Research & Design: Metric 500 Dragster

Introduction

Prior to the manufacturing of a product, industry must perform numerous design steps. One of these steps is **research**. There are different types of research conducted: **pure research**, to obtain knowledge with no practical use in mind; **applied research**, done to solve specific problems; and **market research,** which is done to find out what the consumers want or need, what products they will buy, and what they are willing to pay for it.

The next step is **development**, which is putting all the ideas from research into some practical use. Development has two major categories: **process development,** which deals with methods, machines, tooling, plant layout, and other mechanisms to make the product; and **product development,** which includes the making and testing of new designs. The last step is **engineering**, in which the product is tested and evaluated for final design or **feasibility.**

Activity Description

In this activity you will become familiar with the research and design process, often known as R & D. You are going to design and engineer a CO_2 dragster using **specifications** that must be adhered to for your car to qualify for racing. You will begin this activity by conducting research, after which you will draw several **thumbnail sketches**, followed by **rough sketches,** refined **working drawings, mock-ups,** and a final **prototype**.

These CO_2 cars may be entered into a local competition such as the Dade County Youth Fair or Technology Student Association competitions at the state and national level. Students should refer to the *Dade County Youth Fair Handbook* or *TSA Curricular Resources Guide* for rules and regulations governing entry of their cars.

Tools and Equipment

The following tools and equipment are needed for this activity:

band saw
drill press
Styrofoam cutter
scroll saw
belt sander
3/16" twist drill
scissors
stapler
files
X-Acto knife
T-square
triangle
metric ruler
gram scale
manual starter track

Materials and Supplies

For this activity, the following materials and supplies are needed:

balsa or basswood blank
Styrofoam blank
axle material, plastic or aluminum
wheels, front and rear
garnet paper, assorted (i.e. 80, 100, 150, 220, 400)
paint, spray or brush-fast dry
graph paper
tape (double sided)
carbon paper

screw eyes
CO_2 cartridges
washers
masking tape
layout paper

Designing Your Car

Before you begin the design of your car, there are many questions that must be answered. For example, what size is your car going to be? Which materials will you use? What factors affect good design? These are just a few of the many questions you will have to answer during the design of your car. Finding the answers to questions is called **research**.

You will begin your design by conducting research at the library or other source as directed by your teacher. You might use the following key terms to guide your research: aerodynamics, drag, friction, automotive design, and design principles. If you have problems conducting your research, ask the librarian for assistance.

After you have completed your research, you will begin the development phase by drawing thumbnail sketches. These are small sketches of several design options that will give you some idea of what your product might look like. (See Figure 1.)

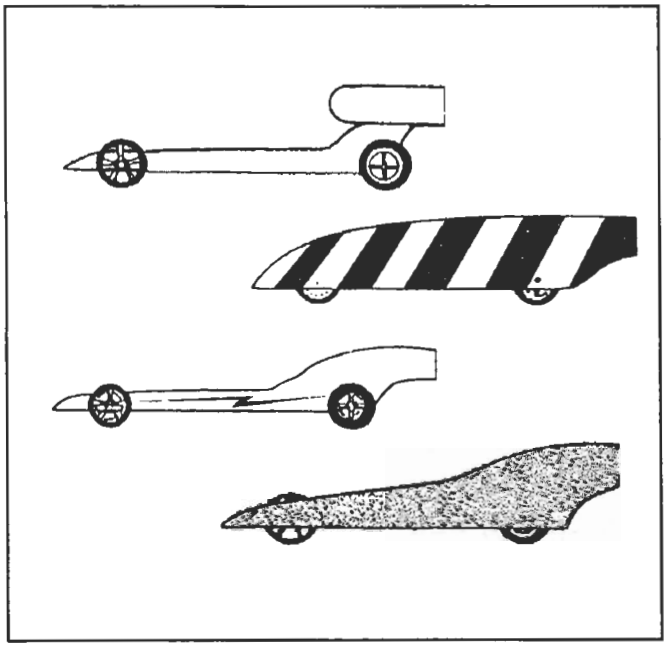


Figure 1 - Design Options

After deciding which thumbnail sketch you will use, a rough drawing of that particular sketch is made, using close to scale measurements. This rough layout is considerably more detailed than the thumbnail sketch. Because the car must be designed within the specifications of this activity, you need to become familiar with these specifications before you begin your full size rough layout. (See Figure 2 for specifications.)

SPECIFICATIONS	LIMITS
Axles - Diameter	3 mm
Axles - Length	42-70 mm
Axle Bearings - Diameter	3.5-4.5 mm
Axle Holes - Diameter	3.5-4.5 mm
Axle Holes - Body Bottom to Center Line	3.5-9 mm
Axle Holes - Position from Closest End of Body	9-100 mm
Bearing (Spacer) - Diameter	7-9 mm
Dragster Body - Length	200-305 mm
Dragster Body - Height at Rear with Wheels	56-75 mm
Dragster Body - Mass with Wheels	40-170 g
Dragster Body - Width at Axles	35-42 mm
Power Plant - Depth of Hole	51 mm
Power Plant - Minimum Thickness around Housing	3 mm
Power Plant - Diameter of Hole	19-20 mm
Power Plant - Centerline from Body Bottom	31-35 mm
Screw Eye - Inside Diameter of Eyelet	3-5 mm
Screw Eyes - Distance Apart	155-270 mm
Wheels, Front - Diameter	32-37 mm
Wheels, Front - Width of Greatest Diameter	2-5 mm
Wheels, Rear - Diameter	30-40 mm
Wheels, Rear - Width of Greatest Diameter	15-18 mm
Wheelbase - Centerline to Centerline	105-270 mm

Figure 2 - Dragster Specifications

You will use **orthographic projection,** drawing a top and side view of your car. (See Figure 3.) To make this stage of the design process easier, you may use the layout paper provided by your teacher. Notice that it has the two views of your car blank drawn for you, as well as the placement of the power plant chamber.

Making Your Working Drawing

The finished, or working, drawing is a refined drawing made to scale using the actual **dimensions** of your car. You may use metric graph paper or drafting paper to make this drawing. Begin by sliding the paper in line with the T-square until the blade lines up with the bottom of the paper. When you have the paper perpen-

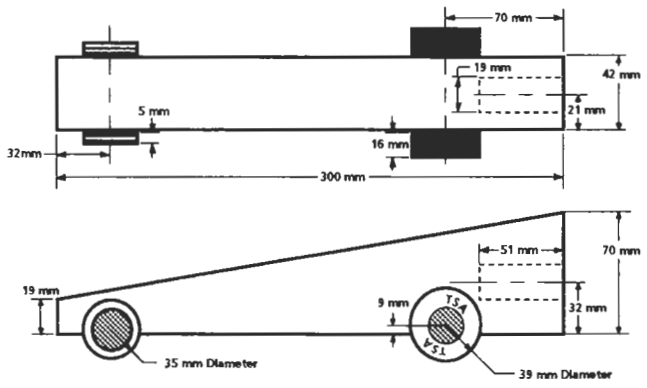


Figure 3 - Orthographic Projection

dicular to the edge of the drawing board, tape it down. Lightly draw the top and side view of the car blank using a 4H pencil. Then begin drawing in the actual design of your car, using the T-square, triangle, French curve, compass, and other drafting tools as needed. Remember that these drawings will be used for production of the mock-up and prototype and must conform to specifications for your car.

As with any drawing, attention must be paid to neatness and detail. If you are entering your car in competition, you may want to redraw your design as the drawing itself will be judged. You may use tracing vellum placed over your completed working drawing to retrace the actual drawing. Be sure to use your drafting tools for this important step.

For local, state, and national competition, your drawing must be an orthographic two-view (top and side) drawing with metric dimensions made on 11" x 17" drawing paper. A three-view (top, side, and end) drawing will be accepted, but will not change point allotment. Drawings are to be made using ink or graphite. Originals, blueprints, or computer-aided drawings (CAD) will be accepted. The title block should only include the words "Entry Number", which will be assigned at registration time and placed on the entry prior to turn in.

Making a Prototype

Your prototype can be made from pre-cut Styrofoam blanks. Using a copy of your working drawings, lay out the front and top views on the Styrofoam blank as shown in Figure 4. You may use double-sided tape to accomplish this task. The Styrofoam blanks may be cut out using a Styrofoam cutter or band saw.

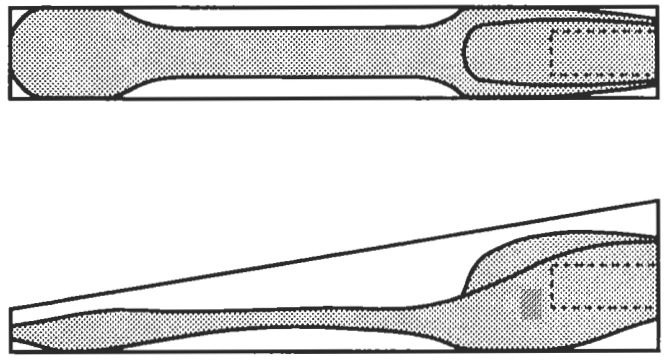


Figure 4 - Styrofoam Blank with Design

Testing Your Prototype

The Styrofoam prototype is now ready for testing. You may use a **wind tunnel** (if available) to determine the **aerodynamics** of the mock-up. If your design does not test well or you're not satisfied with it, go back to your thumbnail sketches and choose another design. You will have to make a new working drawing and prototype. If you are happy with your design and it meets all the specifications, you may proceed to the construction of the final product.

Final Design

Lay out your two-view drawing on the balsa or basswood blank just as you did with the Styrofoam blank. This may be done by stapling or taping your design on the blank, but before doing either, make sure your views line up properly with the pre-drilled hole in the back of your blank. If you are not careful, you may cut through the power plant chamber, and you will have to start over with a new blank. Trace your pattern with a felt tip pen or marker. Drill axle holes first; then cut out the top or side view. Tape pieces back on that will be needed to accurately cut out the other view using double-sided tape. File and sand the prototype to the desired shape; then paint and assemble. Remember to adhere to the specifications!

Student Design Tips

1. Shell cars with internal wheels front and rear are usually most competitive, although there have been shell cars with external wheels in the front registering good times.

2. Vehicle length has not been proven to be a determining factor in overall speed of the vehicle. However, overall vehicle weight has proven to be a critical factor.

3. Longer vehicles have some advantage at the beginning of the race because the front extends beyond the shorter vehicle, although the distance may or may not hold true in the end.

4. The screw eyelet should be closed completely to prevent the line from coming out during a race. On soft woods such as balsa, the designer may wish to reinforce the screw eyes by adding glue to the tip of the screw.

5. Plastic axles (Delrin) may be used in competition, although design elements regarding friction and impact should be considered when making the vehicle.

6. The vehicle must have four wheels which comply with specifications. The wheels may be placed in position(s) to create the effect of a two, three, or four-wheel vehicle. The wheels must remain independent of each other, (i.e., not glued together) and must roll.

Ecology

Use spray paint in a well **ventilated** area or a spray booth. Vapors are very harmful to breathe. Check with your teacher for proper disposal procedures for spray cans.

Safety

Your instructor will provide you with safety procedures for using the band saw, drill press, Styrofoam cutter, and scroll saw. When using a knife, be sure to make all cuts away from your fingers and body.

When racing cars, keep a safe distance away from the track to avoid being struck by a car leaving the track.

Vocabulary

pure research
process development
applied research
product development
market research
engineering
consumer
feasibility
product
specifications
tooling
dimensions
layout
thumbnail sketches
rough sketch
working drawings
mock-up
prototype
Styrofoam
orthographic projection
aerodynamics
wind tunnel

On Your Own

1. Make a list of several companies in your area that do research and development. Give examples of the things they do. Make a list of career opportunities that exist in this field; identify the ones that interest you.

2. Obtain a copy of the video "Believing the Dream" from your teacher. After viewing the video, make several sketches of the different dragster designs shown.

Office of Vocational, Adult, Career, and Community Education
Technology Education
Dade County Public Schools • Miami, Florida

TEACHER GUIDE
RESEARCH AND DESIGN: METRIC 500 DRAGSTER

Objectives: Upon completion of this assignment, students will be able to:

- Identify the stages of research and development.
- Identify vocabulary associated with the process of research and development.
- Design a CO_2 race car using specifications.
- Make orthographic drawings of the design.
- Produce a completed CO_2 race car.
- Demonstrate safe practices while working with tools and equipment.
- Use metric weights and measurements in the car design.

Helpful Hints:

1. The following vendors are recommended suppliers of materials for the CO_2 Racer:
   Pitsco 1-800-243-2329
   Modern School Supplies 1-800-243-2329
   Hearlihy & Co. 1-800-622-1000

2. Have students drill axle holes in balsa blanks before cutting out their designs.

3. Allow a minimum of 3 mm tolerance at critical areas (ex. power plant, axle holes) for safety considerations.

4. Drill out shell cars before cutting out the design.

5. Order the video tape "Believing the Dream". It is a very motivational video for students. (Pitsco item # 77060 $19.95)

6. Obtain copies of Dade County Youth Fair race specifications. Have every student enter a dragster; the students receive ribbons, cash awards, and are eligible to win a trophy.

7. Review all laboratory and machine safety rules and procedures before you begin the project.

8. If you are planning on using power tools, obtain parental permission before allowing students to operate any power equipment.

LANGUAGE ARTS APPLICATION
RESEARCH AND DESIGN: METRIC 500 DRAGSTER

_____
Student Name

In all types of jobs and occupations you will need to be able to effectively communicate ideas to others that you will work with or for. The following activity will allow you to practice some of your communication skills.

1. Race cars are a popular medium for the advertisement of products and services. Look in a magazine or newspaper for pictures of race cars. Write down the names of five products or services that are advertised on these cars. Include a sentence or two that describes what those products or services are.

   A. _____

   _____

   B. _____

   _____

   C. _____

   _____

   D. _____

   _____

   E. _____

   _____

2. Write a business letter to a potential sponsor. In the letter you should give several reasons why the individual or company should sponsor your racing team.

MATH APPLICATION
RESEARCH AND DESIGN: METRIC 500 DRAGSTER

_____
Student Name

The ability to apply mathematical principles is of utmost importance in the world of design. In the automotive design field, the ability to compute such data as weight to speed ratio, acceleration, drag, and speed is essential to insure a successful design.

As the designer, you will be required to use many mathematical formulas during the design process. For example, to calculate the rate or speed at which your design will travel, you would use the formula for speed. (Speed = Distance / Time)

Example 1: Calculate the speed of a race car that travels 65 feet in 2 seconds.

$$\text{Speed (?)} = \frac{65 \text{ feet}}{2 \text{ seconds}}$$

Speed = 32.5 feet per sec

Example 2: To convert to Miles Per Hour (MPH):

$$\text{MPH} = \frac{\text{Speed(32.5 feet per sec) X 3600 (sec per hour)}}{\text{5280 (feet per mile)}}$$

$$\text{MPH} = \frac{(32.5 \text{ X } 3600)}{5280}$$

$$\text{MPH} = \frac{117000}{5280}$$

MPH = 22.159 or 22.2 MPH

Try these: Solve the following problems.

1. How fast is your race car traveling if it takes 1.1 second to go 65 feet?

Feet per second: _____ MPH: _____

2. How fast is your race car traveling in if it takes 1.5 second to go 65 feet?

Feet per second: _____ MPH: _____

MATH APPLICATION
RESEARCH AND DESIGN: METRIC 500 DRAGSTER (Cont'd.)

3. How fast is your race car traveling if your car travels 65 feet in .95 seconds?

   Feet per second: _____ MPH: _____

4. How fast is your race car traveling if your car travels 250 feet in 4 seconds?

   Feet per second: _____ MPH: _____

5. How far would a race car travel in 5 seconds at a speed of 85 feet per second?

   Distance traveled in 5 seconds: _____

6. How long will it take for your race car to travel 200 feet if it is going 75 feet per second?

   Answer: _____

7. Calculate the average speed of your race car after five heats.

1st heat	44.1 mph
2nd heat	41.1 mph
3rd heat	42.3 mph
4th heat	46.0 mph
5th heat	40.5 mph

   Answer: _____

QUIZ
RESEARCH AND DESIGN: METRIC 500 DRAGSTER

_____
Student Name

Multiple Choice:

_____ 1. A non-working model made to show how a product will look in three dimensions.
a. Mock-up
b. Layout
c. Prototype
d. Rough Draft

_____ 2. Research done to identify the needs of the consumer.
a. Market Research
b. Product Research
c. Applied Research
d. Development Research

_____ 3. Research directed toward solving a problem is called:
a. Development Research
b. Market Research
c. Product Research
d. Applied Research

_____ 4. Orthographic Projection can show up _____ dimensions in each view.
a. Four
b. Two
c. Five
d. Three

_____ 5. The first drawing(s) done to obtain ideas is:
a. Rough Sketches
b. Thumbnail Sketches
c. Orthographic
d. Finished

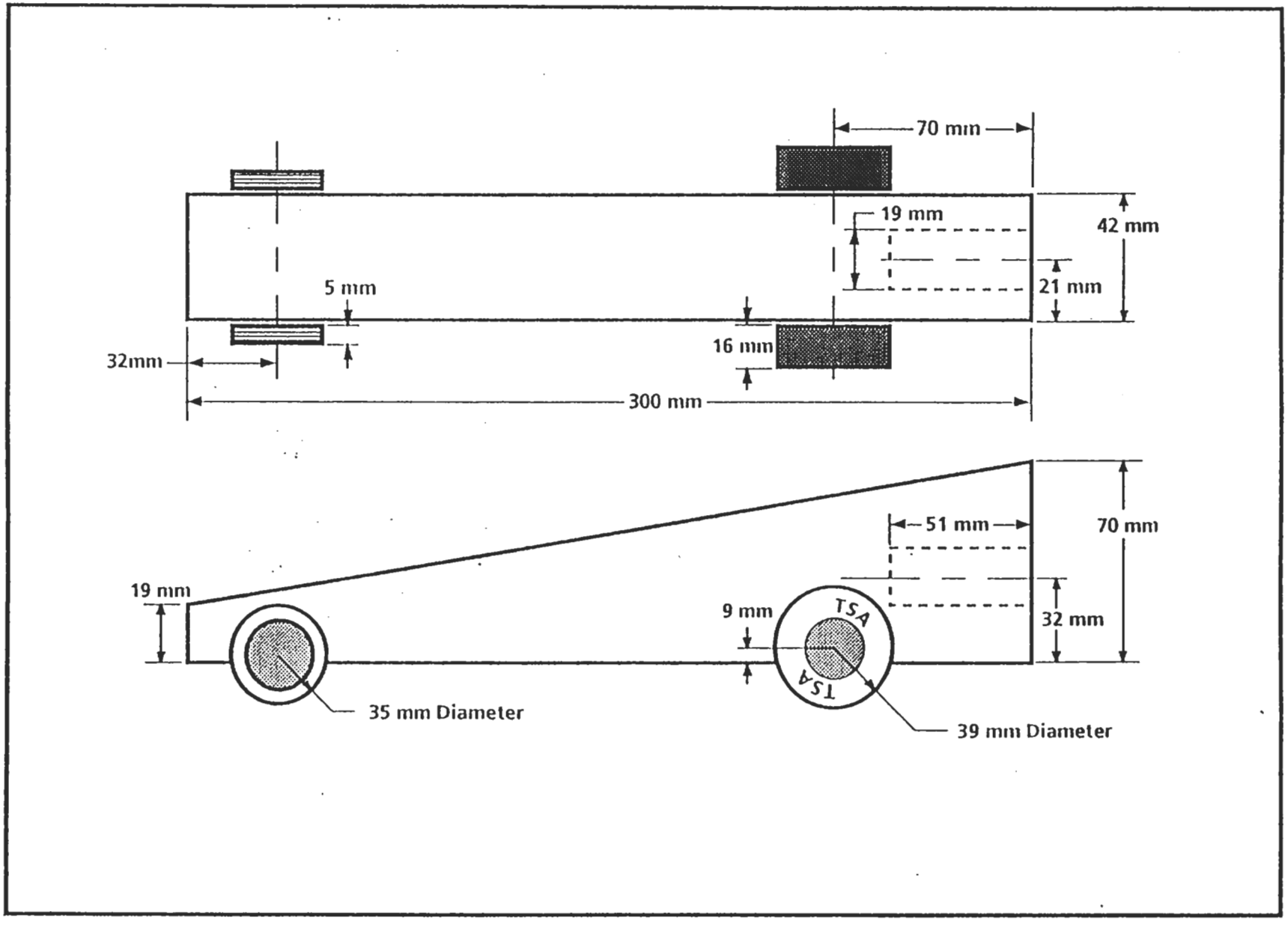
_____ 6. The best material to make a prototype of the CO^2 car is:
a. Wood
b. Metal
c. Styrofoam
d. Rubber

_____ 7. A working model of a product is called:
a. Prototype
b. Layout
c. Mock-up
d. Design

_____ 8. A measurement system based on feet and inches.
a. Metric
b. Scale
c. Customary
d. English

_____ 9. Workers who seek new information and knowledge are called:
a. Designers
b. Engineers
c. Researchers
d. Consultant

_____ 10. A detailed description of the particulars of a product is called:
a. Copy
b. Specification
c. Project Plan
d. Appearance Mock-up


70 mm
19 mm
42 mm
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16 mm
300 mm
51 mm
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TSA
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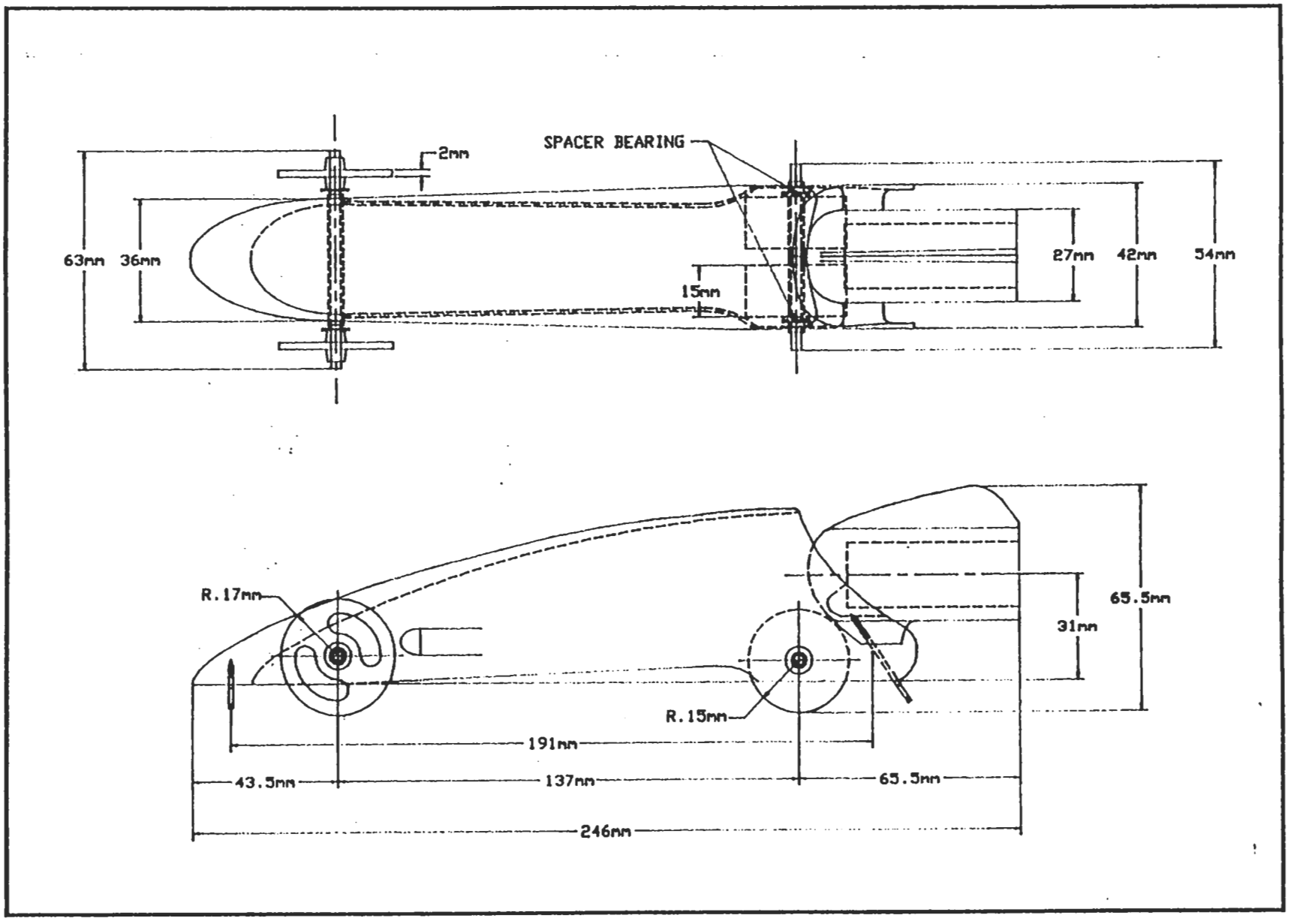
2mm
SPACER BEARING
63mm
36mm
15mm
27mm
42mm
54mm
R.17mm
R.15mm
31mm
65.5mm
191mm
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137mm
65.5mm
246mm