

App Inventor with LEGO NXT robot

CAVE Education



- Lego Beyond Toys !

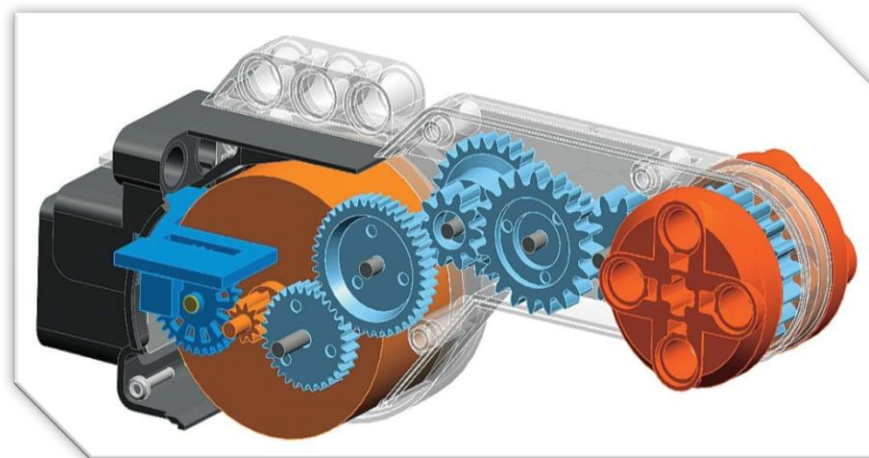
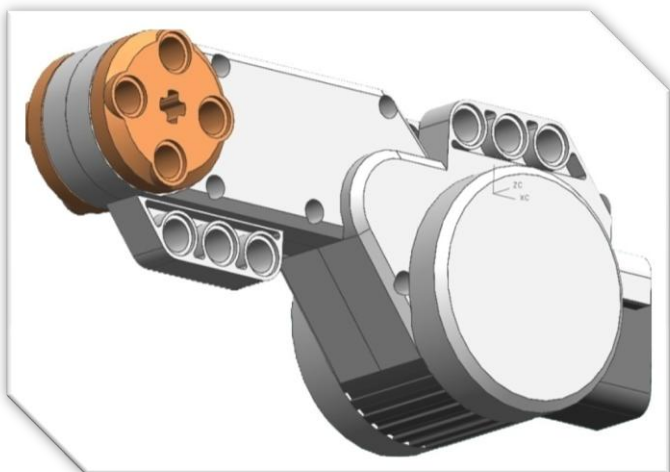


Lego Mindstorms 簡介

電子零件介紹



■ 馬達介紹



特色：

- ▣ 高扭力
- ▣ 內建角度感應器



各式樂高馬達簡介

9 V supply	 2838	 2986	 71427	 43362	 5292
Rotation speed (rotations per minute)	4100 rpm	35 rpm	360 rpm	340 rpm	1300 rpm
No-load current	35 mA	6 mA	3.5 mA	9 mA	160 mA
9 V supply	 47154	 NXT	 PF Medium	 PF XL	 9V Train
Rotation speed (rotations per minute)	460 rpm	170 rpm	405 rpm	220 rpm	2000rpm
No-load current	31 mA	60 mA	65 mA	80 mA	90mA

☐ <http://www.philohome.com>



■ 感應器介紹

觸碰感應器



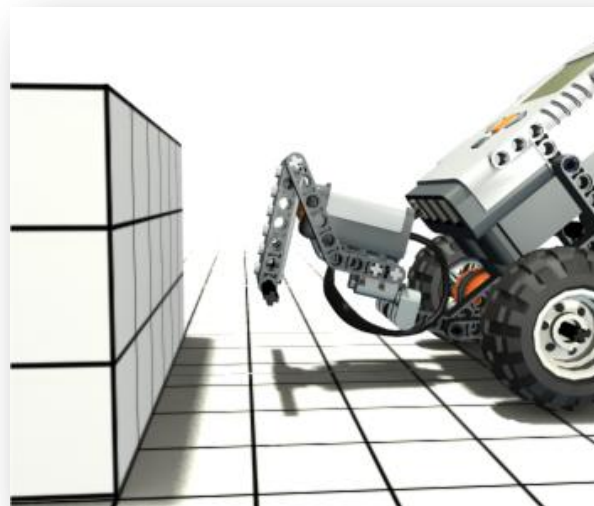
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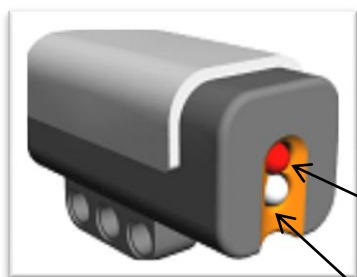
RELEASED



BUMPED

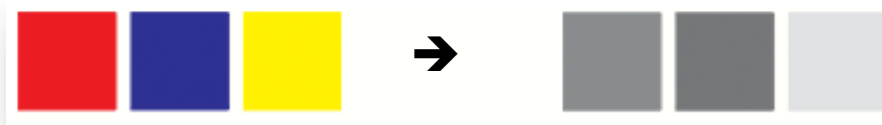


光感應器



phototransistor

LED



偵測顏色表面的光強度



聲音感應器



- ▣ 最高可偵測約90分貝



超音波感應器



- 最遠可偵測約255cm



他牌感應器

 **Hitechnic**



Color Sensor



NXT EOPD



NXT IRSeeker



NXT Compass Sensor

<http://www.hitechnic.com/>

 **Mindsensor** mindsensors.com



Vision Subsystem v3 for NXT



Line Sensor Array

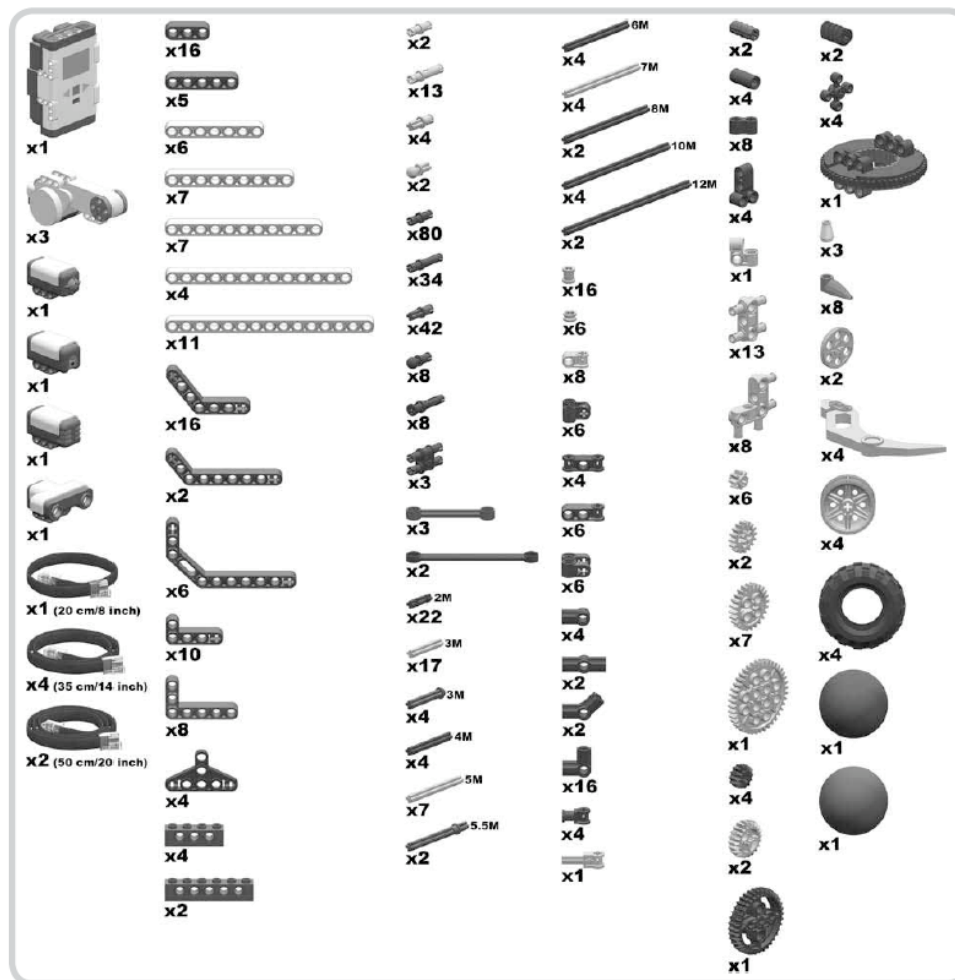


Pneumatic Pressure Sensor

<http://www.mindsensors.com/>



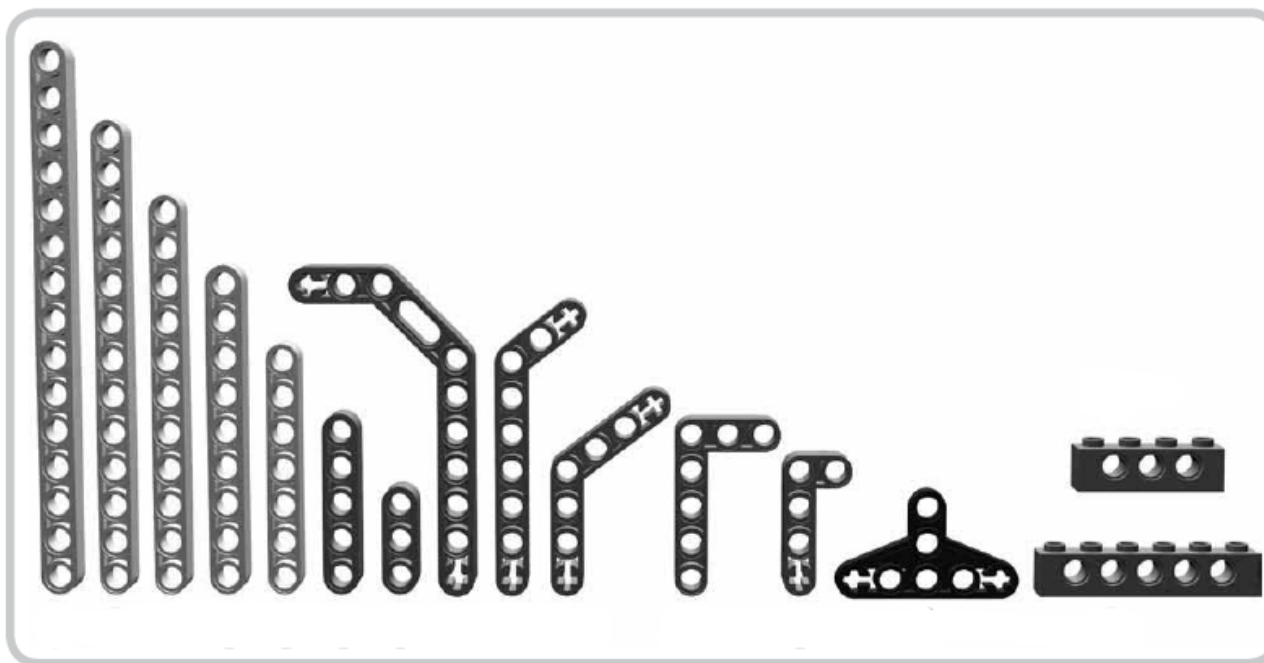
2. 零件的建構

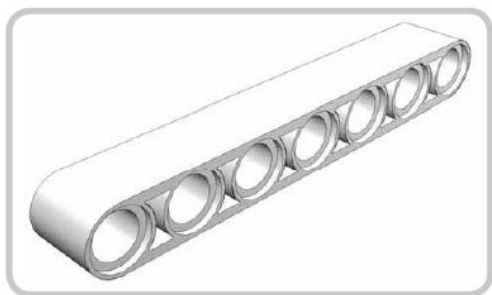


- 連桿
- 連接器
- 齒輪
- 其他

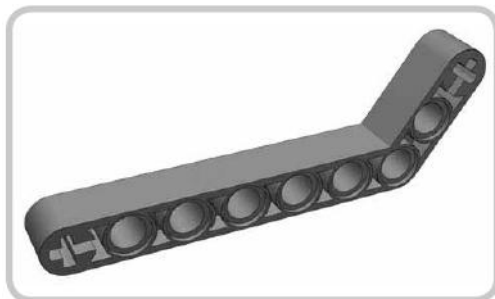


- 連桿 (Beams)





直連桿



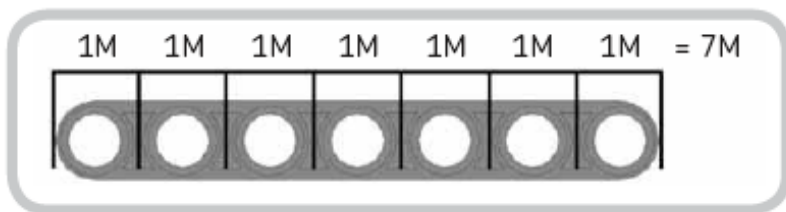
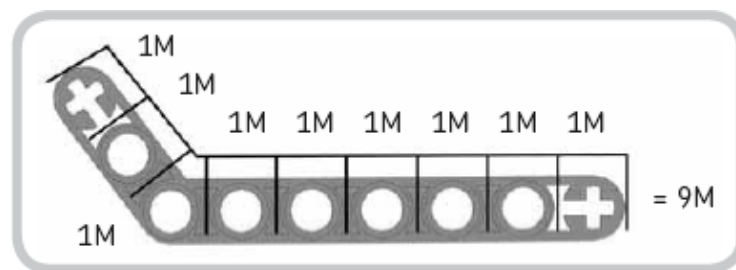
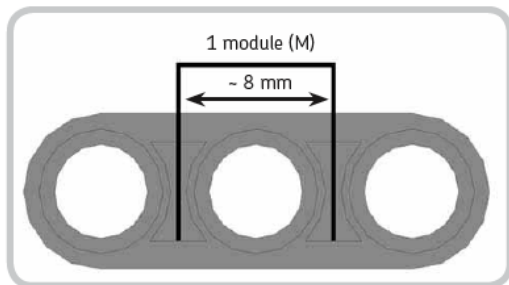
角度連桿



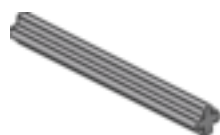
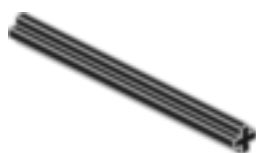
半連桿



樂高單位



軸



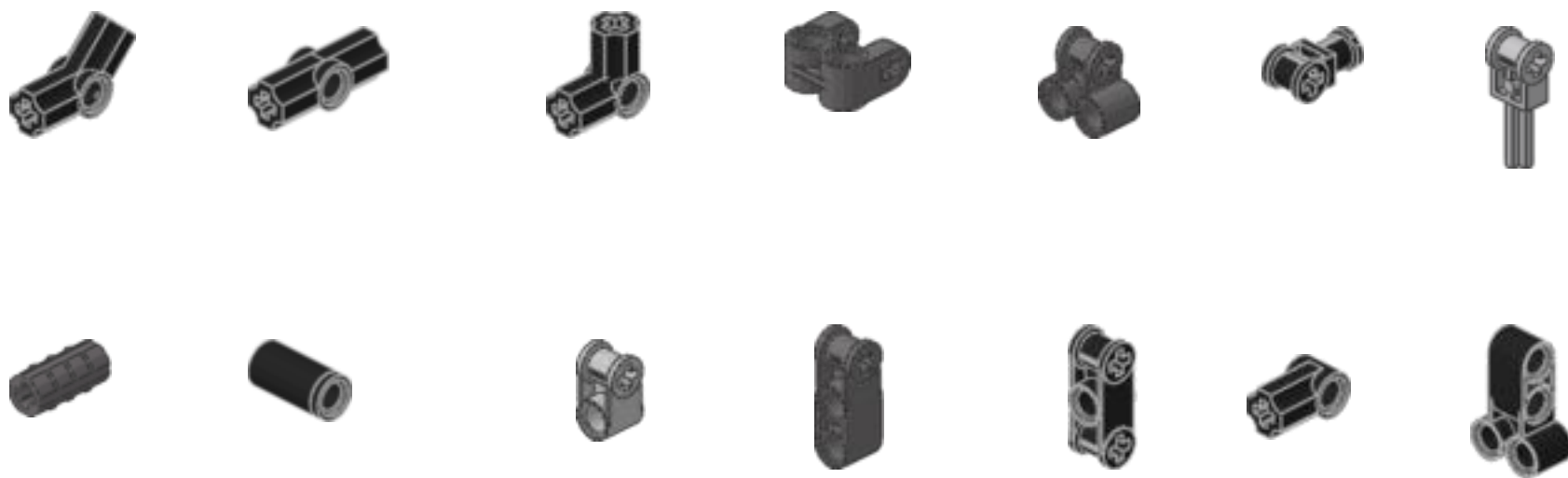
套筒

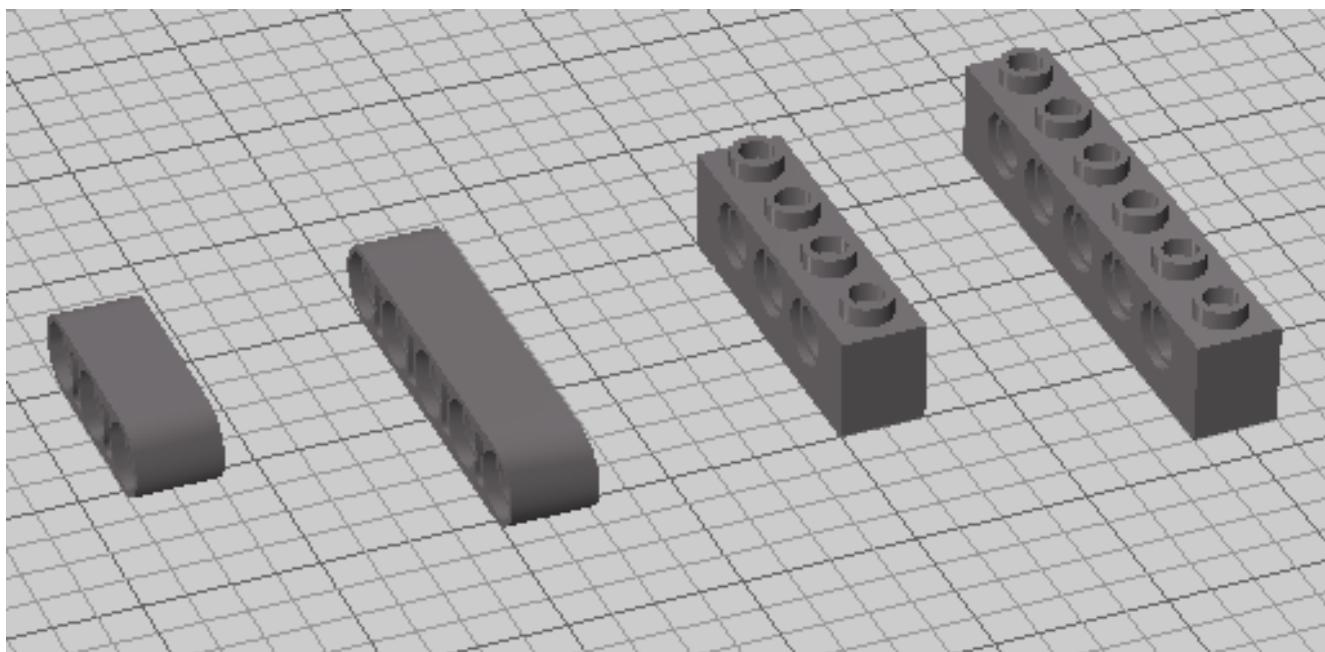


插銷



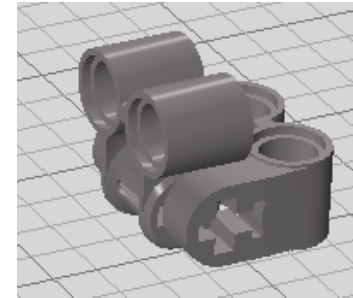
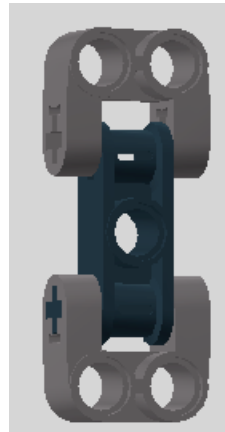
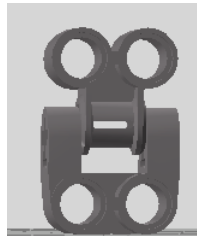
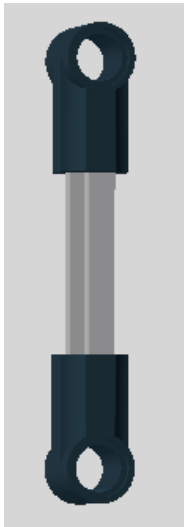
軸連接器及插銷連接器





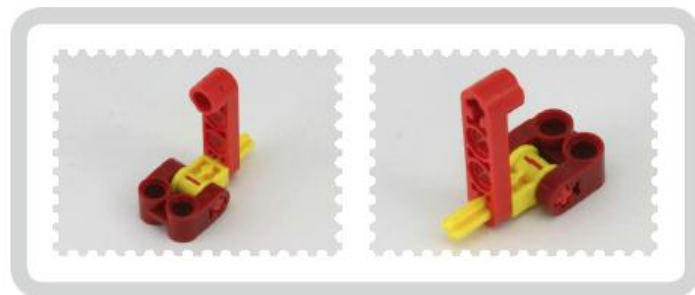
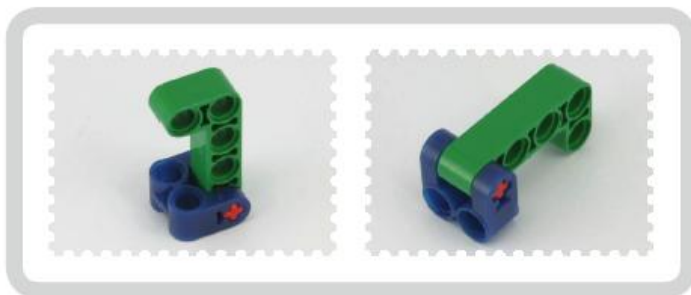
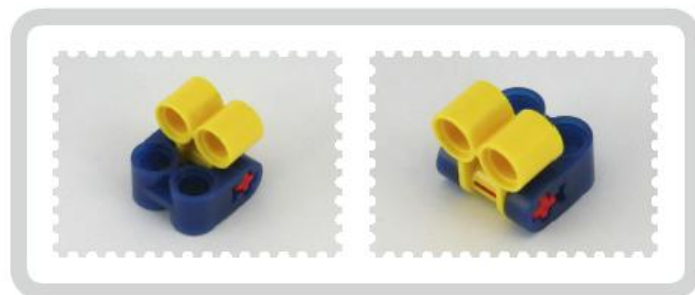
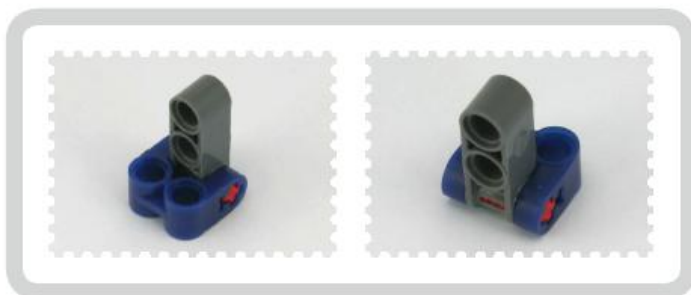
- ▣ 连接器重要性的提昇在於連桿的演變





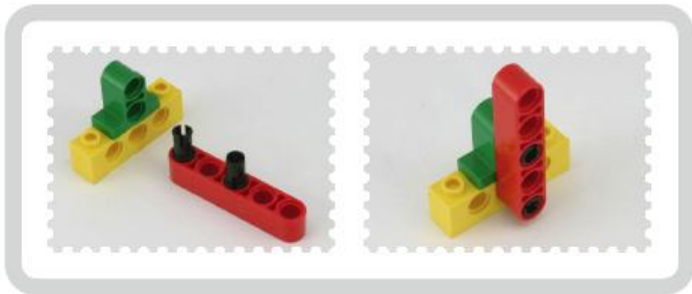
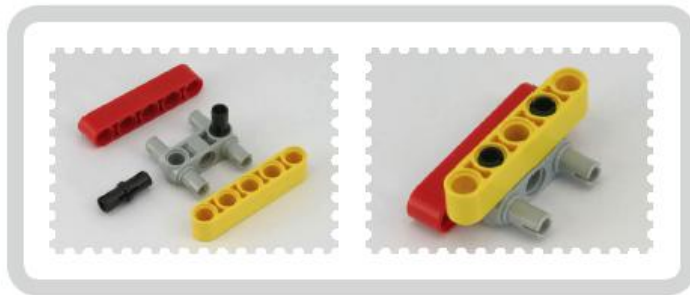
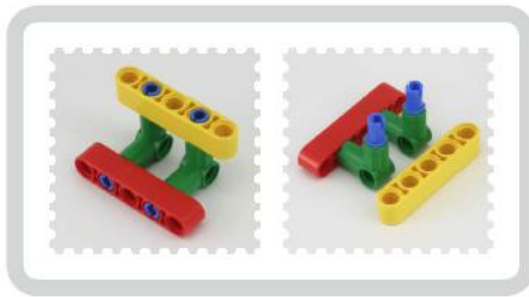
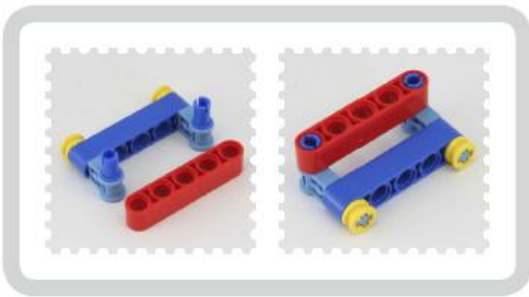
- ▣ 連接器彼此間常用的接合方法

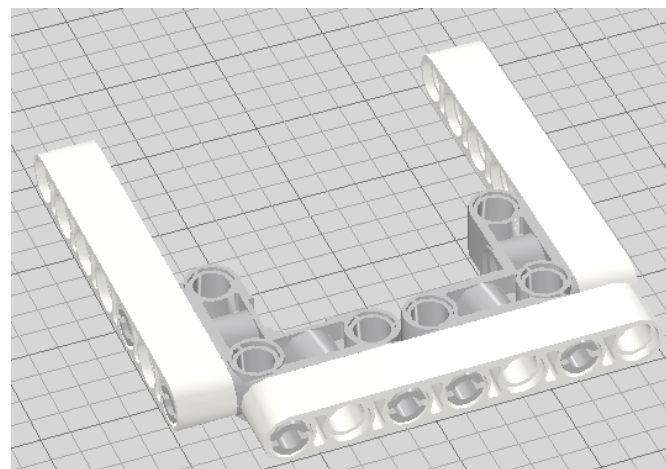
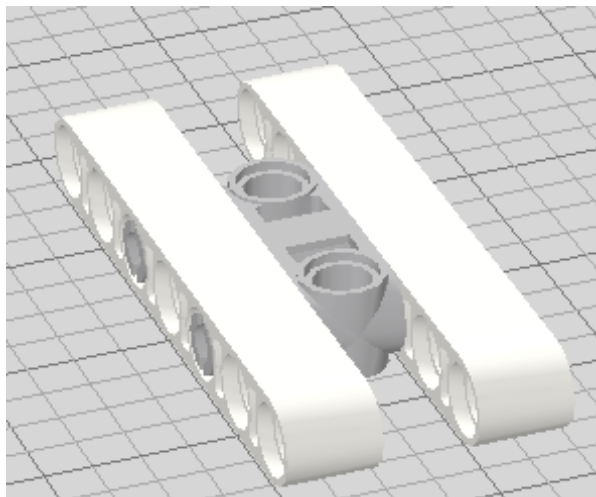




▣ 連接器的功能在於角度的轉換及延長

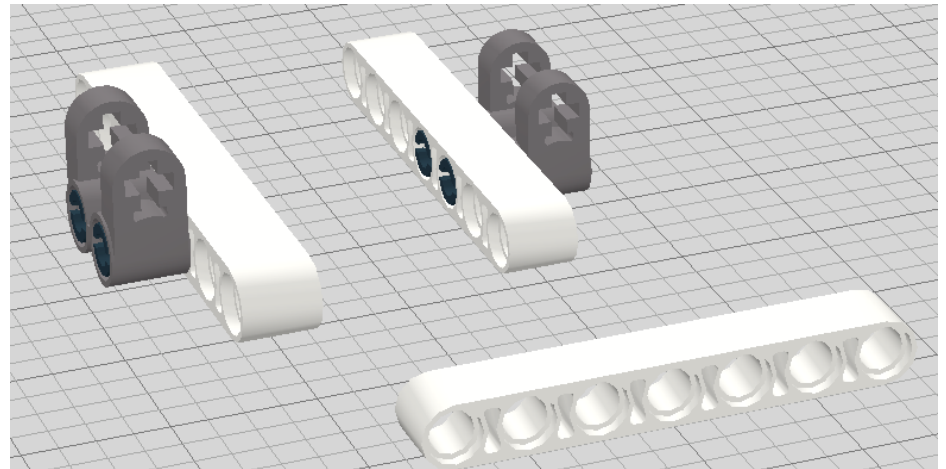
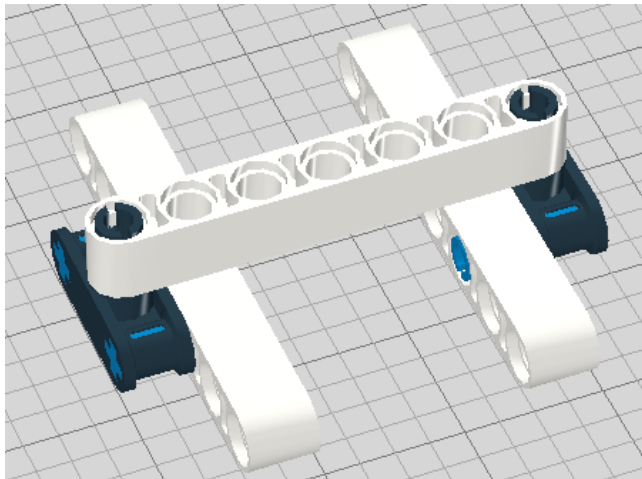


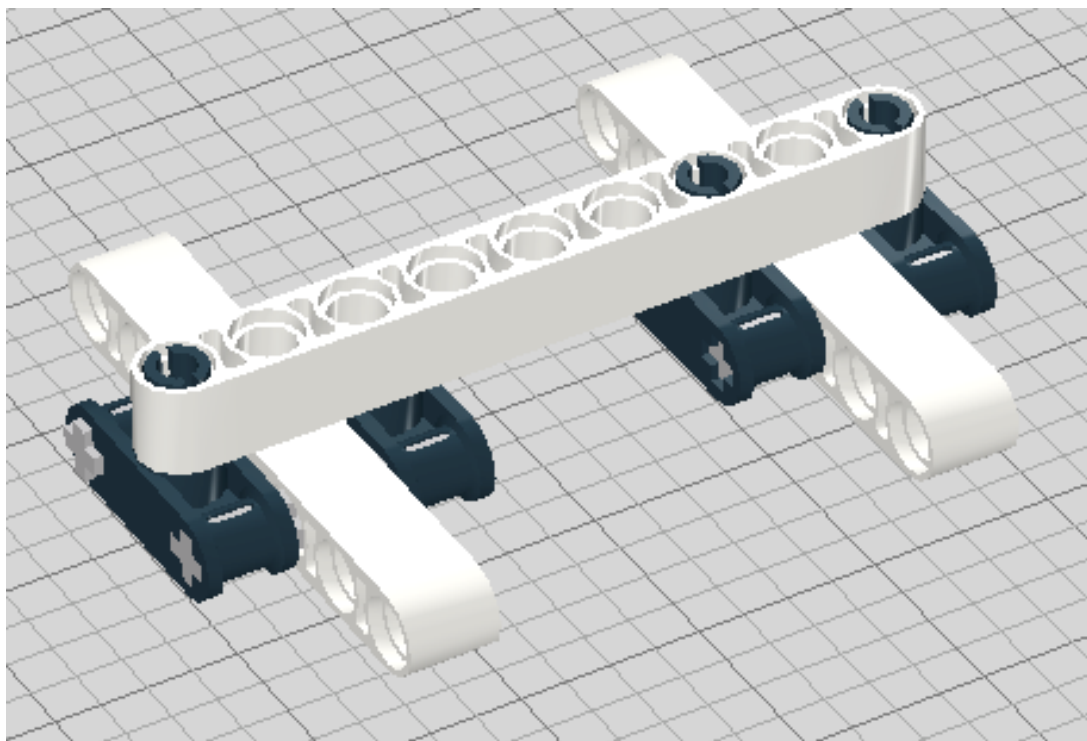




- ▣ 範例：平行連桿的建構





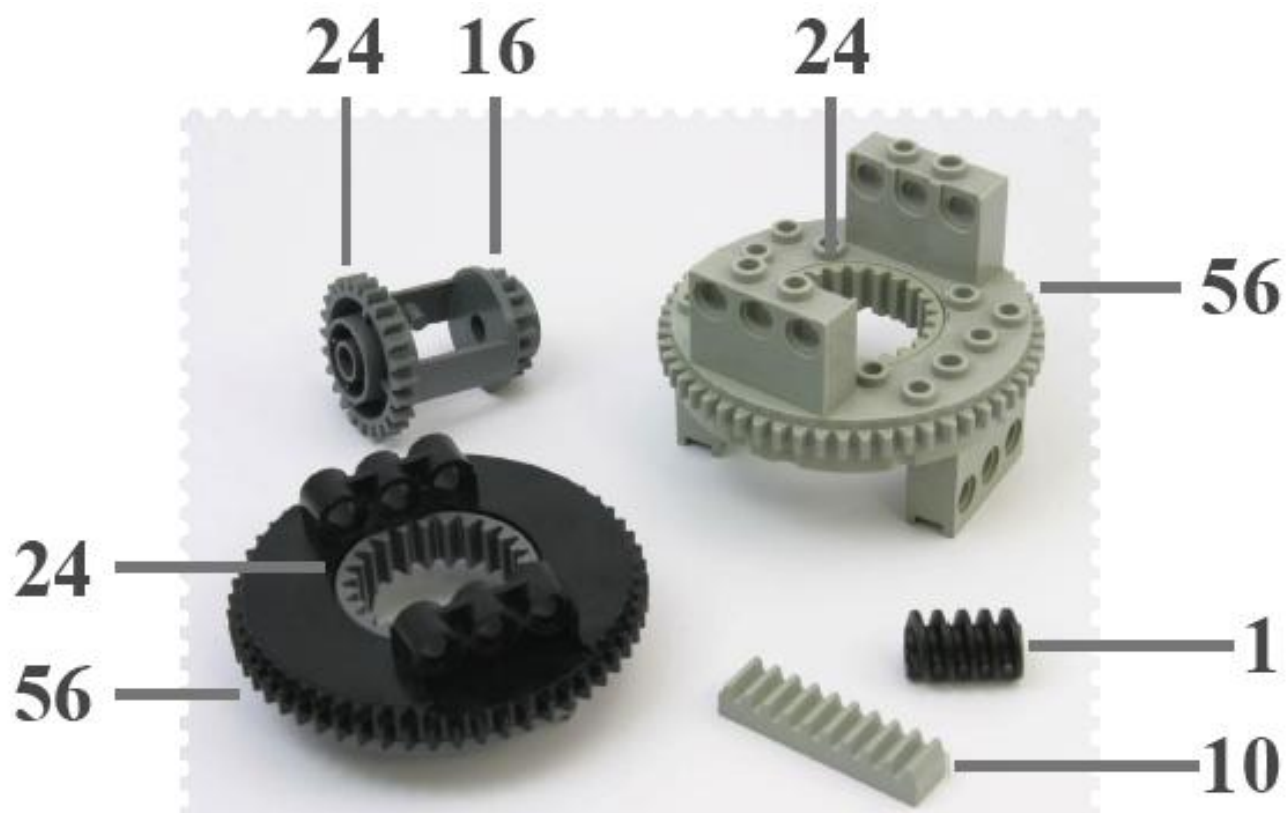


■ 齒輪(Gears)

正齒輪與斜齒輪



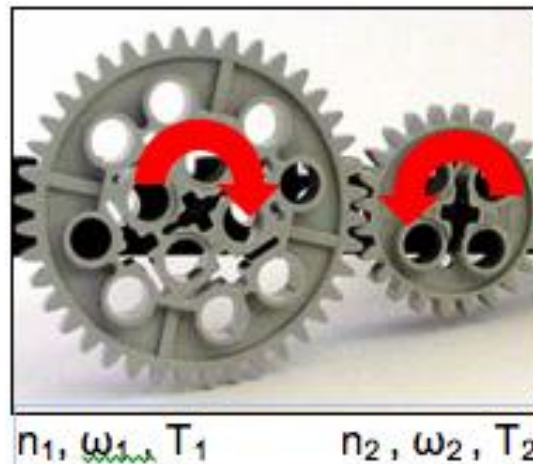
其他齒輪



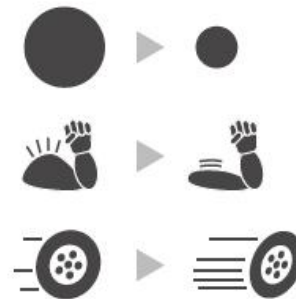
$$n_1\omega_1 = n_2\omega_2$$

$$T_1\omega_1 = T_2\omega_2$$

$$T_1n_2 = T_2n_1$$



改變扭矩



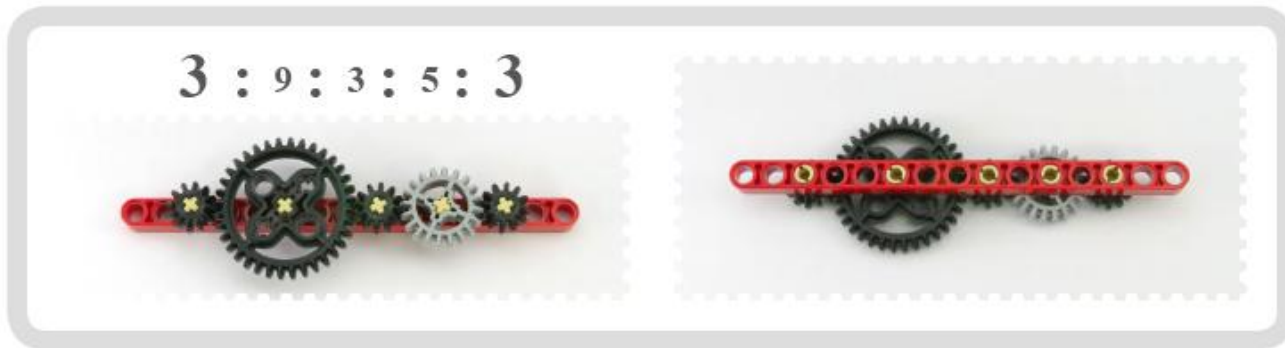
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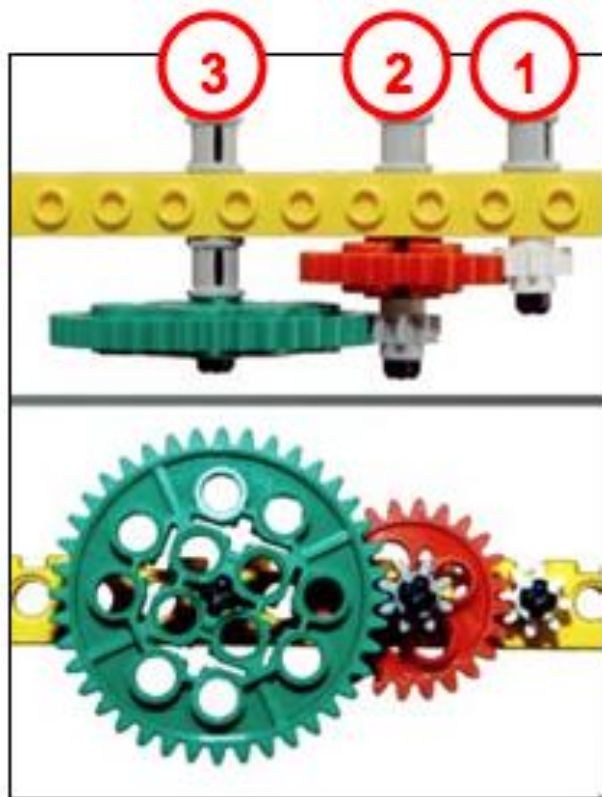
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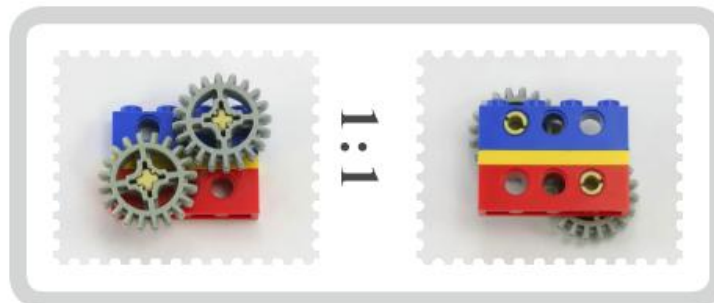
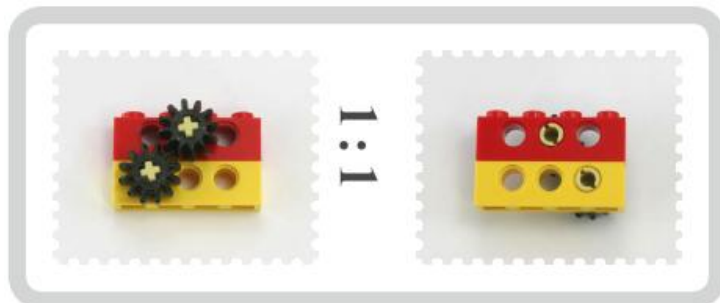
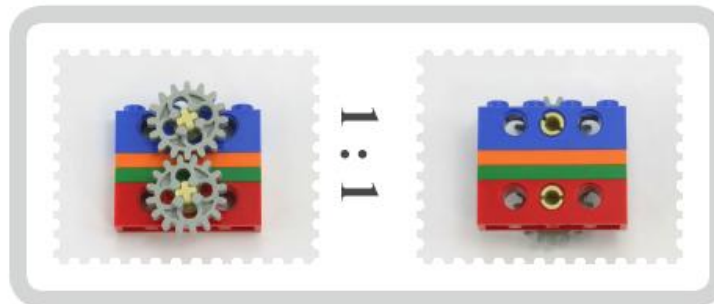
惰輪



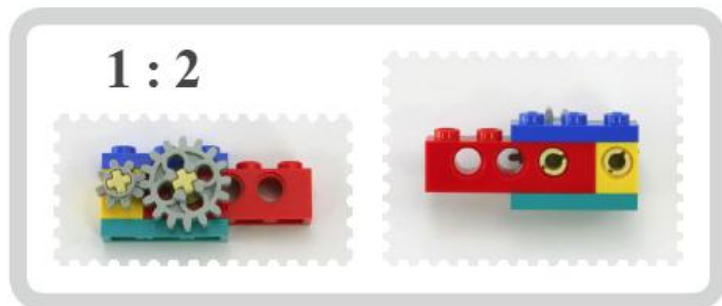
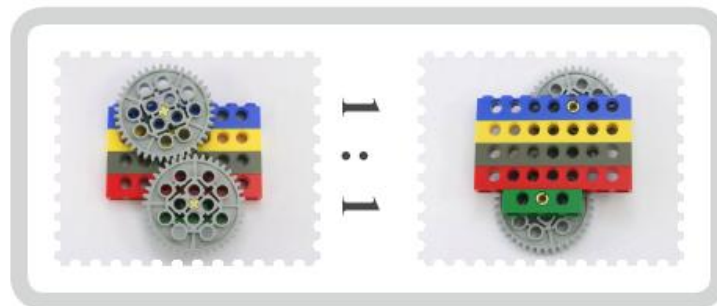
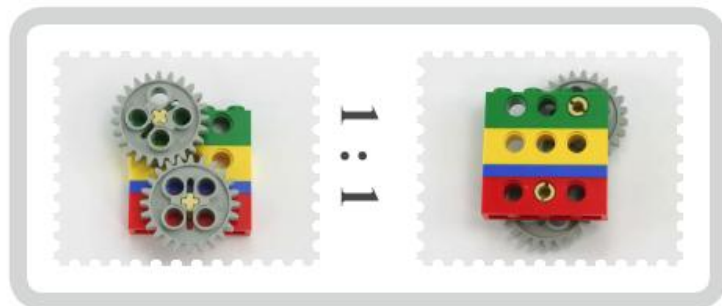
複合齒輪組



斜齒輪與正齒輪的使用



斜齒輪與正齒輪的使用



斜齒輪與正齒輪的使用



1 : 7



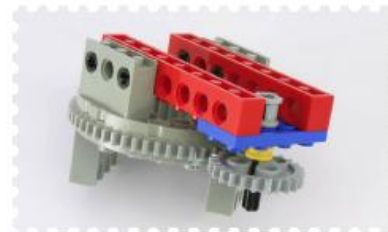
2 : 7



3 : 7



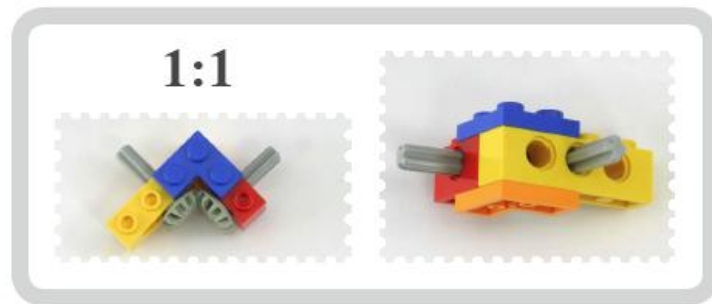
3 : 7



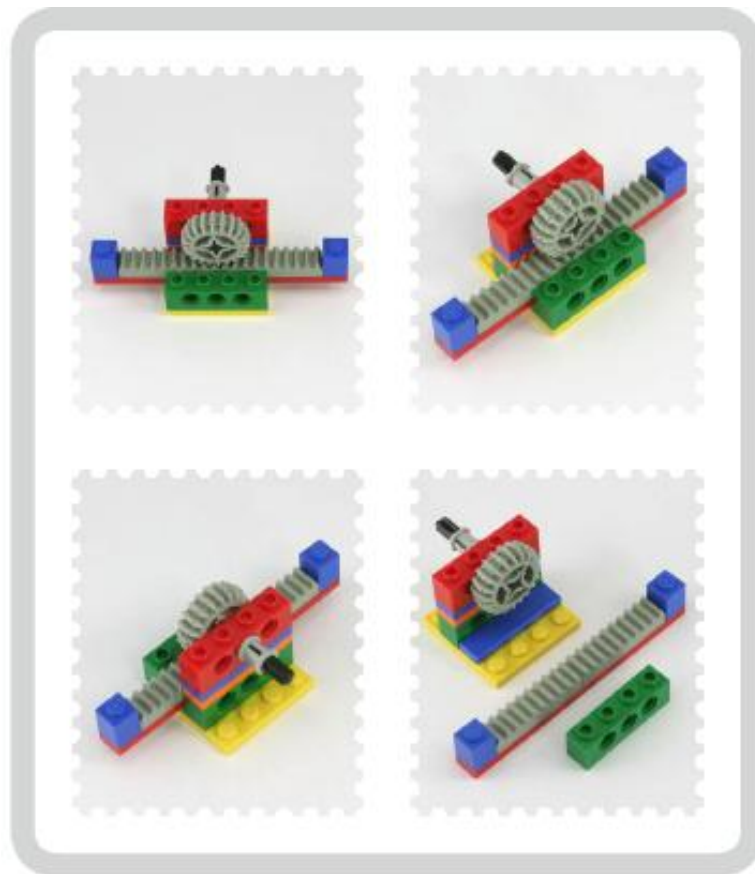
蝸桿的使用



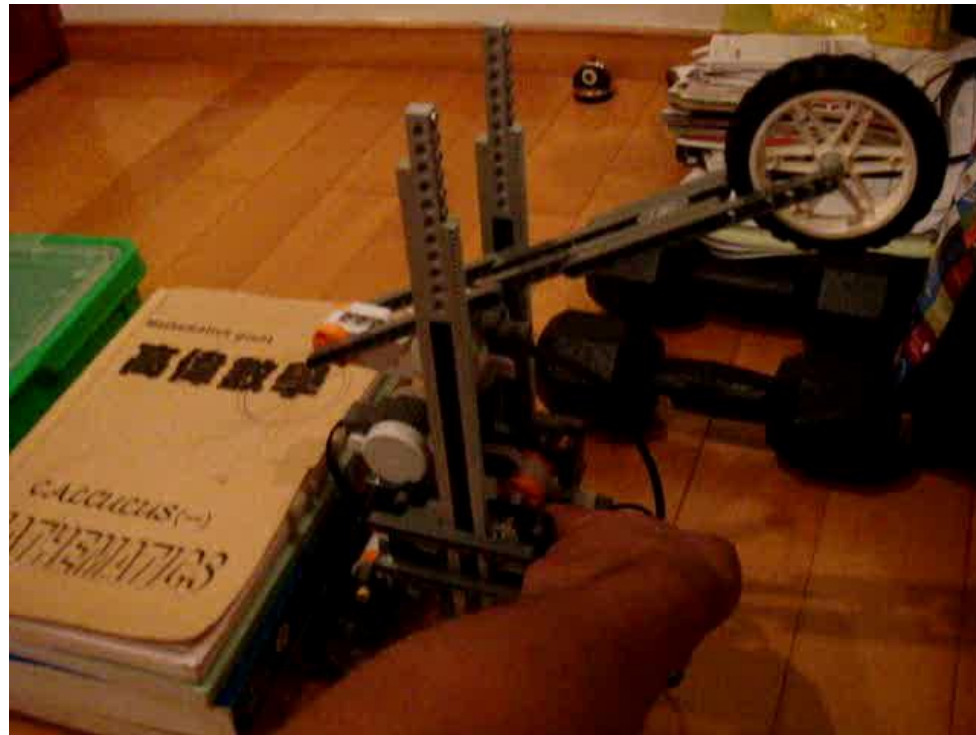
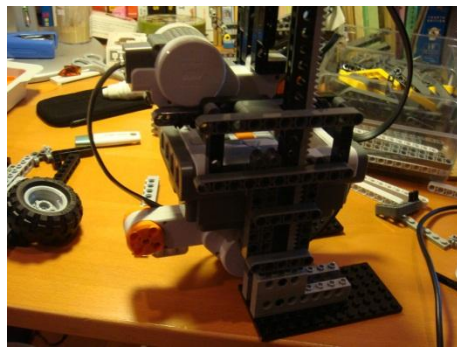
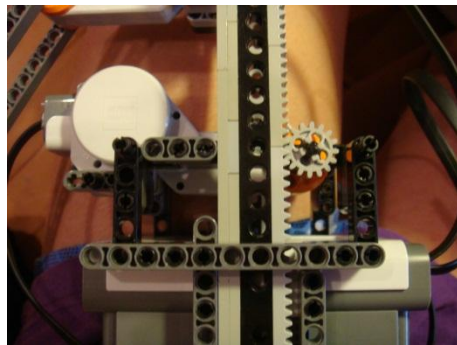
斜齒輪可改變力的方向



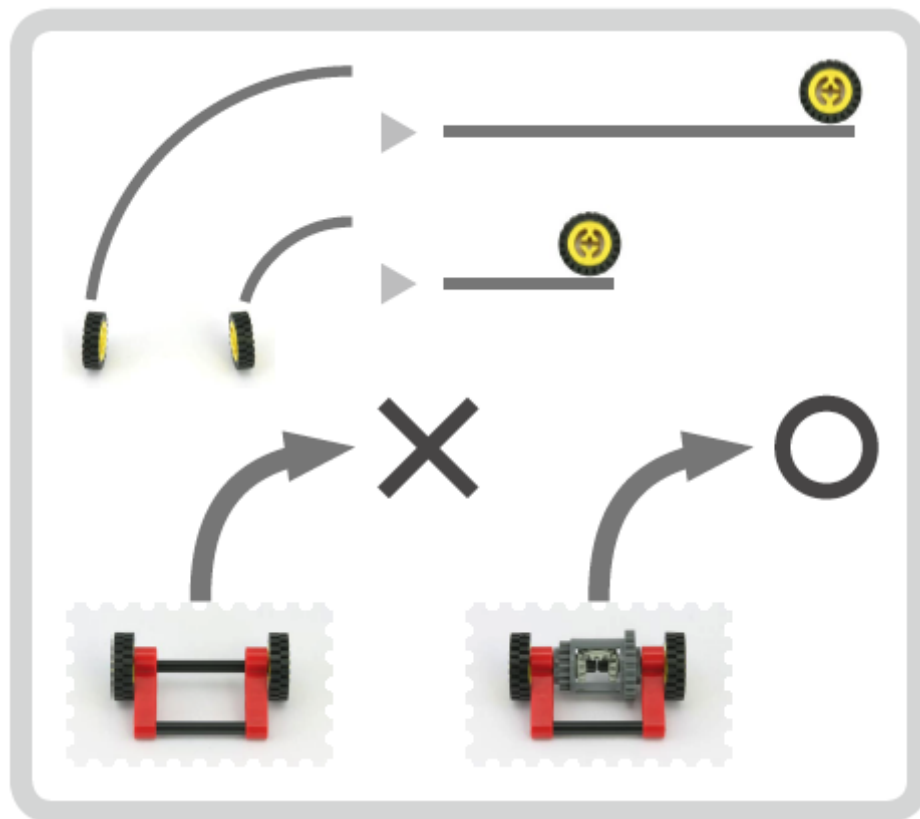
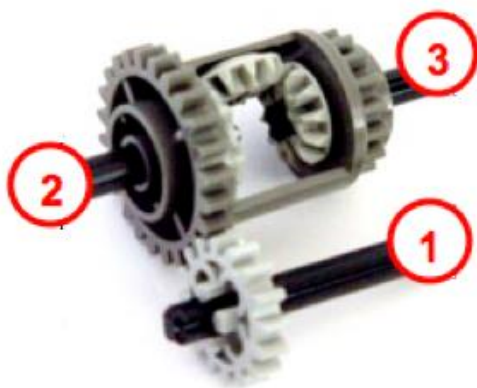
齒條的使用



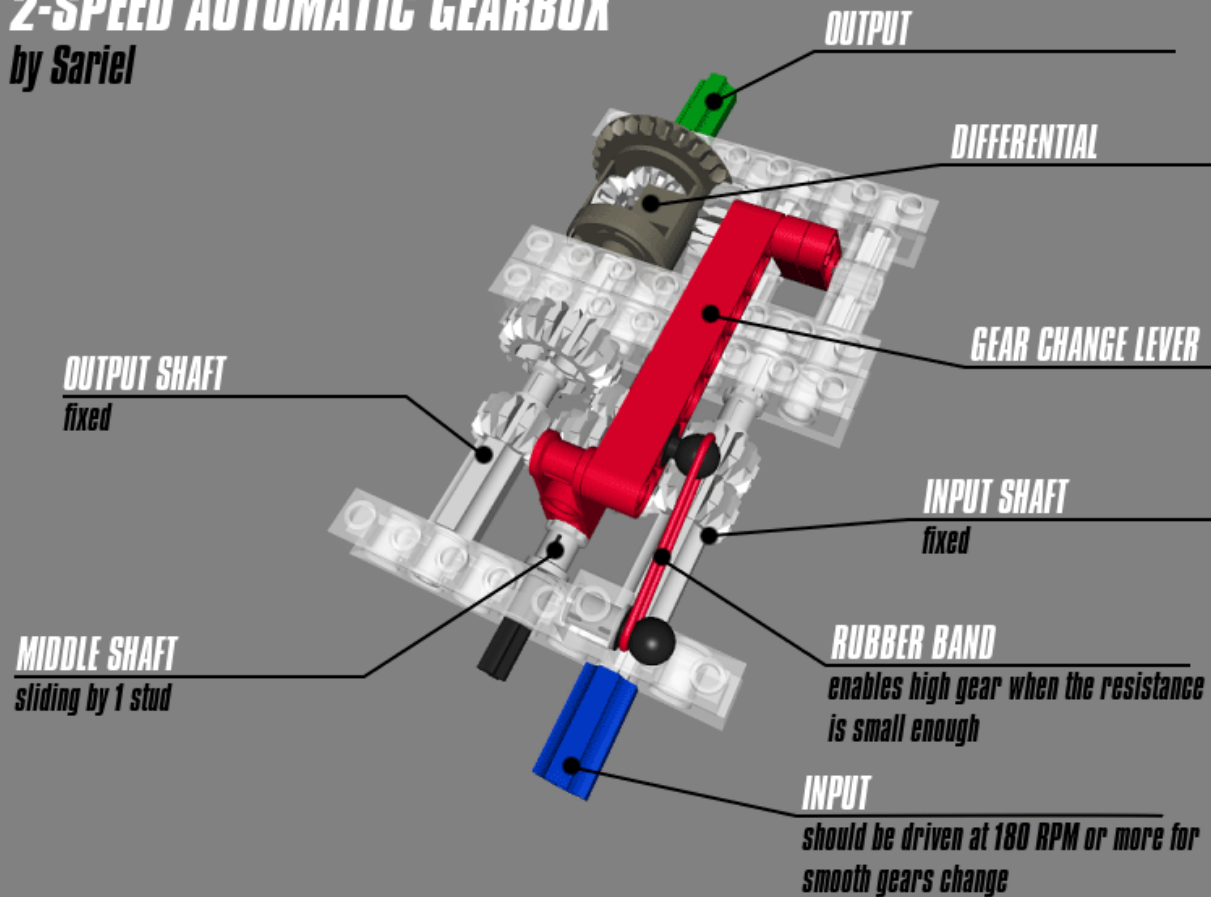
齒條的應用-NXT Climber

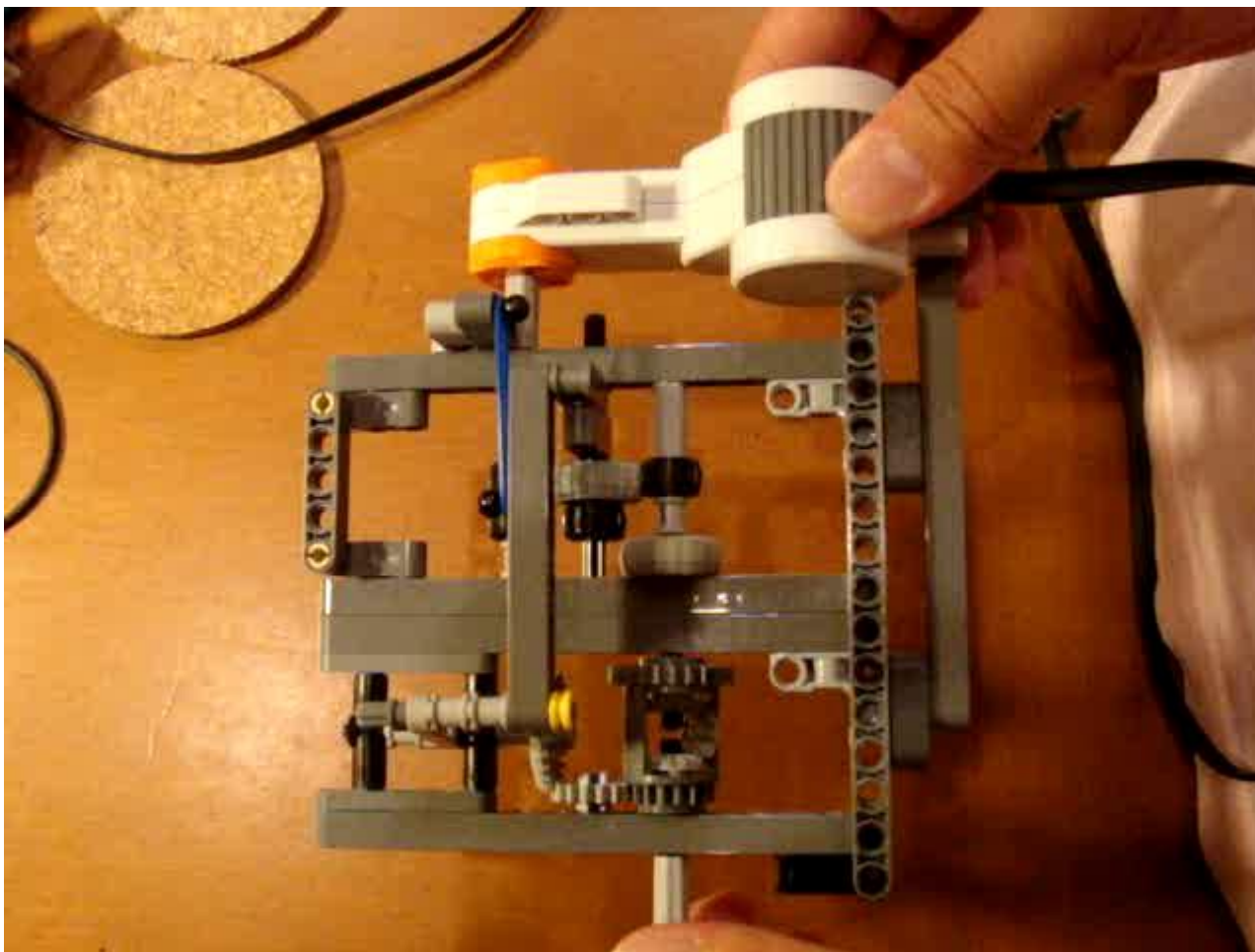


差速器的使用



2-SPEED AUTOMATIC GEARBOX by Sarel



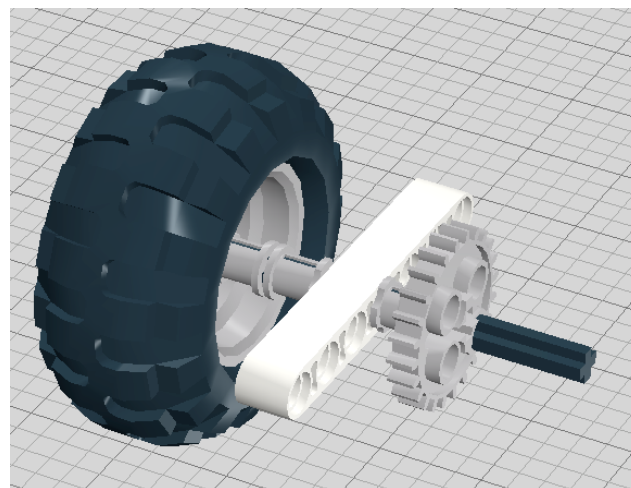
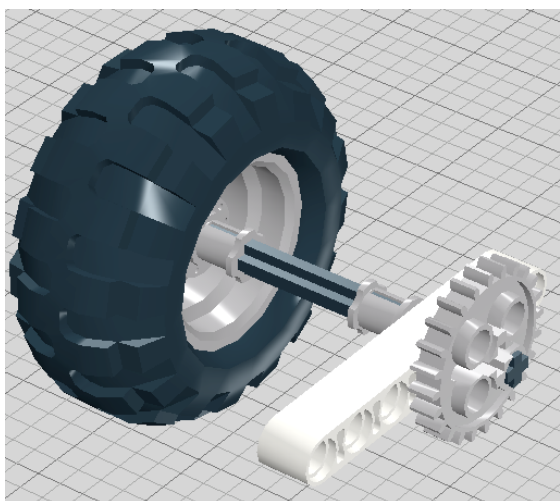


- 其他 (Miscellaneous elements)



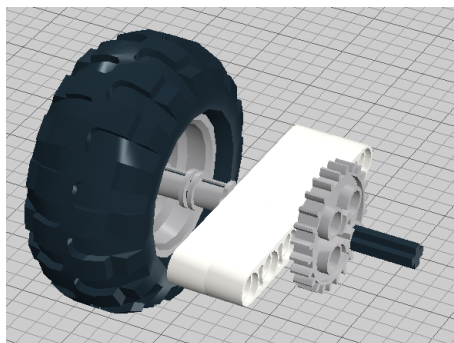
■ 組裝注意事項及範例

更穩固的結構

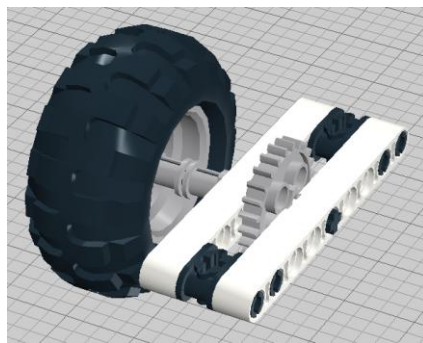
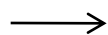


- ▣ 輪子需盡量靠近連桿

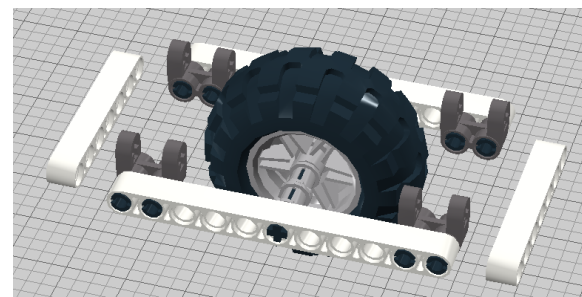
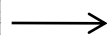




good



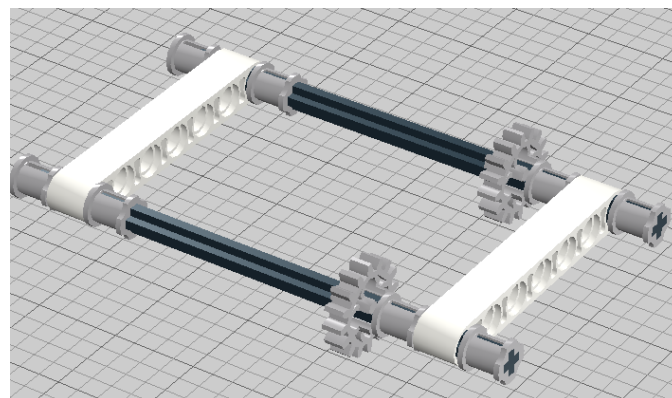
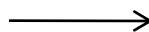
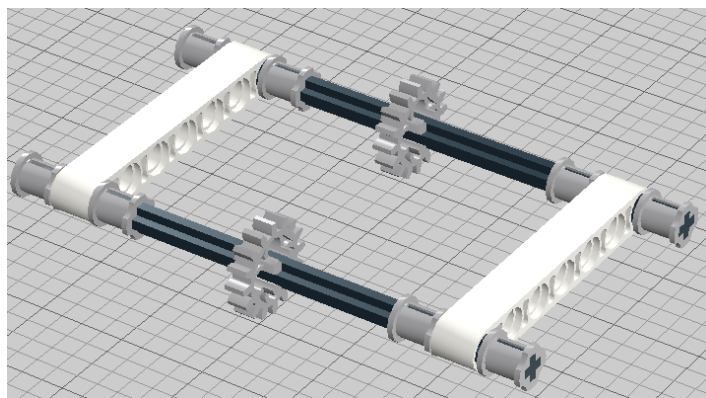
better



best

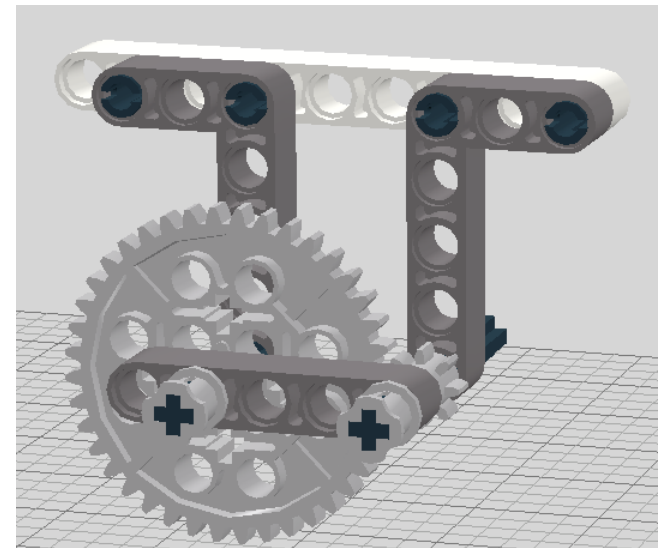
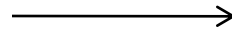
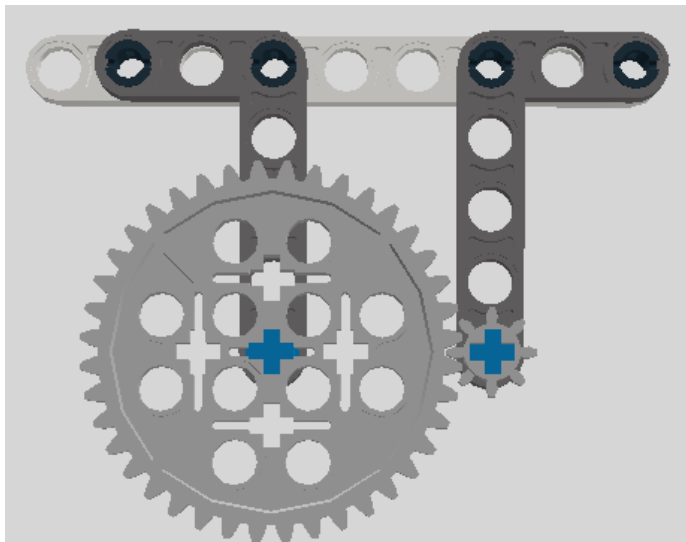
▣ 兩條連桿支撐勝過一條





▣ 齒輪需靠近支撐的連桿

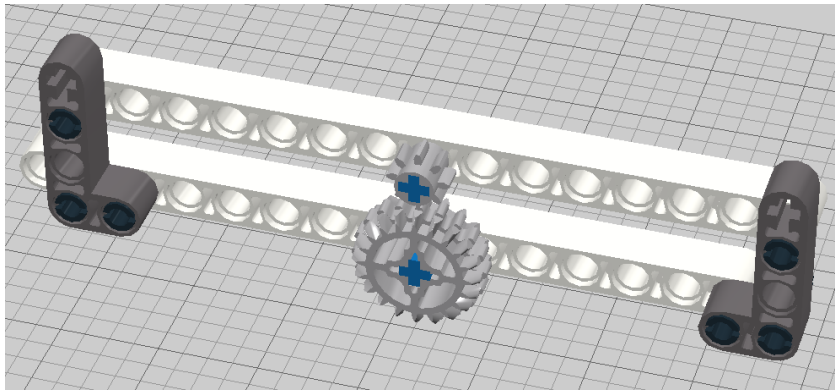




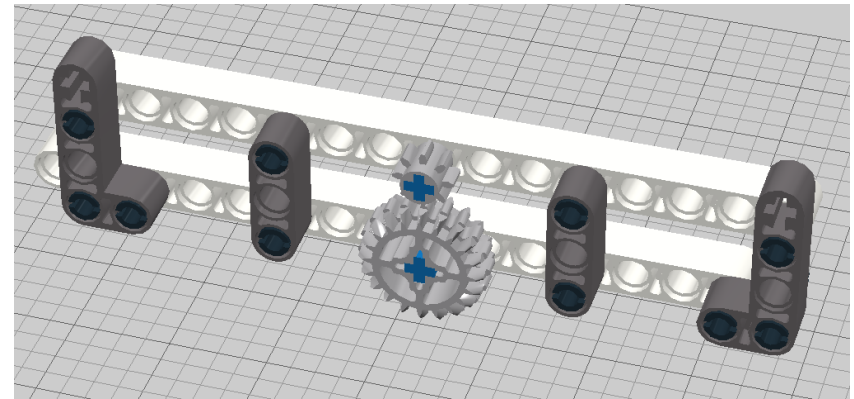
- ▣ 同一列但位處不同連桿的齒輪需外加連桿固定





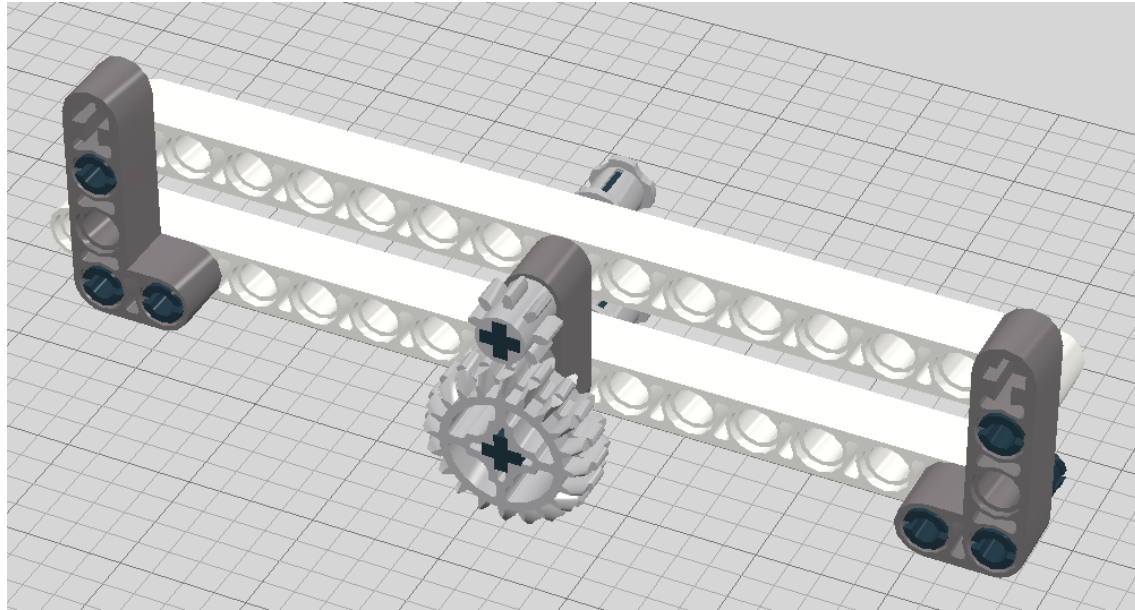


good



better

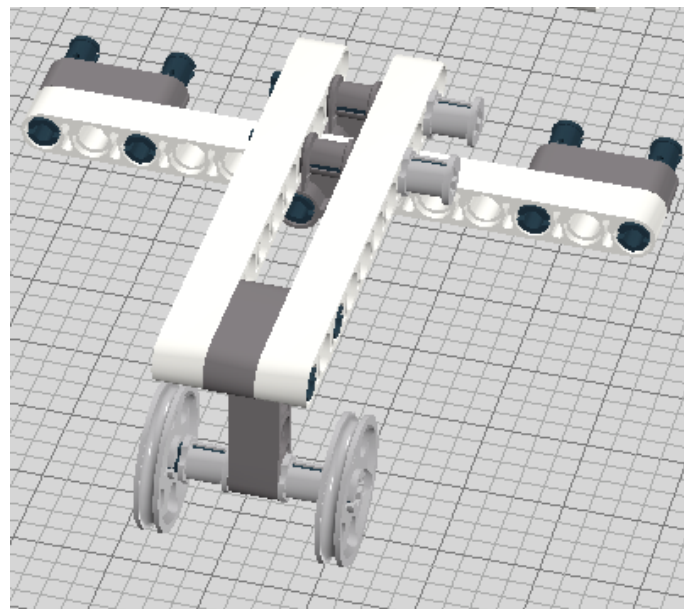
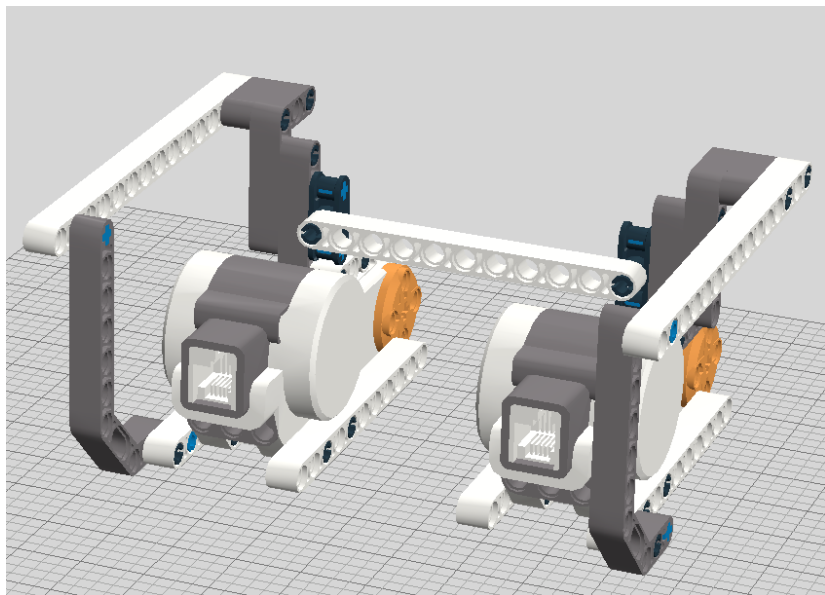


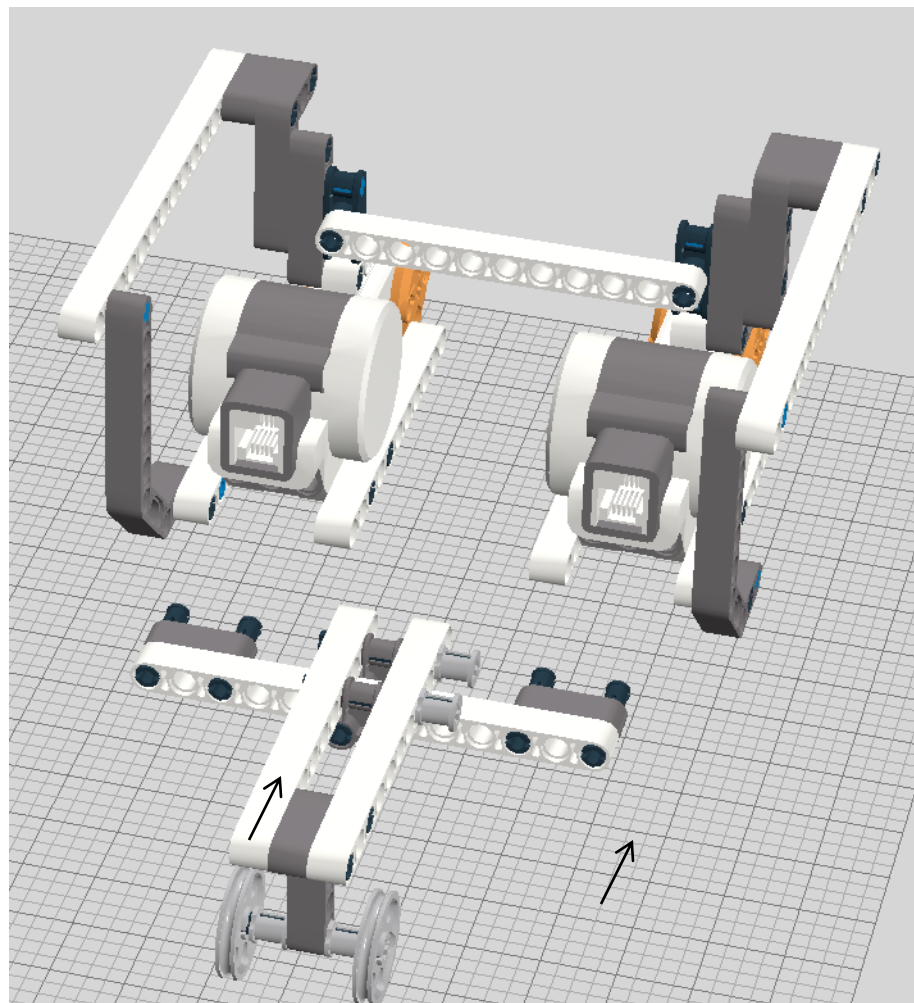


best



- 模組化





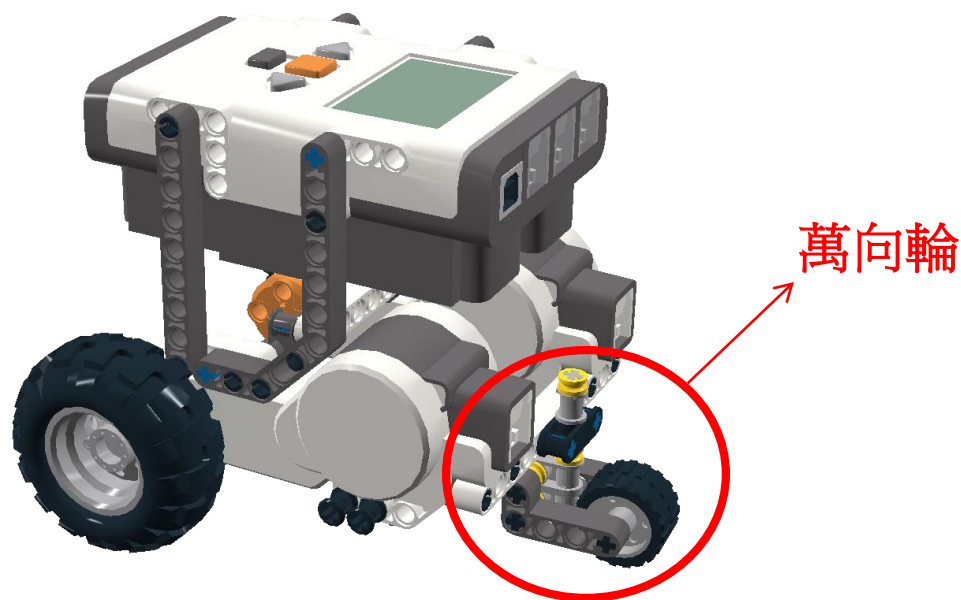
3. 常見車體介紹與實作

- 基本車體
- 連桿式轉向機構
- Synchronized drive
- Omni drive

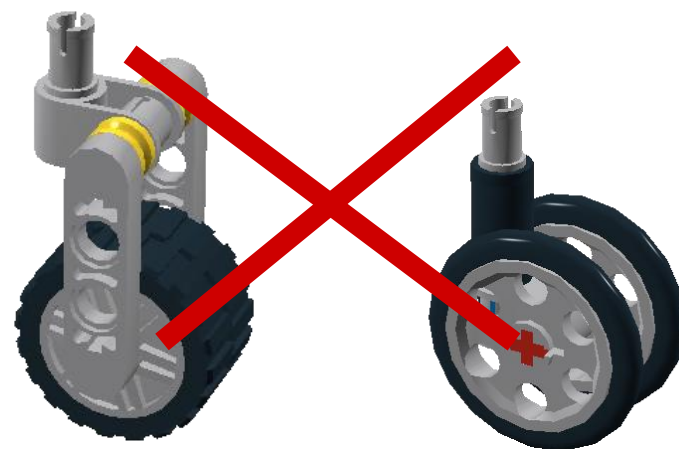
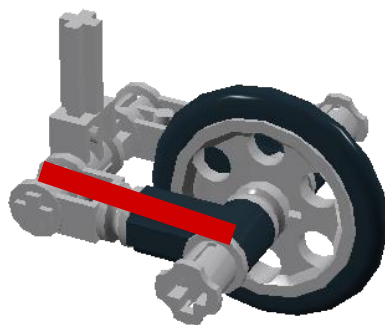
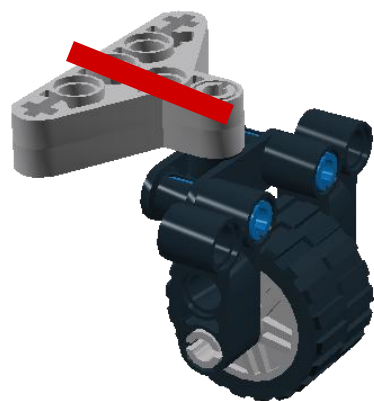


■ 基本車體

兩輪驅動 + 萬向輪



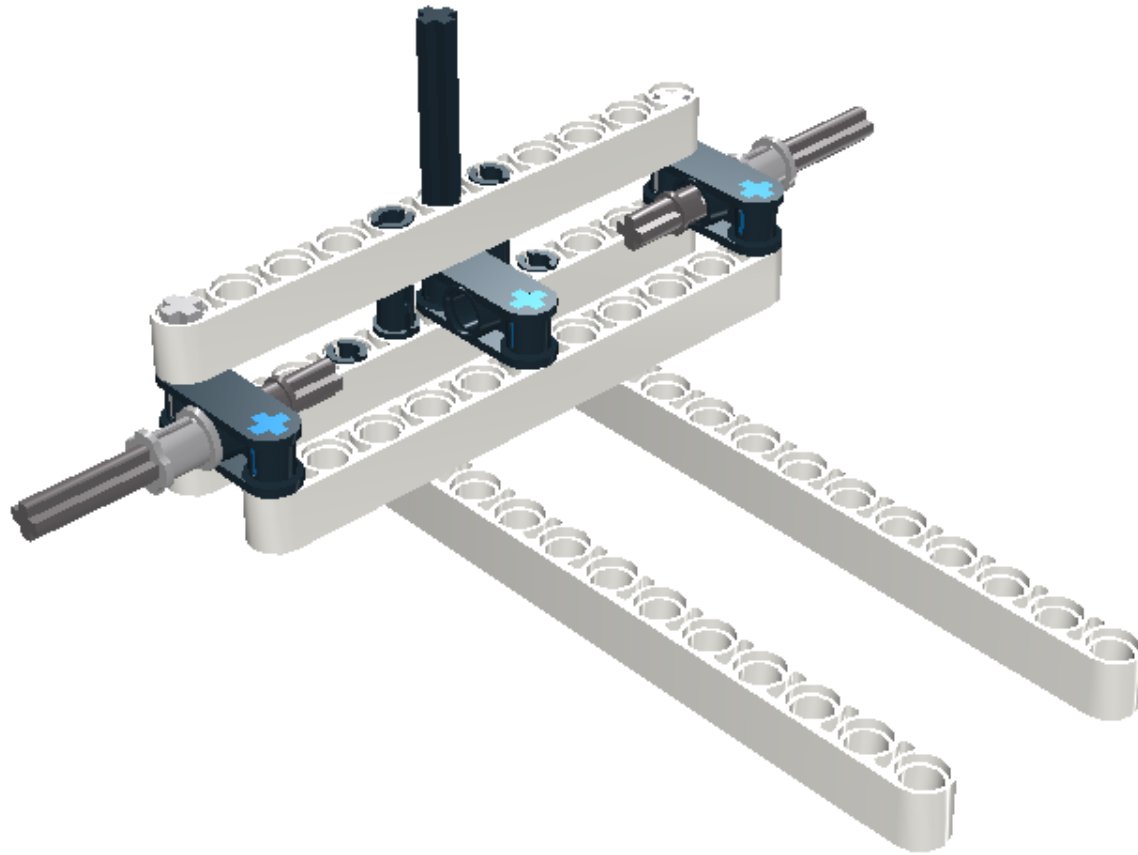
萬向輪的建構

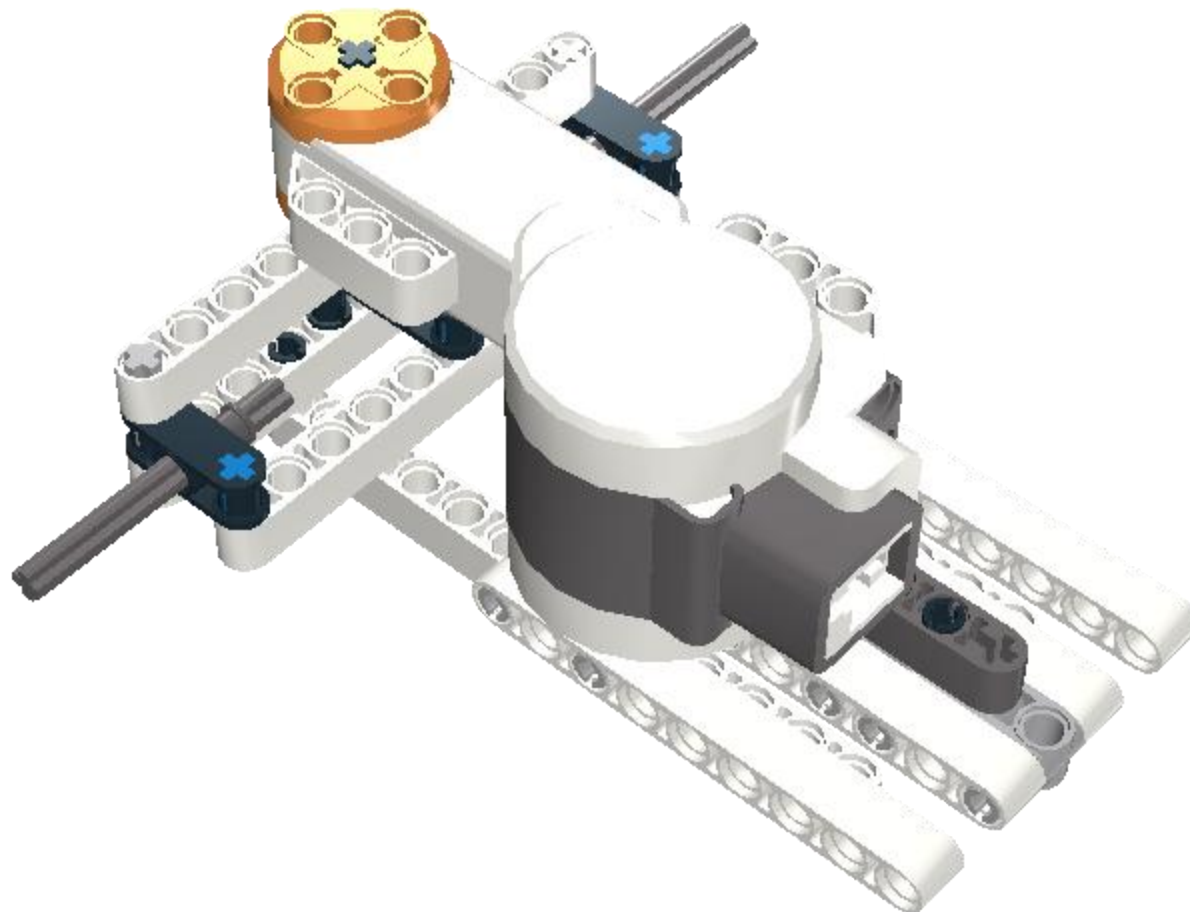


必須有施力臂，才能順暢轉向



■ 連桿式轉向機構

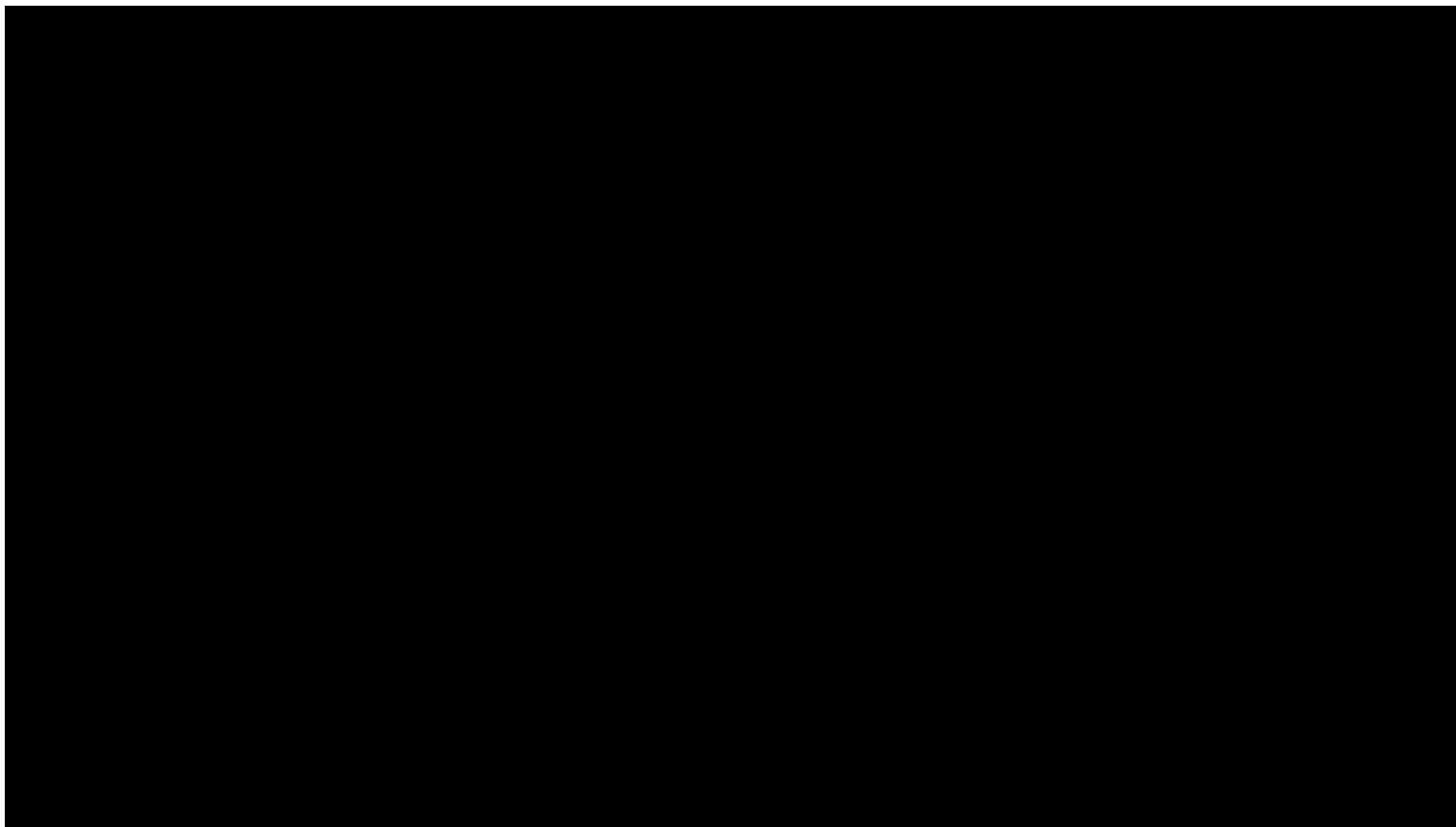


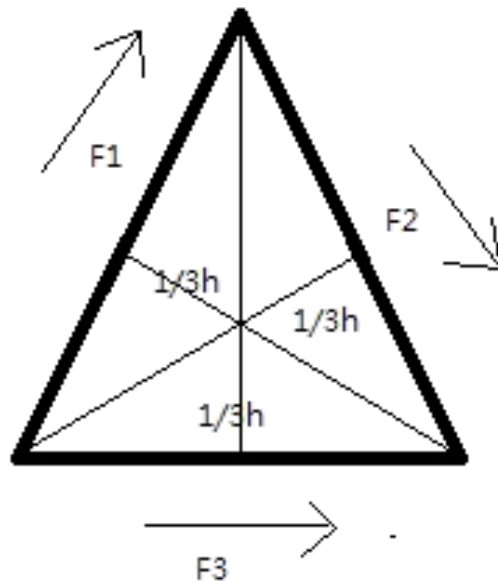






- Synchronized Drive





- 分量表示

- $F1_x = \cos 60^\circ * F1$

$$F1_y = \sin 60^\circ * F1$$

- $F2_x = \cos 60^\circ * F2$

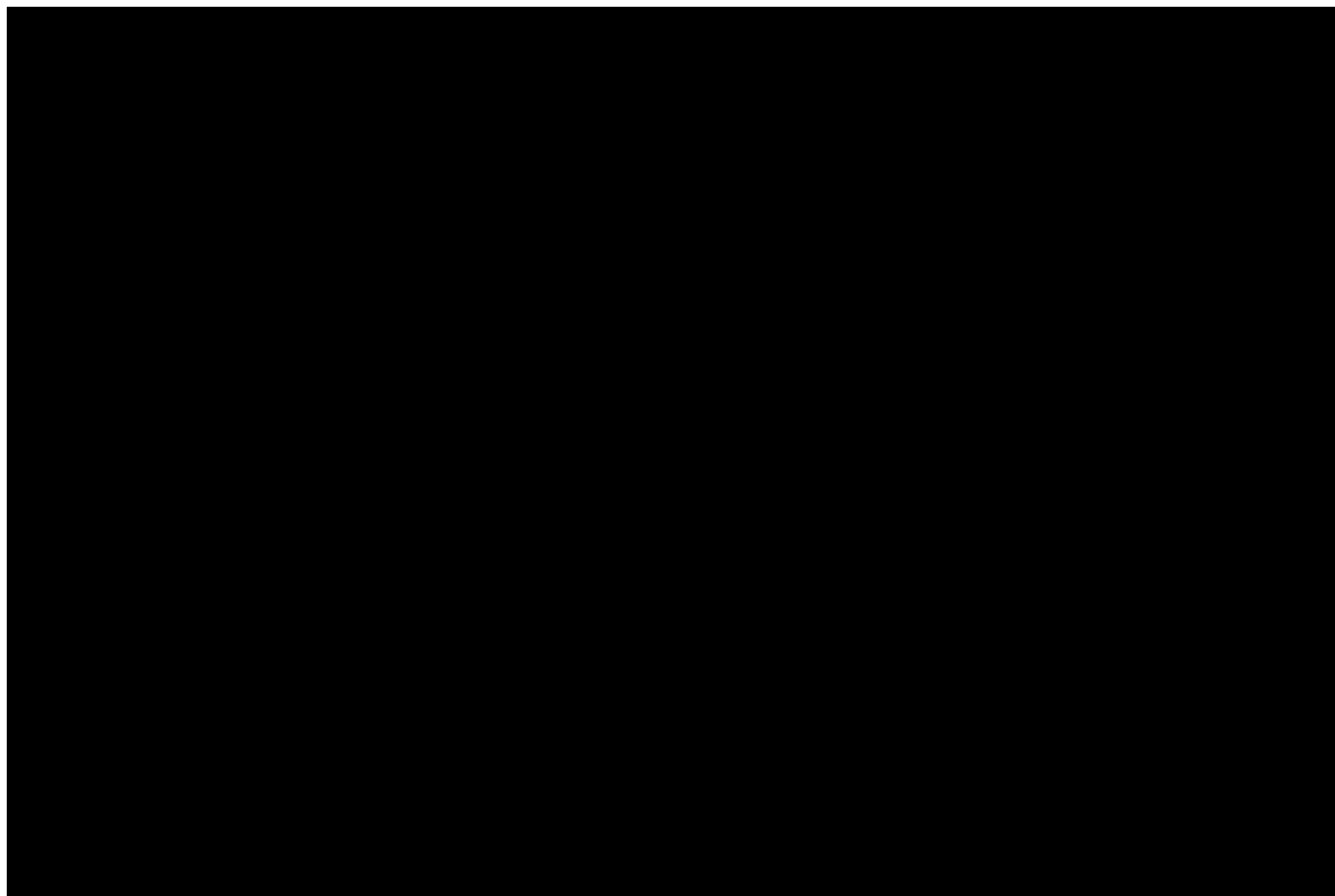
$$F2_y = \sin 60^\circ * F2$$

- $F3_x = \cos 0^\circ * F3$

$$F3_y = \sin 0^\circ * F3$$



- Omni drive



範例1：機器人資訊

主機名稱

電量

韌體版本

當前正在運行的程式

藍牙實體名稱



執行過程

1. 將手機與NXT進行藍牙配對
2. 由手機發起連線
3. 擷取NXT資訊
4. 顯示在手機畫面上



如果用Java來寫的話，很複雜

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Text;
using System.Windows.Forms;
using NPi.MindSpells;

namespace NetRemotel
{
    public partial class Form1 : Form
    {
        private NetBrick brick;
        private NetMotorSync motorPair;

        public Form1()
        {
            InitializeComponent();
            this.Text = "Disconnected";
        }

        private void btnConnect_Click(object sender, EventArgs e)
        {
            try
            {
                byte comPort = byte.Parse(this.txtComPort.Text);
                brick = new NetBrick(comPort);
                brick.MotorB = new NetMotor();
                brick.MotorC = new NetMotor();
                motorPair = new NetMotorSync(brick.MotorB, brick.MotorC);
                brick.Connect();
                this.Text = "Connected: " + brick.Message;
            }
            catch { }
        }
    }
}
```

```
private void btnConnect_Click(object sender, EventArgs e)
{
    try
    {
        byte comPort = byte.Parse(this.txtComPort.Text);
        brick = new NetBrick(comPort);
        brick.MotorB = new NetMotor();
        brick.MotorC = new NetMotor();
        motorPair = new NetMotorSync(brick.MotorB, brick.MotorC);
        brick.Connect();
        this.Text = "Connected: " + brick.Message;
    }
    catch { }
}
```



新增元件

The screenshot displays the NXT software interface with the following components:

- Palettes:** Basic (Button, Canvas, CheckBox, Clock, Image, Label, ListPicker, PasswordTextBox, TextBox, TinyDB), Media, Animation, Social, Sensors, Screen Arrangement, LEGO® MINDSTORMS®, Other stuff, Not ready for prime time, Old stuff.
- Viewer:** A central workspace showing a screen titled "Screen1" with a status bar at 5:09 PM. Visible components include "藍芽裝置連線" (Bluetooth Device Connection), "Text for Label1" through "Text for Label5", and "中斷藍芽連線" (Disconnect Bluetooth Connection). A "Non-visible components" section at the bottom lists "NxtDirectCommands1", "BluetoothClient1", and "Clock1".
- Components Panel:** Lists "Screen1" and its sub-components: ListPickerConnect, Label1-5, ButtonDisconnect, NxtDirectCommands1, BluetoothClient1, and Clock1. Includes "Rename..." and "Delete..." buttons.
- Properties Panel:** Shows settings for the selected component, including BackgroundColor (White), BackgroundImage (None...), Icon (None...), ScreenOrientation (Unspecified), Scrollable (checked), and Title (Screen1).



元件

ListPicker

Basic→ListPicker

Label

Basic→Label

Button

Basic→Button

NxtDirectCommands

LEGO_MINDSTORMS_→NxtDirectCommands

BluetoothClient

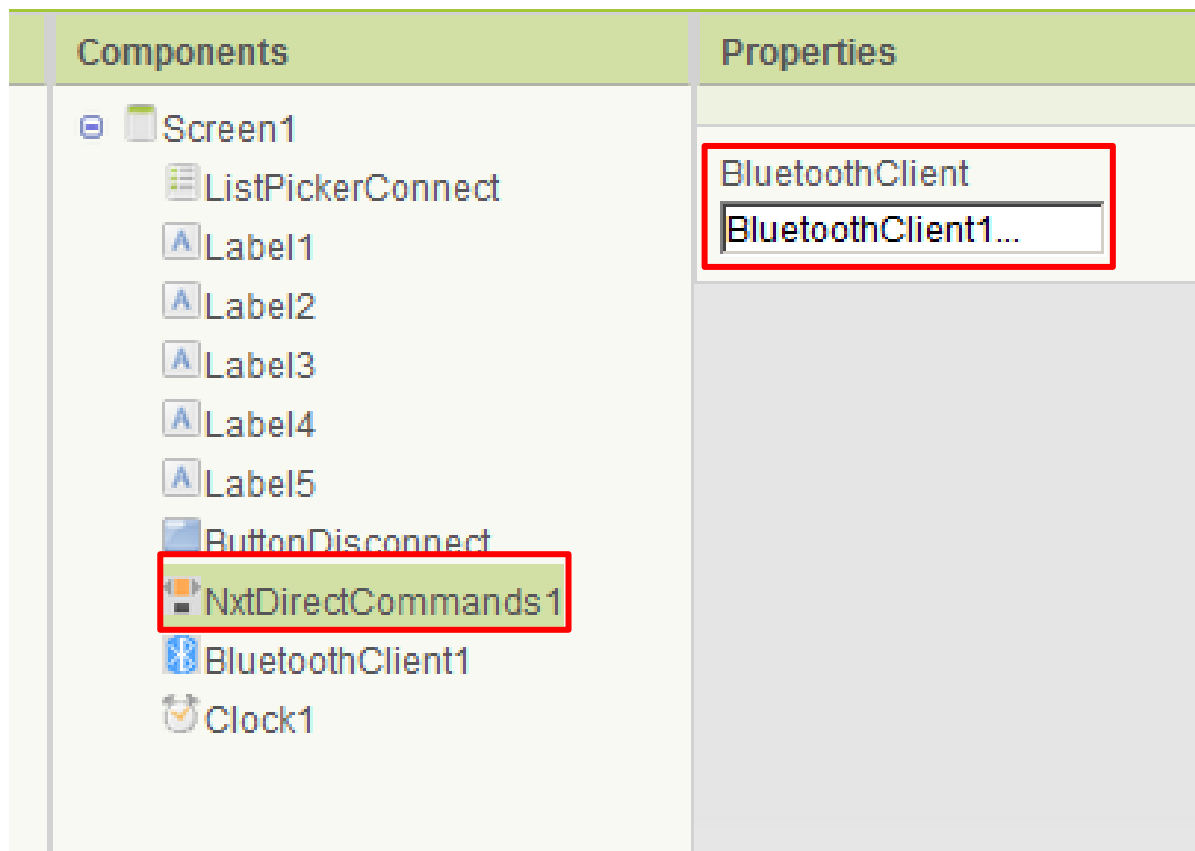
Other stuff→BluetoothClient

Clock

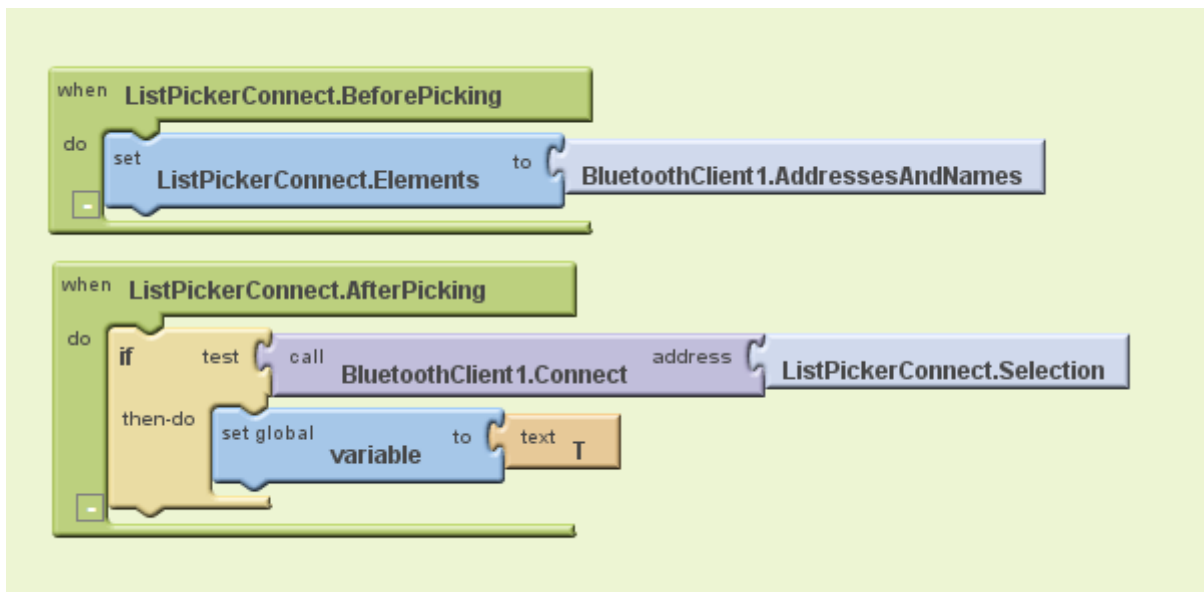
Basic→Clock



Nxt各元件都要設定BluetoothClient



藍牙連線



My Blocks

Listpicker→

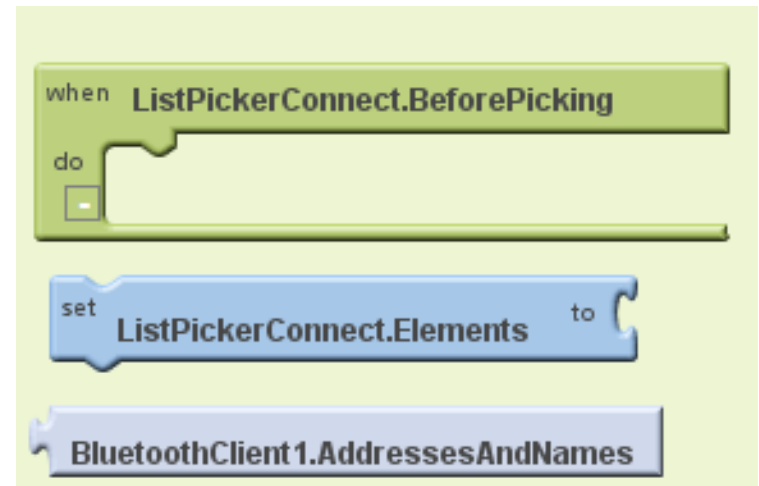
Listpicker.BeforePicking

Listpicker→

Listpicker.Elements

BluetoothClient →

BluetoothClient.AddressesAndNames



My Blocks

Listpicker→

Listpicker.AfterPicking

BluetoothClient→

BluetoothClient.Connect

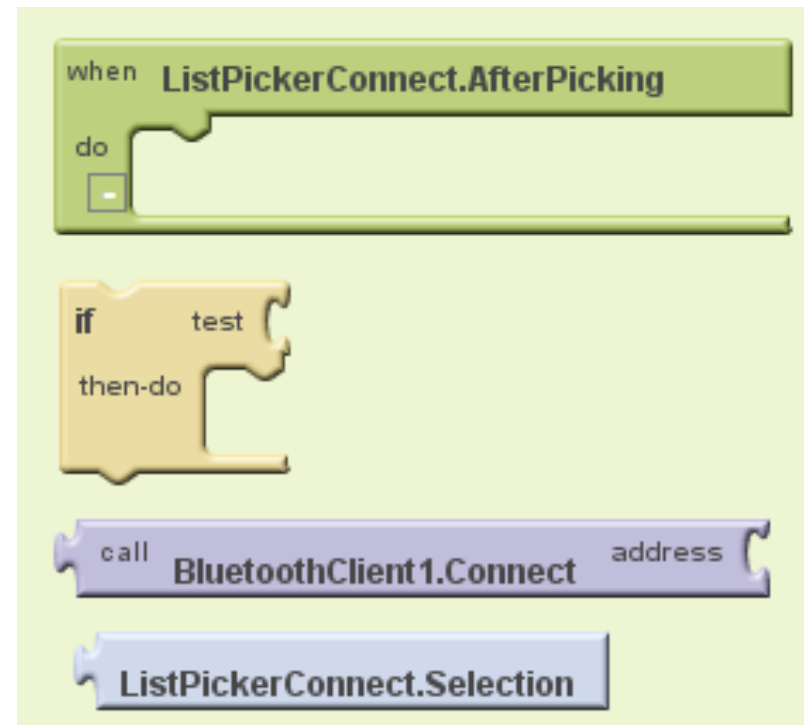
Listpicker→

Listpicker.Selection

Built-In

if

Control →if



中斷藍牙連線

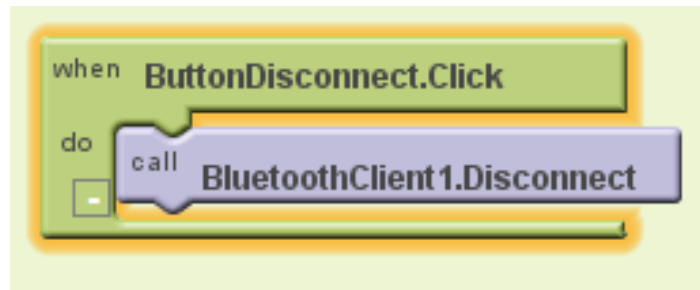
設置一個按鈕定義連線中斷

Button→

Button.Click

BluetoothClient→

BluetoothClient.Disconnect



顯示NXT資訊



GetBatteryLevel 取得NXT電池電量



GetBrickName取得NXT機器人名稱





GetCurrentProgramName

取得當前NXT執行程式



GetFirmwareVersion

取得韌體版本



Selection

取得藍牙資訊



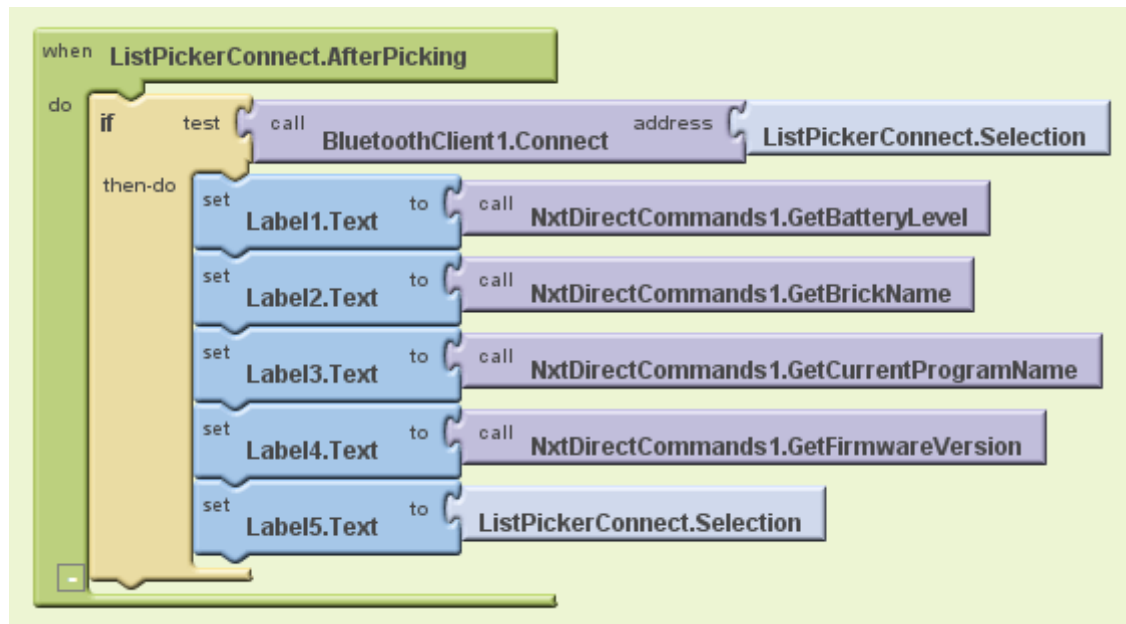
資訊顯示完成圖



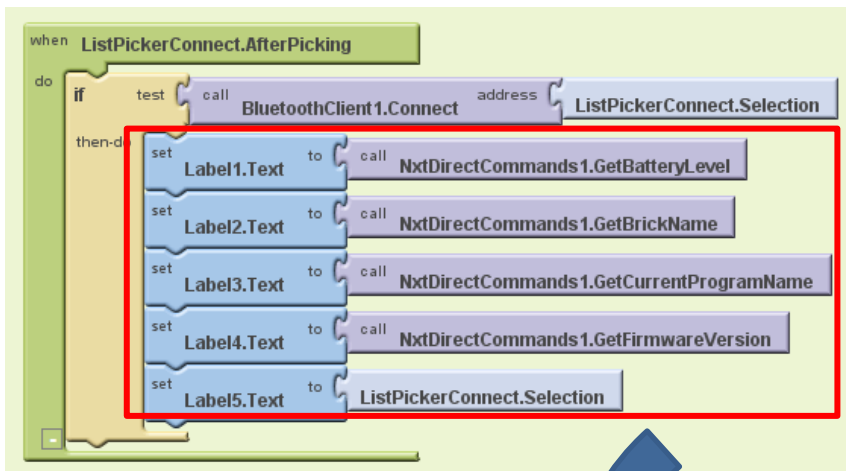
執行測試

執行測試(需要實體Android裝置)

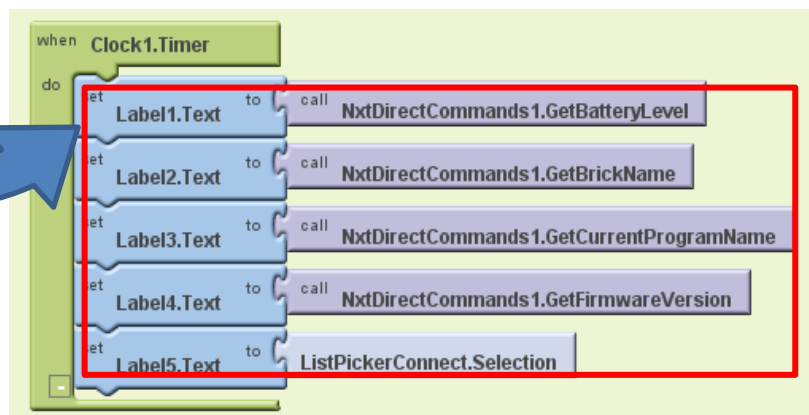
※無法以VM做模擬執行

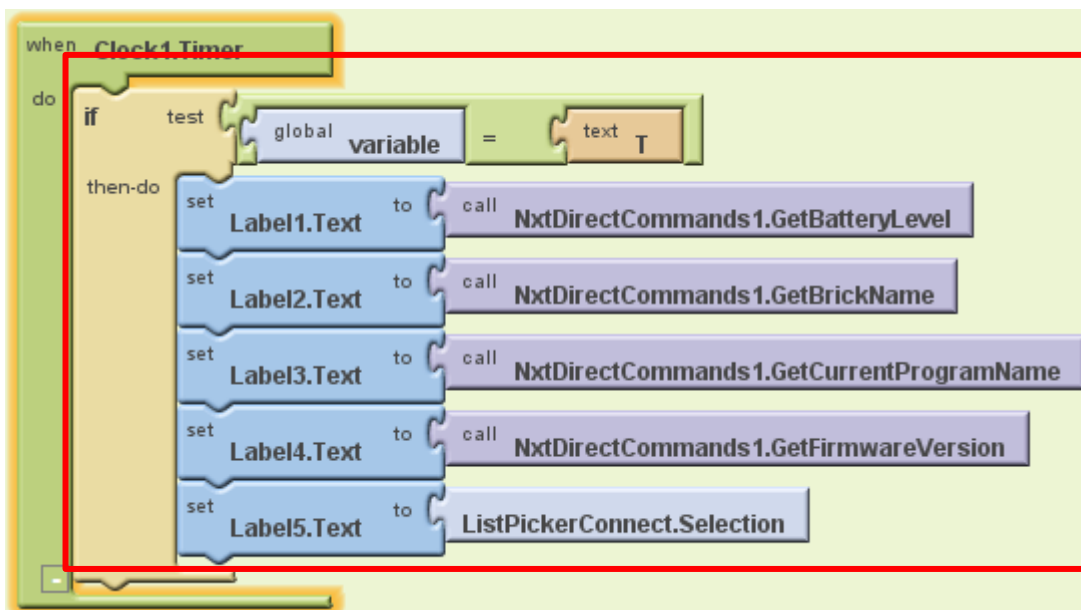
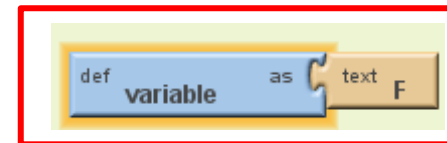
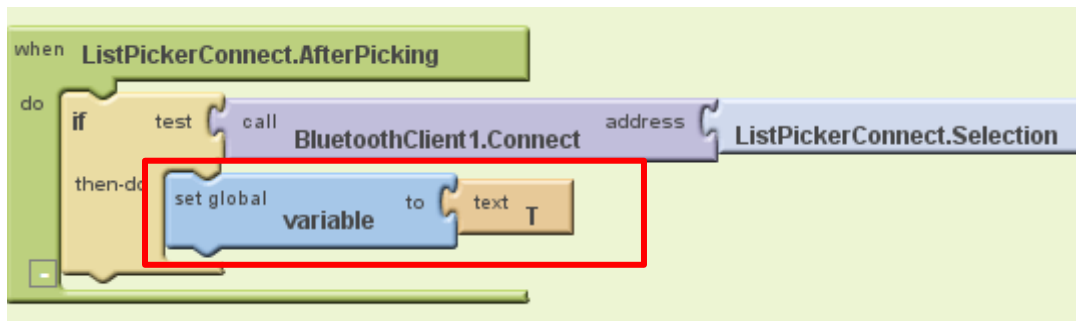


時間(Clock)



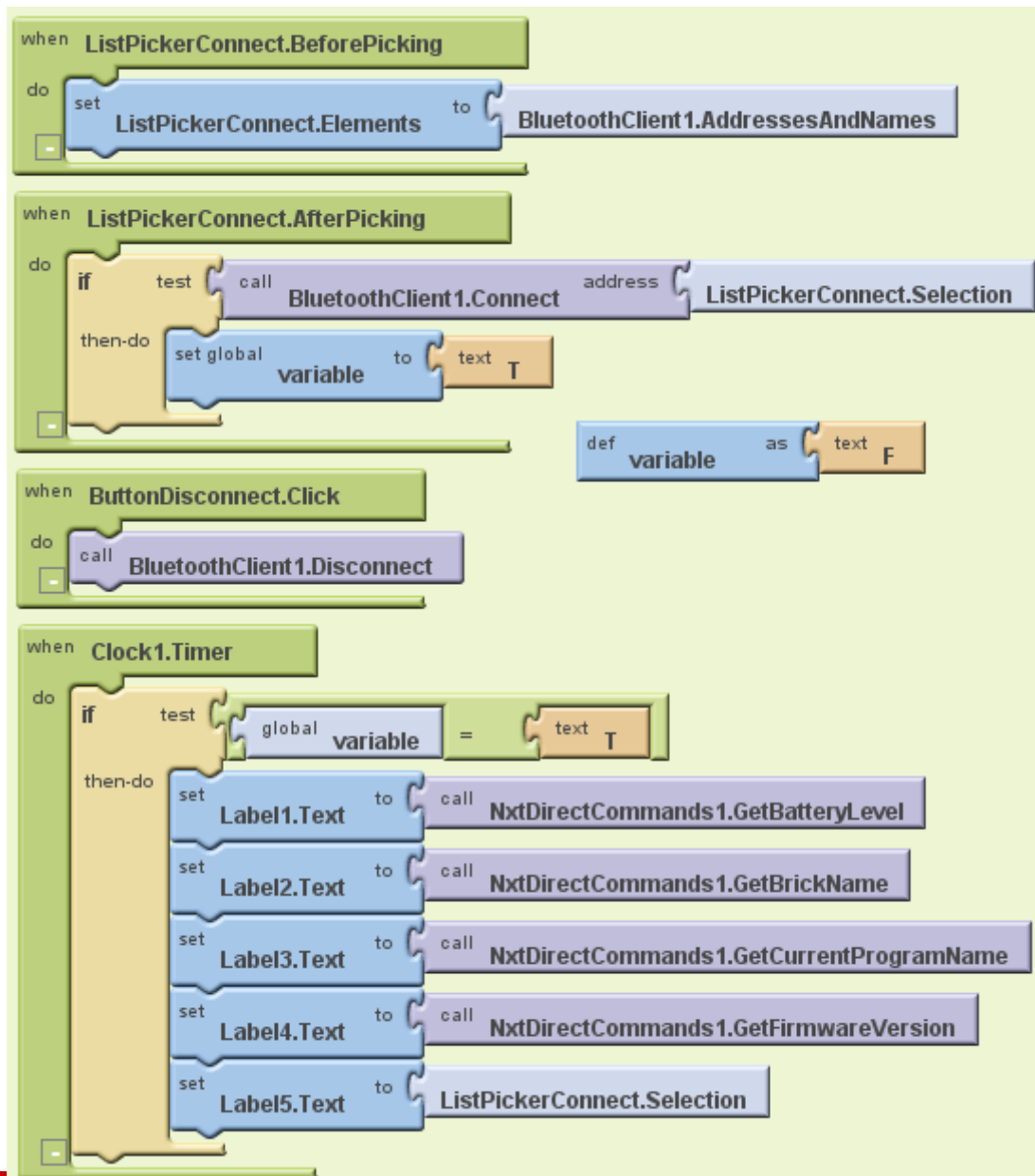
使用做連續讀取(100)
Clock→Clock.Timer





宣告一個變數
做為NXT資訊
擷取啟用判斷





範例2：感應器面板

The screenshot displays the LightSensorNXT application interface. At the top, there are menu options: "Save", "Save As", "Checkpoint", "Blocks Editor is open", and "Package for Phone". The interface is divided into several sections:

- Palette:** A list of UI components categorized into "Basic" (Button, Canvas, CheckBox, Clock, Image, Label, ListPicker, PasswordTextBox, TextBox, TinyDB), "Media", "Animation", "Social", "Sensors", "Screen Arrangement", "LEGO® MINDSTORMS®", "Other stuff", "Not ready for prime time", and "Old stuff".
- Viewer:** A central area showing a screen titled "Screen1" with a status bar at the top displaying "5:09 PM". The screen content includes:
 - A checkbox labeled "Display Invisible Components in Viewer".
 - A title bar "Screen1".
 - Five text input fields: "連芽裝置連線", "光感值:", "分貝值:", "按鈕:", and "距離值:".
 - A button labeled "藍芽連線中斷".
- Non-visible components:** A list of hidden components including NxtLightSensor1, BluetoothClient1, Clock1, NxtSoundSensor1, NxtTouchSensor1, and NxtUltrasonicSensor1.
- Components:** A tree view of the application's components, including Screen1, ListPicker1, HorizontalArrangement1 (with Label1, Label3LS), HorizontalArrangement3 (with Label4, Label2SS), HorizontalArrangement4 (with Label6, Label1TS), HorizontalArrangement5 (with Label8, Label4US), Button2, Label3, NxtLightSensor1, BluetoothClient1, Clock1, and NxtSoundSensor1.
- Properties:** A panel for editing the selected component's properties, such as BackgroundColor (White), BackgroundImage (None...), Icon (None...), ScreenOrientation (Unspecified), Scrollable (checked), and Title (Screen1).

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NXT感應器元件

NxtLightSensor

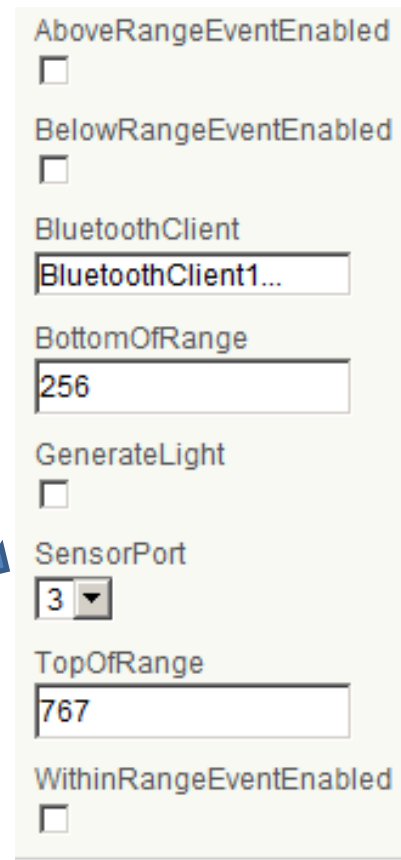
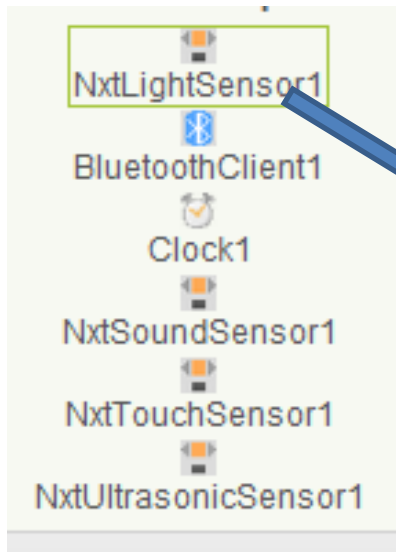
NxtSoundSensor

NxtTouchSensor

NxtUltrasonicSensor



NXT感應器Port設定



NxtLightSensor

 GetLightLevel (0~100)

NxtSoundSensor

 GetSoundLevel (0~100)

NxtTouchSensor

 IsPressed (true / false)

NxtUltrasonicSensor

 GetDistance (0~255)



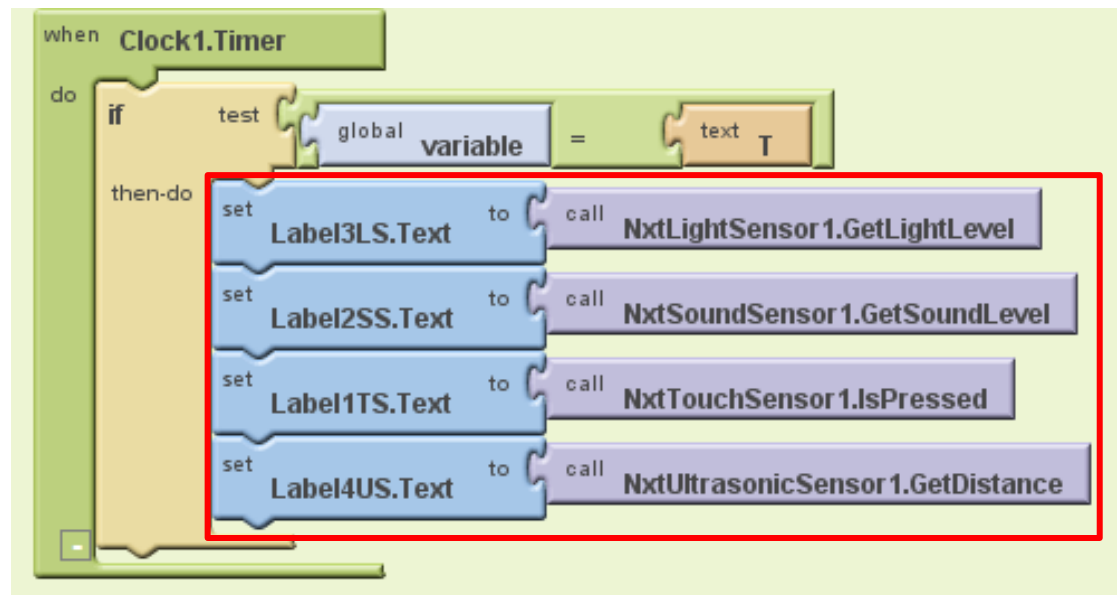
顯示NXT感應器數值

光感值

分貝值

按鈕判斷

距離值(cm)



```
when ListPicker1.BeforePicking
do
  set ListPicker1.Elements to BluetoothClient1.AddressesAndNames

when ListPicker1.AfterPicking
do
  if test call BluetoothClient1.Connect address ListPicker1.Selection
  then-do
    set global variable to text T

when Button2.Click
do
  call BluetoothClient1.Disconnect

when Clock1.Timer
do
  if test global variable = ∇ text T
  then-do
    set Label3LS.Text to call NxtLightSensor1.GetLightLevel
    set Label2SS.Text to call NxtSoundSensor1.GetSoundLevel
    set Label1TS.Text to call NxtTouchSensor1.IsPressed
    set Label4US.Text to call NxtUltrasonicSensor1.GetDistance
```

def variable as text F



範例3：按鈕控制



Non-visible components

BluetoothClient NxtDriveB NxtDriveC NxtDirectCommands SoundBeep



範例4：機器人大軍



範例5：指南車

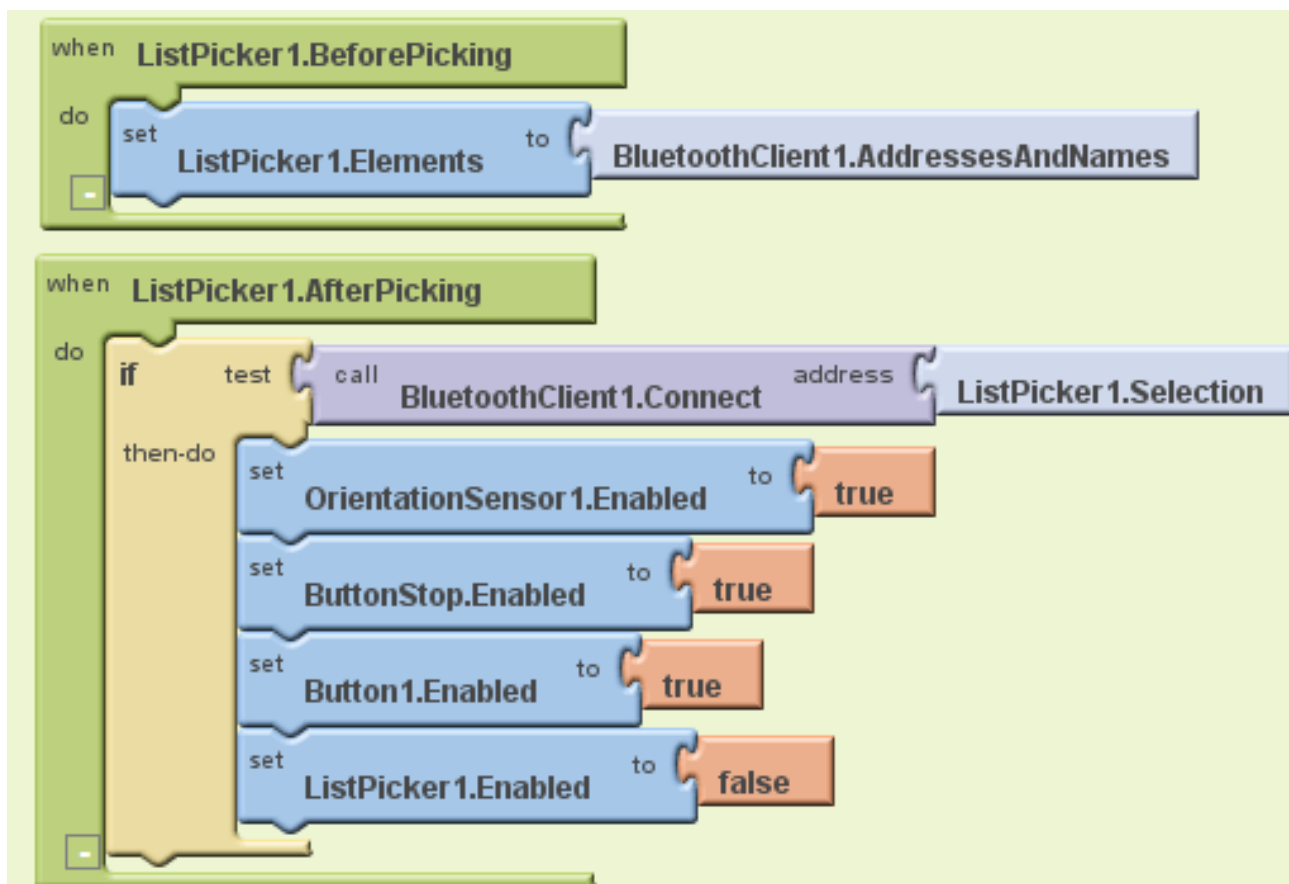


範例6：翻轉控制

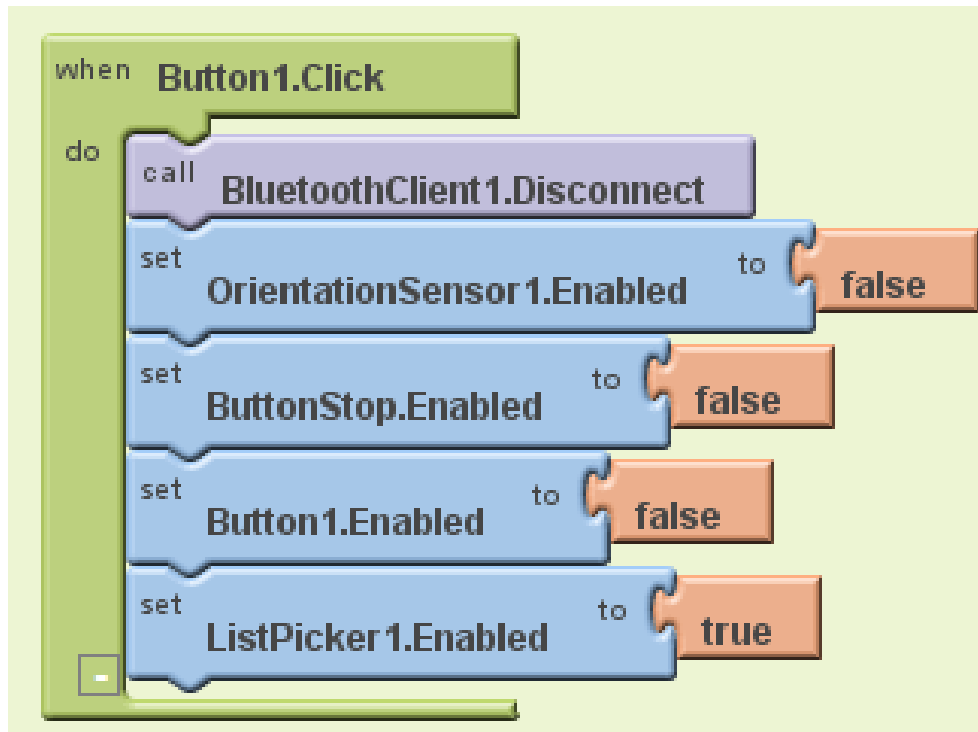
利用手機內的姿態感測器來控制機器人



藍牙連線前後的設定(同前)

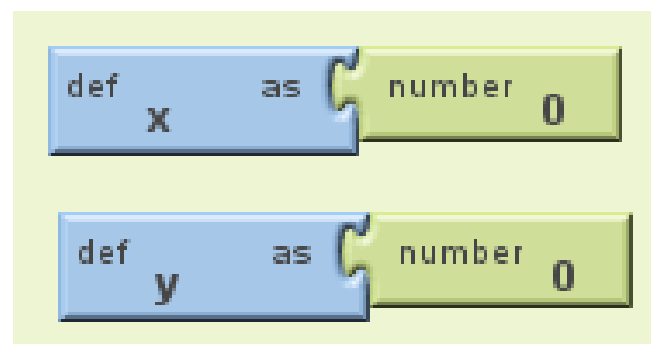


中斷藍牙連線



設定變數

設定變數接收手機
X-Y數值做運算



```

when OrientationSensor1.OrientationChanged
  yaw name yaw
  pitch name pitch
  roll name roll

do
  set LabelPitch.Text to
    text Pitch: join
    value pitch * number 2

  set LabelRoll.Text to
    text Roll: join
    value roll * number -2

  set global x to
    call atan2
    value pitch
    value roll * number -1 - number 45

  set global y to
    call sqrt
    value roll * value roll + value pitch * value pitch * number 8

  call NxtDriveB.MoveForwardIndefinitely
    power call cos degrees
    global x * global y

  call NxtDriveC.MoveForwardIndefinitely
    power call sin degrees
    global x * global y

  set LabelLeftMotor.Text to
    text LeftMotorPower join
    call cos degrees
    global x * global y

  set LabelRightMotor.Text to
    text RightMotorPower join
    call sin degrees
    global x * global y

```



停止

停止B-C馬達。

