

FSEA PROJECT PLANS

August 14, 1999

L' AUTO 2 LA2

Applicable Grades	6 th -12 th
Number of Members Per Team	Two
Number of L' Autos Per Team	One
Number of Sessions	Eight to Ten

SKILLS AND ENGINEERING CONCEPTS DEVELOPED:

Design, fabricate, test and compete a vehicle within a given set of parameters.

Complete a Bill of Material or Parts Order List. Familiarization with scientific concepts.

(e.g. friction, torque traction, energy, etc. Develop an awareness of cost effectiveness.

INTRODUCTION

The invention of the wheel thousands of years ago has been called the most significant event of all time. Just about every modern convenience has a wheel of some sort contained within it. And it goes without saying that modern day transportation could not exist without the wheel. From skateboards to the space shuttle, the wheel is essential.

The word AUTOMOBILE is derived from the Greek word "Autos", which means self and the Latin word "mobilis" which means movable. The term automobile has come to mean any self-powered vehicle capable of being steered by the operator and designed for use on a roadway or street. Today automobile is used mainly for vehicles designed to carry from one to seven people. Larger vehicles designed for more passengers are referred to as omnibus, buses or simply vans.

The first successful automobile was a steam-powered vehicle invented by a Frenchman, Nicholas Joseph Cugnat in 1770. It wasn't until the mid to late 1800's that gas engines become practical and were used to power vehicles.

Today scientists and engineers are working to develop vehicles that use alternative power sources such as electric cars which utilize either solar generated power or storage batteries.

For this project, the student will utilize rubber bands as their source of power for the vehicle they design and build.

The following are important considerations for a wheeled vehicle with propulsion.

- *Wheel Size
- *Material
- *Traction
- *Energy Source
- *Amount of Stored Energy
- *Torque
- *Power (Rate of Energy Release)
- *Friction
- *Overall Vehicle Design
- *Mass

OBJECTIVE

The objective used in this project is for the students to design and build a rubber band powered vehicle that can perform a variety of tests with emphasis on the cost effectiveness of the designs.

While performing the tests, the students will be exposed to such concepts as mass, velocity, energy storage , power and friction along with the effects on performance when various design changes are made.

PROJECT DESCRIPTION

Mentors should start this project with a discussion about the automobile and the various scientific principles that effect the vehicles performance. (Reference Appendix "A") Caution- never talk more than 5 minutes.

After this introduce the students to the concept of cost-effectiveness. When the students have grasped this concept, a Parts List should be given to each team. At this point, each team should design their vehicle on paper.

The teams are constrained by the Parts List and may NOT use any material that is not listed. As always, the mentor's discretion is the final authority for the class. However, if an inter-school competition is planned, no exceptions to the Parts List of materials will be allowed for the competition.

Each team completes a Parts List indicating their desired material and quantities. Mentors should review the team's design prior to their filling out this form. The mentor obtains the material requested from FSEA. Allow at least two weeks for delivery.

Upon receipt of their ordered material, each team constructs their vehicle. After the construction has been completed, the teams then test the vehicles to determine how well they perform in the various categories.

Teams may redesign any part or all of their vehicle based upon their test results. A competition will be conducted to determine the most cost effective vehicle design. Once the competition has started, no further redesigns will be permitted.

COMPETITION

There will be six events in the competition. The same basic vehicle must be used for each competition, however minor modifications can be made as desired between events.

The events for which points will be awarded are as follows.

- 1) Speed (Fastest for a 10' run)
- 2) Distance (Farthest travel, perpendicular to start line.)
- 3) Control (Travel 8' towards wall and stop without hitting it)
- 4) Intelligence (Travel 5' forward and reverse back to start line.)
- 5) Tractor Pull (Pull a given weight as far as possible)
- 6) Death Leap (Travel across a gap, widest gap wins)

See Appendix "C" for details of the events and suggested method of scoring.

Prior to the competition, each car will be evaluated and a cost figure determined for it. The total number of points scored by each vehicle will be divided by the cost of the vehicle to obtain a figure of merit.

The team whose vehicle scores the largest figure of merit will be declared the winner of the competition.

AWARDS

Certificates will be given to all who participate in the project. Awards will be made for first, second and third place winners , based on the point system.

LESSON PLAN BY SESSION

Session 1

Discuss What FSEA is, if not done in previous classes.

Who is the Sponsor and what do they do.

Show video (Suggestion Bikes & What is an Engineer) (OPTIONAL)

Have members form into teams. If a problem have teacher make the teams.

Describe the project (general terms)

Discuss cost effectiveness

Describe the competition.

Discuss principles. (See Appendix B.

Demonstrate Friction.

Pull an object with a rubber band on sandpaper and a smooth surface.

Demonstrate Mass.

Pull a light and heavy object and note the difference
rubber band stretch.

Demonstrate Energy.

Pull an object up and down an incline plane.

Demonstrate Force

Use a ruler and a spring scale and show the pounds of force based on the
stretch distance of the rubber band.

Have students look for examples of force, mass, energy and friction for next
time.

Session 2

Have students give example of force, mass friction and energy they observed.

Discuss: Inertia, Velocity, Acceleration, Kinetic Energy

Hand out Bill of Material (Appendix C)

Show members each type of material available

Have members start vehicle design

Think about how to design a vehicle that will perform in all 6 areas.

Session 3

Work on design

Video (Drag-Cars, Tractor Pull, Big wheels)(OPTIONAL)

Discuss: Torque, Power, Angular Momentum

Finish design.

Make up Bill of Material per team. Order Material for next session 5

Discuss physical and math principles. (Reference Appendix B)

Session 4 & 5

Complete assembly

Start testing

Make any retrofits

Discuss physical and math principals

Session 6

Modification and testing

Session 7

Competition (May require two sessions)

Session 8

Evaluation and awards

Review

Student project assessment(See mentor manual for forms)

Session 9-10 (If Necessary)

FACILITIES AND EQUIPMENT REQUIRED (Tools)

Provided by FSEA as Sample Material in initial order:

Qty 2	3" bases
Qty 2	6" bases
Qty 2	8" bases
Qty 10	5" x 5/16" dowels
Qty 1	Glue vial (wood glue)
Pckg	#117-B rubberbands (motor option)
Pckg	#32 rubberbands (motor option, also tire tread for larger wheels)
Pckg	#64 rubberbands (motor option)
Pckg	#30 rubberbands (tire tread for small wheels)
Qty 20	#4 x 3/4" wood sheet metal screws
Qty 4	4" sides
Qty 4	7" sides
Qty 4	9" sides
Qty 4	3 1/2 dia. X 3/4" wheels
Qty 4	2 1/2 dia. X 3/4" wheels
Qty 4	1 1/2 dia. X 3/4" wheels
Qty 3	roll pins (useful as axle drive pins for the Intelligence Test)
Qty 3	sheets of sandpaper

Further material will be provided when the teams complete their designs and submit their material request to the mentors (see Appendix D).

Material helpful to the project, not provided by FSEA:

Screw Drivers (Phillips head).

Drill (for pre-drilling screw holes in the axles to prevent axle splitting).

Clamps (for holding sides to base while the glue dries).

Hammers

SAFETY PROCEDURES

In this project all power tools will be **operated by the mentor or teacher**. Hand tools can be used by the students.

APPENDIX A

Research required - Look up definitions of mass, traction, friction torque.

Design Constraints - Only materials furnished by FSEA (See Bill of Material) will be allowed in the construction of the vehicle.

Bill of Material - See L'Auto Parts Order Form in Appendix C.

Competition - The competition for L'Auto will consist of the following events and will be scored as shown for each event in Appendix C.. In case of a tie in any event, the team scores for in that event will be added together and divided by the number of teams tied.

All measurements will be taken from the furthest forward front end point of the vehicle, either the body or the wheel

The following material should be used during the first session.

For ideas for your demonstration on Mass, Friction, Force, Inertia, Velocity, Acceleration Kinetic and Potential energy, the following are some ideas.

These ideas are what are normally used in Jr. high school settings and are probably not accurate by your standards. But one must not go too deep at too early an age.

Mass - Student definition. "The amount of material in an object." We often relate this to a solid, liquid or a gas. Having the students stand up close together to be a solid, far apart for a liquid and very far apart for a gas. Showing something the same size can have a lot less mass in it, because mass is atoms. We weight different things the same size to demonstrate, such as a brick and a brick of Styrofoam.

Energy - Student definition - "The ability to move matter and produce changes in it, Energy is the ability to do work". Work requires movement. We demonstrate things like a bow and arrow, pulling it back and then letting it go to show to show potential and kinetic energy, holding a rock above ground and dropping it, bouncing a ball from a certain height and its bounce back up is representing kinetic energy, up of war, domino effect et, are all ways to discuss energy.

Friction - Student definition - The force that slows down an object by acting in a direction opposite to the motion of an object. Demonstrate block of 2x4s covered with different grades of sandpaper and sliding it down a ramp will help in understanding the "opposite" concept. Rolling a ball on the floor, Why did it stop? This will lead students to an understanding of the concept.

Force - Student definition - "A force is a push or a pull that is applied to an object. There are four types of forces: Gravitational, Mechanical (like hitting a ball with a bat), Magnetic and Electrical (both have to do with the force of the atom.) We set something on a table and have the students how it would move, hopefully coming to the

conclusion that an outside force would have to make it move or it would be there for ever.

We jump up to show gravity, we push something to show mechanical force and play with magnets and electric cars. We ask students to tell us of any other ways they can think of that scientists accepts, not like bending a fork with your mind. We say there may be other forces, they just have not been discovered yet.

Inertia - Student definition - "The tendency for objects to continue their state of motion". Roll a ball on the floor and discuss why it did not go forever. Discuss space and a space station, what it does once it is set into motion etc. We have a spring that moves back and forth that can hold different weights. Showing that the heavier the weight, the slower it will swing back and forth, but the longer it will go which also deals with momentum.

Velocity - Student definition - "Speed in a given direction". We discuss things that have speed and those that have speed with velocity as a rule, like a bullet, a space ship, but not usually a car or a person walking, etc.

Acceleration - Student definition - "A change in velocity or speed in a given direction over a given time". We have a free fall device to show the rate of any object is the same, if its shape is the same. You can do it by dropping a baseball and a marble or a crumpled piece of paper from a table top to show they hit the floor at the same time, but their mass is different. The heavier they are the harder they fall idea. We talk about the old leaning tower of Pisa and Galileo's demonstration. We roll two different shapes of rings with different weights down a ramp to show acceleration, we talk about a truck and a VW bug in a drag race, which one gets off the line first.

APPENDIX B

DEFINITIONS

The following information is for reference only, but do not try to teach the students.

W = Weight

g = Gravity, (32.2 feet per second squared)

M = Mass

F = Force = $M \cdot a = (W/g)a$

a = acceleration, distance per second squared

KE = $1/2 MV^2$

V = velocity = distance per unit of time

COF = Coefficient of friction = F/W

PE = Potential energy = $Mgh = (W/g)h$

h = height

T = Torque = $F \cdot L$ (L = length of lever arm)

P = Power = time rate of doing work

C = $2\pi r = \pi d$

$\rho = \pi = 3.14$

r = radius

d = diameter

APPENDIX C

This section of the appendix presents the details of the six events in the competition and presents a suggested scoring method. This scoring is applicable when there are 10 or more teams competing. For less than 10, the Mentor should tailor the number of places awarded points accordingly.

Prior to the start of competition, the cost of each vehicle should be determined and recorded for later use. Also included in this appendix are the scoring forms for use during the competition.

EVENTS

SPEED

This is a timed event. Each vehicle will be allowed two runs on course of 10 feet. the lowest time of the two runs will be official time recorded for the vehicle.

Suggested scoring for this event:

Fastest vehicle (lowest official time)	= 20 points
Second fastest	= 10 points
Third fastest	= 5 points
Fourth fastest	= 3 points
Fifth fastest	= 1 point

DISTANCE

This is a measured event. Each vehicle will be allowed two runs on the designated course. The distance traveled perpendicular to the starting line will be measured and the greater of the two will be the official distance recorded or the vehicle. Each vehicle will receive 1 point for each complete foot traveled. (No points for a partial foot) In addition bonus points will be awarded as follows

Furthest	
1st place	= 10 points
2nd place	= 5 points
3rd place	= 3 points
4th place	= 2 points
5th place	= 1 point

CONTROL

This is a measured event. Each vehicle will get two attempts to come as close as possible to a wall without hitting it, starting at a distance of 8 feet away. The closest of the two attempts will be recorded as the official distance for this event. Suggested scoring is as follows:

Stop within	
1" of wall	= 20 points
3" of wall	= 10 points
6" of wall	= 5 points
12" of wall	= 2 points

Any vehicle which hits the wall or stops greater than 12" away from the wall is given No Score.

TRACTOR PULL (OPTIONAL)

This is a measured event. Each vehicle will be given two attempts to pull load of 6 ounces as far as possible. The weight will be in a paper / plastic plate attached to the vehicle with string. The greatest distance traveled by the vehicle perpendicular to the starting line will be the official distance recorded for the event.

Suggested scoring for this event:

Two points for every complete foot traveled.(No points for an incomplete foot)
Bonus point will be as follows:

Furthest	
1st place	= 10 points
2nd place	= 5 points
3rd place	= 3 points
4th place	= 2 points
5th place	= 1 point

INTELLIGENCE (OPTIONAL)

In this event, a vehicle is placed at a starting line, it must then travel a distance five feet, crossing a line with some part of the vehicle and then return across the starting line automatically.

Suggested scoring is as follows:

Completes requirement of 5 feet forward and 5 feet return = 20 points

Completes requirement partially.(5 feet forward and at least 1 foot back, but less than 5 feet.)= 10 points

Travels more than halfway forward (2 1/2 feet) and returns over starting line = 10 points

DEATH LEAP (OPTIONAL, Ramps not Supplied)

This is a measured event. In this event a vehicle must start behind the ramp, travel up the ramp and leap a gap to a second ramp. The mentor should set the gaps initially at 2" and allow each vehicle two attempts to leap that distance. Those who fail get No Score. The gap should then be set at 4" and the process repeated. Only those vehicles successfully completing a smaller gap continue as the gap is widened.

Suggested scoring is as follows:

Gap	Points	Gap	Points
2"	=2	10"	=10
4"	=4	12"	=12
6"	=6	14"	=15
8"	=8	16"	=20

Bonus points

Longest gap

1st place	=10 points
2nd place	=5 points
3rd place	=3 points
4th place	=2 points
5th place	=1 point

After completing any or all of the six events, the points awarded to each vehicle should be totaled. The point total is then divided by the cost of the vehicle previously determined and a Figure of Merit is calculated. The vehicle with the largest Figure of Merit is the winner of the competition.

The following pages are the scoring sheets for each event, total competition points, the Figure of Merit calculation and the Bill of Material.

Appendix D L'AUTO 2 PARTS ORDER FORM

Parts Description	Quantity		Price		Total
<u>WHEELS</u>					
3 1/2" Diameter	_____	x	\$2.00 ea	=	_____
2 1/2" Diameter	_____	x	\$1.00 ea	=	_____
1 1/2" Diameter	_____	x	\$0.50 ea	=	_____
<u>BASES</u>					
3 1/2" x 1/8" x 6"	_____	x	\$1.00 ea	=	_____
3 1/2" x 1/8" x 8"	_____	x	\$2.00 ea	=	_____
<u>SIDES</u>					
2" x 3/8" x 6"	_____	x	\$1.00 ea	=	_____
2" x 3/8" x 9"	_____		\$2.00 ea		
<u>AXELS</u>					
5/16" x 5"	_____	x	\$1.00 ea	=	_____
#4 X 3/4 screws	_____	x	\$0.25 ea	=	_____
Metal Dowels	_____	x	\$0.25 ea	=	_____
					Total _____

MISC. Items
Provided With Order

Scotch Tape	Provided	No Charge
#30 Rubber Bands	Provided in Bulk	No Charge
#32 Rubber Bands	Provided in Bulk	No Charge
#64 Rubber Bands	Provided in Bulk	No Charge
#117 Rubber Bands	Provided in Bulk	No Charge
Sand Paper	Three Sheets	No Charge
Glue	One vial for four teams	No Charge

School/Team Name	Team Members

Mentor Note: This form should be copied and passed out to teams for placing their orders. Team orders should be consolidated on one form and faxed to FSEA for parts. 714 229-2228. When Faxing in the order please include address to ship to and phone number.

SPEED COMPETITION

TEAM	FIRST TRY	SECOND TRY	POINTS

Fastest Vehicle

- 1st place = 20 points
- 2nd place = 10 points
- 3rd place = 5 points
- 4th place = 3 points
- 5th place = 1 point

L'Auto Competition Figure of Merit Sheet

TEAM	TOTAL POINTS	\$COST OF VEHICLE	FIGURE of MERIT POINTS/COST

After Completing the chosen events, the points awarded to each vehicle should be totaled. The point total is then divided by the cost of the vehicle previously determined and a figure of merit is calculated. The vehicle with the largest figure of merit will be the winner of the competition

FAX (714) 229-2228

Order Form

NAME♦		PHONE♦	
ADDRESS♦			
CITY♦		ST♦	ZIP♦
MY SCHOOL IS♦			
TODAY'S DATE♦		/	/
DATE NEEDED♦		/	/

FILL IN YOUR ORDER BELOW. STEPS 1,2,3 (SEE CATALOG FOR PROJECT INFORMATION)

<u>PROJECT NAME</u>		<u>CODE</u>		<u>NUMBER OF STUDENTS</u>	
STEP 1 (EXAMPLE)	LAND YACHT	STEP 2	LY1	STEP 3	30

PLEASE, NO MORE THAN TWO PROJECTS PER ORDER FORM

T-shirts SM ME LG XLG
D

Girls					Total
Boys					
Hats One size fits all					

Miscellaneous

Sets

Extra Ribbons - One set = One 1 st , 2 nd , 3 rd	
Extra Certificates	
Portfolios	

Membership Cards

Count

Engineer Technician	
Junior Engineer	
Engineer	
Senior Engineer	
Engineer Specialist	

Other (Please Note)
