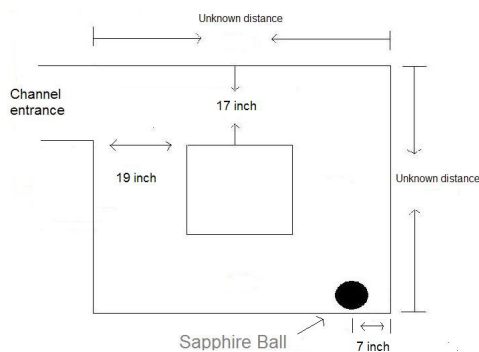


## Project - King Manco Capac tomb excavation

Erwei Bai is an archaeologist at the University of Iowa. About two years ago, his good friend Professor Indiana Jones of Princeton informed him of a newly discovered early Amerindian tomb, high in the Andes near the capital Lima.



All preliminary findings seem to suggest that it is the ancient King Capac's tomb who died in 1231AD. Dr. Bai spent the last two summers working with Professor Jones in the Peruvian mountains and excavated an Incan manuscript that provided a layout of the tomb.



Detailed Treasure Channel drawing

Surprisingly, according to the description, the Blue Sapphire Ball, which has been considered long gone, was buried in a tiny “treasure channel” deep in the tomb. The treasure channel was carved out in a solid rock and is double L shaped as to make the treasure unreachable by non-engineers. You as members of IEPS are to assist Dr. Bai on his request to recover the Blue Sapphire Ball. As his assistants, your job is to build a robot to retrieve the Blue Sapphire Ball (2 inch in diameter). The Drawings of the tomb and the treasure channel are shown above. You do have access to the entrance of the treasure channel. You may also place your robot at the entrance and retract the robot when it comes out of the entrance. You are provided a Lego MindStorms NXT set from which various robots can be constructed using touch, light, sound, ultra-sonic (distance)

sensors, motors and other Lego pieces. Robots can be programmed to do complicated tasks. Shown below is an example made by Dr. Bai.

[http://www.engineering.uiowa.edu/~eng\\_0055/2021/video/excavationBAI.wmv](http://www.engineering.uiowa.edu/~eng_0055/2021/video/excavationBAI.wmv)

In addition to building a robot and retrieving the Blue Sapphire Ball, your team needs to

1. Power point presentation (<2 minute, strictly enforced) on 10/23 or 10/25 addressing every question below
  - *a clearly defined approach,*
  - *research of possible solutions,*
  - *team member assignments,*
2. Demonstration/Competition on 11/6 or 11/8
3. Written report due on the same day 11/6 or 11/8
  - *summary of the overall approach taken by the team,*
  - *description of any research/background work carried out by the team,*
  - *discussion of alternative designs considered,*
  - *rationale for selecting the chosen design,*
  - *overview and operational details of the chosen design,*
  - *problems encountered/unresolved issues,*
  - *possible legal/ethical/social issues, e.g., with respect to treasure belongings/tomb excavation and early stage practices by European explorers in Egypt, Greece, China, ...,*
  - *lessons learned and recommendations,*
  - *each team member's contribution,*

You may want to look some examples made by EPS classes,

[http://www.engineering.uiowa.edu/~eng\\_0055/2021/video/Excavation12-15.wmv](http://www.engineering.uiowa.edu/~eng_0055/2021/video/Excavation12-15.wmv)

[http://www.engineering.uiowa.edu/~eng\\_0055/2021/video/Excavation12-16.wmv](http://www.engineering.uiowa.edu/~eng_0055/2021/video/Excavation12-16.wmv)

To download the Lego NXT software, go to

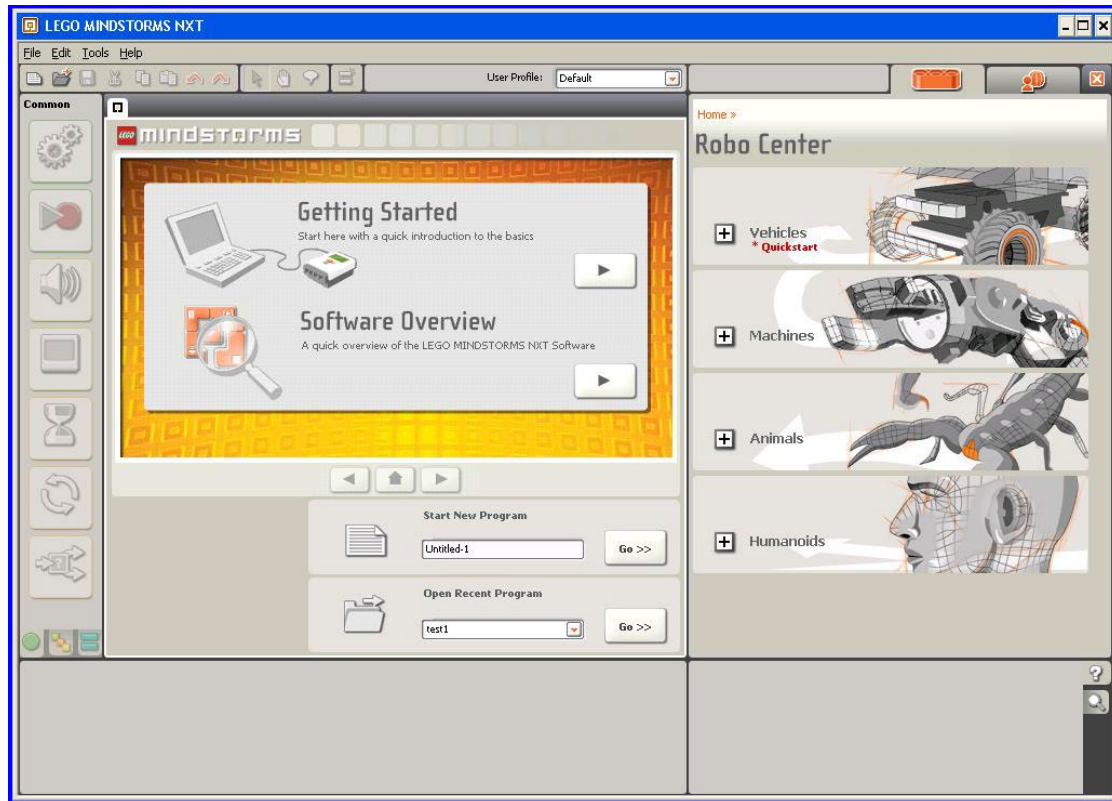
<https://www.lego.com/en-us/themes/mindstorms/downloads>

and follow the instructions for both Mac and Windows users.

#### Appendix:

**Robot building:** You can find many reference books on MindStorms Robots and some are available in the engineering library. Also, please check “MindStorms NXT” on Web.

**MIndStorms NXT software:** This is a very friendly graphic based program.



Detailed description of each block is attached.

## NXT Robot Programming Manual

Most useful blocks for this program. But feel free to be creative and explore the use of other blocks.

### Move



Set your robot to move forwards, backwards, or turn according to your direction and steering specifications. Set the duration in seconds, rotations of the motor, or degrees for greatest precision.

### Wait



Wait to execute next block. You set this condition to link to any of your sensors or a set amount of time. For instance, using the touch sensor, this could mean, "When the touch sensor is pressed, move on to next block."

### Motor



Useful for motors not powering the wheels. Set the motor's direction, duration, and whether this block should be completed before the program moves on to the next block.

### Touch



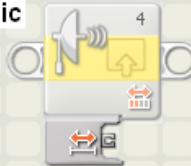
Block provides a logic value linked to the touch sensor. Can be set such that it will provide "True" if the sensor is pressed, released, or bumped (pressed and released)

### Light



Similar to the touch block, but linked to the light sensor. This block can also provide a specific numeric value of the current light.

### Ultra Sonic



Again, like the other sensor blocks, but this time with the ultrasonic sensor, which senses how far away an object is. Default sets value to "True" if an object is less than 50 inches away.

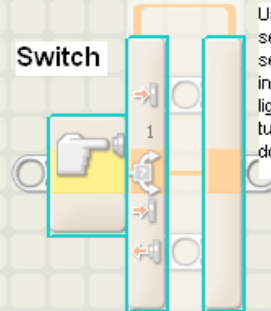
### Sensors

### Loop



Use this block to repeat sequences of code which you can place in the center of the loop. Set it to repeat forever, a set number of times, until a sensor detects true, or a length of time.

### Switch



Use to select between multiple sequences of code. Link to a sensor or a logic value. For instance, you could say, "If the light sensor detects a light change turn on the motor. But if the sensor doesn't detect, back up."

### Flow



Here is an example of how a robot will travel in a square using a touch sensor when hitting the wall.

### Example Program

- Robot will travel in a square using its touch sensor to find obstructions

**Beginning of Program**

**END: program ends after the loop is finished**

Loop block runs these 4 blocks 4 times total. Configure according to what you want to mark the end of a loop: a counter, a time amount, a sensor

Download program to robot and run it immediately. Don't push this unless you're ready for the robot to start right away. Be ready to unplug the USB fast.

Opens a window which shows the status of your NXT brick's battery, memory, etc.

Download the Program to your robot. Robot must be connected via USB cable.

Find specifics on how the selected block works here. Click "More help" to get a complete rundown of all configuration options.

Runs selected block. You probably won't need this button.

Stops Program

**Configuration Panel**

This is where you configure each block you add to your program. Every block has different settings to be configured. This move block achieves a reverse 90 degree turn resulting in the robot facing to the right from its original direction. Testing is required to get these settings just right on several of the kinds of blocks. I had to determine that this steering and duration setting worked.

**Help Panel**

**Move Block**

Use this block to set your robot to go forwards or backwards in a straight line or to turn by following a curve. Define how far your robot will go by using the Duration property.

[More help >](#)

The screenshot displays the LEGO Mindstorms NXT software interface. At the top, a program loop is shown with four blocks: 'Move forward infinitely', 'Wait until Touch Sensor pressed', 'Stop', and 'Turn robot'. Below the loop, detailed instructions explain each block's function. To the right, a 'Help Panel' provides information on downloading the program and running it. At the bottom, the 'Configuration Panel' shows settings for the selected 'Move Block', including port selection (A, B, C), direction (forward, backward, turn), duration (780 degrees), and next action (Brake, Coast). A 'More help >' link is also present.