JR. SCIENTIST SERIES™

Tumbling Robot

A single motor produces amazing actions!

THE SECRET OF THE 3 SENSORS

The 3 sensors at the belly, the back, and the leg of Co-Bot make it possible. Sensors are pushed by falling and getting up and change the internal gears.

CO-BOT 3 MODES

01 Amazing and Amusing Walk!
Falling and stumbling, Co-Bot will never give up!
Let's go Forward!
Co-Bot has amazing power and energy.
Let's Go Mode

02 Let's cheer on Co-Bot for neat somersaults!
Never tiring somersault Mode

03 Swinging arms widely, dance around with great balance!
Wobbly-funky!?
Dance Mode

Why and how? Secrets of Co-bot

Co-Bot can walk! No matter how many falls and stumbles, Co-Bot gets up without any help! How does Co-Bot maneuver these complex motions? The secret is in its original mechanism.

MADE IN CHINA P38-GK013-81001000

EDU-TOYS®

A Science Guide with Supplemental Experiment Kit

AGES 8+

JR. SCIENTIST SERIES™

EXPERIMENT

A single motor produces amazing actions!

Tumbling Robot

Gears and Cranks

You can learn the basics of the machine!

Please purchase 2 AA batteries separately.

CONTENTS

JR.SCIENTIST™ SERIES

TUMBLING ROBOT

FALL, GET UP AND FALL AGAIN

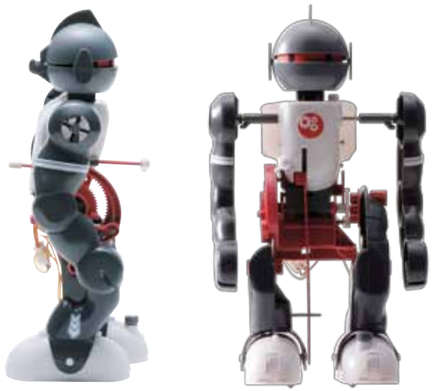
TUMBLING ROBOT

LET'S PLAY WITH "CO-BOT"!

AMAZING AND AMUSING WALK!

Complete

Amazing Actions with a single motor!
Brilliant work of gears and cranks!"



CAUTION!

Please read before assembling this product (adults/supervisors must read)

- Follow the instruction manual for assembly and operation of this product for the safety.
- Be cautious with small parts. They are choke hazards.
- Handle sharp corners and pointy parts with caution.
- Do not leave the product on the floor. Injury can occur by stepping on it.
- Do not coil the wires on body parts. This may cause injury.
- Do not touch the gears during the operation. This may cause injury.
- Do not experiment in the road.
- Do not experiment near river or pond.
- Do not experiment outdoor in the evening. It is dangerous due to poor visibility.
- Hard tugging and over stretching of the electrical wires may damage the wire.
- Pulling the arms and legs of the robot in the wrong direction may damage the product.
- Forcing to stop the movement of the robot by hand during the operation may damage the product and/or cause injury.
- Do not disassemble the robot by unscrewing. It may damage the product.
- Do not use the damaged and deformed parts.
- Store away from toddlers' reach after completing the experiment.

* Recycle and dispose according local regulation.
* The photo images of the product may vary slightly from the actual product in colors and/or small details.

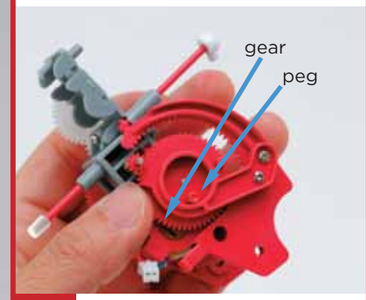
STEP 01

LET'S ASSEMBLE "CO-BOT"

Parts list

Right Leg Assembly

01 Turn the gear in the hip so the peg is positioned down.



02 Insert right leg from side slit.

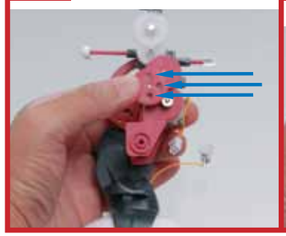
03 Slightly lift the top gear and hook the leg hole on the peg.

04 Move the leg carefully over the hip hook and bring the leg down.

05 Line up the lower hole of the hip assembly and the elongated leg hole. Insert a pin into the two holes so two parts are joined.

left Leg Assembly (This is "Let 'Go Mode" in page 9)

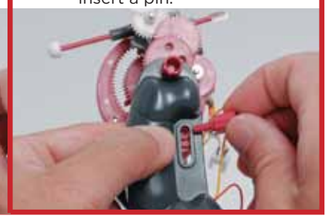
01 Line up the holes as shown in the picture.



02 line up the left leg hole and bottom hole of the gear as shown in the picture.

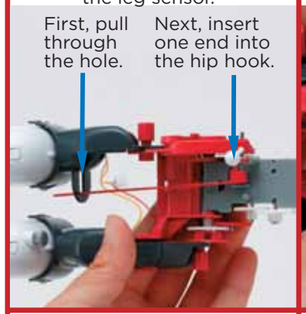
03 Push a pin firmly in until it stops.

04 Line up the lower hole of the hip assembly and the elongated leg hole and insert a pin.



Chest Assembly

01 Hold hip-leg assembly sideway and attach the leg sensor.



02 Align pegs and grooves and snap on the chest.

Arms Assembly

Line up the gears as shown in the picture. Snap on the arm axis rod into the two side grooves (catch) of the chest. Push the axis rod firmly in until it clicks.

Back Installation

Line the back so the back sensor should penetrate the back through the hole and install the back.

Head Installation

Align tongues and holes. Push the head straight down.

If the foot detaches...

Insert the foot back into the bracket by slightly opening the bracket. Be careful not to insert the foot backward. Orientation of Toes and heels is crucial for walking.

* toes have big grooves

How to use Decals

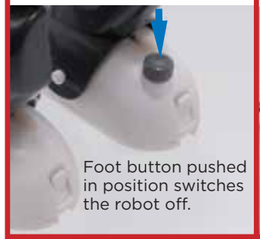
Be creative and find your own expressions! You can use a blank sticker and draw your own design, too!

Replaced with a head from different toy figure!

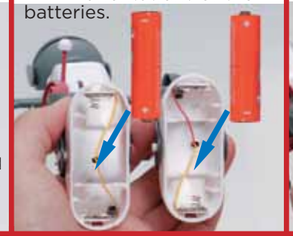
Example of using moving eye stickers. (stickers not included.)

Electrical Set Up

01 Keep foot button pushed in.



02 Be careful with positive and negative orientations of the batteries.



03 Attach the soles of feet. Be careful with right and left soles!

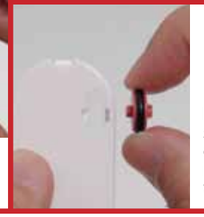
04 Twist the yollow lead wire around the hip hook (one turn).

05 Plug the connectors.

To exchange batteries...

Pry the sole off using a coin at the grooves on toes and heel.

If the wheels detach...



Push the square axle of the wheel into the wider hole.

STEP 02 LET'S OPERATE "CO-BOT"

There are 3 modes of Co-Bot. The features of 3 modes are illustrated in the next page.

01 Pulling the foot button up will turn the switch on.

Not recommended to operate the robot on tables and furniture that can be scratched and damaged. Operating the robot on the carpeted floor will make the robot fall down easier.

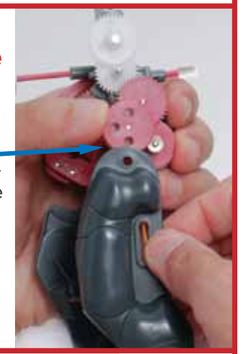
IF THE FOOT BUTTON (SWITCH) DETACH ...

Insert the button back into the hole aligning the pointy side with the toes.

02 Co-Bot starts moving vigorously.

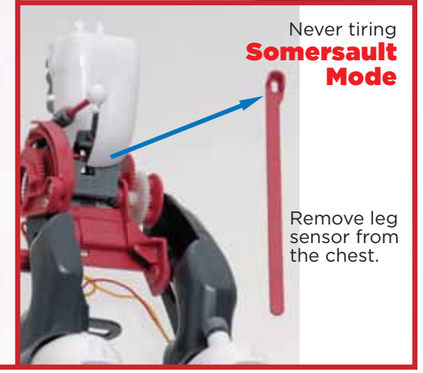
Wobbly-funky!?
Dance Mode

Orient the gear as shown in the picture, pin the left leg on the bottom hole.



Never tiring
Somersault Mode

Remove leg sensor from the chest.



01

Amazing and Amusing Walk!
Falling and stumbling, Co-Bot will never give up!
Let's go Forward!
Co-Bot has amazing power and energy.
Let's Go Mode

Orient the gear as shown in the picture. Pin the left leg to the bottom hole.

CO-BOT 3 MODES

Wildly Funny

You will laugh and enjoy amazing and unexpected moves of Co-Bot!

02

Let's cheer on Co-Bot for neat somersaults!
Never tiring somersault Mode

Remove leg sensor from chest.

03

Swinging arms widely, dance around with great balance!
Wobbly-funky!?
Dance Mode

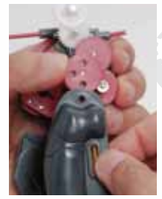
Try This!

Use a rubber band and restrict the belly sensor. Co-Bot will repeat bend down and stretch.

Tie a rubber band around the belly sensor and the side hook of the chest.

Fun to watch two Co-Bot interact!

* If a rubber band is too tight, Co-Bot will become in the Somersault Mode.

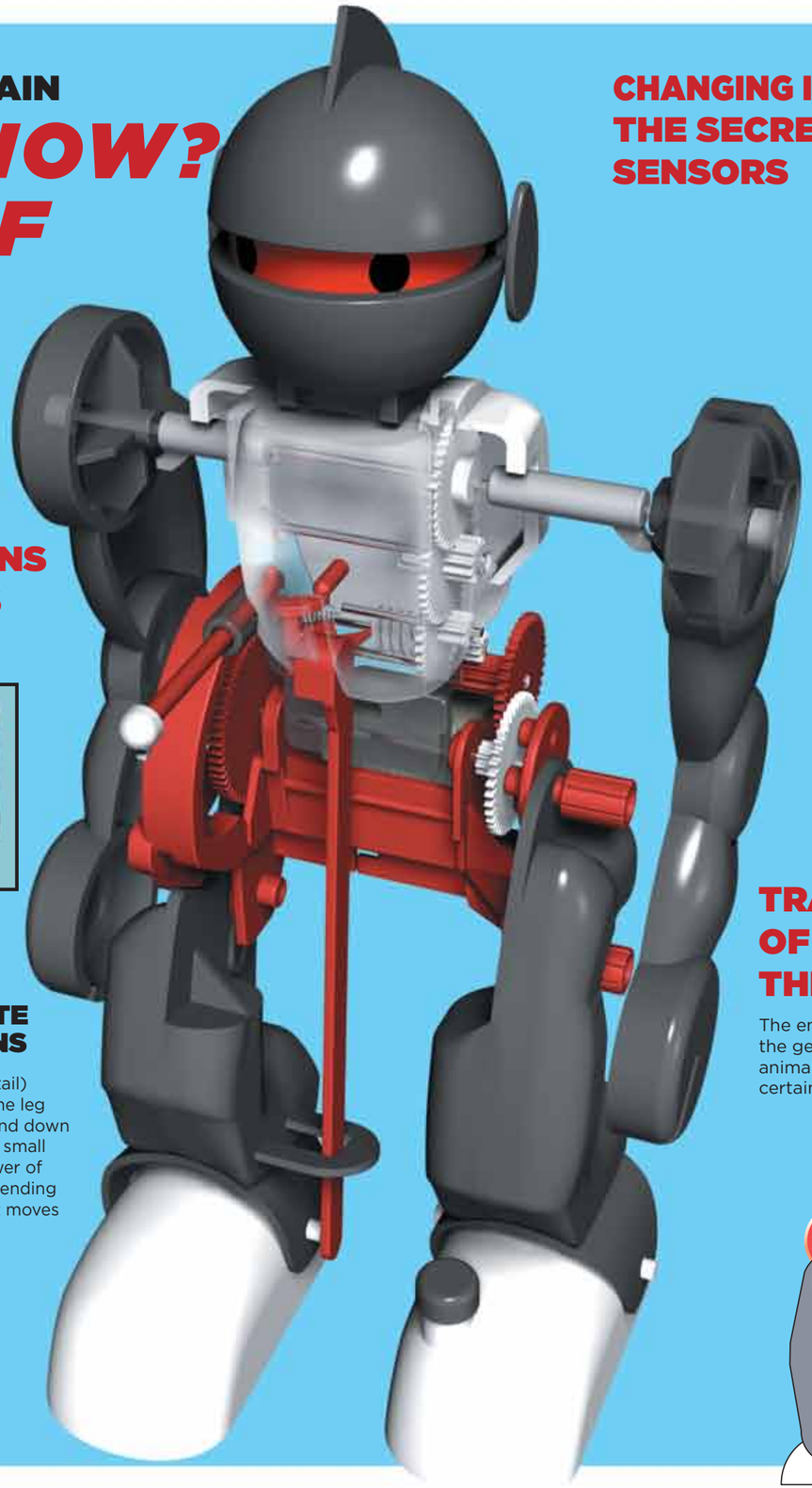


Orient the gear as shown in the picture, pin the left leg on the bottom hole.

FALL, GET UP AND FALL AGAIN

WHY AND HOW? SECRETS OF CO-BOT

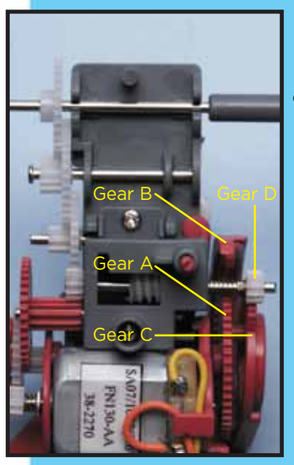
Co-Bot can walk! No matter how many falls and stumbles, Co-Bot gets up without any help! How does Co-Bot maneuver these complex motions? The secret is in its original mechanism.



CREATING COMPLEX ACTIONS THE SECRET OF THE GEARS

• 12 GEARS IN ONE CO-BOT!!

Co-Bot uses total of 12 gears. The most important one is the red gear at the right hip. "Kagaku no Tamago" original design, this gear creates dynamic stand up action.



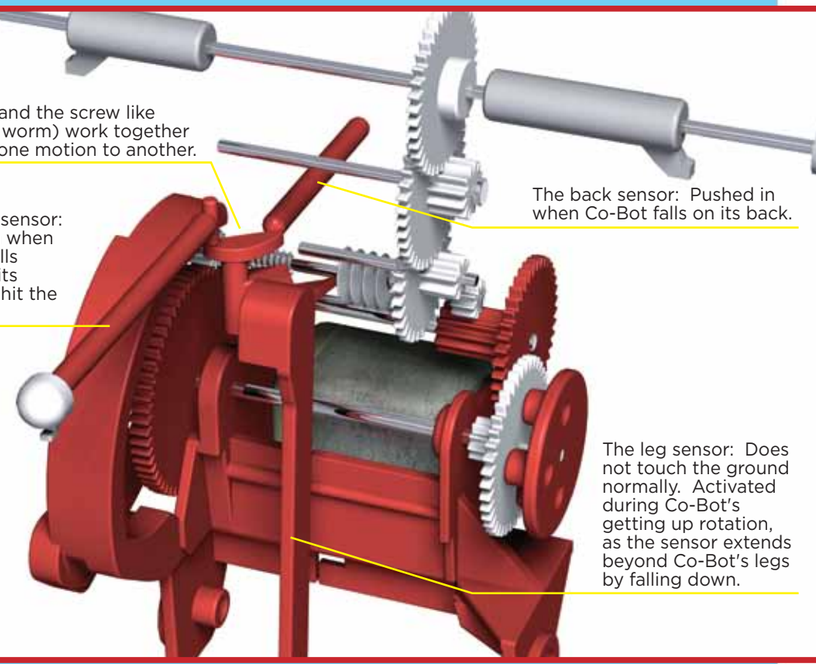
• HIP GEARS ACTIVATE DIFFERENT MOTIONS

Gear A (see the right page for detail) works as a crank that command the leg motion. Gear C makes Co-Bot bend down and Gear B stretches the body. A small Gear D will transfer rotational power of the motor to the other gears. Depending on which gear is powered, Co-Bot moves differently.

* Colors of the photographed parts may be different from the actual product.

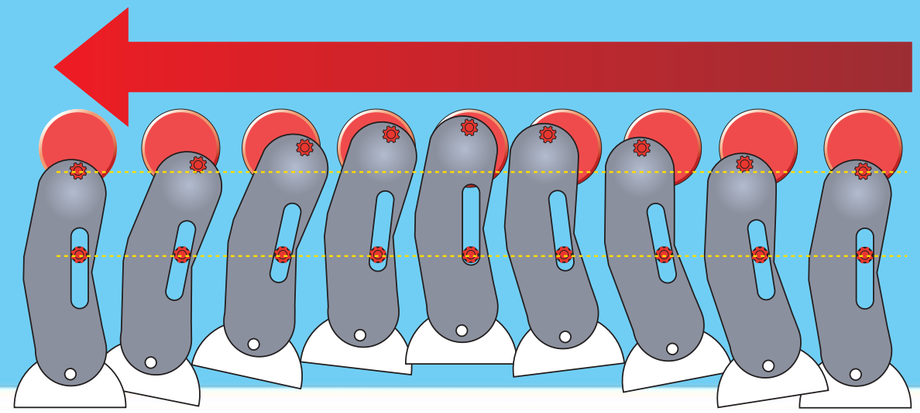
CHANGING INTERNAL GEARS THE SECRET OF THE 3 SENSORS

All the great functions of Co-Bot, such as walking and getting up, becomes useful only when those functions are activated at the right moment. The 3 sensors at the belly, the back, and the leg of Co-Bot make it possible. Sensors are pushed by falling and getting up and change the internal gears.



TRANSFERRING ROTATIONAL MOTION OF MOTOR TO LINEAR MOTION OF WALK THE SECRET OF THE CRANK

The end of Co-Bot's leg is pinned to the hip gear. Since it is not glued on, the leg can move freely as the gear rotates. Co-Bot's leg will lift off the ground and steps forward just like humans and other animals. This becomes possible because the elongated leg slit limits the motion of the legs within a certain range. This mechanism, transferring a rotational motion into a linear motion, is called a crank.



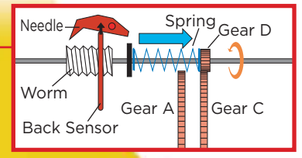
COMPLETE GUIDE!!

CO-BOT'S GETTING UP ACTION

How does Co-Bot get up? Let's look at the motion step by step!

01 FALLS BACKWARD!

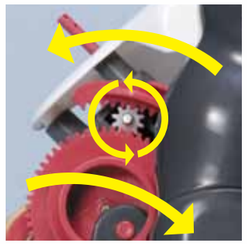
*Gear B is omitted



When the back sensor gets pressed, the needle is lifted and disengaged from the worm. The spring on the axis extends and bring Gear D to Gear C. Co-Bot is switched to getting up mode.

When Co-Bot sits up, the body pushes the leg sensor. The leg sensor extends beyond the legs.

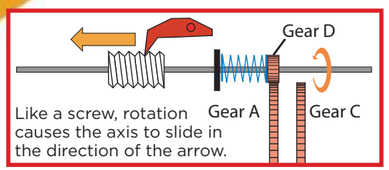
05 GETTING UP ACTION COMPLETE!!



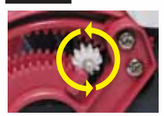
As the body gets up, Gear D engages Gear B (middle gear) and A (inner gear). When the body stretches all the way, gear D leaves gear B and moves only gear A. Co-Bot will continue walking.

04 THE LEG SENSOR TOUCHES THE GROUND!

The Leg sensor pushes the needle on the worm. Because the threads of the worm run diagonal like a screw, it slides the axis toward left side of the hip.



02 CO-BOT SITS UP!



When Gear D engages Gear C, The upper body of Co-Bot lifts up. When upper body bend forward all the way, Gear D starts idling. It remains idling until the body starts stretching.

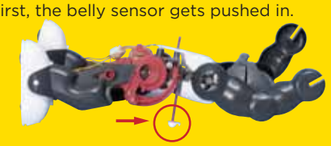
03 PUSH UP THE BODY WITH ARMS!

The arm axis rotates. A fin on the axis meets the fin on the shoulder and pushes the arms around.

WHEN FALLS DOWN ON BELLY, CO-BOT JUMPS UP SWIFTLY!!

When Co-Bot falls forward, the belly sensor is pushed by the ground and the body bends in half. The leg sensor immediately touches the ground and bring the body upright. It is much quicker motion than getting up by the arms.

- First, the belly sensor gets pushed in.



- The moment the body folds in half, the leg sensor touches the ground.

- Instantly, the body jumps back up!!

LET'S CHECK THE FUNCTION OF A SENSOR!

Co-Bot doesn't have abilities to see things or make decisions. Co-Bot relies on sensors to maneuver and switch between the different motions. Let's check the function of a sensor by moving the sensor by hand.

- Pick up the walking Co-Bot and push the back sensor...

- The body bends in half even though Co-Bot didn't fall down!!

❗Be careful not to drop Co-Bot

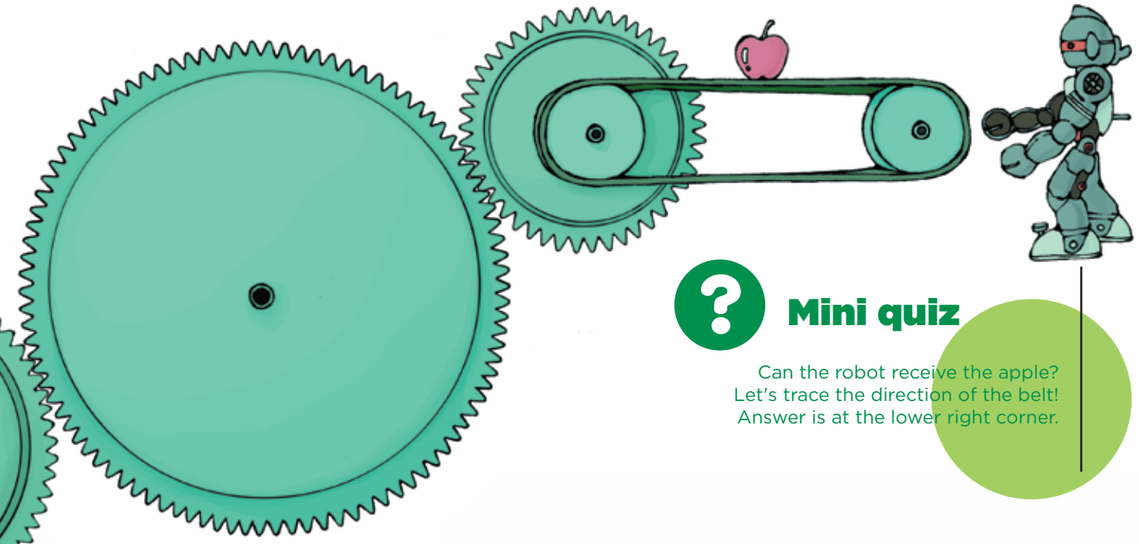
MECHANISM OF MACHINES MASTER CLASS

GEARS, BELTS, & CHAINS

-TRANSFER ROTATION, CHANGE SPEED AND DIRECTION OF ROTATION-

Gears, belts, and chains transfer rotational motion. They are used in many mechanisms of everyday devices such as bicycles and cars.

Technical consultation: Masahiro Mori, Professor Emeritus, Tokyo University
illustration: Kasyu



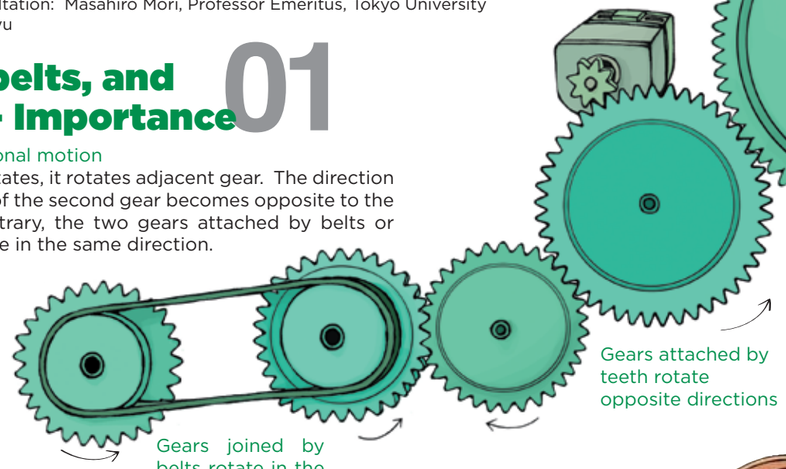
Mini quiz

Can the robot receive the apple?
Let's trace the direction of the belt!
Answer is at the lower right corner.

Gears, belts, and chains - Importance 01

•Transfer rotational motion

When a gear rotates, it rotates adjacent gear. The direction of the rotation of the second gear becomes opposite to the first gear. Contrary, the two gears attached by belts or chains will rotate in the same direction.



Gears attached by teeth rotate opposite directions

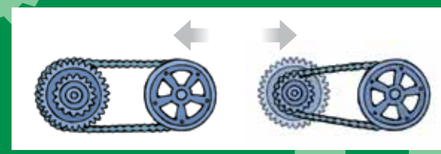
Gears joined by belts rotate in the same directions

Gears, belts, and chains - Importance 02

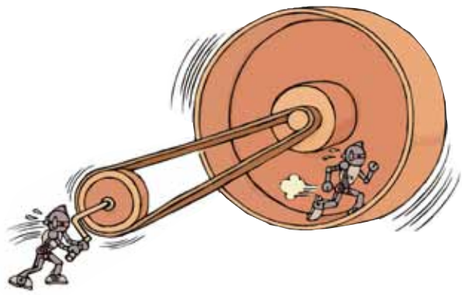
•Change the rotational speed

When two gears have same diameter, the rotational speed of the two gears is the same. On the contrary, when two gears have different diameters, the two gears have different rotational speeds. The larger the diameter becomes, the slower it rotates. The smaller the diameter becomes, the faster it rotates. Geared bicycles use this mechanism of gears. The same rules apply to the number of teeth. The more teeth a gear has, the slower it rotates.

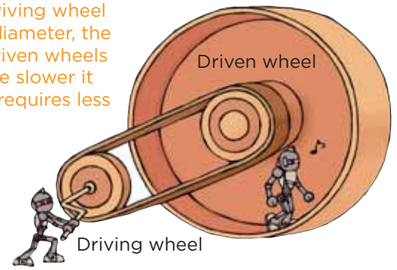
Gear Change of Bicycle



The smaller the gear becomes, the faster the wheels rotates. The pedals require greater force.



When the driving wheel has a fixed diameter, the larger the driven wheels becomes, the slower it rotates and requires less force.

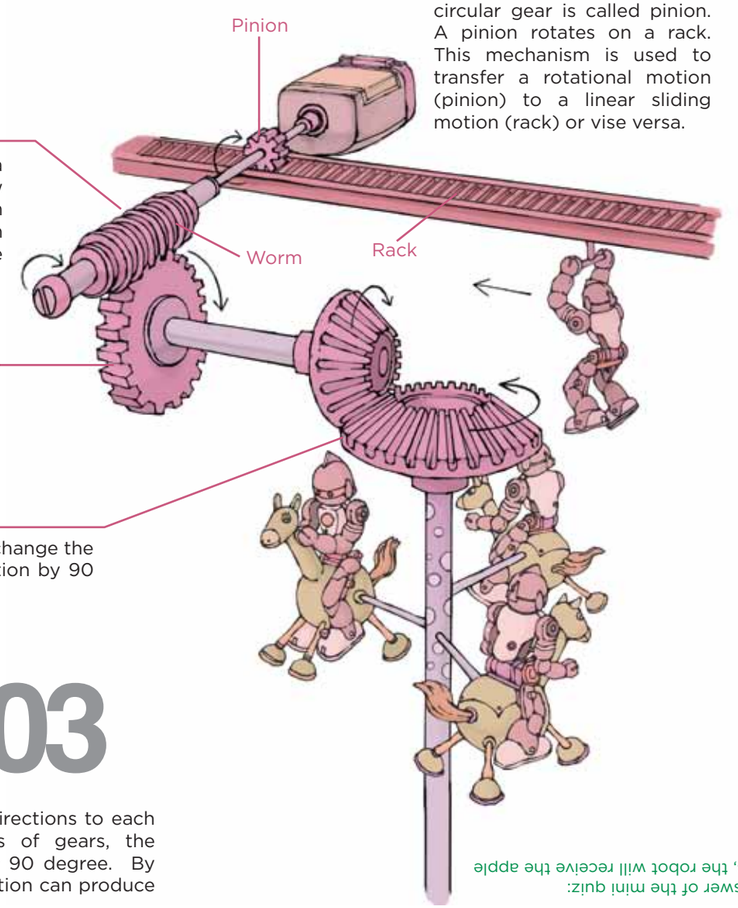


•Rack and Pinion

A rack is a linear gear bar. A circular gear is called pinion. A pinion rotates on a rack. This mechanism is used to transfer a rotational motion (pinion) to a linear sliding motion (rack) or vise versa.

•Worm Gear

Worm gear is an assembly consists of a worm and a worm wheel. Worm's screw like thread rotates the worm wheel. Worm gear can shift the direction of the rotation by 90 degree. It is useful to reduce the rotational speed by large amount.



•Bevel Gear

Bevel gears can change the direction of rotation by 90 degree.

Gears, belts, and chains - Importance 03

•Change rotational directions

Adjacent gears usually rotate opposite directions to each other. However, choosing right types of gears, the rotational directions can be changed by 90 degree. By arranging special gears, one motor's rotation can produce motion in a variety of directions.

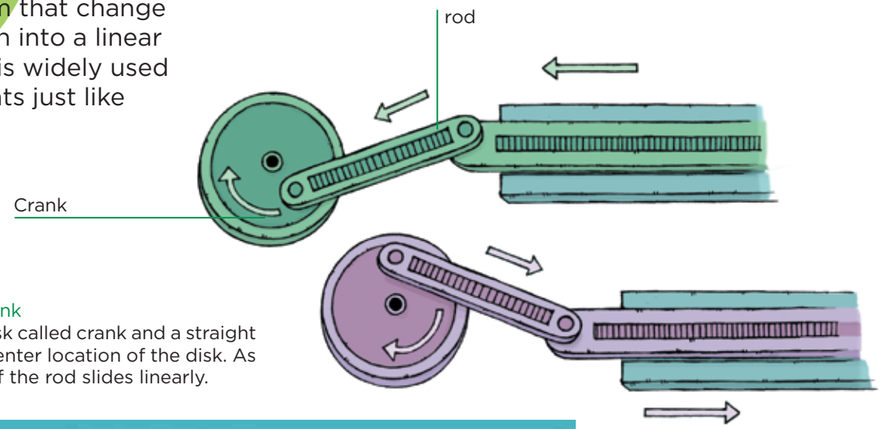
Answer of the mini quiz:
Yes, the robot will receive the apple

MECHANISM OF MACHINES MASTER CLASS

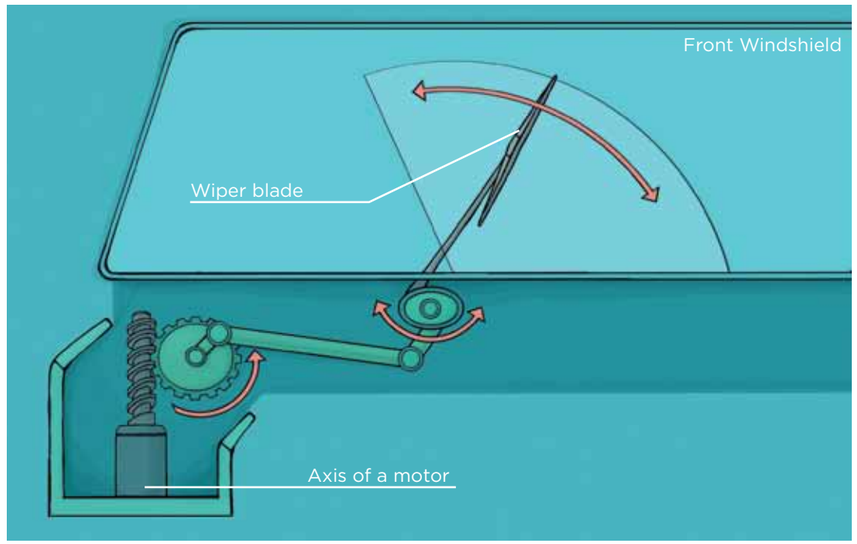
CRANK

-TRANSFER ROTATIONAL MOTION TO LINEAR MOTION-

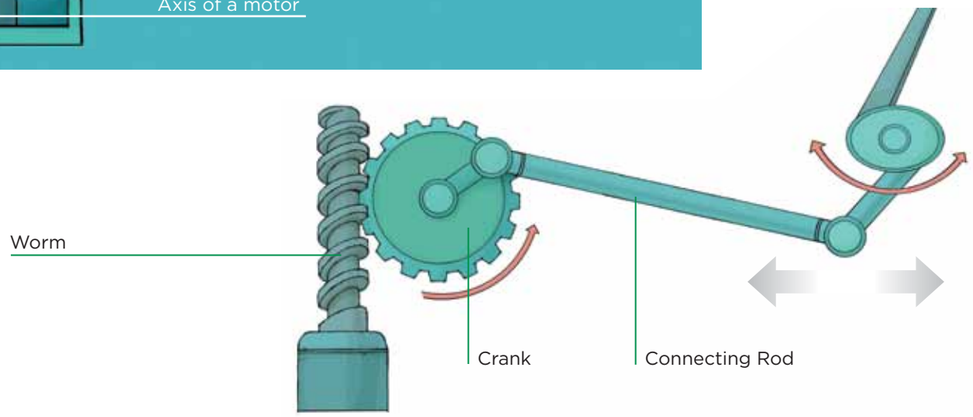
A crank is a system that change a rotational motion into a linear sliding motion. It is widely used in many equipments just like gears and belts.



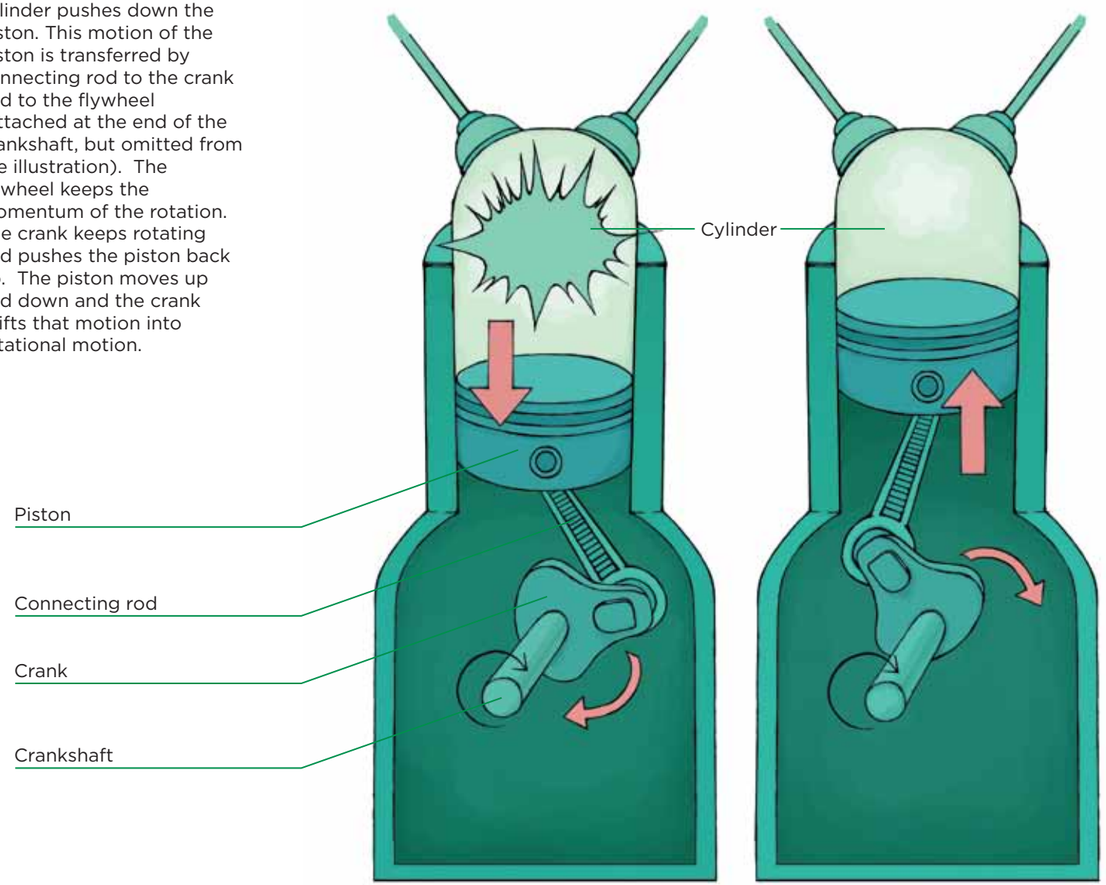
•Basic structure of a crank
A crank has a circular disk called crank and a straight rod attached at an off center location of the disk. As crank rotates, the end of the rod slides linearly.



•Windshield Wiper
Windshield wiper of a car uses a crank to change rotational power of a motor to sliding motion so that the wiper blades move side to side on a windshield.



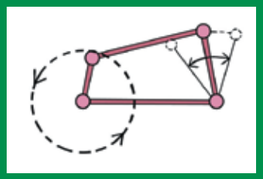
• Crank of a Car Engine
A gasoline explosion in a cylinder pushes down the piston. This motion of the piston is transferred by connecting rod to the crank and to the flywheel (attached at the end of the crankshaft, but omitted from the illustration). The flywheel keeps the momentum of the rotation. The crank keeps rotating and pushes the piston back up. The piston moves up and down and the crank shifts that motion into rotational motion.



Various Linkage

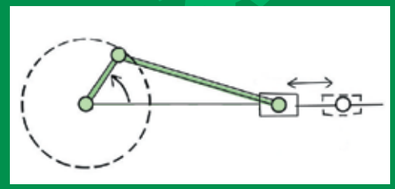
There are various linkage technics to power one part of the system and move other parts in different patterns. There are many more technics other than the examples of windshield wipers and car engines.

Four Bar Linkage with Crank



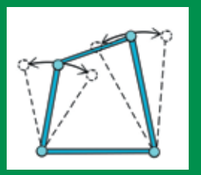
Combining a crank and a four bar linkage, a rotational motion can be changed into a side to side fanning motion or vice versa.

Crank Slider Mechanism



Combining a crank and a slider, a rotational motion can be changed into linear sliding motion or vice versa.

Four Bar Linkage



Joining four bars and form a loop, one side to side motion can be changed to another side to side motion.

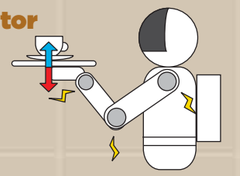
Mechanism in State-of-the-Art Robots

Co-Bot uses gears to transfer the rotational power of a motor to arms and legs. Let's explore some of the mechanism used in the other robots.

Robots powered by Servomotor

What is a Servomotor?

A servomotor uses computerized feed back system so that it provides more precise control. A servomotor makes it possible for robots to stop the motion at a desired position, to produces quick and compact movements, and to operate with less noise.



When the weight of the cup pushes downward, the servomotor senses the force and push it up with equal amount of counter force. The robot can keep the posture stable.

Robotic Suit: HAL-5

- Height: 160cm / Weight: 23kg
- CYBERDYNE Corporation

A collaboration of a human and machine, HAL-5 is a type of cyborg. The suit reads the neural signal through muscle system of the wearer. It was developed to assist the daily activities of people with health problems or injuries. The weight of the suit is supported by HAL-5 itself so that the wearer do not feel the weight of the suit.

WL-16R III

- Height: 128cm
- weight: 76kg
- Waseda University
- Department of Mechanical Engineering
- Atsuo Takanishi Lab
- Temzak Corporation

It carries people and walks with two legs. It can be operated like a car as well. Can be used outdoor and supports up to 94kg.

KHR-2 HV (A-624 Genex)

- Height: appr.34cm / Weight: appr.1.3kg
- Kondo Technology Corporation

This is not a working robot. It was developed for the purpose of study, play, and competition entry. It is affordable for normal people and a very friendly robot.

ASIMO

- Height: 130cm / Weight: 54kg
- HONDA

One of the well known state-of-the-art robots. ASIMO has been in TV commercials and traveled abroad. ASIMO can recognize human faces, run, and deliver drinks on a tray.

HRP-3 Promet Mk-II

- Height: 160cm / Weight: 68kg
- Kawada Industry

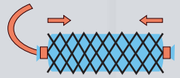
This is a robot that can work with humans. He can walk on slippery surfaces and work in light rain with no problem. The stylish design is also attractive. He holds a power tool in his hand.

Air Pressured Artificial Muscle, "Muscle Suit"

What is an Air Pressured Artificial Muscle?

An Air Pressured Artificial Muscle uses air pressure in its mechanism. It is made of rubber tubes encapsulated inside woven sleeves made from inflexible material. When the rubber tube inflates, the woven sleeve becomes fatter and shorter. Its softer material makes it possible for a wearer to move with more freedom compared to a metallic suit.

Relaxed in normal state...



When it's inflated, crates compression force in the direction of its length.

Muscle Suit

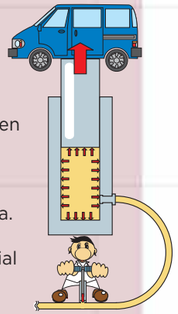
- Tokyo Science University Dept. of Mechanical Engineering Kobayashi Lab

Muscle suit was developed to assist people as well. It is light weight and worn only on the upper body.

Hydraulic System "T-53 Enryu"

What is a Hydraulic System?

A hydraulic system utilizes the power of fluid (oil) pressure. When two different size pistons are connected, the larger diameter piston will exert a greater force because of the larger surface area. The popularity of hydraulic machinery is due to the substantial amount of power that can be transferred through small tubes.



T-53 Enryu

- Height: 2.8m
- Weight: 2950kg
- Temzak Corporation

Because of its great power, it works best for reconnaissance missions at disaster sites. It can lift 100kg with one arm. It also moves around well with its caterpillar leg in rugged terrain.

▲ T-53 demonstrating moving a drum can.

Troubleshooting Q&A

If there is any trouble during the operation, turn the power switch off first.
Troubleshooting with power on may cause injury or damage the product.

Q

It does not stand up after falling...

A

Find a similar symptom from the following.

- **Arms do not move.**

  The shoulder rod may be dislocated and gears may not be engaged properly. Remove the back, fix the problem and re-install the back

Arms stop rotating due to shoulder axis dislocation

Use thumb and press the rod firmly in place

- **Stops moving during getting up sequence.**

  The lead wire may be caught on the belly sensor. Take the lead wire off and free the belly sensor. Re-wire the lead wire around only the hip hook without excess wire hanging loose.

Lead wire is caught on belly sensor and sensor doesn't move properly.

Coil the excess wire on the right side peg and keep it away from other moving parts.

- **Co-Bot's action sequence does not change from one motion to another after it falls down.**

  Sensors may not be pressed all the way. Check the sensors function by pressing the sensors by hand.

- **Doesn't stand up but somersaults.**

  Make sure that the leg sensor is placed properly. If it is dislocated, re-install properly.

Q

I would like to change modes, but I cannot take the leg pin off...?

A

Use a coin

Insert a coin between the leg junction and hip part, twist coin and remove the leg. Be sure not to loose the pin.

Q

Co-Bot falls down too easily or does not fall down at all..?

A

Change batteries

Co-Bot is sensitive to the weight of batteries. Its likelihood of falling can be varied by that. Weight of batteries may vary slightly by the brands. As the batteries get older and their power gets weaker, the Co-Bot's motion becomes less vigorous and makes it harder to fall down.

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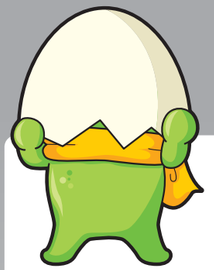

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