To master a Challenge, you must follow three basic steps:

1. Construct – To start, review the Design Brief. Then gather the pieces you need to meet the Challenge and start building. (Don’t hesitate to customize your robot with additional parts and pieces.)

2. Program – Once your robot is built, you can program it using the simple, but powerful, programming language included on the CD-ROM. Your program will determine how your model reacts to its environment.

3. Test – Now it’s time to test your program and design. Once you have downloaded your program from your PC to your RCX using the infrared transmitter, your robot can run independent of your computer. Now let it loose and watch what happens!
# CONTENTS

<table>
<thead>
<tr>
<th>PROJECT IDEAS</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROBO 1</td>
<td>6</td>
</tr>
<tr>
<td>ROBO 2</td>
<td>9</td>
</tr>
<tr>
<td>PATHFINDER 1</td>
<td>13</td>
</tr>
<tr>
<td>PATHFINDER 2</td>
<td>15</td>
</tr>
<tr>
<td>ACROBOT 1</td>
<td>17</td>
</tr>
<tr>
<td>ACROBOT 2</td>
<td>20</td>
</tr>
<tr>
<td>SPECIAL FEATURES</td>
<td></td>
</tr>
<tr>
<td>Movement</td>
<td>26</td>
</tr>
<tr>
<td>Sensors</td>
<td>28</td>
</tr>
<tr>
<td>TIPS &amp; TRICKS</td>
<td>32</td>
</tr>
<tr>
<td>TOP SECRET PLANS</td>
<td>39</td>
</tr>
<tr>
<td>PARTS IDENTIFICATION</td>
<td>47</td>
</tr>
</tbody>
</table>

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What follows are basic instructions for building the six subassemblies associated with the CD-ROM Challenges. The same instructions can be used for building your own robotic inventions.

ROBO 1
- Slowly moves back and forth.
- Requires one motor.

ROBO 2
- Slowly rotates in one direction.
- Requires one motor.

PATHFINDER 1
- Quickly turns left and right.
- Requires two motors.
PATHFINDER 2
• Slowly turns left and right.
• Requires two motors.

ACROBOT 1
• Quickly turns left and right.
  Even does “wheelies.”
• Requires two motors.

ACROBOT 2
• Moves fast and flips upside down.
• Requires two motors.
To get started on Robo 1, follow these five steps.

1. BEFORE YOU GET STARTED...
Make sure there are batteries in your RCX. For help installing batteries, turn to page 38.

For this step, you need:

- 8-tooth gear
- 2 x 6 plate with holes
- Motor

Put the 8-tooth gear on the motor.
Put the motor on the 2 x 6 plate with holes.

4x means you need 4 of these.

2. For this step, you need:

- Bushing
- 24-tooth crown gear

To measure an axle, see page 37.

Push the 24-tooth crown gear onto the axle.

Attach this to the previous step.

Push the wire into the groove.
3 For this step, you need:

- Dark gray connector peg

2 x 6 plate with holes

Do this first!
Put the 2 x 6 plate with holes here.

4 For this step, you need:

- Connector peg with axle
- Dark gray connector peg

Put the beams on the RCX using the dark gray connector pegs.

Put the connector peg with axle here.
Attach the end of the wire to port “A”.

HINT: Try this wheel.

HINT: Try this wheel.

IF YOU NEED HELP COMPLETING YOUR ROBOT...
• Check out “Special Features” on page 26.
• Turn to “Tips and Tricks” on page 32.

TO PROGRAM YOUR INVENTION...
• Go to the MoboRobo challenge or the Robo Bumper challenge on the CD-ROM.
Build the foundation for Robo 2 by following these eight steps.

**BEFORE YOU GET STARTED...**
Make sure there are batteries in your RCX. For help installing batteries, turn to page 38.

1. For this step, you need:
   - 2 x 6 plate with holes
   - Motor
   - 1 x 2 plate

   *1x means you need 1 of these.*

   **Put the 1 x 2 plates here.**

   Put the motor onto the 2 x 6 plate with holes.

2. For this step, you need:
   - 8-tooth gear
   - Gray connector peg

   **This is the gray connector peg.**

   **Put the 8-tooth gear on the motor.**
For this step, you need:

To measure an axle, see page 37.

Push the wire into the groove.

Do this first!

Put the bevel gear on the differential.

Put the bevel gear in place and push the axle into it.
5  For this step, you need:

- 1 x 6 plate
- Dark gray connector pegs

Put the 1 x 6 plate here.

Do this first!
Put the beam here.

6  For this step, you need:

- Dark gray connector peg

Put the beams on the RCX using the dark gray connector pegs.
For this step, you need:

2 x 8 plate with holes

Bushing

Put the bushing on the axle.

Put the 24-tooth gear here.

Put the beam onto the gray connector peg.

For this step, you need:

2 x 8 plate with holes

IF YOU NEED HELP COMPLETING YOUR ROBOT...
- Check out “Special Features” on page 26.
- Turn to “Tips and Tricks” on page 32.

TO PROGRAM YOUR INVENTION...
- Go to the Robobeeper challenge or the Robioptic challenge on the CD-ROM.

HINT: Try this wheel.
To start building Pathfinder 1, follow these four steps.

**BEFORE YOU GET STARTED...**
Make sure there are batteries in your RCX. For help installing batteries, turn to page 38.

1. **For this step, you need:**
   - 2 x 4 plate with holes
   - Skid plate
   - 2x means you need 2 of these.
   - Put the 2 x 4 plate with holes here.
   - Put the skid plates here.

2. **For this step, you need:**
   - Inverted roof brick
   - Put the inverted roof bricks here.
3. For this step, you need:

- Motor
- RCX

Put the motor on here.
Put the ends of the wires here.
Put the RCX on top.

4. For this step, you need:

- RCX

IF YOU NEED HELP COMPLETING YOUR ROBOT...
- Check out “Special Features” on page 26.
- Turn to “Tips and Tricks” on page 32.

TO PROGRAM YOUR INVENTION...
- Go to the Outback Tracker challenge or the Light Tracker challenge on the CD-ROM.

HINT: Try this wheel.
To get started on Pathfinder 2, follow these four steps.

1. BEFORE YOU GET STARTED...
Make sure there are batteries in your RCX. For help installing batteries, turn to page 38.

For this step, you need:

- 4x means you need 4 of these.
- To measure an axle, see page 37.

Put the bushings here.

2. For this step, you need:

- 1 x 2 brick

Put the 1 x 2 bricks here.
For this step, you need:

1 x 16 beam
Dark gray connector peg

Put the 1 x 16 beams on the RCX using the dark gray connector pegs.

Attach this to the previous step.

For this step, you need:

Motor
Large pulley

Attach one end to the motor, the other to port A. Attach one end to the motor, the other to port C.

Put the large pulleys onto the axles.

IF YOU NEED HELP COMPLETING YOUR ROBOT...
• Check out “Special Features” on page 26.
• Turn to “Tips and Tricks” on page 32.

TO PROGRAM YOUR INVENTION...
• Go to the Trail Tracker challenge or the Track Talker challenge on the CD-ROM.

HINT: Try this skid plate.
HINT: Try this wheel.
To get started on Acrobot 1, follow these five steps.

BEFORE YOU GET STARTED...
Make sure there are batteries in your RCX. For help installing batteries, turn to page 38.

1. **For this step, you need:**
   - Black connector peg
   - 2x means you need 2 of these.

2. **For this step, you need:**
   - 1 x 8 beam
   - To measure an axle, see page 37.
For this step, you need:

- Dark gray connector peg

Put the black connector pegs here.

Put the beams on the RCX using the dark gray connector pegs.

For this step, you need:

- RCX

Do this first!

Make this piece for each side and attach to the black connector pegs.

Put this on the bottom of the RCX.
For this step, you need:

2 x 8 plate with holes

Do this first!
Put the 2 x 8 plates with holes here.

HINT: Try this wheel

HINT: Try this wheel

IF YOU NEED HELP COMPLETING YOUR ROBOT...
- Check out “Special Features” on page 26.
- Turn to “Tips and Tricks” on page 32.

TO PROGRAM YOUR INVENTION...
- Go to one of the Robo challenges on the CD-ROM.
For a jump start on Acrobot 2, follow these six steps.

1. **BEFORE YOU GET STARTED...**
   Make sure there are batteries in your RCX. For help installing batteries, turn to page 38.

For this step, you need:

- **Black connector peg**
- 6x means you need 6 of these.

**Do this first!**
Attach the beams using the black connector pegs.
For this step, you need:

- 2x beams
- 2x small beams
- 1x RCX

Attach the beam to the RCX.

Attach this to the previous step.
3

For this step, you need:

- 1 x 6 beam

Put the 1 x 6 beams here.
For this step, you need:

- 1/2 bushing
- Axle with stop
- Long black connector peg

Put the axle with stop through the beam. Then add the 1/2 bushings. Slide the piece in along side the motor.

Make two of these.

The long black connector peg must be put in like this.
For this step, you need:

1. Make two of these.

2. The long black connector peg must be put in like this.

3. Slide the piece in along side the motor.
For this step, you need:

2 x 10 plate

HINT: Try this wheel

IF YOU NEED HELP COMPLETING YOUR ROBOT...
• Check out “Special Features” on page 26.
• Turn to “Tips and Tricks” on page 32.

TO PROGRAM YOUR INVENTION...
• Go to one of the Robo challenges on the CD-ROM.
There’s more than one way to get things moving. Here are a few ideas to get your mind in gear.

1. Push the hub into the tire.

2. Large and small tires can be used on the same model.

3. Put a 16-tooth gear here. For more details on how to build this, see Tips & Tricks on page 34.

4. Even gears can be used as wheels!

5. There are two ways to make your wheels swivel.

6. Big wheels lift your robot higher off the ground. (This is especially useful on Acrobot 2. See page 25).
A Walking Mechanism

Look closely at the photograph to make sure you build it correctly.

For help, turn to Tips & Tricks on page 36.

Put an 8-tooth gear onto the motor.

This wheel can be attached directly to the motor.

This wheel requires some building before you attach it to the motor.
Sensors make it possible for a robotic invention to respond to its environment. Here are a few ideas on how to use light sensors and touch sensors.

**Light Sensor**
- Use a light sensor “facing” down to locate a line.
- Connect this end to the gray ports on the RCX.
- The sensor “reads” the light here.

**Touch Sensor**
- Push the touch sensor here.
- Connect this end to one of the gray ports on the RCX.

**Project Ideas**

1. Use a light sensor “facing” down to locate a line.
2. Make a bumper with a touch sensor.

---

**Special Features**

*Sensors*
Hand-Held Controller

Here is how you can build a hand-held controller using two touch sensors.

Step 1

Step 2

Step 3

Attach the two wires from the hand-held controller to the RCX on ports 1 and 3.

When you turn the steering wheel it will press the touch sensor, causing the motor to stop and your robot to turn.
Here are more examples of how you can use sensors. There are also ideas for decorations such as “eyes” and “noses.”

A light sensor that looks down

A light sensor that looks down

A light sensor that looks up

A bumper that uses one touch sensor

A bumper that uses one touch sensor

A bumper that uses two touch sensors

Eyes for decoration

A face for decoration
These eyes are just for decoration.

This eye is the one that really “sees.”

A touch sensor in the middle of a hand.

A light sensor facing down.

A touch sensor added to the end of an arm.

Arms for decoration.
If you want to make your invention bigger, stronger, faster, or work even better, try using these tips and tricks.

**Adding features to your RCX**

Add bricks or special features directly to the top of your RCX.

When you add a turntable, the items you put on top of it will rotate.

To attach one or more pieces, place a dark gray connector peg into the hole.

**Attaching different pieces**

Attach pieces using the angle piece.

Don’t forget... you can always add pieces to the bottom of your RCX.

Attach a beam by using two dark gray connector pegs.
Making angles

Adding axles

This one spins.
This one doesn't spin.

Adding plates to a beam

Adding length using plates

Adding length using a beam and connector pegs

Extending an axle

Adding height
Making a hand

Push these four pieces together to make a hand.

Push the cone into the hole of the beam.

Adding hubs for caterpillar treads
**Using connector pegs**

![Image of connector pegs being used to lengthen a motor shaft.]

The black connector pegs hold pieces more tightly than the gray connector pegs.

**Building a frame around a motor**

![Image of a motor with a frame built around it.]

**Lengthening the motor shaft**

![Image of a motor shaft being lengthened with a special connector.]

Use a special connector to lengthen the motor shaft.

A tire can be added.
Tips & Tricks

Using gears to speed things up

Use this gear combination to make the axle spin faster.

Using one motor to drive two gears

You can use this set-up to make a walking mechanism. See page 27, #7.

Creating a more powerful motor using a belt drive

You can use this set-up to make Pathfinder 2. See page 15.

A tire can be added.
Changing speed using different-sized gears

This gear combination will move slowly but provide a lot of power. This makes it possible for your robot to do things that require greater strength.

A tire can be added.

How to measure an axle

Use this chart to measure the length of an axle.
Battery installation for the RCX

1. Remove the bottom of the RCX.
2. Insert 6 AA (LR6) batteries.
3. Put the bottom back on the RCX.

Instructions for use of battery box
Never mix different types of batteries or old and new batteries in one battery box. Always remove the batteries from the battery box for long-term storage or if they have reached the end of their life. Liquid leaking from dead batteries will damage the battery box. Rechargeable batteries can be used but power may be reduced. Do not recharge the batteries in the battery box. Rechargeable batteries are only to be charged under adult supervision.

Battery installation for the Infrared Transmitter

1. Slide the cover back.
2. Insert the 9V battery.
3. Close the cover.
The Torbot is a robot that gets around on caterpillar treads and is able to travel on top of a table with no risk of falling. Its secret lies in the strategic placement of its touch sensors. To build the Torbot, follow these 12 steps.

1. For this step, you need:
   - Black connector peg.
   - 4x means you need 4 of these.
   - Put the black connector pegs here.
   - To measure an axle see page 37
   - 2 x 8 plate with holes

2. For this step, you need:
   - Put the 2 x 8 plates with holes here.
   - Put the 2 x 8 plates with holes here.
   - Put the 2 x 8 plates with holes here.

3
For this step, you need:

- 24-tooth gear
- Motor

Put the 24-tooth gear onto the motor.

4
For this step, you need:

- Dark gray connector peg

Put the dark gray connector pegs here.
5
For this step, you need:

2 x 4 plate with holes

6
For this step, you need:

1 x 2 plate
1 x 8 plate

Put the 2 x 4 plates with holes here.

Put the 1 x 2 plates here.

Put the 1 x 8 plate here.
For this step, you need:

Touch Sensor

Put the touch sensor here.

Be sure to put your long connector peg in this way.

Long black connector peg

Put the long black connector peg here.
For this step, you need:

- 1 x 12 beam
- 1 x 4 plate

Put the 1 x 12 beam here.

Attach the pieces over here.

1 x 4 plate
For this step, you need:

- Put the 24-tooth gears here.
- Put the black connector pegs here.
For this step, you need:

- 4x bushings
- 2x bushings

Put a bushing here.

Put another bushing on the axle over here.
## 12

**For this step, you need:**

- Caterpillar tread
- 16-tooth gear
- Rubber band

Assemble the caterpillar tread the same way on this side.

Put the rubber bands here.

Put the 16-tooth gear here.