsmanship, and mechanical elegance. Named in honor of distinguished Art Center faculty Gaylord Eckles who introduced a rubberband powered car project to the college in the 1980s.

Sculpture Garden Flats

A figure 8 with obstacles. At 322 feet this is the longest of the formula **e** tracks. This event puts emphasis on driving skill and ability of the vehicle to accelerate, brake and corner. Vehicles race one at a time against the clock.

Ashtray Alley Drag way

A classic drag race layout emphasizing, acceleration, top speed and straight line stability. Vehicles race one at a time against the clock on the 136 foot long straight.

Sinclair Masters Hill Climb

This course is 228 feet of uphill grade with one 90 degree left turn midway. The event puts emphasis on vehicles to have sufficient torque and on driver skill to navigate the turn without losing too much momentum.

Best in Show

This trophy recognizes the team with the best collective point score accumulated through performance in the other contests.

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OFFICIAL RULES

1.0 TEAMS

1.1 Teams will consist of 2-4 members

1.2 Each team will design and build at least one racer capable of competing in all of the contests.* Teams may elect to emphasize performance in certain events.

1.3 Each team member must drive (pilot) the vehicle for one heat in each contest for up to the total of 3 heats per each racing contest. No one other than a recognized member of the team can pilot the vehicle in an official race.

1.4 The contest for measuring aesthetic and build quality achievement should precede all other (dynamic) contests

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OFFICIAL RULES

2.0 VEHICLES

2.1 The vehicle must achieve forward motion only by the energy stored in one specified official rubber band strip medium. The rubber strip must be attached only to the vehicle. Rubber band strip for the official race will be provided by and may only be acquired from the race operators. This will typically be One (1) 3/16” x 16ft rubber strip (FAI Tan Rubber Strip or PeckPolymers Rubber Strip)
Race teams may use lubrication mediums to enhance the performance of rubber strip and may pre condition strips prior to races without modifying the composition of the strip and with passing of inspection by race officials.

2.2 Each vehicle may have no more than 2 remote radio controlled servos, each servo capable of one degree or axis of 3D motion in two directions and typical of hobby servos. Servos are assumed to include the supporting components for such servos (ie. battery, switches, and receiver) that can be used to provide remote control for any function required. (ex. steering and braking) No other on or off board sensors, guidance or other control systems are allowed.

2.25 Teams may use any and the latest technology for servos, batteries, receivers, switches, controllers etc. as long as it was/is *reasonably* available for all of the competitors within the development time of the race vehicles. Exclusive prototype components from vendors are not allowed.

2.3 The vehicle must have one and the same setup/configuration and components for all of the contests. The team may have replacement parts or assemblies of the same design and the team may develop an entire spare vehicle of the same design. Teams may not change configuration other than:
a) the number of winds or loops in a rubber band for different contests.
b) protective bumpers and collision guards

2.6 There are no restrictions on the dimensions, materials and /or methods used to fabricate the vehicle.

2.7 Vehicles may utilize purchased components including steering knuckles, wheels, etc.

2.8 Vehicles must be substantially designed and assembled/ constructed by the team and may not be substantially outsourced to other service providers.

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OFFICIAL RULES

3.0 RACE RULES

3.1 Each team will race their vehicle (one at a time) - against the official timing clock to achieve a best time. Start/Finish will be measured “nose to nose” Vehicles must have their complete physical form behind the start line. Vehicles will be measured as “at the finish line” when the first physical element of the vehicle arrives at the finish line. Infrared or other automated systems will typically be utilized to measure and monitor race times. Officials may elect to utilize back-up timing results of race times by manual timing methods in the case of a failed automatic timing run or authorize a re-run of the race for a new time.

3.2 There will be 3 heats for each team for this contest. A separate time will be recorded for each contest and the best of the 3 times will be recorded as that team’s official best time for that event.

3.3 Each team must be ready to race for their scheduled time when they are called to the start line or after 60 seconds they will forfeit that heat. Teams will be informed that they need to be on deck prior to their scheduled race time. Racers are to wind their vehicles and otherwise to be ready to race before their scheduled start time. Racers have 3 minutes to complete the specific heat after arriving successfully for their scheduled start time.

3.4 The team achieving the best time or rank for any event will be awarded 5 points. The team with the second best time will receive 4 points. The team with the third best time will receive 3 points. The team with the fourth best time will receive 2 points. The team with the fifth best time will receive 1 point. Total point scores will be used to award the ***Best in Show*** trophy.

3.5 Team members may be stationed anywhere on the course during their contests.

3.6 No objects may be placed in or on the course; examples are ladders, bicycles, ramped turns, etc. that may impair competitors or produce advantages for teams.

3.7 No roller blades, skateboards, rolling shoes or other personal mobility advantages are allowed for vehicle drivers or team members.

3.8 Team members may walk or run on or off the course to drive or follow the vehicle during their race.

3.9 Raceways are generally defined by the width of the sidewalk or barriers of lawn, curb, or wall, etc. immediately adjacent.

OFFICIAL RULES

3.0 RACE RULES (continued)

3.10 Hitting or deflecting off of objects within and adjacent to the course is allowed. Examples are curbs, benches, stairs and walls.

3.11 The vehicle must follow and complete the entire course from start to finish, if the vehicle spins out, misses a turn, or otherwise goes off course then a member of that team (only) may replace the vehicle on the course at or before the location of forward progress through the course where it went off course. The clock will continue to run.

3.12 Off-Course / Touch / Gain Penalty:
The contest referee may elect to penalize any team at her/his discretion for up to 5 seconds for driving or deflecting the vehicle off of the course or otherwise assisting the forward progress of the vehicle by other than the stored power in the rubber band- especially to gain a time advantage.

3.13 Vehicles must be able to start the race without being touched or held behind the start line location. That is: the vehicle must by a brake or other automatic mechanism be able to hold itself at the start of the race for at least 5 seconds with the forward most part of the vehicle between the start line and no more than 6” (150 mm) behind the start line.

4.0 A team may be disqualified by the referee if any team member engages in intentional interference, damage or sabotage to any vehicle regarding the race event in any way.

5.0 Non ACCD Grad ID teams may compete by meeting all requirements and successfully participating in the prior qualifying race.

6.0 The winning team of each contest will be presented the appropriate trophy in a ceremony following the race and their record will be added to the historic legacy trophy after the event.

7.0 The referee makes the final ruling for any disputes.

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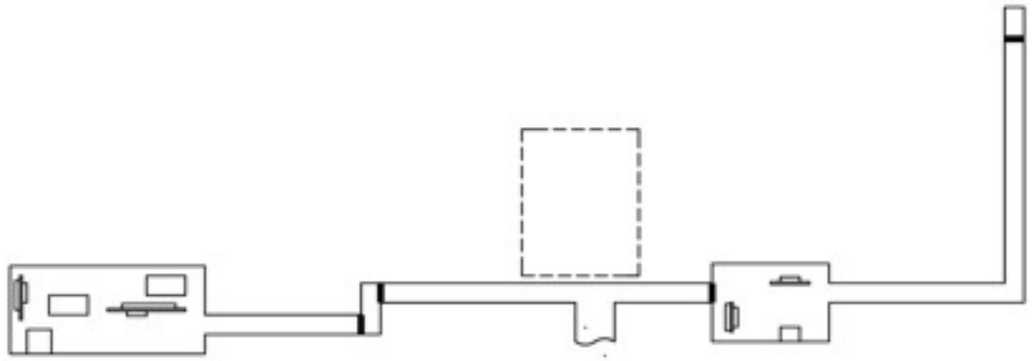
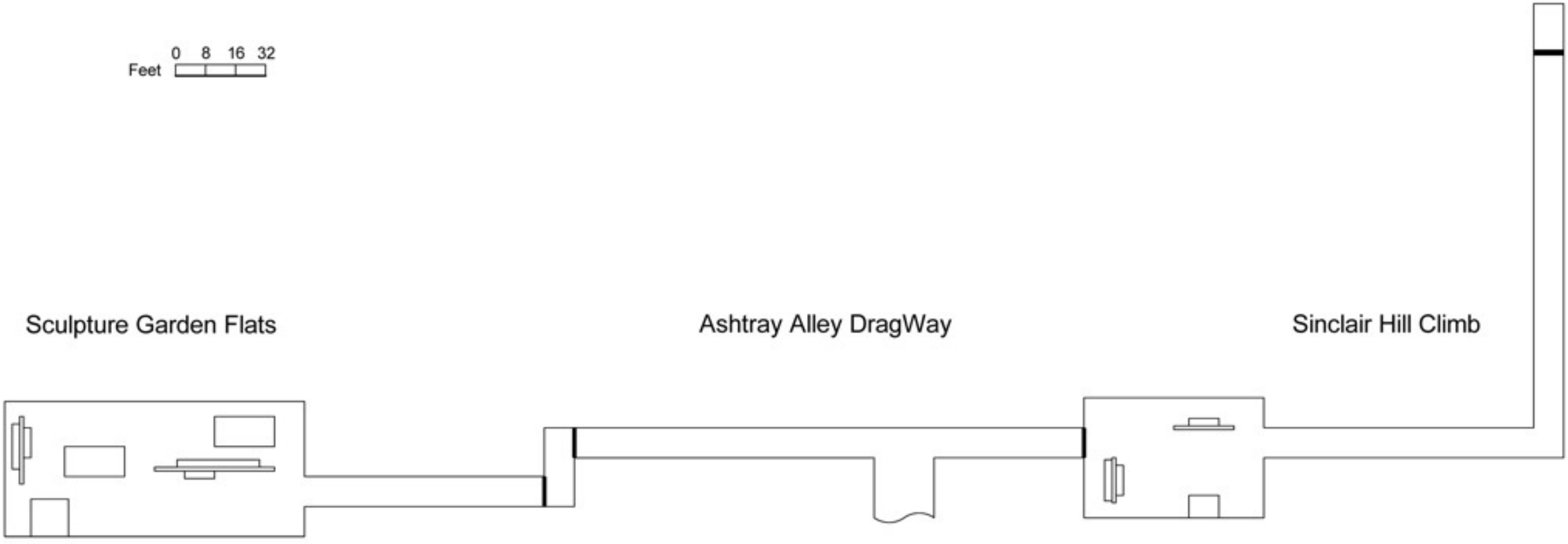
OFFICIAL TRACKS

Art Center College of Design
Hillside Campus
1700 Lida St. Pasadena CA 91103





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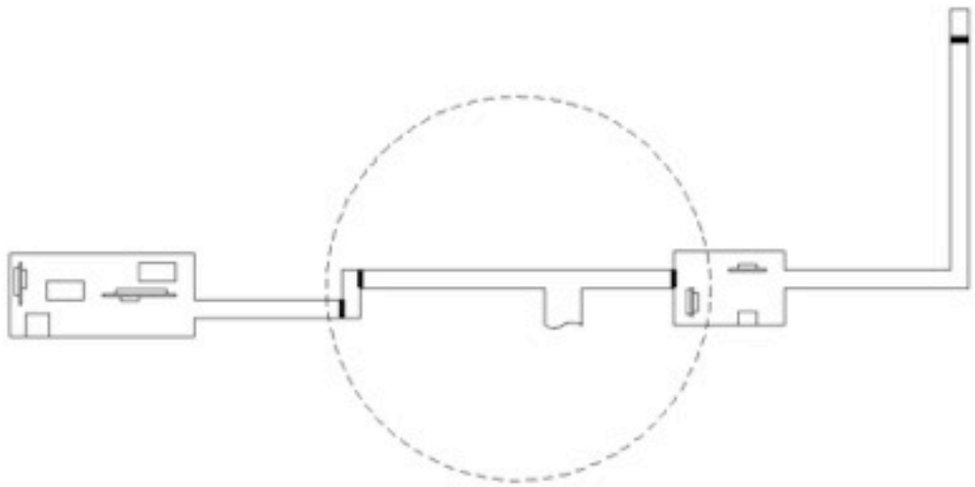
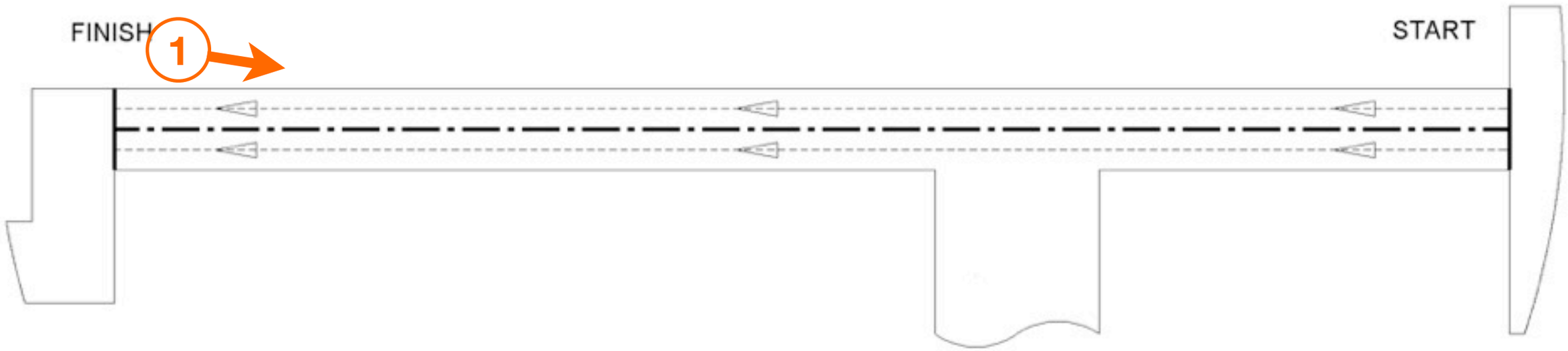
Sunday, November 6, 2011

OFFICIAL TRACKS

Ashtray Alley Dragway

136 feet





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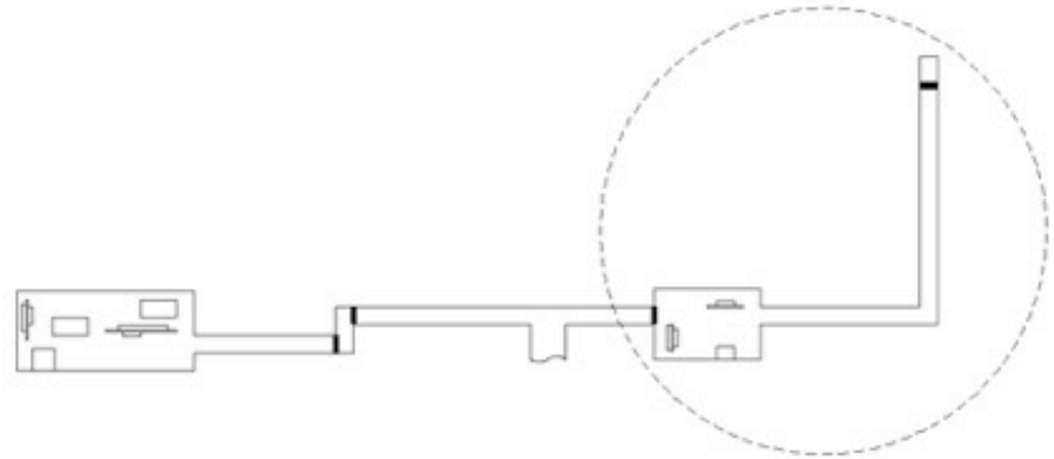
Sinclair Hill Climb

228 feet



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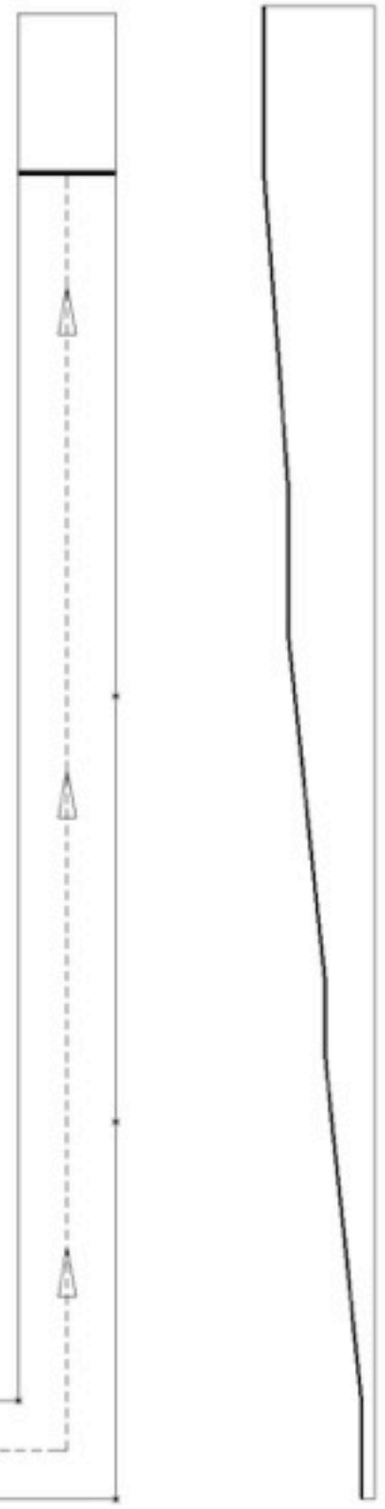

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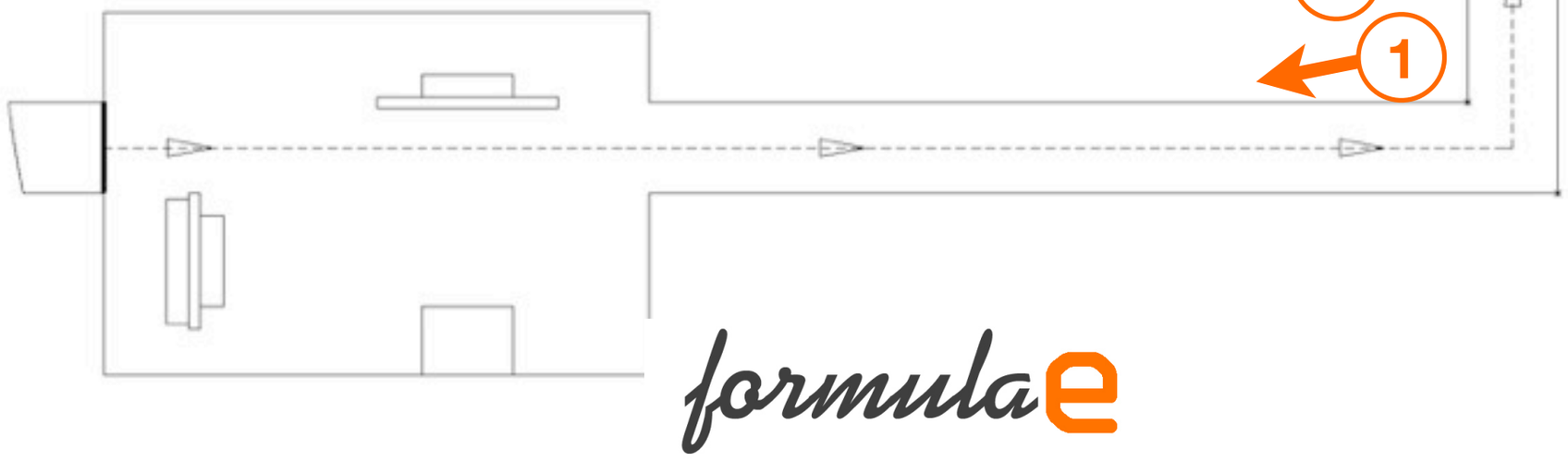

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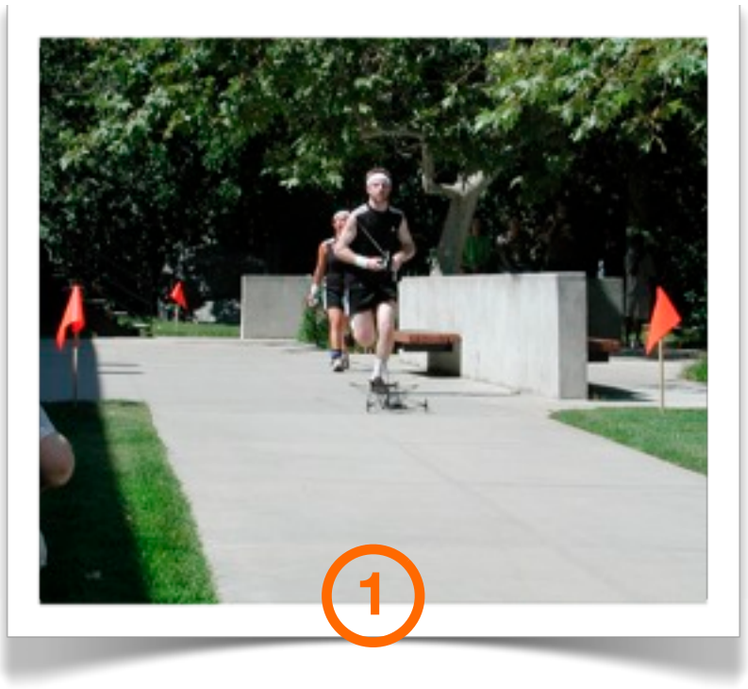
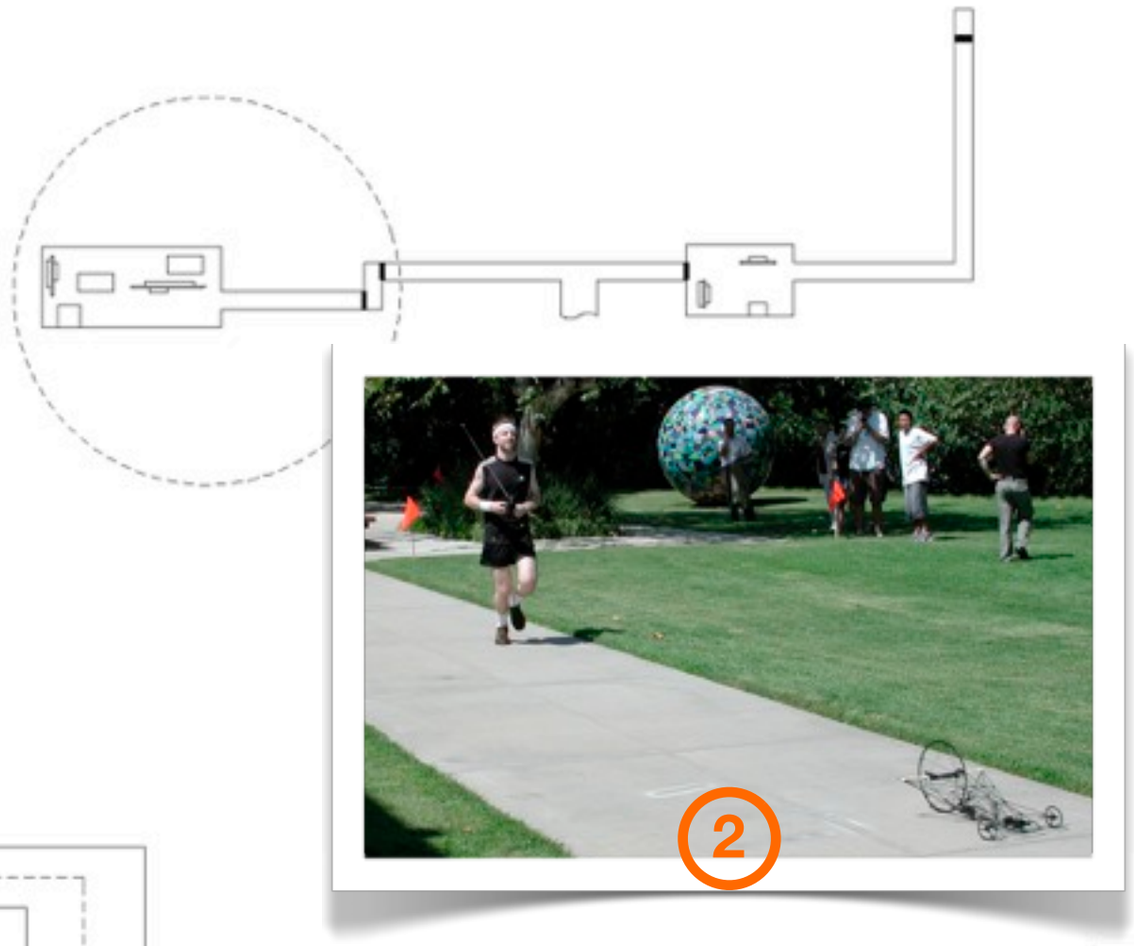
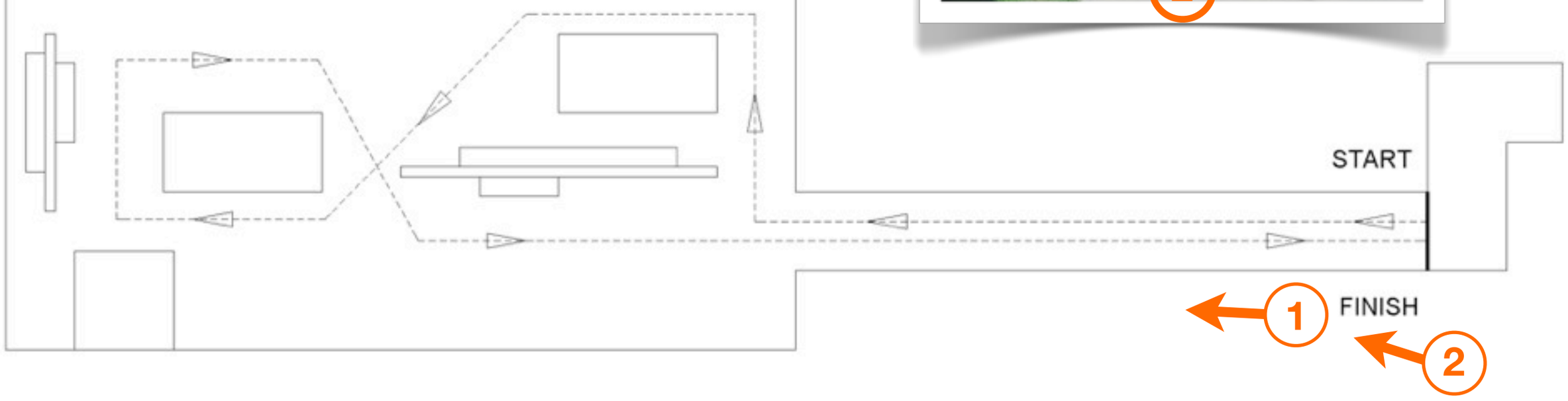
OFFICIAL TRACKS

Sculpture Garden Flats

322 feet







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Some Typical Design and Engineering considerations
(not prioritized)

Layout; number of wheels; drive wheels and free wheels
Drive Train and Rubber Strip configuration (geared drive vs. direct drive etc.)
Wheel diameters (circumference x number of winds = distance)
Wheel base and track,
Rolling resistance
Traction
Balance
Handling dynamics
Power vs. weight
Acceleration
Top Speed
Torque
Performance requirements for each event
Energy Transmission
Bearings, bushings, shafts and all hardware
Winding method
RC components, function and placement
Steering geometry
Brake components
Driving skills and driving techniques
Structure, Chassis Rigidity vs. Body Flexion
Materials: woods, metals, plastics, composites, etc.
Methods of manufacturing, attachments and adhesives
Dynamic forces and loads
Weight to strength ratio
Durability, Resilience; impact survival
Center of Gravity, weight distribution, rolling resistance
Kinetics/Motion, moving parts in an assembly
Aesthetics
Performance Testing and Reliability
Aerodynamics

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Vehicle Development Milestones

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2005 Formula E begins

The first season of Formula E was a half term project of 6 weeks. All but one design adopted an inline rubber band and a right angle drive to two wheels. All teams were provided the same analog controls and servos.

Guest Judges review the designs for the "Eckles" build and design trophy

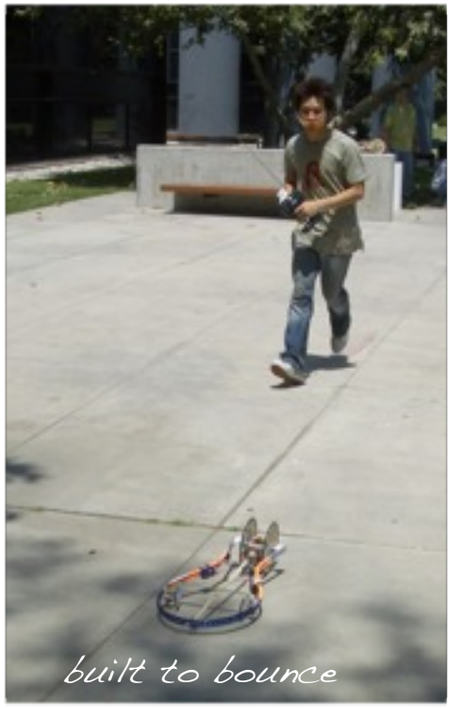
2005 The first 5 teams

Bob Obier presents his teams water jet cut aluminum and carbon fiber arrow shaft design with disc brake. Although the design was adjustable the components all came together with no time left to test and adjust.

Jae Yoo spent more time testing with his drifter design with no tires. It slid around corners to win the first figure 8 contest

2005 Formula E begins (continued)

The first season of Formula E is characterized by lots of breaking and people running behind their cars


built to bounce

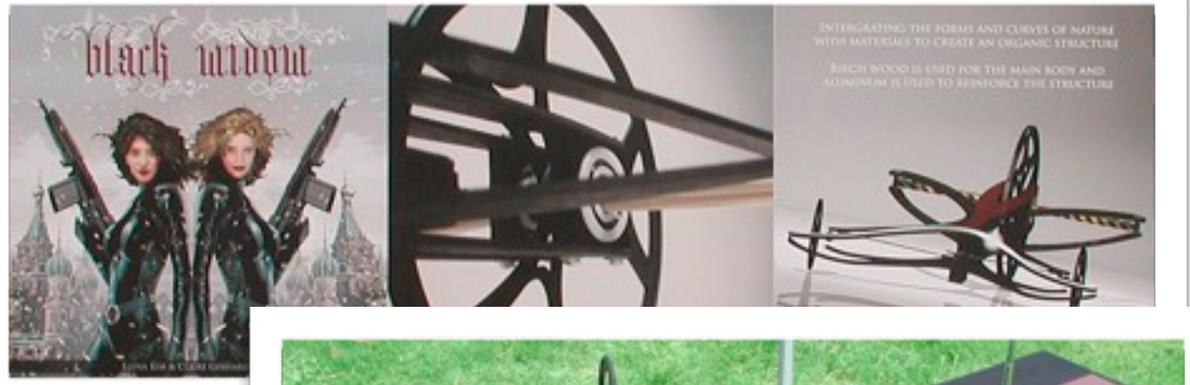

DRIFTER


people running behind their cars

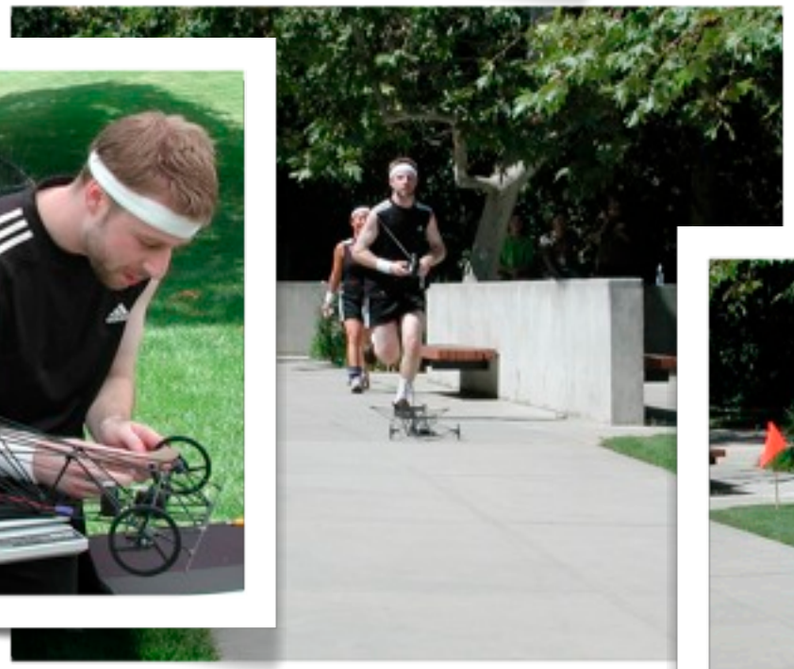

winding up

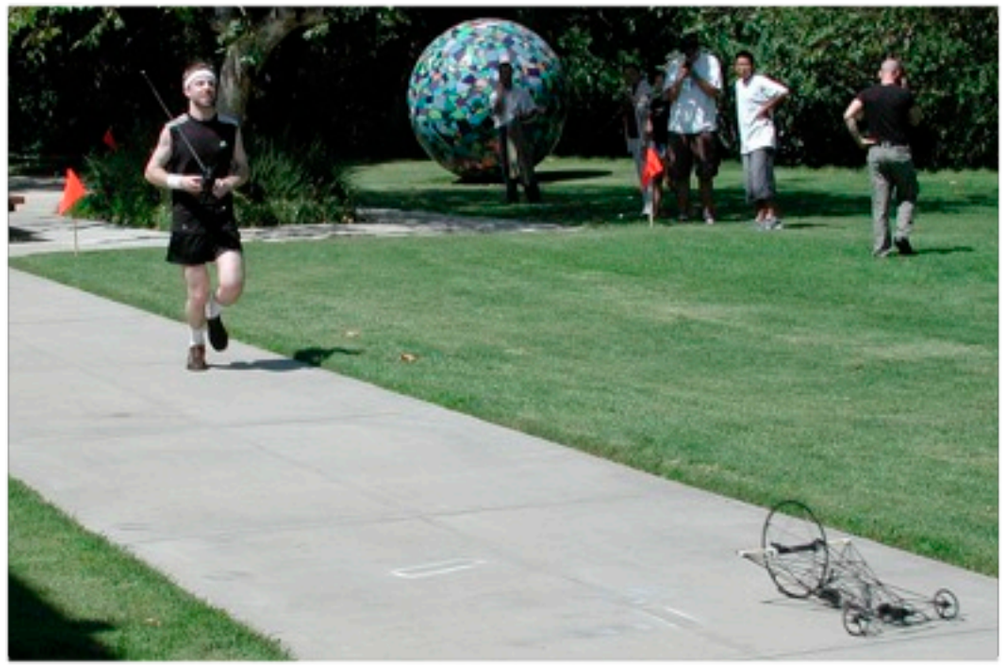
Xuan Yu and team develop a superior direct drive design that eliminated the drive train friction losses in their competitors designs. But the rubber band winds were split in two requiring a much larger wheel to finish the longest race. The vehicle flips and tumbles in the turns due to the high CG. Without the ability to stretch wind they utilize a handle and push the vehicle around the track in reverse to wind it with just the right number of turns.

2006 Direct drive takes over



Claire Gerhardt and Elena Kim style a priority for their *Black Widow*

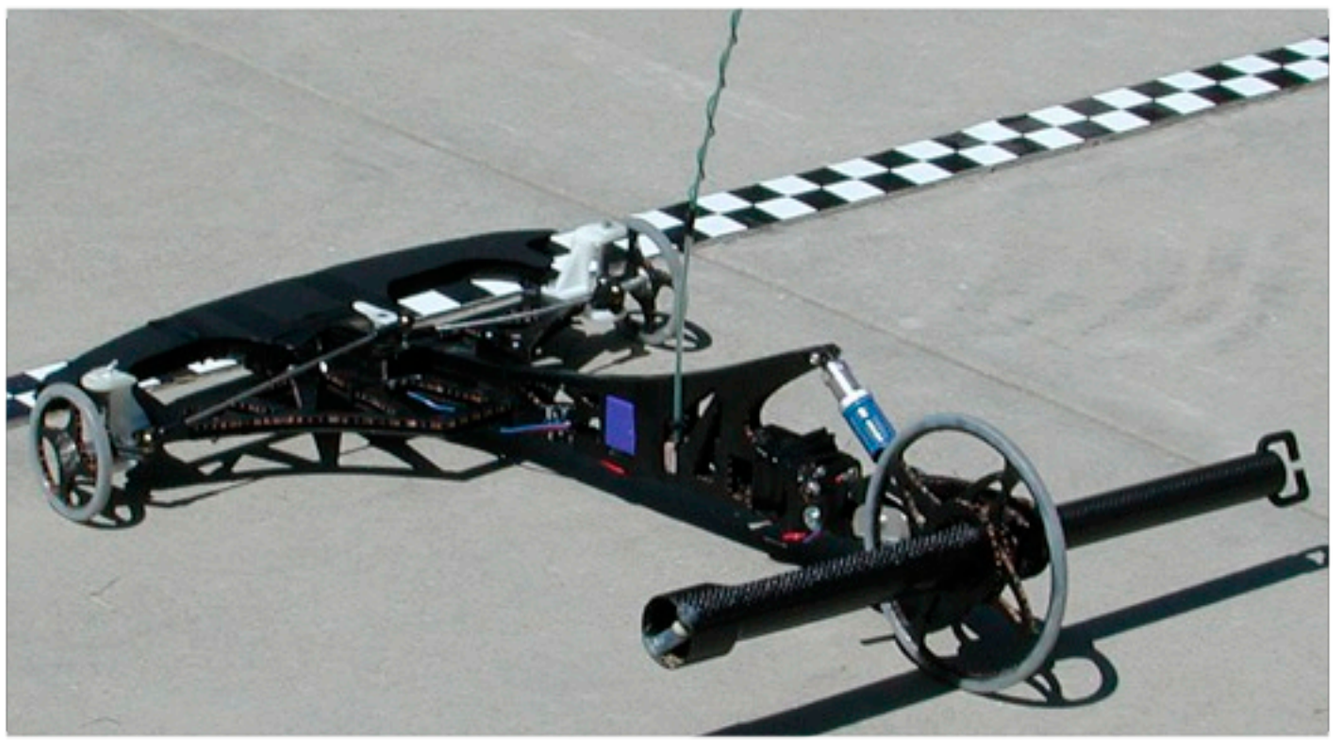


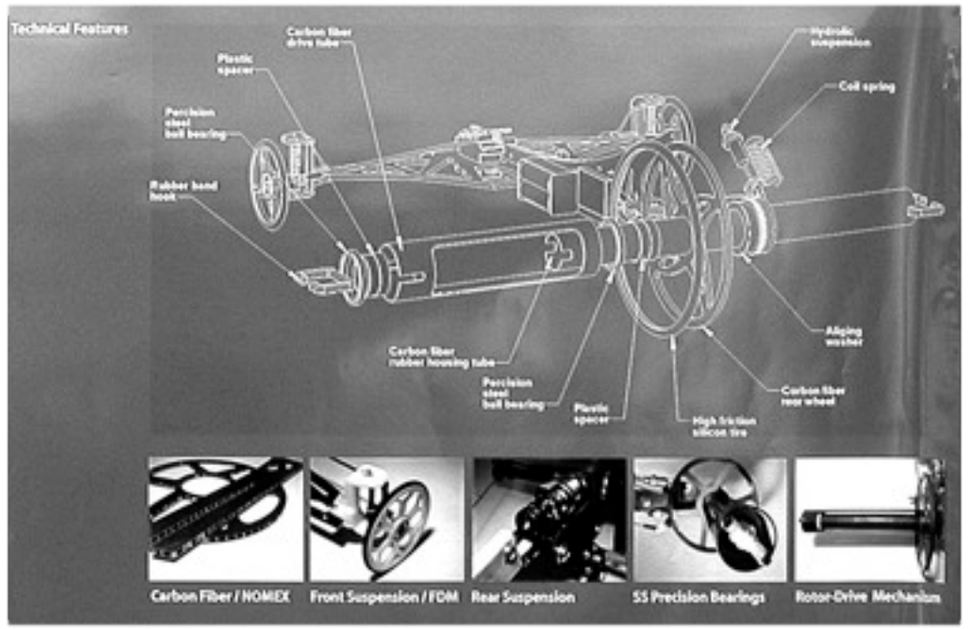


Kathy Huang and Dan Winger's ultra light weight birdcage advanced the 2005 direct drive design with a large diameter rear wheel and limited winding rolling backwards. The large wheel makes for high top speed for the drag race but the high CG makes turning hard .

2006 Direct drive gets a new level

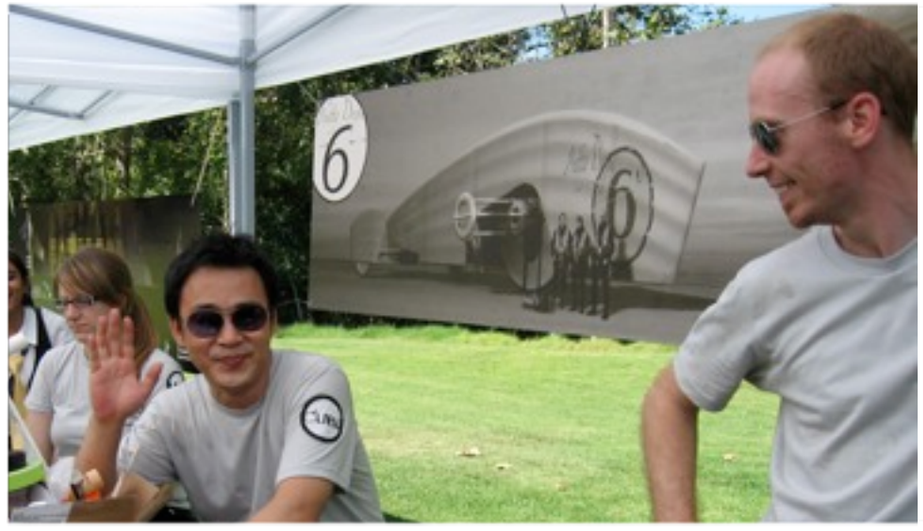
Dokyun Kim and Hiroshi Hori really get into the racer project and set a goal that they will set records that no one will be able to beat for 5 years, They do the research, make 8 prototypes and, with extensive testing, take things to an entirely new level. The final design utilizes 2 precision bearings, a new direct drive design, full suspension, a water jet cut carbon fiber & nomex honeycomb chassis and silicon tires. Prior direct drive designs split the length of the rubber band and available winds in half. The new drive allows for the full length of the rubber band, stretch winding - which allows for many more winds and higher torque, and therefore a smaller rear wheel which spins up to top speed much faster. They achieve new speed levels in the turns and get going fast enough that they find suspension is needed.
They also practiced driving with RC cars all term to really learn the courses and developed techniques to position themselves in key places to reduce running behind the vehicle to pilot it.





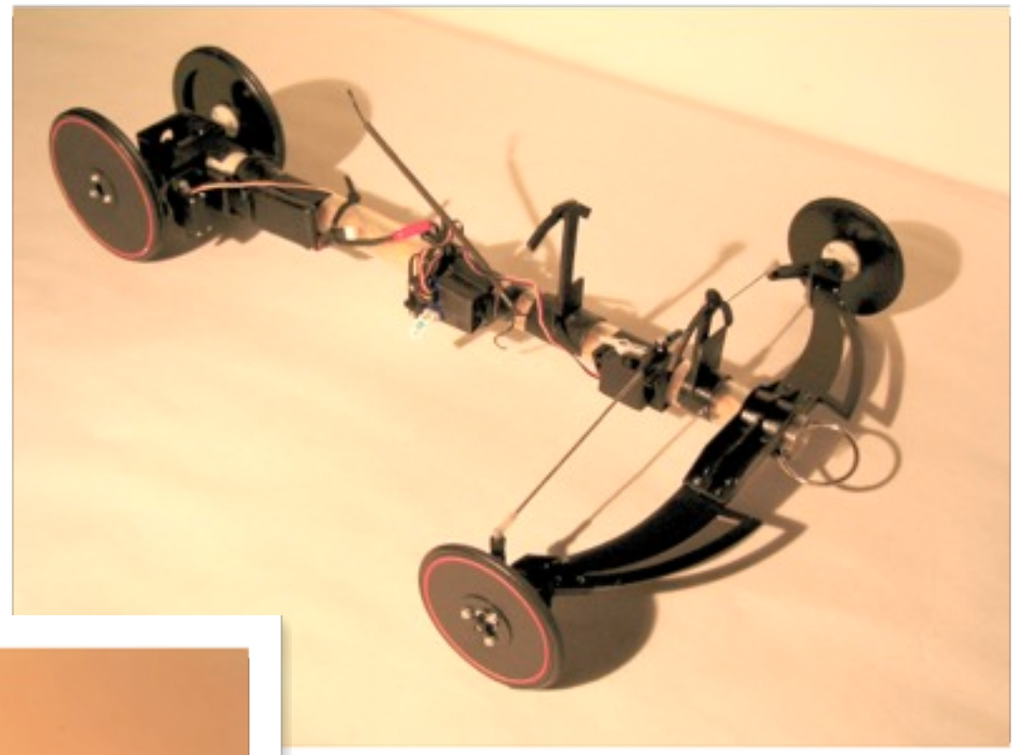
2008 Light weight, aerodynamics, and themes

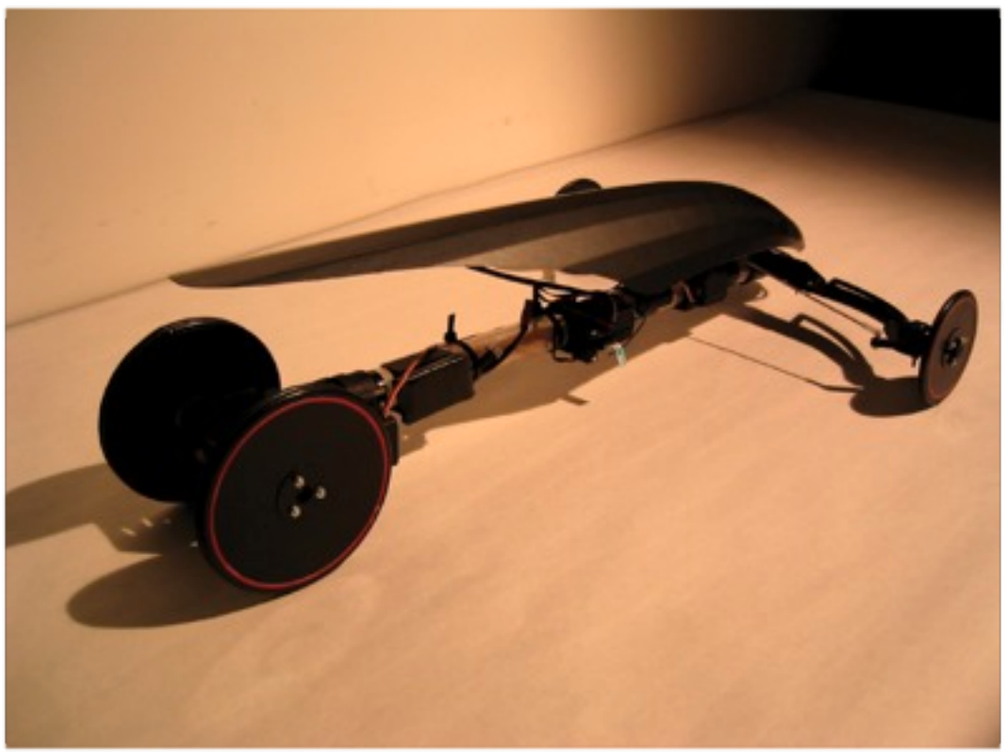
“Cuba” Lee, Jeff Koffman, and Leslie Evans optimize components and make a full bodied direct drive design that wins the most events and the event’s first “Best in show” trophy. On the way they are inspired to build a team brand that will set the tone going forward.

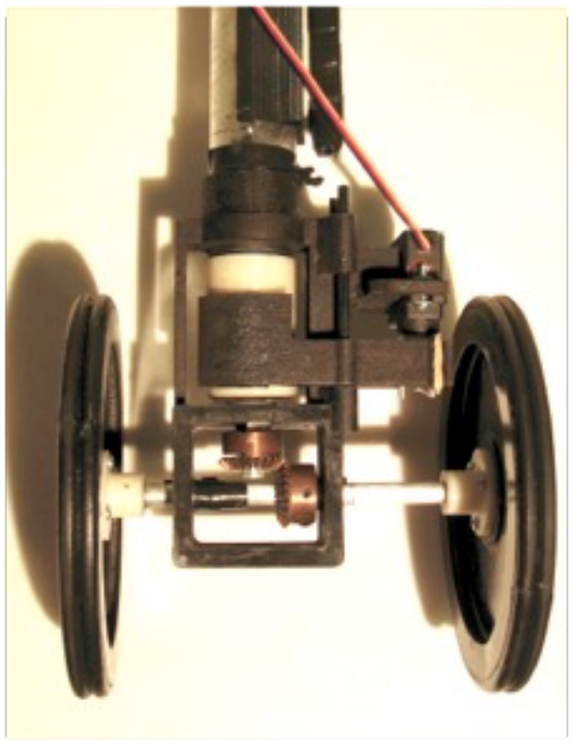


2009 clutches and the return of the 4 wheel inline layout

Direct drive dominates until James Chiang and Jin Kim develop a surprisingly fast inline design that employs a clever two stage function for one of the two allowed servos; achieving clutching as well as breaking on one axis of control. By turning on and off the stored energy to the drive wheel the vehicle handles and accelerates through turns allowing them to achieve new record times in almost every event. In addition they adjust for excellent alignment of the gears to overcome the friction losses in the prior inline designs.







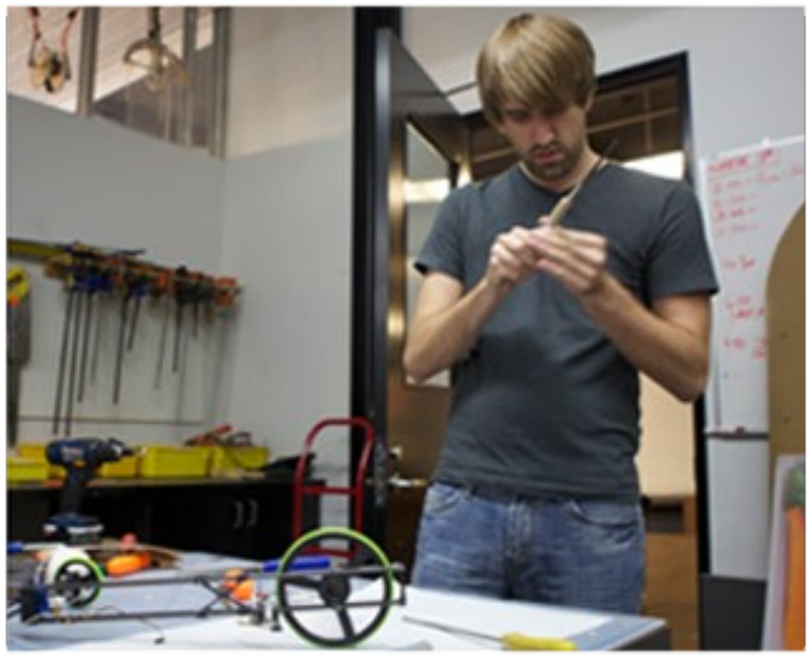
2011 Direct drive with clutch, super light weight, and high torque

In 2011 Formula becomes a bigger event and connects with the community. Over 300 people including kids and parents from the local community and a judging panel comprised of alumni, trustees, and design executives from Southern California studios participated in the 3 hour event as 7 teams went head to head for 5 events MC'd by television host of *American Inventor*, Matt Galant.

Each team gained a student from Pasadena City college and took on a new challenge to raise money for a local charitable organization through their race activities. Two teams worked with kid organizations and create a junior race that brings kids and parents into the picture.

The technology continues to advance and teams find they can shorten the loop dimension of the 16 feet of rubber band to achieve more winds and greatly increase the stored energy. Rapid prototyped parts employ hollow sections for light weighting and new stronger materials. Clutch bearings and thrust bearings abound. There is so much power that materials research to achieve better traction becomes critical. Wheels are regularly shredded. The prototypes break more often and more catastrophically. On race day new records are set and some of the high power designs break before they can show their potential. Speeds approach 30MPH.


FLAMMABLE

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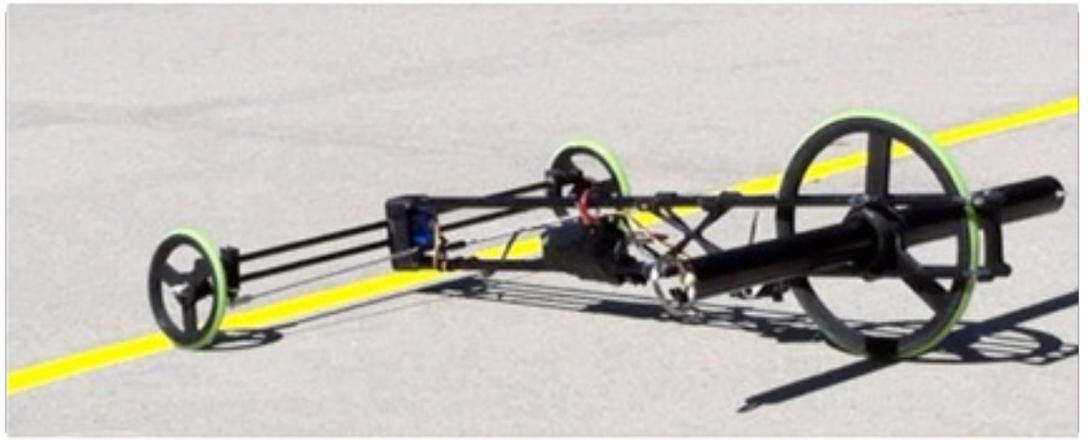

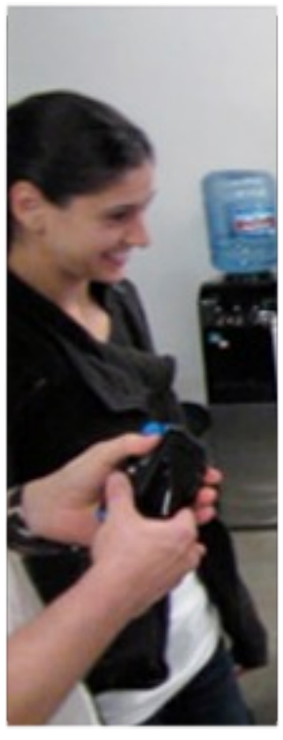

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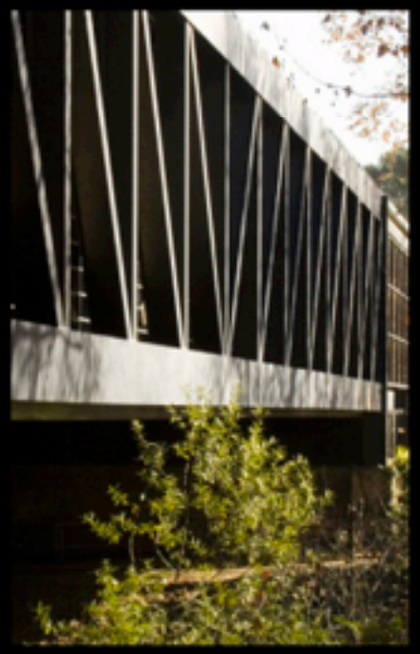

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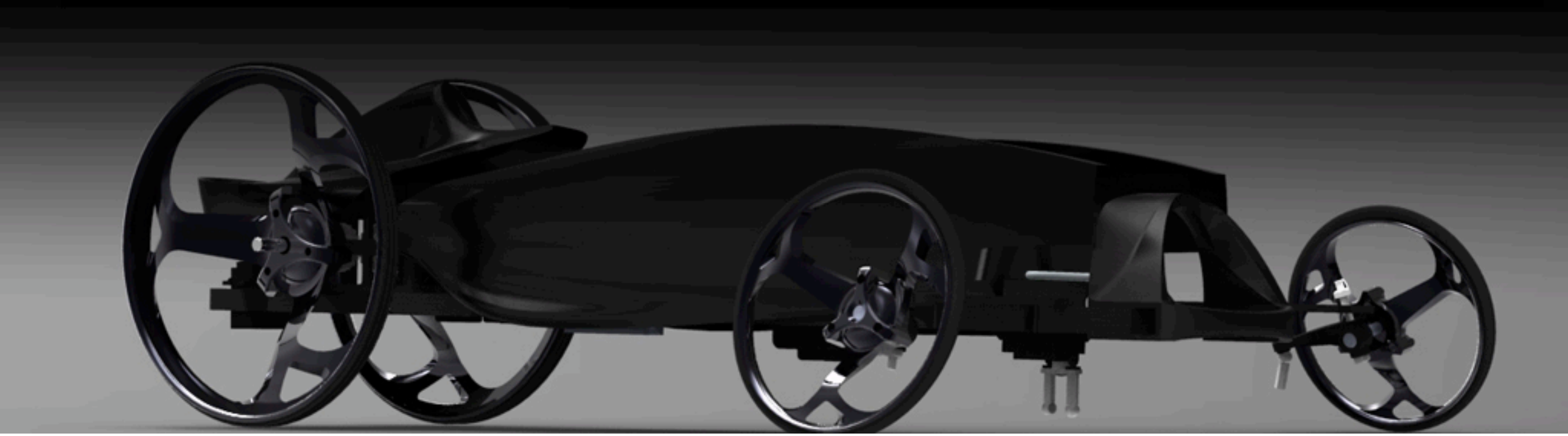


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Sunday, November 6, 2011


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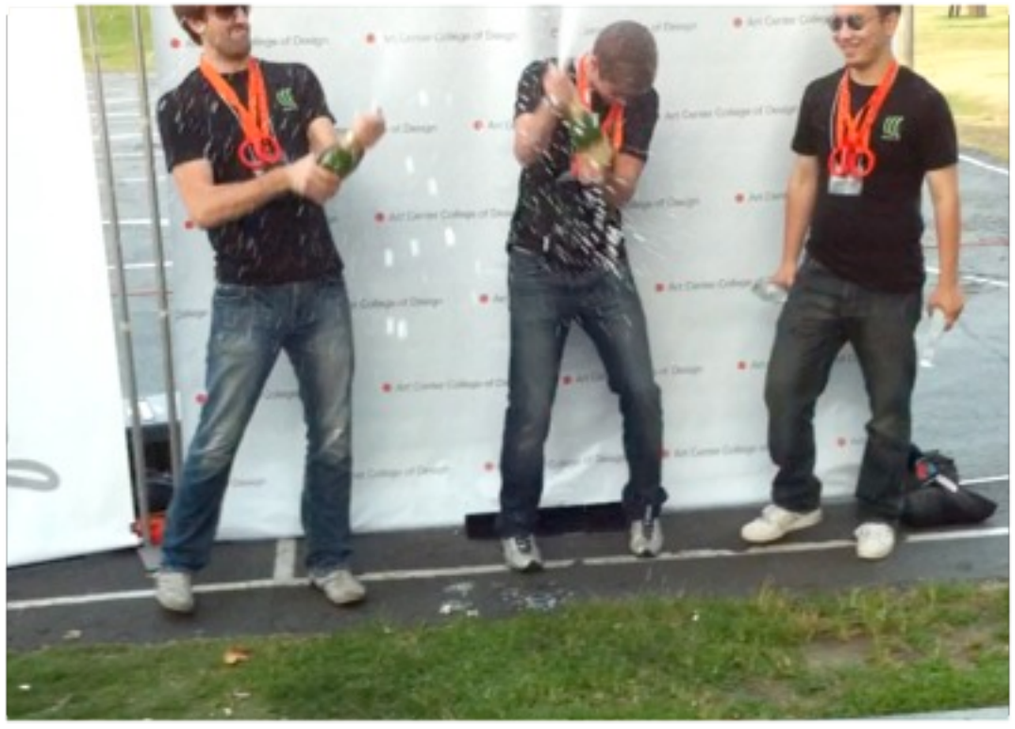

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