

The Remote Captain

<Author> Immaculada Abad Nebot

<Author> Pere Compte Jové



<Info>

<Keywords> remote control, 2D and 3D design, modelling, electronic board soldering, chip programming, app programming, 3D printer

<Disciplines> technology, engineering

<Age level of the students> 14–16

<Hardware> Arduino^[4], Bluetooth module, materials for building the model boat

<Language> Arduino, ArduinoBlocks^[2], AppInventor^[3]

<Programming level> medium

<Summary>

The students will design and build their own boat and navigate in a pool. Once they have completed this initial challenge, they will use an Arduino board to control the boat remotely with a tablet or smartphone.

<Conceptual introduction>

The students will design their own model boat and learn how to look at this task from an engineering perspective. The project will start with an analysis of the different kinds of boats using the Internet. After that, a small group of students will build a model that is stable on water.^[4]

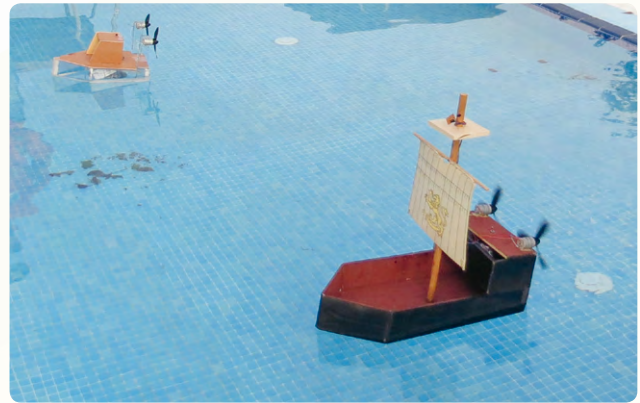
It will work with a reversing switch made by the students which lets the user control two motors (each one can turn forwards and backwards).

The students will incorporate a Bluetooth device so they can control the boat remotely with a smartphone. Using AppInventor^[3], they will program a mobile app with different control systems, e.g. with buttons, with voice control or with an accelerometer (the boat will change direction according to the hand position of the person controlling it).

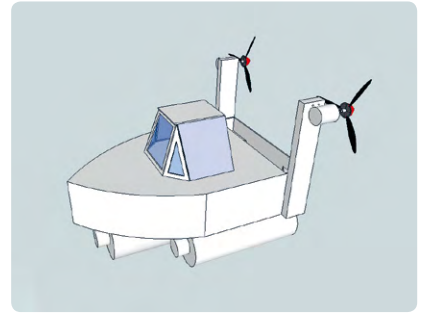
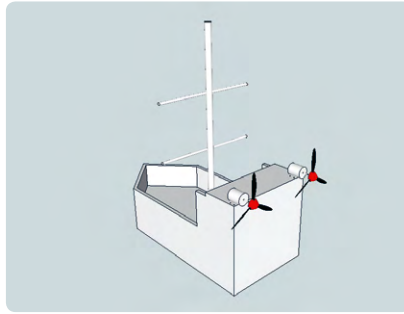
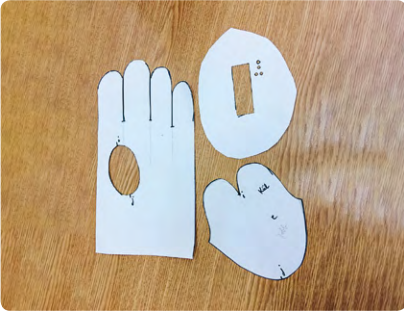
Finally, the students will have the opportunity to present their designs at a naval modelling exhibition ([@1]) in front of experts, and to discuss any possible shortcomings in their models with them. This expert input will allow the students to improve their future models.

<What the students/teachers do>

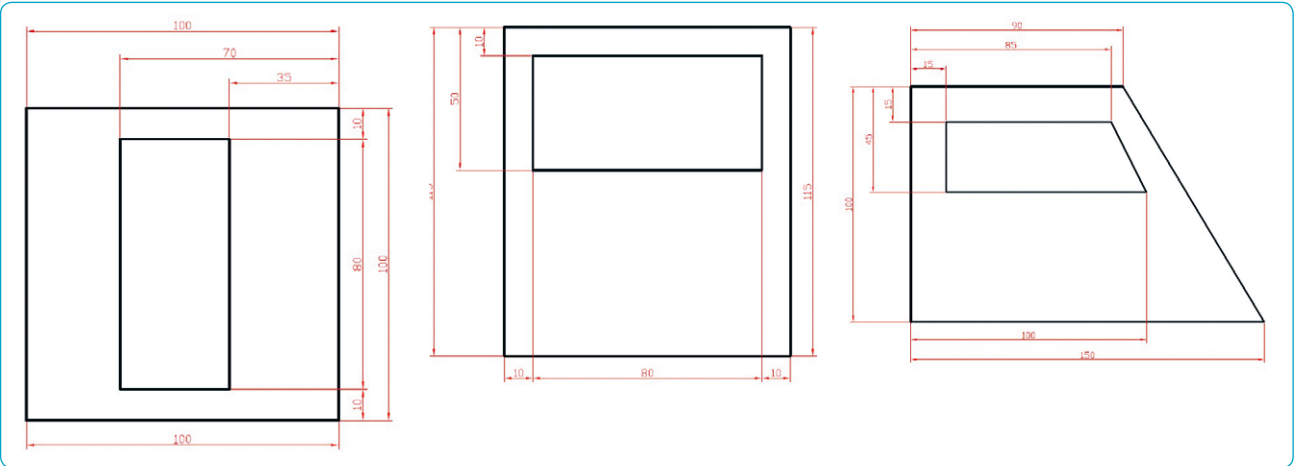
The students will create their design of choice after investigating different boat shapes on the Internet. They can draw the boat with a 3D design software such as sketchUp^[5] or Tinkercad^[6]. However, they need to keep in mind that the boats must be very stable on water to prevent them from overturning. ([@2])



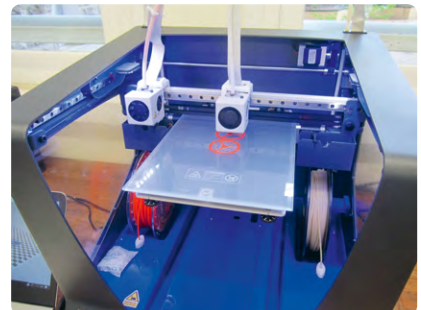
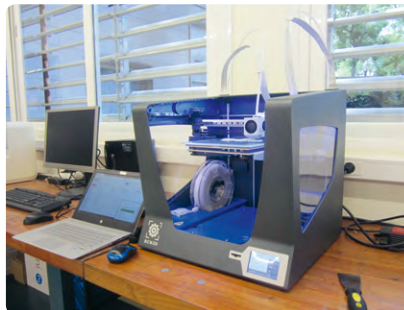
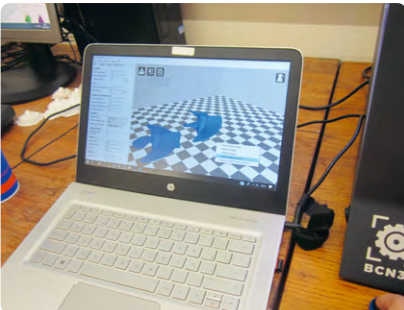
@ 1: Presentation of the model boats at a naval modelling exhibition in Spain



© 2: Various 3D boat models



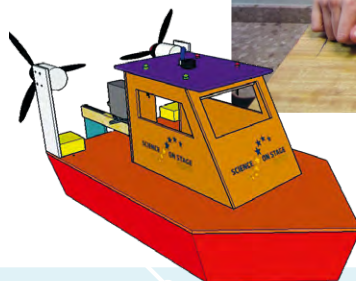
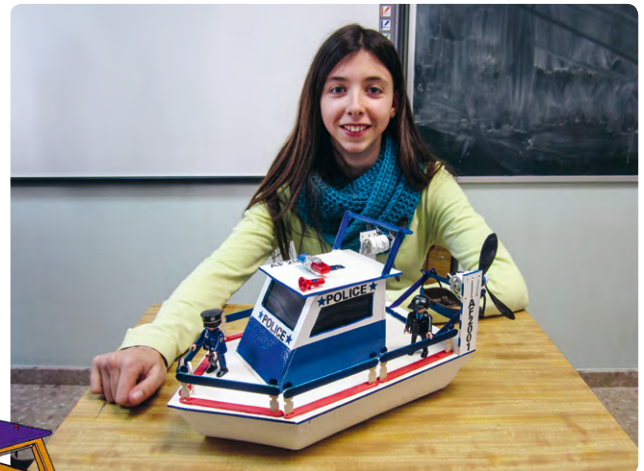
© 3: Door, front and side of the boat cabin



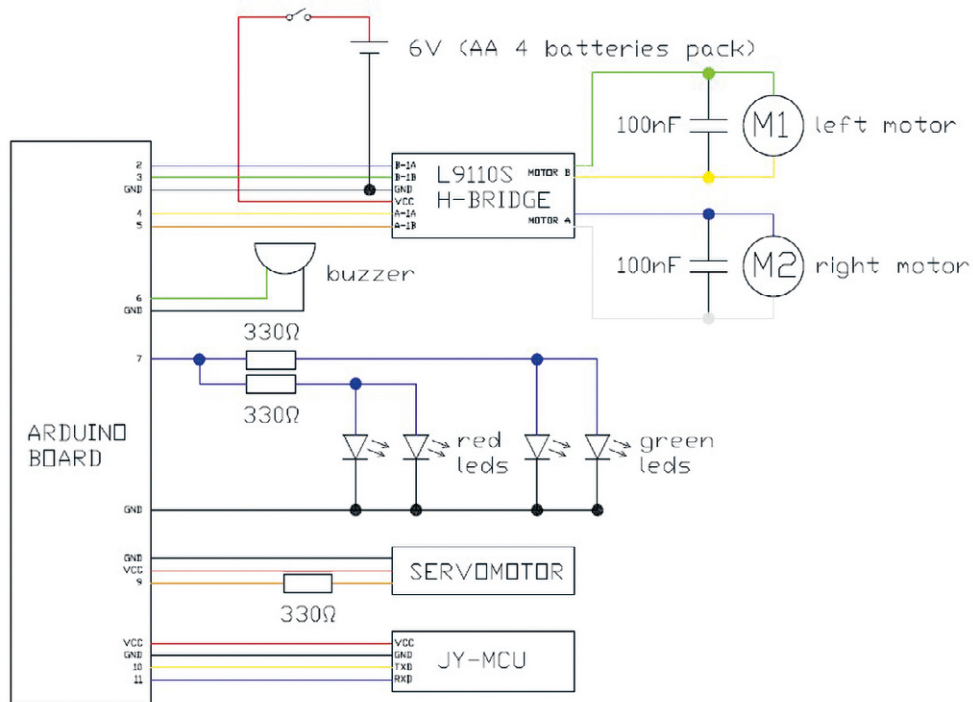
© 4a-c: Printing blades at the 3D printing centre Cesire Aulatec, Barcelona

We provide the plans for one model boat (©3), including the required measurements, online. If you would like to change this design or print it, you can download various formats (.skp, .stl and .gcode).^[4]

If your school does not have a 3D printer, it is often possible to cooperate with other institutions such as universities, maker spaces or similar. In our case, the students did their 3D printing at a 3D printing centre (©4a-c). Step-by-step instructions for building the boat are available online.^[4]



© 5, 6: Finished boat and 3D model

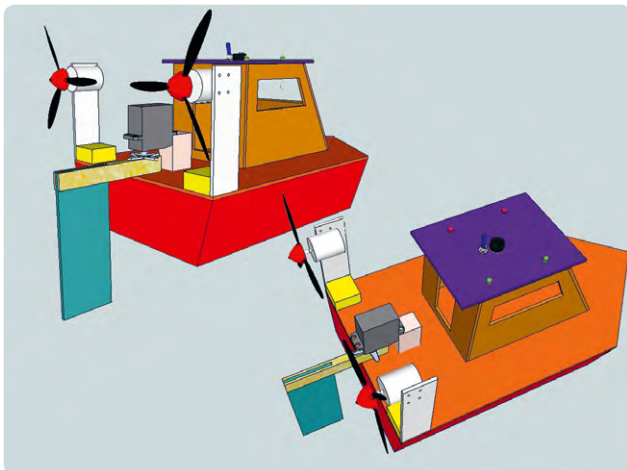


Ⓒ 7: Electronic circuit diagram

<Electronic circuit>

To connect the accessories to the Arduino board^[7], use the electronic circuit diagram in Ⓒ7 and follow the respective instructions:

1. You can install a buzzer (Arduino pin 6) and lights (Arduino pin 7) on the roof. (Ⓒ8)
2. At the rear of the boat, you can connect a servomotor to control a rudder (Arduino pin 9). (Ⓒ8)
3. Connect the Bluetooth module in accordance with the schema TXD (Arduino pin 10) and RXD (Arduino pin 11).
4. Connect an L9110S motor driver controller board for Arduino with external batteries. (Ⓒ7)



Ⓒ 8: The boat with accessories



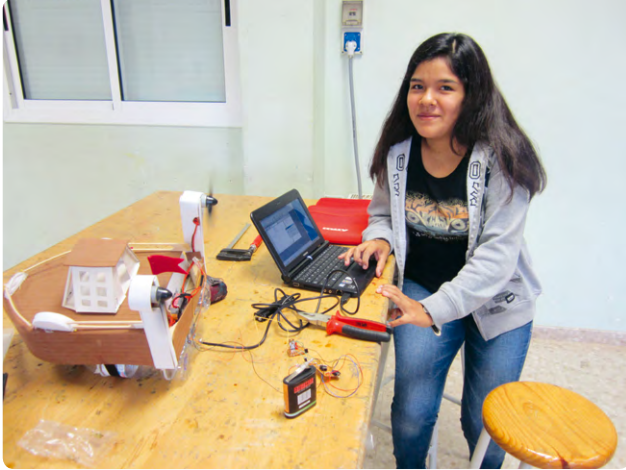
Ⓒ 9: Construction of the boats

<How to control the motors and other features of the boat>

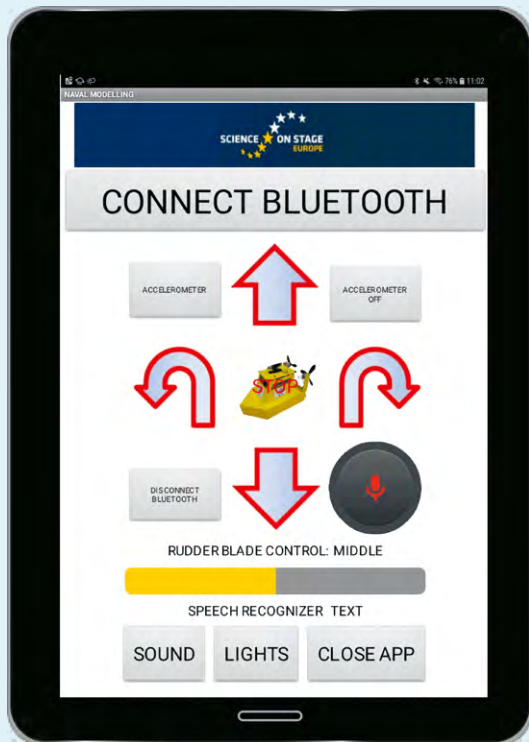
We recommend that you program the Arduino with Arduino IDE^[1], ArduinoBlocks^[2] or another similar program. The students can program the following tasks:

1. Connect and disconnect the lights on the roof.
2. Make a sound with the buzzer.
3. Control the servo position (40° right, 20° right, in the middle, 20° left and 40° left).
4. Both motors must turn and the boat moves forwards.
5. Both motors must turn and the boat moves backwards.

- 6. The boat must change its direction to the right (the left motor turns forwards and the right motor turns backwards).
- 7. The boat must change its direction to the left (the right motor turns forwards and the left motor turns backwards).
- 8. Control all the programs with Bluetooth.



© 10: Coding for the boats



© 11: The user interface of the app

<Program the app to control the boat with a smartphone using AppInventor^[3]>

- 1. Program the app so it uses Bluetooth to connect with the boat.
- 2. Control the different elements of the boat with buttons.
- 3. Control the rudder blade with a scroll bar.
- 4. Control the boat using the accelerometer of the tablet or smartphone; tilting the smartphone forwards, backwards, right or left will cause the boat to move in the corresponding direction.
- 5. Use the option of speech recognition to control the boat with your voice.
- 6. Combine all these programs.

<Material list and equipment needed>

You can find a list containing all the required materials online^[4]. The list includes details such as the quantity needed, price range and where the materials can be found.

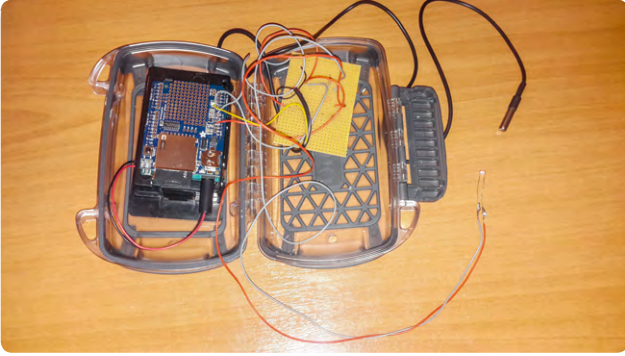
The material for one boat costs roughly €21. We spent approximately €15 on the electronics and €6 on the rest of the required materials.

<Cooperation activity>

While editing this material, we cooperated with Eleftheria Karagiorgou and Sevasti Tsiliki from the 7th Senior High School of Trikala, Greece, to implement an Arduino circuit in a hydrobot that allows us to navigate underwater. In this case, it is very important to protect the motors with wax and use protective as well as waterproof housing for the Arduino plate to prevent any water from entering the motors. We equipped our hydrobot 'Argolith'^[8] with the microcontroller Arduino UNO to provide it with an electronic 'brain' and to record luminosity and temperature measurements underwater. The 'brain' also included a data logging shield, which offered us a real-time clock and a recording circuit for an SD card, where we saved the measured data.



© 12: Constructing the hydrobot



© 13: Arduino with waterproof casing

The online material contains an underwater video of the 'Argolith' hydrobot during testing in a river in Trikala, Greece.^[4]

<References>

- [1] www.arduino.cc
- [2] www.arduinoblocks.com
- [3] <http://appinventor.mit.edu>
- [4] All the steps in this project and additional information:
www.science-on-stage.de/coding-materials.
- [5] www.sketchup.com
- [6] www.tinkercad.com
- [7] www.arduino.cc/en/Reference/Board
- [8] A construction manual is available at
<http://seaperch.mit.edu/build.php>.

<Imprint>

<Taken form>

Coding in STEM Education

www.science-on-stage.eu/coding

<Published by>

Science on Stage Deutschland e.V.

Am Borsigturm 15

13507 Berlin, Germany

<Revision and Translation>

Translation-Probst AG

<Design>

WEBERSUPIRAN.berlin

<Illustration>

Rupert Tacke, Tricom Kommunikation und Verlag GmbH

<Credits>

The authors have checked all aspects of copyright for the images and texts used in this publication to the best of their knowledge.

<Please order from>

www.science-on-stage.de

info@science-on-stage.de

<ISBN PDF>

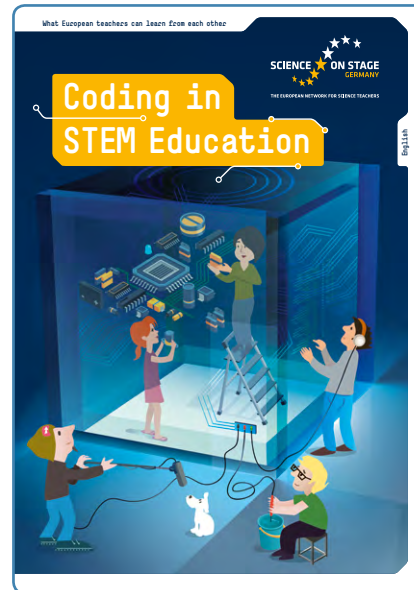
978-3-942524-58-2

This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License:
<https://creativecommons.org/licenses/by-sa/4.0/>.



First edition published in 2019

© Science on Stage Deutschland e.V.



Science on Stage -

The European Network for Science Teachers

... is a network of and for science, technology, engineering and mathematics (STEM) teachers of all school levels.

... provides a European platform for the exchange of teaching ideas.

... highlights the importance of science and technology in schools and among the public.

The main supporter of Science on Stage is the Federation of German Employers' Association in the Metal and Electrical Engineering Industries (GESAMTMETALL) with its initiative think ING.

Join in – find your country on

www.science-on-stage.eu

www.facebook.com/scienceonstageeurope

www.twitter.com/ScienceOnStage

Subscribe for our newsletter

www.science-on-stage.eu/newsletter

A project by



Main supporter of
Science on Stage Germany



Proudly supported by

