Open Environmental Sensing Toolkit

OPEN!
NEXT

waag futurelab

Introduction

Welcome to the Open Environmental Sensing Toolkit! This kit can be used as a guideline for developing open hardware for environmental sensing. Co-creating devices such as meters for air quality or sound level disturbance together with citizens will lead to better problem-solving in the local environment. Not to mention the benefits of open-source hardware: by sharing your process, others can learn and build upon what you have made, and vice versa.

Colophon

The Open Environmental Sensing toolkit is developed by Waag Futurelab as an adaptation on paper of the digital “Transforming Citizen Sensing Toolkit”. The digital “Transforming Citizen Sensing Toolkit” was developed on the Miro platform and it was used during the series of four online workshops called “Transforming Citizen Sensing Design Sprint” to tackle air quality issues and concerns. The Design Sprint was released in the context of Open Next.

Open Next is a European project that aims to provide access to and share current open source technology, to create collaboration between the Fab Labs community and companies, to work with open source hardware to co-develop products and services with makers and their customers, and to document these journeys and to share all the results of this project.

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Instructions for use

The Open Environmental Sensing toolkit consists of four blocks. Each block is dedicated to a different topic related to an environmental monitoring action. The topics cover the scenario in which the monitoring should happen, the features that the hardware should have, the data management and, to conclude, the map of desired roles involved in the sensing action.

The toolkit is developed to be used through a series of in-person workshops to facilitate the collaborative design process in the frame of Open Source Hardware. The toolkit aims to facilitate the collaboration between individuals, communities of citizens and organisations with data-tech companies and municipalities.

During the workshop the toolkit should be used in groups; each group should be guided through the kit blocks by someone who is familiar with the toolkit and the concepts of environmental sensing. To use the full potential of the toolkit, it is strongly recommended to involve experts in the field of environment, hardware and data in the workshop.

The output of the toolkit should be the definition of the main features that define a sensing device, how the data should be managed and who should participate in the monitoring action.

The final aim of the toolkit is the definition of a business model where the collaboration is defined around Open Source Hardware.

Note: this version of the toolkit is developed around air quality issues. To be able to tackle other environmental problems, some adjustments must be made.

Block 1
The Scenario

Presenting yourself

Let’s get to know each other and get familiar with the toolkit.

- Take a picture (polaroid) of yourself and write your name on it.
- Draw an image that represents your interest/experience in environmental sensing and write what it is.
- Fill in the Scenario table. You can fill one or all the cells.
- Each participant will introduce themselves.
- Form groups based on similar concerns/impact/setting.
- Once the groups are formed, move the photos on the “groups board”.

Name:

Profession:

Interests:

photo

Name:

	Scenario	Your own scenario	Draw an image that represents your interest
CONCERN	What drives your interest in environmental sensing? What are you concerned about the most: environmental pollution? Health, lack of awareness, quality of nature...		
IMPACT	What would you like to achieve through environmental sensing? Behaviour change, politics, justice, awareness, industrial standard...		
SETTING	Description of the place		

Scenario

It is time to work in groups! Now you will reflect on the scenario that brings together the participants in this group. The scenario is characterized by three aspects: concern, impact, setting. These will be used to define the first specification of the sensing device.

- Together, fill in the table below.
  Members of the group use different colours to share individual answers.
- As a group, reflect on the answers, find shared points.
- Define the group scenario and define the common concern, impact and setting.
- Summarise the input and note them in the rightmost column.
- Pick a group name.

Group name:

Members:

	Scenario	Individual answers (diverge)	Common answers (converge)
CONCERN	What environmental factors do you need to measure, to tackle your concern? What should the device measure? What quality of measurements is required to identify and communicate your concern?		
IMPACT	How would you use the collected data to accomplish your impact?		
SETTING	Where should the device be placed?		

Map the criteria

What are the values that the sensing device should represent? The three most relevant criteria for the group will be our reference for the definition of the sensing device and the development.

- Each group member selects three criteria and marks them with a red sticker.
- Write down why they are important for the design and development of the sensing device.
- As a group select the three most relevant criteria and mark them with the green stickers.

Add your own criteria here.

	Sustainability	Open Data	Accessibility	Easy to use	Open Source	Engagement	Low cost	
Personal preferences & reasons								
Group choice								
(For use in Block 4) Do the hardware/ data choices reflect the chosen criteria?								

Block 2
The Hardware

Picture the setting

Imagine and sketch the setting in which the device should be deployed.

Setting

Mark the kind of setting of the monitoring action:
(you can mark more than one setting)

- ☐ outdoor public spaces
- ☐ indoor public spaces
- ☐ outside my home
- ☐ inside my home
- ☐ rural
- ☐ wild area
- ☐ other .....

Picture the concern

Add the environmental factors that you are concerned with (like sources of pollution) to your drawing on the right.

The setting:

Hardware specifications

What are the best choices in terms of hardware and technology based on the envisioned setting? The four technical topics are: setting identification, mode, power and connectivity.

Mark/write down the answers per topic.

Setting identification

How does the sensing device know in which setting it is running (indoor, outdoor, both)? Pick one:

- ☐ It is not relevant. The device is supposed to work only in one setting.
- ☐ I update the settings manually on the registration platform, for example on a web browser platform.
- ☐ I use the interface on the device.
- ☐ The device should know by itself:
  Can you think of a hardware solution so the device recognizes the different settings indoor and outdoor? Write down your answer:

Mode

In which mode will the sensing device operate?

☐ Mobile ☐ Static

If static, how should the device know the location?

- ☐ The device should know it by itself. (GPS)
- ☐ I update the location on the registration platform, from web browser.

If the device operates both in mobile and in static mode, how does the device know whether it is moving or static?

- ☐ I use the interface on the device.
- ☐ The device should know it by itself.
- ☐ If the device should know it by itself, can you think of a hardware solution so the device recognizes the different conditions?

Power

How should the device be powered?

- ☐ The sensing device must be plugged to the grid.
- ☐ The sensing device runs on battery.
  If it uses batteries, how long should they last?
  Your answer:
  Would the battery be rechargeable? If so, how should the battery be recharged? Your answer:

Connectivity

Can you identify the best connectivity for your setting?

- ☐ LTE-M – There are no passwords involved, it uses the network of mobile phone providers, you need a SIM card.
- ☐ WiFi – It has a range limitation, you need access to the wifi network, you need to insert the password.
- ☐ LoraWAN – You must be sure that there is network coverage, there are open source projects that guide you to create your own network, you don't need a password.
- ☐ NB-Iot – It uses a mobile phone provider network, you need a SIM card, you don't need a password.
- ☐ Bluetooth – It has a range limitation, it allows the communication with other BL devices (for example PC, smartphone, etc).
- ☐ Other:

Notes:

Hardware specifications – sensors

Previous experiences
If you have experience with sensing devices and environmental monitoring, this is the right moment to share it with the rest of the team.
If you were involved in the sensing actions, fill in the table.

What was the device that you used?				
Which sensors were included in the sensing device?				
What was successful?				
What should be improved?				
What was unnecessary?				
What was missing?				

Hardware specifications – sensors

Picking the right sensors

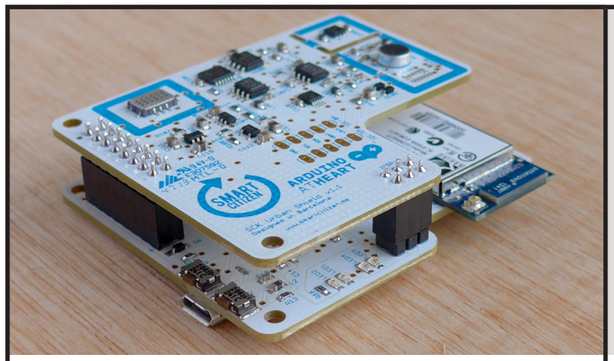
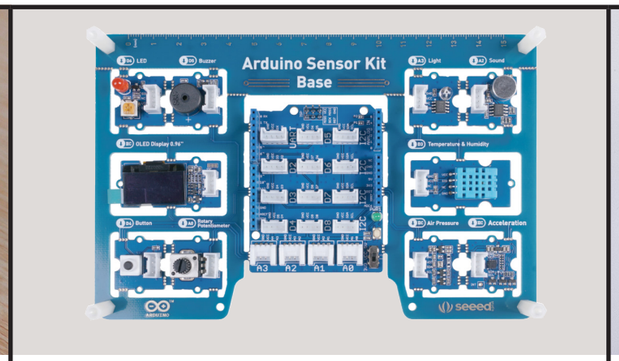
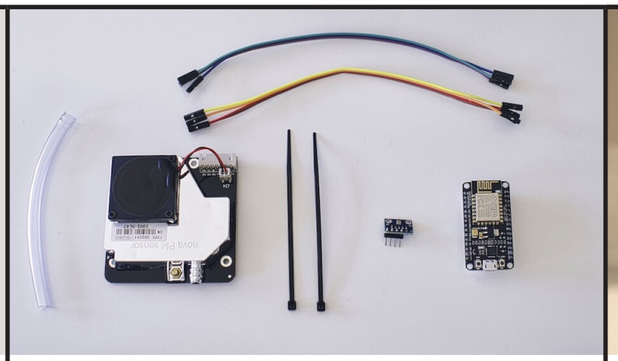
What sensors do you need based on your concern and the scenario that you pictured?				
Are there any extra features that you would like to implement in your sensing device?				

Hardware specifications – usability and sourcing

Please answer following questions:

Who should use and deploy the sensing device?

Considering who will use the sensing device, which is the best physical platform for it?

			
Single Board, off the shelf	KIt Plug and Play, just connecting the modules on the right	Stand alone components	Electronics boards on which the components must be soldered
Description:	Description:	Description:	Description:

Who should source and provide the hardware?

Hardware specifications – enclosure

It is time to reflect on the case that hosts and protects the electronics parts. The kind of enclosure is strongly related to the setting and the location in which the sensor is placed.

Can you specify some features of the enclosure based on the setting?

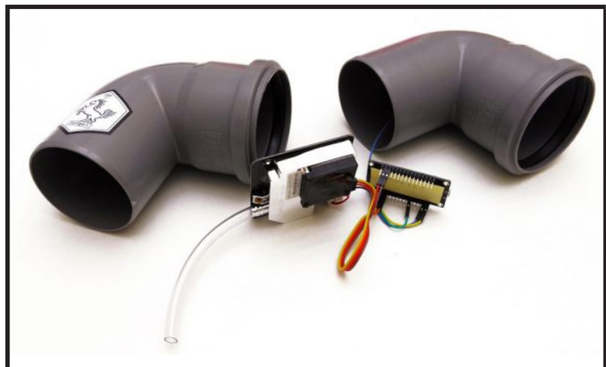
- ☐ Waterproof
- ☐ Vandalism proof
- ☐ Last under UV light
- ☐ other: .....

What kind of mounting does it need?

What kind of interaction should the device provide? Are there lights, buttons, displays...?

Make a sketch of the device as you imagine it

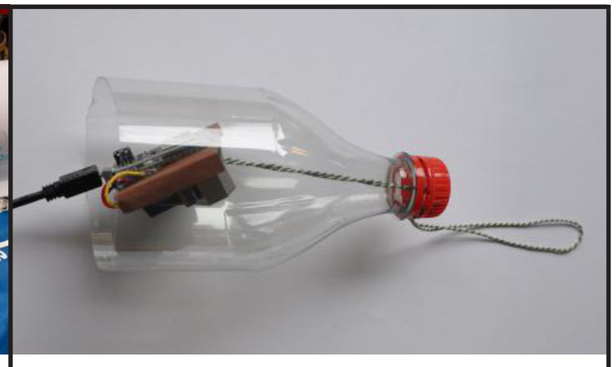
How should the enclosure be made?



Off the shelf standards part

3D printed in a fablab/makerspace

Customised parts, ready to buy



Do It Yourself

Block 3
The Data

Data – impact – back-end

Create a visualisation of the impact with a sketch in the frame to the right, or write down a few key words:

What kind of data do you need or would you be interested in? And why?

How would you use the collected data to accomplish your impact?

Data

What kind of data are you interested in to realise your expected impact?

- ☐ Raw data
- ☐ Calibrated data
- ☐ Processed data: average, minimum/maximum

Can you elaborate on your choice?:

Sketch the impact:

Access/format

What kind of data access do you need?

- ☐ I don't need the data locally stored (e.g. saved on my computer.) I want the data to be visualised and saved somewhere else.
- ☐ I want to be able to download the data. Answer the following questions:

  – In what format would you download the raw data?
  - ☐ Formatted numbers, organised in a table.
  - ☐ A plot, a time series.
  - ☐ A weekly report.
  - ☐ Other:

  – What tool would you use?
  - ☐ API
  - ☐ Online link
  - ☐ Other:

A short explanation of different kinds of data can be found with the link in this QR code.

Data – impact – front-end

It is time to think about the visualisation of the data, where and how it should happen. On site? Online or directly on the sensing device?

On site data visualisation in public or physical spaces

Would you need to visualise the data through a physical interface? (See examples on the right.)

☐ No.
☐ Yes, if your answer is yes:
Where should the physical information be located?

.....

.....

What information should the visualisation contain?

☐ Raw data
☐ Calibrated data
☐ Processed data

Digital data visualisation

Would you need to visualise the data on a digital platform? (See examples on the right.)

☐ No.
☐ Yes. If your answer is yes:
What kind of data are you interested in to realise your expected impact?
☐ Raw data
☐ Calibrated data
☐ Processed data

How would you like to visualise the data on a digital platform?

☐ Single value
☐ Time series

Based on your experience, can you identify one main characteristic that you find essential in the digital data visualisation? (Example: to be able to compare data of different locations, or to get the minimum and maximum values in a specific time range.)

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Data visualisation on hardware, directly on the sensing device

Do you need the sensing device to give you feedback about the collected data? (See examples on the right)

☐ No.
☐ Yes.
If your answer is yes, why?: .....

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.....

What kind of feedback would you like to receive from the device?

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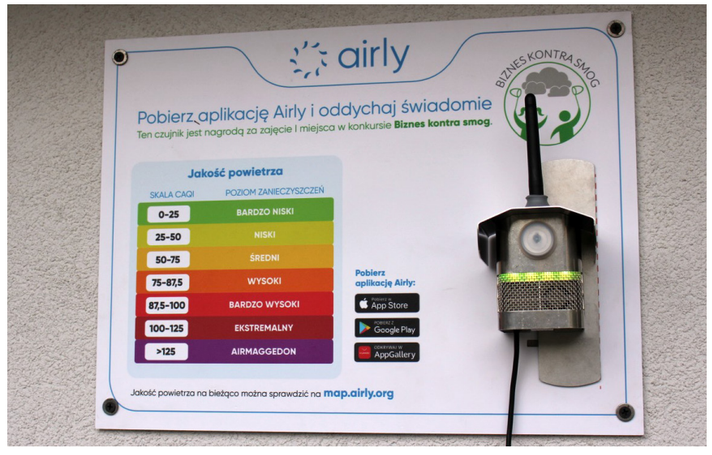
Examples of data visualization on hardware:

Air Quality Egg

Pocket monitor

Examples of physical interface:

Real time data on pollution and climate conditions



An Airly air quality sensor and sign in Poland

Noise pollution visualizer in Barcelona

Data storage and calibration

Storage
Who should own and manage the database where the data is collected and stored?

- ☐ Citizens
- ☐ University
- ☐ Environmental Agency
- ☐ The company that produces the hardware
- ☐ Other: .....

Calibration
Who should apply the calibration?

- ☐ Citizens
- ☐ University
- ☐ Environmental Agency
- ☐ The Company that produce the hardware
- ☐ Other: .....

Open access to data
Who can see the data of your device? And which data?

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Who can download the data from your sensing device?

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Would you share the data with someone else?

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.....

Who can access the different datasets collected by the sensing device? Can you imagine the purpose of each data set?

Dataset	Raw data	Filtered raw data	Calibrated data	Processed data
Who has access?				
What is the use/ purpose?				

Block 4
Finalize

Criteria check

Are we respecting the criteria we selected?

How can the development and the use of the sensing device (hardware and data) reflect the criteria?

Go to ‘Map the criteria’ in Block 1 and fill in the last row of the table.
How do the hardware/data choices reflect the criteria?

Final concept

Let’s recap the many considerations in a single table that can be used to present your work:

Fill in the table, adding the key words and main specifications that describe the concept of your sensing device.

CONCERN	IMPACT

CRITERIA

HARDWARE	
Power	Sensors
Connectivity	Identification (indoor/outdoor and mobile/fixed)

SETTING How would you use the device?	ENCLOSURE What features should the enclosure have?

DATA What data do you need? How would you like to visualise the data?

Map of roles

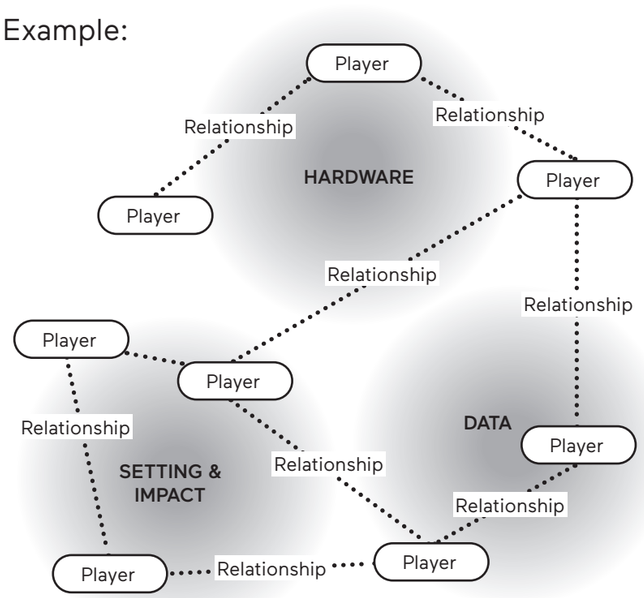
The use of open source devices for environmental sensing involves the participation of different people, organisations, and parties. What is the relation between all of them?

Create the map/network of the entities that are involved in a sensing action and describe the roles and relations.

Consider the following questions:

- Who should develop such a tool?
- Who should pay for it?
- Who should deploy the sensing device, monitor it and maintain it?
- Who should calibrate the data?
- Who should analyse the data?

Example:



Map out the relationships and roles: