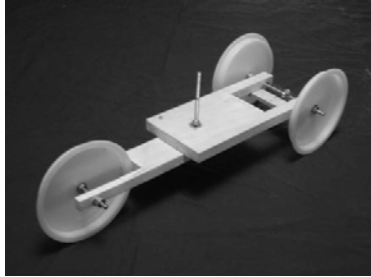


## Wheeled Vehicles



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<http://www.soinc.org/events/wheeledveh/>

Wheeled Vehicle 2007

## Object:

Construct a "vehicle" which uses a non-metallic, elastic solid as its sole means of propulsion.

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## The Vehicle

- Powered only by energy stored in a non-metallic elastic solid.
- Should be adjustable to travel a distance chosen by the judges
- Must come to a complete stop without any outside assistance.
- The foremost non-moving point must be marked to identify where to measure from.
- Nothing, except the elastic solid, may be added to or removed from the vehicle after it is impounded.
- Sighting/Aligning devices (if used) must be part of, and travel with, the vehicle.

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## Elastic Device

- All materials are elastic to some extent
- Must be a solid material
- May not use metal to store energy
- May consist of more than one part
- Must be impounded with vehicle
- Second elastic device may be impounded
- May be left unattached until the run

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## Travel Distance

- The vehicle should be adjustable to travel any distance from 5 – 10 meters.
  - Regional Tournaments - .5 meter intervals
  - State Tournaments - .1 meter intervals
  - National Tournament - .01 meter intervals

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## Starting The Vehicle

- The vehicle must be started in motion by one of the following methods.
  - Regional and State Tournaments may use #1 or #2
  - National Tournament must use only #2
    1. Contestants may manually remove an object placed on the track surface in front of a wheel
    2. May use a pencil, pen or dowel, that does not travel with the vehicle, to actuate a release mechanism that is part of, and travels with, the vehicle.

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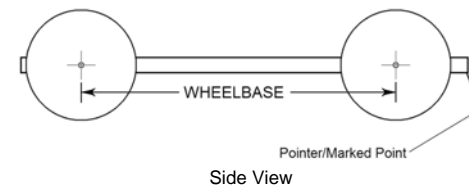
## Braking System

- May not contact floor/tape (except wheels)
- Must be actuated automatically without outside assistance
- No other specifications/restrictions

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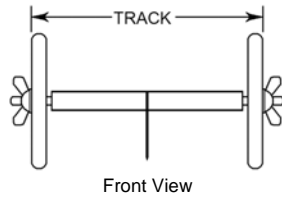
## The Vehicle's Wheelbase

- The distance between front and rear axels
- May not exceed 75 cm.



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## The Vehicle's Track

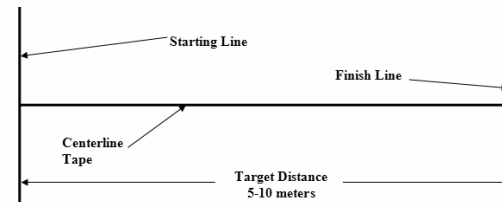


- Measured between outermost wheel/tire surfaces
- Measured on the widest axel
- May not exceed 35 cm

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## The Track

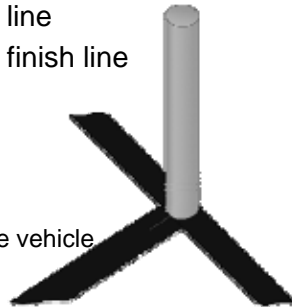
- A smooth, level, and hard surface
- Starting line, finish line, Target Distance and centerline marked with tape
- Inside edge of tape is start/finish line
- Center Tape does not extend beyond start/finish lines
- Should have "Free space" to allow the vehicle to stray from the lane and past the finish line



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## The Finish Line

- The center of the finish line will be marked
- Inside edge of tape is finish line
- Wooden dowel placed after finish line
  - 2 cm (3/4 inch) in diameter
  - 15 cm (6 inches) long
  - Standing on end
  - Touches center of finish line
  - May be used to sight/align the vehicle



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## The Competition

### The Contestants:

- May use electronic calculating/computing devices to determine time/distance prediction
- May not remove/install any parts from vehicle except the elastic solid.
- Will predict the time required to travel the Target Distance – the same prediction and distance will be used for both runs
- Will be allowed 10 minutes to adjust their vehicle and make up to 2 runs – if the a run is started before the 10 minutes is up, that run may be completed

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## The Competition (Cont.)

### The Contestants:

- May verify the track's length/Target Distance.
- Will place their vehicle's marked point on the starting line
- May use the wooden dowel to sight on for aligning the vehicle
- Will set the vehicle in motion using one of the allowed methods.

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## The Judges

### Will determine:

- If the vehicle strays from the center tape.
- The time the vehicle takes to travel the Target Distance.
  - Time starts at the judges signal
  - Ends the first time the vehicle stops or when the marked point crosses the finish line
- The distance the marked point travels from the starting line. Measured perpendicular to the starting line to where the marked point stops. This is a point to line distance.
- The distance from where the marked/fixe point stopped to the center of the finish line. This is a point to point (straight line) distance

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## Scoring

- Up to 200 points for each Run Score.
- The score for each run will be the total of:
  - The Time Score (Up to 50pts)
  - The Distance Score (Up to 100pts)
  - The Lane Bonus (10pts)
  - The Finish Bonus (Up to 40pts)
- Team's final score will be the higher Run Score.

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## The Time Score

- The percent of correctness divided by 2. (50 points maximum)

e.g. The predicted time is 5 seconds and the actual time is 4 seconds.

$$[(5-|5-4|)/5] \times 50 = 40$$

e.g. The predicted time is 5 seconds and the actual time is 6 seconds

$$[(5-|5-6|)/5] \times 50 = 40$$

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## The Distance Score

- The percentage of correctness. (100 points maximum)

e.g. The required distance is 10 meters and the distance traveled is 9 meters.

$$[(10-|10-9|)/10] \times 100 = 90 \text{ points}$$

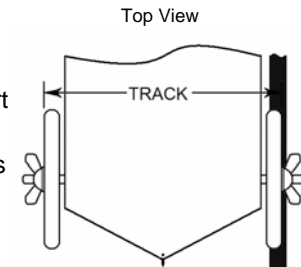
e.g. The required distance is 10 meters and the distance traveled is 11 meters.

$$[(10-|10-11|)/10] \times 100 = 90 \text{ points}$$

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## The Lane Bonus

- 10 Points
- Center tape must stay within the vehicle's track between start and finish lines
- Vehicle will receive these points even if it crosses the finish line or the moves dowel



Center tape is not completely within vehicle's track.

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## The Finish Bonus

- 0 points if dowel is moved (or tipped)
- Up to 40 points if dowel is not moved
- Vehicle may cross finish line
- Depends on how far the marked point stops from the center of the finish line.

e.g., The distance from marked point on vehicle to center of finish line is 13 cm.

$$40-13 = 17 \text{ points}$$

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## Designing the Vehicle

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## Brainstorming

- Useful tool, especially for solving difficult problems
- Allows all members to contribute.
- Use it in the beginning to divide the project into different parts/systems
- Use to develop design ideas for those individual systems.
- Listing characteristics of the part/system to help induce ideas.

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## Brainstorming (cont.)

- All suggestions/ideas are equal.
- Write them all down just as they are suggested.
- No attempt should be made to evaluate them at this time.
- Some need to “settle in” before their value is apparent.
- Others may trigger better ideas.

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## Prototypes

- Allow “Hands on” early in the design.
- Don’t have to work completely. – Just enough to test a specified system.
- Can be modified until they fall apart
- Vehicle must be finished in time to allow thorough testing
- Every completed project is the prototype for the next one

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## Vehicle Components

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## Body / Chassis

- Connects all of the other parts/systems together
- Determines wheelbase – longer wheelbase means it is easier to keep vehicle in the lane.

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## Wheels and Axles

- Wheels are difficult to make exactly round
- Large diameter Wheel
  - Revolves fewer times to travel a given distance.
  - Vehicle travels faster
  - Requires stronger elastic
  - Elastic needs to stretch/bend less
  - Heavier
- Optimum size is somewhere in between

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## Brakes

- None – Coast to a stop
  - Easy to implement
  - Distance unpredictable
- Positive Lock
  - Easier to make
  - May cause wheels to skid and distance to be unpredictable.
  - Always stops in the same position.
  - Combine with friction type for best results.
- Friction – Gradual application
  - Difficult to make
  - Prevents wheel skid
  - Final stopping position unreliable
  - Combine with positive lock for best results.

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## Steering Mechanism

- Adjusts vehicle to travel in a straight path.
- Adjustment need not be very large
- Should retain setting reliably

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## Distance Measuring

- Usually implemented by counting turns of wheels.
- May have scale marked on circumference of wheels.
- May apply brake

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## Elastic Device

- All materials are elastic to some degree.
- Must store enough energy to move the vehicle 10 meters.
- Will warp the chassis if it is too strong
- May cause wheels to spin at start if too strong.
- Use simple machines to multiply the distance it stretches/bends.

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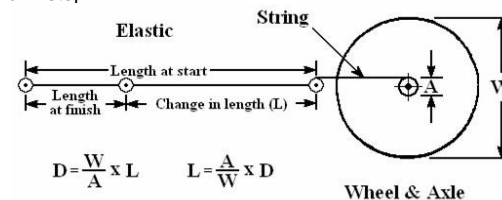
## “Transmission”

- Use IMA of simple machines to “multiply” the stretch of the elastic so the vehicle can go the Target Distance
- Example uses a “Wheel & Axle”
- String wrapped around the axle transfers the energy
- Remember to convert all dimensions to the same units.

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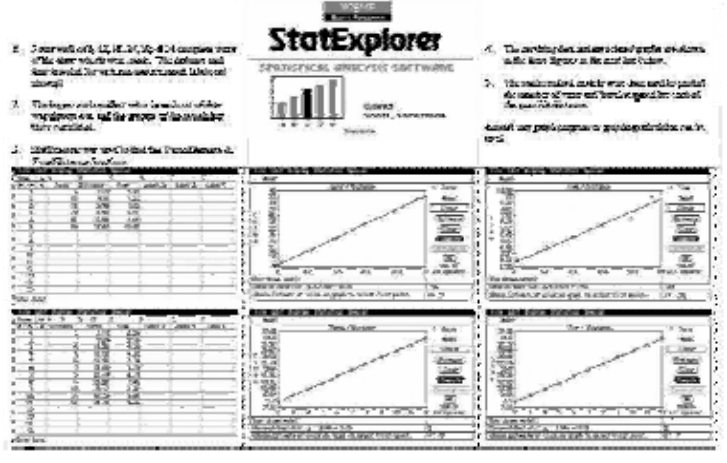
## How Far Will It Go?

1. Divide diameter of the wheel (output) by diameter of the axle (Input) to get the IMA of the Wheel & Axle.
2. Multiply the length the elastic changes (L) by the IMA of the wheel & Axle to find the distance your vehicle will travel.
3. To calculate how much the elastic must change to travel the Target Distance (10 meters), divide 10 meters by the results found in step #1.



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## Graphing the Distance



## The Design Team

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## Advantages of Design Team

- Complicated problems are easier to handle - Solve a piece at a time.
- Divides up the cost in time, money, and effort.
- Allows more people to participate.
- Problems are discovered on paper before time, money, and effort are expended.

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## Disadvantages of Design Team

- Overall time expended may be greater
- One team member can hold up the entire project
- Changes are harder to make

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## The Design Team

- May have as many or few members as you want
- One person designated as the group leader/facilitator (May be teacher/parent)
- Brainstorm to get new ideas/solve difficult problems
- Divide project into components
- Assign components to individual members/groups (Team member may be assigned more than one component)

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## The Design Team cont.)

- Make a list of dates (Milestones) when each phase is to be completed
- Have frequent meetings to coordinate systems
- Perform testing of final project – Allow plenty of time.
- Evaluate progress and adjust Milestones as needed
- The last Milestone (the tournament date) is non-negotiable.

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## Team Members

- Evaluate ideas/suggestions from brainstorming sessions concerning their assigned components
- Build prototypes to test/prove individual components
- Make rough sketches/drawings of their components and provide copies to other team members
- Communicate with other team members to integrate the components
- Design and build their assigned system

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## Questions

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