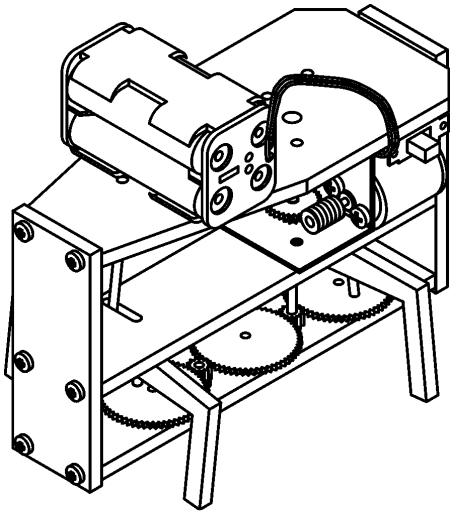
# *ANT*

## DESCRIPTION



The *ANT* is a four legged walking device, with the movement inspired by the motion of a real ant. This walking motion is achieved by the use of a crank mechanism, which moves each leg forwards and backwards, while simultaneously being raised and lowered. The timing of the legs' motion is co-ordinated by a set of gears.

## THE PROJECT

The major aspects of this project are the planning, design, construction and assembly stages of the device. To carry out this project, a student must:

- Investigate what options are available
- Design, mark out and fabricate the respective components
- cut and drill the component parts
- assemble the device
- connect and solder the wires, switch and motor

## INVESTIGATION.

This project lends itself to the students investigating a variety of topics. Some are purely technical areas: eg. the choice and suitability of various materials for this project (different plastics, MDF, PVC, perspex, etc.). Other topics may be related to the natural sciences. The attached diagrams show one (stylised and simplified) interpretation of what an ant's body looks like. Students could study real ants, with the aim of designing a more realistic *ANT*. Or, alternatively they could determine how similar their *ANT*'s movement is to that of a real ant.

## 1. COMPONENTS REQUIRED

**1.1 COMPONENTS SUPPLIED.** These components are supplied in a plastic bag :

| | | | |
|---|---|---|---|
| 1x | 4.5 V Electric motor (round) | 1 x | Worm gear |
| 1x | Sliding switch (small) | 1 x | 30T/10T Spur gear (white,2.4mm hole) |
| 1x | Gear case (ANT) | 3 x | 60T/10T Spur gears (white,2.4mm hole) |
| 1x | 4 AA Battery holder | 7 x | 12T Pinion gears (2.4 mm hole) |
| 3x | Steel rods 2.5 mm dia. 120mm long | 4 x | 2.6 x 4mm long Self tapping screws |
| 5 x | 3mm inner dia 0.5mm (thin) washers | 12 x | 3x10 mm long Self tapping screws |

Note: we suggest that, before you commence construction, you check the components in the kit.

**1.2 ADDITIONAL REQUIREMENTS**

1.2.1 Available from us are 2.3mm and 2.6mm drill bits and AA batteries, and need to be ordered separately.

1.2.2 The additional requirements are: Material for the body parts, and fine electric wire.

*Revised: 29 May 2009*

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Note: For the prototype *ANT*, we used 4.5mm thick clear PVC sheet, although a variety of other suitable materials are available. Suitable materials can be purchased from any plastics supplier (in the Yellow Pages under the heading "Plastics Fabricators")

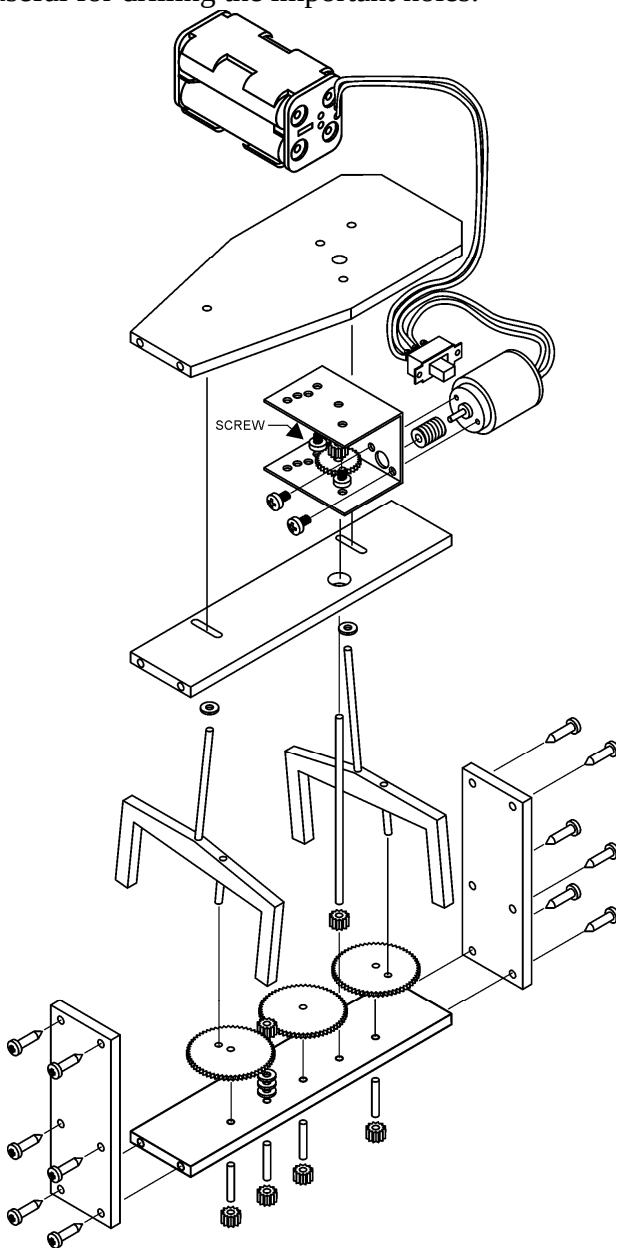
## 2. DESIGN CONSIDERATIONS

- There is a lot of scope in the design of the *ANT's* body. The drawings at the end show the prototype's parts. These show the size and proportions of the prototype, but may be changed and adapted by the designer. Essential (and some additional) dimensions are given.
- The student can, if desired, make the *ANT* as per the supplied drawings. Alternatively, the student might choose to come up with a totally different body shape. However, the centre lines of the gears must be maintained, to achieve proper meshing of the gears.
  NOTE: the designer should look at the design of the *ANT* as a complete unit – not just a collection of components.
- Care must be taken when defining hole size and drilling the holes. The 2.3 mm drill is used for holes which require an interference fit, while the 2.6 mm holes provide clearance holes for the (2.5mm diameter) rotating shafts. Note: some holes will also need to be larger than 2.6 mm, to allow for misalignment between 2 parts.
  HINT: if making a class set, a template may be useful for drilling the important holes.

## 3. THE PLATES, LEGS AND SHAFTS

### 3.1 CHOICE OF MATERIAL

For the prototype 4.5 mm clear PVC was used. This material was chosen as it is easily cut, shaped, drilled and glued. MDF and Acrylic are some other options, although acrylic is more brittle (it may crack with the use of self tapping screws). If desired, 3 mm thick material may be used for the End plates (only).




### 3.2 MAKING THE PLATES

3.2.1 Mark and cut out the Top, Middle and Lower Plates. The location of the holes for the shafts is very important - if the holes are too close, the gears will jam, but if they are too far apart the gears will not mesh (to facilitate class work, one metal template may be made for use by all the students). On the lower plate, the shaft holes need to be 2.6 mm diameter.

3.2.2 The distance between the holes, drilled in the ends of the Plates, can be varied to suit the individual design, but must match the corresponding holes drilled in the End Plates.

### 3.3 MAKING THE END PLATES

3.3.1 The dimensions given for the hole centres, and for the overall size between, are derived from the prototype *ANT*'s

dimensions. These dimensions can be altered to suit each individual's *ANT* design.

3.3.2 The distance between the hole positions in the End Plates, must be the same as the matching holes in the Top, Middle and Lower plate ends.

3.3.3 The distance between the Lower, Middle and Top Plates may be varied by each designer. Note: the shaft length must be cut to suit the distance between Top and Lower Plates.

### 3.4 MAKING THE LEGS

Two pairs of legs are required with this design. Each pair of legs is made up of the leg cut-out, with two lengths of 2.5mm shaft pressed in. The length of the longer 2.5mm shaft needed for the legs will be determined by the distance between the plates. The holes in the legs need to be 2.3 mm diameter, to provide a press-fit.

### 3.5 CUTTING THE SHAFTS

3.5.1 From the supplied rod, cut the required shaft lengths (as in 3.4). After cutting, remove the burr from all shaft ends using a metal file.
Note: the shaft lengths given are for the *ANT* as shown (ie. the prototype).

3.5.2 The longer gear box shaft lengths must correspond to the height of the *ANT* – the prototype's shaft was 80 mm long.

## 4. THE GEAR BOX AND GEARS

### 4.1 MODIFYING THE GEAR CASE

The gear case supplied requires modification to enable it to be attached to the *ANT's* upper plate. To attach it, two holes are to be drilled on the side shown on the drawing. On the opposite side of the case, access holes for the screw driver need to be drilled.

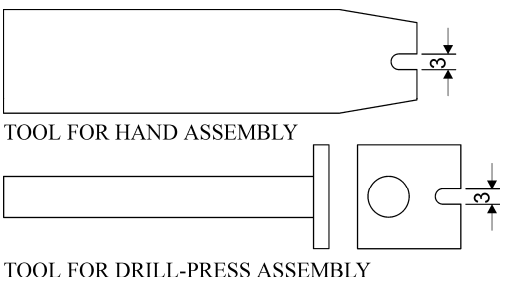
### 4.2 ASSEMBLING THE GEAR BOX

4.2.1 Care must be taken to assemble all the gears and shafts correctly. The shafts should be long enough so that a small misalignment does not allow the shaft ends to become displaced from their holes.

4.2.2 All the gears need to have the shafts pressed in. Care should be taken as the assembly /disassembly of these can be time consuming if mistakes are made.

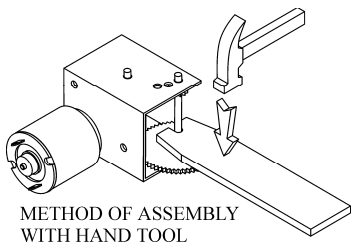
4.2.3 The longest shaft is pressed through a 12 tooth pinion gear and the 30 tooth gear, both of which are inside the Gear case. A short length of shaft protrudes out of the top (a minimum of 3 mm). A 12 tooth gear is assembled close to the other end (the position of this can be adjusted later).

4.2.4 To assemble the gears, the tools shown are useful. The tool on the right is for use with a drill press, while the tool on the left is designed to be used (gently) with a hammer.



TOOL FOR HAND ASSEMBLY

TOOL FOR DRILL-PRESS ASSEMBLY


METHOD OF ASSEMBLY
WITH HAND TOOL

### 4.3 INSTALLING THE MOTOR

4.3.1 Press the worm gear on to the shaft of the motor. HINT: Place the gear on the bench, insert the motor shaft into the pinion's hole and gently tap the end of the shaft (where it exits the motor) with a small hammer. Stop when the pinion is 1mm from the motor's

body. WARNING: Don't just push the motor down by hand as this can push the motor armature out of its bearings and jam the motor.

4.3.2 Attach the motor to the gear case using the 2 small self-tapping screws.

4.3.3 Attach the completed gear box to the upper plate using self-tapping screws.

### 4.4 ASSEMBLING THE GEAR SETS

4.4.1 Before assembling the gears, a 3 mm hole needs to be drilled in two of the 60 Tooth gears - these will be used for the legs' cranks (refer to the drawing). These two gears must be at the ends (as shown in the exploded view).

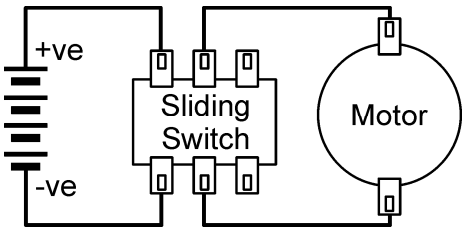
4.4.2 Assemble the gears and shafts to the bottom plate. Check and make sure the gears mesh properly. They must rotate freely.

## 5. ASSEMBLING THE *ANT*

5.1 Assemble all the plates together, ensuring that the gearbox shaft protrudes through the bottom plate.

5.2 Attach the battery compartment's wires to two of the end terminals on the switch. Connect a short length of wire between each of the switch's centre terminals and the motor's terminals. Before soldering, ensure that the switch and motor work.

5.3 Attach the sliding switch and the battery compartment to the top plate. Either double sided foam tape or the use of hot glue is suitable for this task. Retention can be improved by roughening the plate's surface with sandpaper.




*SCHEMATIC DIAGRAM*

5.4 The battery holder is shown on the top (outside). For a more compact design, the battery holder may be installed inside (ie. below the top plate). The top-mounted design is to allow easy access to change the batteries. If the holder is below the Top plate, the plate may need to be removed to change batteries. Alternately, the battery holder may be mounted lengthways.

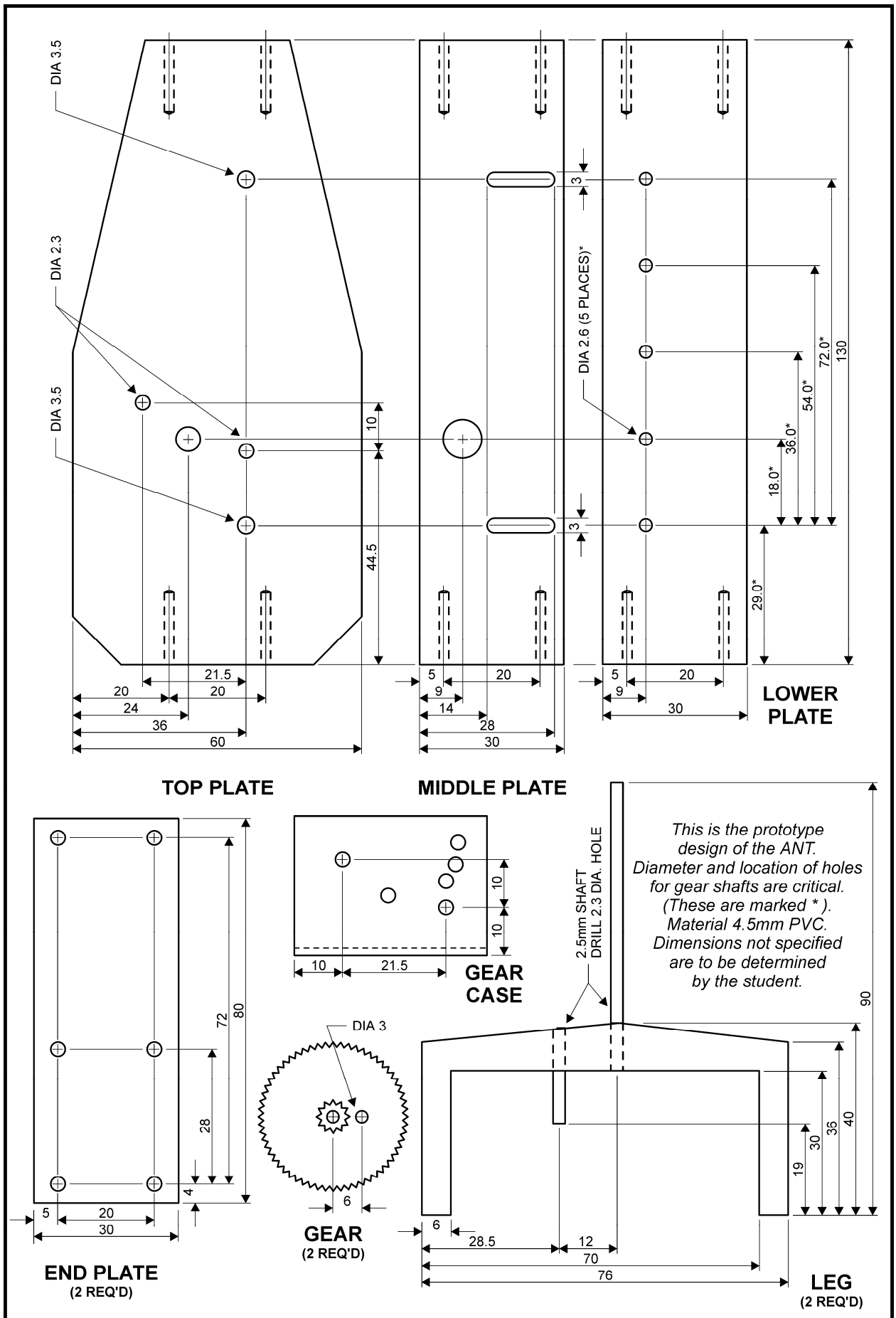
## 6. EVALUATION OF THE FINISHED PRODUCT

The teacher and student should pose a number of questions before commencing the project. These should then be evaluated by the student at the completion of the work.

The questions could be in a variety of fields:

- technical questions: for example: Do the gears mesh well? Does the *ANT* walk straight? Can it be steered (ie. To go in a circle)?
- How can the design be improved?
- Aesthetic questions: for example: Can the appearance be improved, to make it more realistic?
- Self-critique: for example: Is the quality of finish and workmanship satisfactory? How could the production of the piece be improved?
- Assessment of the project: What difficulties were experienced? What caused them? Can they be reduced or eliminated in future projects? How long did the project actually take?
- Critique of the Teaching unit: Was it missing anything vital? What information did it miss out on, which would have been of value?

*CONGRATULATIONS! YOU HAVE BUILT YOUR OWN ANT*

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**ANT - 1**