



# The Internet of Bananas

Critical Design and Playfulness for Citizen Sensing and Electronic Literacy

Mattia Thibault\*  
mattia.thibault@tuni.fi  
Tampere University  
Tampere, Finland

Ferran Altarriba Bertran  
Tampere University  
Tampere, Finland

Eleni Legaki  
Independent researcher  
Athens, Greece

Artur Vasconcelos Cordeiro  
artur.cordeiro@gmail.com  
Independent researcher  
Fortaleza, Brazil

Annique Smith  
Tampere University  
Tampere, Finland

Vera Karina Gebhardt Fearn  
Universidade Nova de Lisboa  
Carcavelos, Portugal

Yoram Chisik  
Goldsmiths, University of London  
London, United Kingdom

Marina Lima Medeiros  
Zentrum für Virtual Reality und  
Visualisierung Forschungs  
Technischen Universität Wien  
Vienna, Austria

Vasileios Kolettis  
Independent researcher  
Athens, Greece

## ABSTRACT

In this paper we recount the “Internet of Bananas” (IoB), a designed exploration of citizen sensing as well as an exercise in “useful futility”. The project mixed critical design and satire to explore social justice attitudes towards data collection and electronic literacy. In the IoB a number of participants from around the world collaboratively created and set up a small IoT network by programming and interconnecting a set of sensor kits with which they monitored the colour, surface temperature and humidity of a network of bananas for the duration of one week. The main goal of the creation of such network was to be a platform for reflection, discussion and exchange on themes related to data production and collection. The IoB was active for a week, the “Banana Jam”, after which a debriefing provided an occasion to gather precious feedback from the participants and to assess, with their help, the entire process. The feedback, articulated around five main themes, has led to the creation of six final design considerations related to the combination of natural elements and digital technologies, the values of weirdness and play for critical design and its dissemination, and the importance of inclusivity and openness in regard of data collection and visualization.

## CCS CONCEPTS

• Hardware → *Bio-embedded electronics*; • Human-centered computing → *Empirical studies in collaborative and social computing; HCI theory, concepts and models*.

## KEYWORDS

Internet of Things, Critical Design, Going bananas

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

CHI EA '23, April 23–28, 2023, Hamburg, Germany

© 2023 Copyright held by the owner/author(s).

ACM ISBN 978-1-4503-9422-2/23/04.

<https://doi.org/10.1145/3544549.3582746>

## ACM Reference Format:

Mattia Thibault, Artur Vasconcelos Cordeiro, Yoram Chisik, Ferran Altarriba Bertran, Annique Smith, Marina Lima Medeiros, Eleni Legaki, Vera Karina Gebhardt Fearn, and Vasileios Kolettis. 2023. The Internet of Bananas: Critical Design and Playfulness for Citizen Sensing and Electronic Literacy. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems (CHI EA '23), April 23–28, 2023, Hamburg, Germany*. ACM, New York, NY, USA, 8 pages. <https://doi.org/10.1145/3544549.3582746>

## 1 INTRODUCTION: BANANA-CENTRIC DESIGN

This paper illustrates the “Internet of Bananas”, a critical design project that mixed satire and digital technology in order to explore social justice attitudes towards data collection and electronic literacy. In the project a number of participants from around the world built, programmed and interconnected a set of sensor kits with which they monitored the colour, surface temperature and humidity of a banana for each station for the duration of one week. At the heart of the project lies the banana, an edible fruit (although botanically a berry) of the genus *Musa* that is richly imbued with nutritional elements and cultural meanings and through its universal appeal and availability acts as a perfect reflection of a ubiquitous product in the global market. Although a profound socio-cultural discussion of the banana would go beyond the scope of this work, we will nevertheless mention a few selected examples here that show the various symbolic meanings of the banana which served inspiration for the project<sup>1</sup>. The first cultural artefacts on which the banana can probably be found come from the Asian and Oceanic region, which is also the original cultivation area. They are found as decorations on various objects such as pots, vases, and other forms of porcelain, as well as singular depictions in drawings, poems and songs, notably in China [11]. From Asia, Arab traders brought the banana to the Middle East and Africa.

In the 15<sup>th</sup> century, the banana was brought to South America by the Portuguese and the Spanish and first artistic representations

<sup>1</sup>You can see some images here. <https://internet-of-bananas.github.io/map/references.html>

of bananas appeared as part of ethnographic portraits. With the declarations of independence of the Latin American states, the banana became a symbol of cultural identity. In the works of the Puerto Rican artist Francisco Oller, the banana becomes a symbol of national pride, and in the avant-garde movements of the early 20<sup>th</sup> century Brazilian artists Tarsila do Amaral, Anita Malfatti and Lasar Segall frequently portray bananas to allude to the influence that people of African descent had upon the Brazilian culture.

With the rise of the international export of bananas numerous artists have also focused on the exploitation of the regions and its population and reflect on the socio-political realities. The latter was impressively shown on two recent works: "Banana Craze", is the first major study and digital exhibition<sup>2</sup> to examine of how the banana has shaped the past and present of Latin America and the Carribbeans, and how this phenomenon finds expression through their culture; and the exhibition "Like a banana tree at the gate" by Yee I-Lann, that was showcased at Mind Set Art Center in Taiwan in 2017, references the a study on early economic form of resistance against colonial forces in Borneo – by not planting a tree at the gate one would not show its wealth and could conceal one's resources from being exploited by the colonizers.

Beyond the places where bananas were grown, the fruit remained relatively unknown until the 19th century. Through improved distribution channels, bananas now also reached the northern hemisphere and quickly became a symbol of economic success. In West Germany, the banana became a symbol of prosperity in the 1950s, which is particularly evident in the advertising of the time. In the GDR, on the other hand, they were synonymous with western living standards, a status symbol that only became accessible with the fall of the Berlin Wall in 1989.

The banana became a (pop) art icon with Andy Warhol's peelable album cover created for rock band The Velvet Underground & Nico that played with the banana being an erotic object. The sexual (and at times offensive) connotation can also be found in language: In Brazil, the obscene gesture *bras d'honneur* is called "give a banana".

Rather recently, the Banana itself has been a reflective object in contemporary arts, namely by Stefan Sagmeister's Banana Wall, who used the banana's deterioration process to showcase the volatility of arts; or Maurizio Cattelan's duct-taped banana in 2019 can be read as commentary on the current nature of the art world.

To summarise, we named four of many ideas that the banana incorporates: the cultural, the capitalist, the erotic, and the crazy. It is this multi-levelled symbolic and at times controversial meaning that makes the banana an interesting object to experiment with. In our project, we decided to harness the critical and design potential of "being bananas" by putting the yellow fruit at the very centre of our design. The Internet of Bananas is a satirical project inspired by principles of critical design, DIY, bottom-up participation and playfulness. In this paper, we will briefly account for these principles and provide an overview on the development and deployment of the IoB. The main contribution of this study emerges from the project's results and the feedback from the participants and consists in a list of key themes and a series of design considerations. We hope the experience of the IoB will offer some useful guidance for scholars, designers and communities interested in citizen sensing (or more

in general in citizen science) as well as in projects of critical and satirical design - and for banana-lovers around the World.

## 2 BACKGROUND - CRITICAL, BOTTOM-UP, PLAYFUL

### 2.1 Critical Design and The Internet of Things

Critical design is a specific approach to design research that reappropriates the language and tools of design and uses them as a means for social critique. It is rooted in several *avant-garde* movements of the 1960s and 1970s, and in particular it emerged from the works and approaches of situationism and radical design. "Radical design" - sometimes "Italian radical design" - indicates a specific set of design products and theories developed between 1960-1975. In that period, designers, especially in Italy, pushed for a reform of the societal role of designers, or, in some cases, rejected their role in the socio-industrial complex altogether [1]. This movement, which focused primarily on interior design, re-imagined the social role of the designer and rooted it on the potential of design to become a tool for social critique [7]. This new approach to design was later expanded to electronic products, for example thanks to the work and practice of Antony Dunne [3], and acquired the name of "critical design". Satire is a salient concept when it comes to critical design [15], and has often been employed in HCI to demonstrate concepts *ad absurdum* [13] [12] [14] and often under influence of dadaistic conceptions. Similarly, uselessness, exemplified by the *Chindogu* (clever and humorous artefacts with no actual use) has often been considered a tool for speculation in design [2], to promote problem solving [17] and defamiliarization [4]. The Internet of Bananas adheres to this approach and is inspired by these principles. The project uses design for advancing critique over the "hunger" of data that characterises the current discourses around technology and its ideological roots. Data, and especially big data, has acquired a position of prominence in the technological landscape of our time, often accepting a-critically the value of data itself. Internet of things applications, aiming to connect everyday objects and collect large quantities of data from them, are generally presented as innovative and beneficial. Sleep-tracking mats promise to improve rest by collecting data about night movement, while products such as the connective doll *Hello Barbie*<sup>3</sup> or the smart dog toy *Wickedbone*<sup>4</sup> claim to improve playful interactions. This *data ideology* could be articulated in three main assumptions: first, that data is key to understanding many phenomena, including anthropological, social and cultural ones; second, that data has an intrinsic value and generating data equals generating value; and, third, that data is truthful, data don't lie. However, data can indeed be deceitful, as in the Volkswagen emissions scandal, in which vehicle controls were programmed to act differently and thus produce a different set of data during emissions testing which in effect falsified the test results showcased [10]. Moreover, issues concerning e-waste are emerging, underlying how much of the data that we are storing and accumulating has no actual value, while still having a considerable negative impact because of its energy consumption and use of real estate [9]. The Internet of Bananas, hence, is a project that makes use of parody to criticise the ideologies behind traditional

<sup>2</sup><https://bananacraze.uniandes.edu.co/language/en/>

<sup>3</sup><http://hellobarbiefaq.mattel.com>

<sup>4</sup><https://www.cheerble.com/en-eu/products/wickedbone>

approaches to big data and the Internet of Things. By creating a network between objects that have no use being interconnected and by collecting data that are implicitly useless, the IoB aims at a reversal of the logic behind IoT technologies.

## 2.2 Citizen sensing

The Internet of Bananas, nevertheless, has also a second dimension, related to electronic literacy and citizen sensing. Our approach is not a “luddist” one, opposing the technology *per se*, but one of social critique and deconstruction: challenging the ideologies and assumptions in its regard. The paradigm of citizen sensing, which has been gaining traction in the last years, is a reaction to some of the most problematic aspects related to the power dynamics in data creation and management. It supports a democratisation of the sensory processes [23], which is believed to allow the production of data that are both more reliable and meaningful. One relevant example is *Safecast*, an international and volunteer-based citizens sensing effort dedicated to gathering and openly sharing data on environmental radiation and other pollutants in the aftermath of the Fukushima Nuclear Power Plant disaster in 2011 [16]. Another example is *Hollandse Luchten*, a Dutch project which deployed a measurement network of sensors to map out the living environment of North Holland. Volunteer citizens received kits that allowed them to build and position the sensors, while the data collected was disseminated in creative and playful ways [22]. From this perspective, the IoB aims to teach its participants how to assemble and code simple sensors and how to display and share openly the data collected on Adafruit IO. Participating in the IoB and constructing one’s own sensors, then, becomes a learning opportunity. After the end of the Internet of Bananas, participants are free to use the sensors they built for whatever purpose they like, collecting and sharing sensor data as they wish.

## 2.3 Playfulness and gamification

Already in the late 1990s, Brian Sutton-Smith was suggesting that Western culture was undergoing a “ludic turn” [20]. This cultural change, that today is becoming an increasingly global form of *ludification*, is at the heart of the many strategies to motivate and attract users, commonly referred to as “gamification” [8]. While the debate about these practices is very much open [21], we recognise that the intrinsic ability of playfulness to disrupt and challenge [19] [6] is a very good fit for the critical and satirical approach of the IoB. Therefore, we decided to include a playful, surreal and situationist character in the IoB. In fact, the very object at the centre of the IoB, the banana, with its intrinsic ambiguity and silly connotations - as well as a rather toyish appearance when it comes to colour, shape and material - is instrumental for this. On the one hand, the silly and playful spirit of the project is meant to capture the attention of the public and participants. On the other hand, the situationist estrangement or defamiliarization effect that emerges from the combinations of bananas and technology supports the satirical and critical objectives of the project.

## 3 METHODOLOGY: HOW TO DO THINGS WITH BANANAS

The IoB project was developed as both a design-led exploration of citizen sensing and an exercise in “useful futility”. Its main goal was to collaboratively create and set up a small IoT network (by providing guidance and promoting electronic literacy among the participants) and use it as a platform of reflection, discussion and exchange on themes related to data production and collection.

The project was hence articulated in three steps. First, the organisers recruited participants interested in realising their own IoB stations. A call for participants was disseminated within several networks and social media and shared directly with designers and academics working on adjacent fields. Fifteen participants expressed their interest in joining the project, even if only eight of them were actually able to participate. The final participants were rather diverse both in terms of background (including designers and researchers on HCI, gamification, education, media architecture, semiotics and more) and geographically (representing eight different countries: Austria, Brazil, Finland, Greece, Israel, Portugal, South Africa and Catalonia). The second step was related to the setup of the IoB stations. The participants, with the help of the organisers, acquired the necessary materials and assembled and programmed the sensors, connecting them to the IoB network. The third step was the Banana Jam, a week-long event at the beginning of which all the participants met remotely and activated their sensors and connected them to fresh bananas, simultaneously. The data were collected throughout the week and displayed on a dedicated website. A final meeting was dedicated to debriefing and sharing experiences, ideas, hopes and feedback.

In the next two subparagraphs we will elaborate more in detail about the last two steps.

### 3.1 Technical specification and setting up of the IoB

Participants were not expected to have any coding or electronic skills. The only requirements stipulated for joining the project were that the participant would have: a computer, a WiFi connection, and the willingness to acquire the materials necessary for the construction of the IoB station. To support the electronic literacy aims of the project, each of the participants had to set up their own IoB station and get it to work. To facilitate this process, we created a page on GitHub with a complete listing of the materials needed for the project including reference images of the required components and brief explanations of common issues that can be expected in order to help the participants acquire the correct items. The total cost of all the components necessary to build an IoB station was about 35 Euros (February 2021 prices, with some variation due to differences in pricing and shipping costs to various countries in which the participants resided.).

The sensors used in the IoB were selected to be cheap and easy to purchase (also to allow participation from all countries, regardless of their income levels) as well as simple to set up (without requiring soldering or any special tools) and to program to maximise accessibility. As the experience of measuring and sharing information was more relevant to the project than the high accuracy data, we did not opt for expensive and precise sensors. In order to have a

standard reference to get the data, the whole network of IoB should be based on the same devices. Each of the IoB stations is composed of a microcontroller NodeMCU Esp8266, a colour sensor TCS3200 and a temperature and humidity sensor DHT11. The colour sensor was used to monitor the skin colour of the banana, while the DHT11, placed close to the banana, monitors the air temperature and humidity nearby. The data collected by the sensors are sent via a WiFi connection to the Adafruit IO platform, every 30 seconds. The data from all the IoB stations around the world were then gathered using Adafruit IO API and displayed in a custom World Map web page. Besides the electronic components, participants needed an USB wall charger and an USB cable Micro-B to power the IoB station, as well as an electrical tape, and rubber bands to secure the components, and, of course, a fresh, yellow, banana. The whole process of configuration was explained in a tutorial available on GitHub as well as through video calls in which one of the organisers would guide them through each step. The setup included the installation of the microcontroller driver in the computer, so it could be programmed using the software Arduino IDE; the wiring connection of the sensors to the microcontroller; the colour calibration of the sensor, updating the code with the values of references obtained from reading a black and white surface; the code update with the name and password of the available WiFi network; and the creation of an account at Adafruit IO, whose user name and key would also need to be inserted in the code, so the sensor data could be saved at Adafruit IO server. The code for the IoB, written by the organisers, is openly available in the GitHub repository<sup>5</sup>. To facilitate understanding and learning, six code files of increasing complexity were provided to help participants understand the different sections of the code and combine them. The different files were also used to gradually test the installation of the components, in particular testing the colour sensor, applying an Exponentially Weighted Moving Average (EWMA) filter to decrease noise in the colour reading, calibrating the colour sensor, converting of decimal numbers to hexadecimal values, testing the temperature and humidity sensor, and finally putting all the pieces together to connect to the Internet and send the data to the Adafruit IO. The setup process ran rather smoothly, and was the main process dedicated to improve the electronic literacy of the participants. As the participants had rather different backgrounds, some needed more support than others, while some were able to set up their stations without needing any significant assistance. As expected, some technical issues did occur. For example, one participant had a microcontroller driver issue in a new Macintosh computer and which was not solved on time, therefore hindering their participation in the Banana Jam.

### 3.2 The Banana Jam

The second week of June 2021 was dedicated to the Banana Jam, an event that brought together all the IoB network. It opened with a kick-off event, in which the participants presented the main ideas behind the project (citizen sensing, critical design, playfulness). Later the participants were given time to introduce themselves and their backgrounds and to express their initial thoughts about being part of the IoB. Finally, all participants showed their IoB stations and their bananas - often unprompted decorated in playful ways and

baptised with cheeky names - and all the sensors were turned on. The stations were accompanied by pictures and a short description, also shared on the website<sup>6</sup> (Fig. 1):

- Ba Nana (Athens, Greece) - I am a beautiful banana living in Greece. With the help of friends I will document my life and share it with you. Nice to meet other bananas around the world in this lovely experiment.
- Liliana (Tampere, Finland) - Liliana is an augmented banana. Originally from Peru, she is now living in Tampere. She is interested in transfruitism and likes to look badass.
- Bananenstein (Barcelona, Catalonia) - Bananenstein — also referred to as "what the f\*ck are you doing with my banana?" (my dad dixit). Bananenstein is a rather funky assembly of electronics and perishables created for the IoB network. It features a banana from the Canary Islands.
- Prata (Fortaleza, Brazil) - Banana Prata is the famous Musa x paradisiaca from the family Musaceae. The connected Prata is an organic banana from the hills of Baturité, and now it lives near the Atlantic Ocean.
- Banano and Banana (Cacilhas, Portugal) - Originally from Madeira, a small island in the Atlantic ocean, the twins Banano and Banana are on their first-ever holiday and are currently hanging around in Cacilhas. They already spent some days in a small Chinese fruit shop and met distant relatives there and are now taking some days off to enjoy the *dolce far niente* and get tanned.
- Bananatrooper (Vienna, Austria) - After a breakthrough Bananatrooper found out that she comes from a Rainforest in a galaxy far far away. Now she joined the Climate Change Resistance to fight the Empire of Agribusiness and save her homeland. She is now in Vienna for a special mission.
- Benjamin Banana (Pretoria, South Africa) - I am a proudly African banana. I am excited to be networking with other bananas around the globe and tracking my degeneration process.
- Baaaaanaaaaanaaa (Haifa, Israel) - It is of an unknown origin and was found roaming the streets of Haifa, Israel. It currently resides in shaded accommodation in an apartment to keep away from the sun and the packs of wild boars who roam the city in search of fruits and other edibles and serves as its roommate's writing muse.

For the subsequent week, the IoB stations independently collected data about the slowly decaying bananas and sent it to the Adafruit platform. The IoB website showed the collected data, as well as the profiles of each banana and a map of the network.

At the end of the Banana Jam a second meeting was organised, to debrief and share experiences. The organisers showed some data visualisation of what was collected during the week, and highlighted some smaller technical hiccups. Subsequently it was the participants that shared their experiences and feelings about having the IoB running in their homes or workplaces. Finally some last steps were discussed, including potential academic dissemination and, most importantly, exploring possible alternative uses of the sensors.

<sup>5</sup><https://github.com/Internet-of-Bananas>

<sup>6</sup><https://internet-of-bananas.github.io/map/>



Banana Jam, Day 1



Banana Jam, Day 8

**Figure 1: All the IoB stations at Day one (left) and 8 (right) of the Banana Week**

## 4 RESULTS: FRUITFUL EXPERIENCES

### 4.1 Data and data visualisation

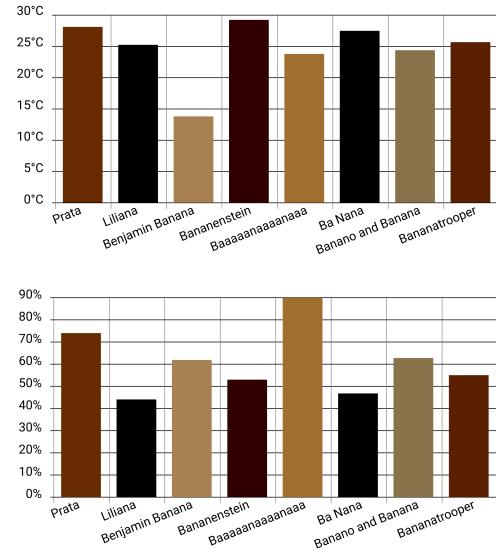
Throughout the Banana Jam, for an entire week all the IoB stations of the Network were active, sharing three different data sets: skin colour of the bananas, air temperature and air humidity. At any given moment, the last updated data related to all the IoB stations could be seen on the participants' dashboard in their account of Adafruit IO, as well as in the IoB website, created expressly to this end with a particular attention to the data visualisation. The eight IoB stations were spread in different regions of Planet Earth, sometimes separated by thousands of kilometres. If Liliana in Tampere would want to visit Benjamin Banana in Pretoria she would need to travel about 10.000km. In order to highlight the width of the Network, the IoB Website features a world map (Fig. 2) which displays the location of all the IoB stations. Positioning the cursor over one of the banana icons representing the stations on the yellow map would also reveal the last data collected, allowing a general overview of the whole IoB network. As a style of representation it was chosen to display the map with only the cities names, without countries names, so as to represent the World as a global territory for the banana network. The map had limited zoom rate, and therefore did not reveal the exact location of each station: the world map

showed the IoB station icon in the latitude and longitude coordinates of the respective city, not in the exact position where the IoB station actually was located.



**Figure 2: The IoB World Map**

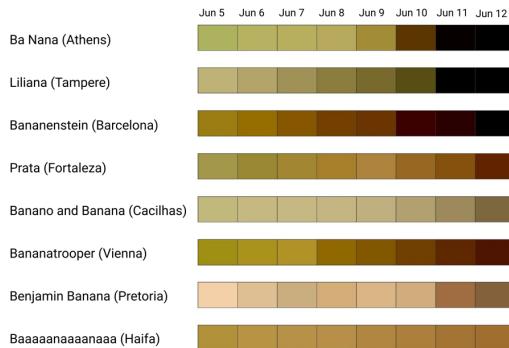
The humidity and temperature data (Fig. 3) were interesting information to help contextualise the condition where the banana was placed, revealing some interesting relations across continents and hemispheres. Even though it was summer in the northern hemisphere, Liliana in Tampere was not as hot as Prata in Fortaleza. And the winter temperature in Pretoria, around 15° Celsius, may suggest why the banana did not become completely black during the Banana Jam.



**Figure 3: A visualisation of the colour (the bars' colour correspond to that of the banana skin), temperature (top), and humidity (bottom) of the IoB stations in a given moment of time.**

The participants were asked to photograph their IoB stations before and after the Banana Jam, so as to capture their particular visual styles and their levels of ripeness. In parallel, the organisers

collected a history of the colour data set so as to allow a diachronic parallel visualisation of the evolution of the colours sensed by all the stations. This data was then displayed in an unplanned table, which however was not featured in the website, but shown to the participants during the debriefing (Fig 4).



**Figure 4: The colour of the Bananas thought the week**

During the Banana Jam issues arose with some IoB stations. To display the colour data at Adafruit IO dashboard, the number had to be formatted as hexadecimal (#RRGGBB). However, we found an issue in the code when a “0” was in the left position of one of the RGB values, for example #C95E0D, the “0” was omitted resulting in #C95ED, thus Adafruit IO displayed black. This problem only happened when the banana skin was becoming darker, so when the numbers were becoming lower, and for this reason was discovered late. A patch was made to fix the bug and we requested the participants to update their codes on 10th June, two days before the end of the Banana Jam. However, the station of Benjamin Banana could not be updated because the original code file was deleted, so it lost its colour calibration values. However, since Benjamin Banana did not become dark enough to trigger the issue, it did not face the colour bug until after the end of the Banana Jam. Benjamin Banana’s issues were not over: its colour data seemed sometimes inconsistent: the brightness of the colour was not decreasing as it was supposed to do. This happened because the colour sensor was not tight firmly to the banana, so the change in position of the colour sensor resulted in change of the colour reading values. This as easily fixed. Another issue happened with Baaaaanaaaanaaaa, because the WiFi connection of the IoB station was based on the cell phone of the participant, and every time he left the house, the Baaaaanaaaanaaaa lost its internet connection. Those issues provided important evidence that even a simple network of connected devices such as the Internet of Bananas may face complex challenges which may compromise the whole project.

## 4.2 Participants’ experiences and feedback

The debriefing at the end of the Banana Jam was an occasion to gather precious feedback from the participants and to assess, with their help, the entire process. After a recount by the organisers of the overall experience and of the technical hiccups that inevitably occurred, the participants were invited to share their experiences,

thoughts and feedback. The meeting was recorded, with their explicit consent, so as to be able to reexamine it at a later point. One of the participants, who was not able to join the debriefing, but participated for the rest of the banana week, sent instead a 5 minutes video with his thoughts, which was shown during the event. In the feedback collected from the participants, we extracted some key elements from the videos and recordings of the debriefing and then used an affinity diagram to identify and analyse patterns in the recollections of the participants. We identified five:

- Fun. Rather simply, many participants used the word “fun” to describe how they experienced the Banana Jam and the whole process of being involved in the IoB. Assembling the components, without exactly knowing what was going on, was mentioned as one of the aspects that created more enjoyment, together with a sense of “ownership” for the devices and of being part of something weird and unusual. Someone also mentioned the names, descriptions and pictures of other participants’ bananas as a source of fun and entertainment.
- Social Interactions. Several participants mentioned that the IoB prompted several kinds of unusual social interactions. The ambiguity and strangeness of the IoB stations was reported to attract a lot of attention from family members and friends (when they were situated in homes), colleagues (when situated in office spaces) as well as on social media (Instagram was mentioned several times). The participants often described the reaction of other people to their bananas and sensors as one of curiosity and, in some cases, even of “freaking out” because of the unusual appearance of the artefact. Different participants took different stances towards this curiosity. Some enjoyed being the instigators of such open ended interactions and maintained an aura of mystery around it. Others reported that it opened discussions with their friends around topics that they would not discuss otherwise. Due to the duration of the process, a participant also recounted how her colleagues would ask for updates about the banana well-being.
- Sensor awareness. Several participants underlined how the IoB project influenced their relationship with sensors. While the ownership of the sensors was described as making the whole experience more interesting, many reported an increase in their awareness of the sensors already existing in their private spaces. This was perceived, in some cases, as an intrusion, making emerge the tensions and concerns surrounding data collection. In one interesting case, one of the participants provided the WiFi to the IoB through his phone. This meant that, whenever he was outside of his house, the data flux would be interrupted. In turn, this meant that observing the interruption in the data gathered by the IoB ended up being an invasion of privacy, potentially allowing to track whenever he was outside his residence. This unexpected accident with his IoB station (that was amicably renamed “spynana”), raised more important questions about the ethical concerns related to data collection.
- Engagement with the data. While the data was collected without any real purpose beside a critical reaction to IoT media ideologies, the participants often reported several kinds

of engagement with the data collected by the IoT Network. The data collection prompted some of the participants to pay close attention to the chromatic evolution of their bananas. In one case, the banana was reported to have been green for several days, and then turned brown after a stern rise in humidity. Another participant was surprised how long the fruit lasted before starting to rot, prompting him to reflect on the unusual weather of that period. Some users compared the colours of all the IoB stations, to track the evolution of their own. On the other hand, several participants recalled using the data also for other purposes, such as tracking the temperature in their office while considering if they might need to purchase a cooler, or comparing indoor temperatures in different countries to console themselves in a heat-wave.

- Emotional attachment. In some cases, participants recounted creating a bond with their bananas while taking care of them. They reported “checking on them” from time to time, keeping the dashboard under close surveillance, moving the banana if it would end up under direct sunlight and even stating that they would miss it after the Jam. Other participants, however, also expressed some regret that there was not much to do with the banana, while it was doing “her own thing”.

Part of the discussions initiated during the debriefing (and continued with email exchanges), regarded possible evolution of the IoB project as well as different possible uses of the sensors.

### 4.3 Future Perspectives

In regard to the future of the IoB network, the participants stated their desire to engage with future iterations and often agreed to become “banana evangelists” in the attempt to involve more people in the Network. As for the evolution of the project itself, one main theme emerged, that of increasing the possibility of interaction with the stations bringing “the human into the loop” - for example tracking the interactions as well. In regard to the possible uses of the sensors, two participants expressed the desire to create their own weather station with the sensors after the end of the Banana Jam. This prompted the organiser to ask the participants to imagine alternative uses of the sensors as a follow up task. The organiser themselves imagined a use of the sensor to track the change of leaf colour in a house plant (Fig. 5).

Only one of the participants responded to the request, providing a detailed account of her plans: “(...) I would like to use my station to map the weather outside my house along with the temperature inside. I plan to 3d print a case for the board to keep it safe and attach it to a power bank, like you’ve suggested. Then I will attach it outside my house, under the eave of the roof. Ideally, I would like to get another station for the inside of the house. In time, I plan to develop a web interface which would allow me to easily see the data from these devices on my smartphone and add notes. For example, if it is particularly hot on a day, I can add a note to say that there is currently a heat wave in the city etc. My goal with this setup would be to create a set of data that allows me to see the changes in temperature throughout the year, and how the temperature inside my house corresponds. Ideally, I would like to create some interesting visualisations using both sets of data”



Figure 5: The IoB sensors repurposed

### 4.4 Design considerations

Designing the Internet of Bananas, along with the experiences and feedback of the participants, was an instructive process, which can be ascribed to a form of research through (critical) design [5]. The organisers - and designers - of the project organised a follow up meeting several weeks after the Banana Jam to discuss their own findings, reflections and considerations around the IoB. These findings can be articulated in 6 main points.

- (1) The combination between nature and technology resonated strongly with the participants. In particular, the ephemeral nature of fruits (and other perishable items) that degrade through the project could work as a strong metaphor for key issues such as the climate crisis to the central role of time in nature-technology relations. Design projects focusing on such intersections can be timely and impactful.
- (2) The contradiction between the weirdness and familiarity of the artefact was able to attract a lot of attention. This seems to confirm how the renegotiation of the socio-technical position of everyday life objects can be a strong asset for speculative and critical design. In particular, fruit items - and more generally food - might be indicated for such semantic explorations.
- (3) The intrinsic playfulness of the project smoothed technical issues and motivated the participants. This seems to confirm current literature on ludification [18] and possibly emerges some of the parallelisms between tinkering and play in terms of exploration, curiosity, creativity and trial and error.
- (4) The participants’ reports on the interest provoked by the IoB on bystanders make it feel almost “contagious”. This could suggest that a situationist approach to citizen sensing could be used to create a snowball effect and mobilise and motivate citizens to participate, adding to pre-existing activist and politically informed motivations.
- (5) The open source nature of the IoB emerged as a source of trust between participants and organisers. Beside the relevance of open source practices for sharing information and

knowledge, transparency seemed to be a key element in a project that involves collection of data from within the participants' living or working environments.

- (6) The project's idea to sacrifice some sensor accuracy for making the IoB economically and technically accessible seems to have paid off. Despite the relative simplicity of the technical implementation of the Network, the focus on electronic literacy (and hence the decision to let the participants assemble their own sensors) and the constraints of working remotely faced several technical issues. This underlines the importance of considering accurately the technical complexity related to the goals of proposals of this type.

IoB was designed for participants with no programming skills and focused in the setting up of the multi-sensory stations and in the data visualization, all the code was provided by the organizers. In this regard there are still open questions if the experiences of the participants would be influenced by unveiling one more layers of the technology, with a basic programming workshop to explain the code to the participants and how the sensor's data was translated to colors and graphics of the dashboard. These questions might lead to future projects and investigations.

## 5 CONCLUSIONS

Throughout the Banana Jam, for an entire week all the IoB stations of the Network were active, sharing three different data-sets: skin colour of the bananas, air temperature and air humidity. The data related to all the IoB stations could be seen on the participants' dashboard on Adafruit IO, as well as in the IoB website, created expressly to this end with a particular attention to the data visualisation. Several tools for data visualisation were put into place, and the participants shared photographs and bios of their IoB stations to capture their particular visual styles (all participants decorated in some ways their bananas)(Fig 1). Designing the IoB, along with the experiences of the participants, was a research through (critical) design process [5]. The insights gathered through the project can be articulated in 6 main points summarised here:

- (1) The combination between nature and technology resonated strongly with the participants. Design projects focusing on such intersections can be rather timely and impactful.
- (2) The contradiction between the weirdness and familiarity of the artefact was able to attract a lot of attention. Such weirdness might be well indicated for critical design explorations.
- (3) The playfulness of the project smoothed technical issues and motivated the participants.
- (4) The participants' reports on the interest provoked by the IoB on by-standers could suggest that a situationist approach to citizen sensing could motivate citizens to participate.
- (5) The open source nature of the IoB was a source of trust between participants and organisers.
- (6) The project's idea to sacrifice some sensor accuracy for making the IoB economically and technically accessible seems to have paid off.

In conclusion, the banana-centred design was able to engage the participants in the creation of a global network of connected devices, based on an interest focused on the process, rather than on data use. The IoB project, moreover, allowed us to collect both

useful feedback from the participants and informed considerations by the designers to advance our understanding and practice in areas of critical design, citizen sensing and gamification.

## ACKNOWLEDGMENTS

This work was supported by the Academy of Finland Flagship Program (337653 Forest-Human-Machine Interplay (UNITE)).

## REFERENCES

- [1] Emilio Ambasz. 1972. *Italy: The new domestic landscape: Achievements and problems of Italian design*. New York Graphic Society Books, New York, New York.
- [2] Mark Blythe, Kristina Andersen, Rachel Clarke, and Peter Wright. 2016. Anti-solutionist strategies: Seriously silly design fiction. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, New York, 4968–4978.
- [3] Anthony Dunne. 2008. *Hertzian tales: Electronic products, aesthetic experience, and critical design*. MIT press, Cambridge, Massachusetts.
- [4] Shamal Fairly. 2012. Analysing chindogu: applying defamiliarisation to security design.. In *Proceedings of the 2012 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, New York, 1–4.
- [5] William Gaver. 2012. What should we expect from research through design?. In *Proceedings of the SIGCHI conference on human factors in computing systems*. Association for Computing Machinery, New York, New York, 937–946.
- [6] William Gaver. 2015. Homo ludens (subspecies politikos). In *The gameful world: Approaches, issues, applications*, Steffen P Walz and Sebastian Deterding (Eds.). MIT Press, Cambridge, Massachusetts.
- [7] Vittorio Gregotti. 1972. Italian Design 1945 1971. In *Italy: The new domestic landscape: Achievements and problems of Italian design*, Emilio Ambasz (Ed.). New York Graphic Society Books, New York, New York.
- [8] Juho Hamari. 2019. Gamification. In *The Blackwell Encyclopedia of Sociology*. Wiley Online Library, Online, 1–3.
- [9] Stacey Higginbotham. 2018. The internet of trash [Internet of Everything]. *IEEE Spectrum* 55, 6 (2018), 17–17.
- [10] Rónán Kennedy. 2019. De-camouflaging Chameleons: Requiring Transparency for Consumer Protection in the Internet of Things. *European Journal of Law and Technology* 10, 1 (2019), 1–27.
- [11] Uta Lauer. 2022. *The Iconography of the Banana Plant in Chinese Art*. China Academy of Art Press, Hangzhou, Zhejiang, China.
- [12] Joseph Lindley and Paul Coulton. 2015. Game of drones. In *Proceedings of the 2015 annual symposium on computer-human interaction in play*. Association for Computing Machinery, New York, New York, 613–618.
- [13] Conor Linehan, Sabine Harrer, Ben Kirman, Shaun Lawson, and Marcus Carter. 2015. Games against health: a player-centered design philosophy. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*. Association for Computing Machinery, New York, New York, 589–600.
- [14] Conor Linehan and Ben Kirman. 2017. MC hammer presents: the hammer of transformative nostalification-designing for engagement at scale. In *Proceedings of the 2017 CHI conference extended abstracts on human factors in computing systems*. Association for Computing Machinery, New York, New York, 735–746.
- [15] Matt Malpass. 2013. Between wit and reason: Defining associative, speculative, and critical design in practice. *Design and Culture* 5, 3 (2013), 333–356.
- [16] Victoria Palacin, Sarah Gilbert, Shane Orchard, Angela Eaton, Maria Angela Ferrario, and Ari Happonen. 2020. Drivers of participation in digital citizen science: Case Studies on Järviviki and safecast. *Citizen Science: Theory and Practice* 5, 1 (2020), 1–20.
- [17] Angela Patton and Richard Bannerot. 2022. Chindogu: a problem solving strategy for transforming uselessness into fearlessness. In *2002 GSW*. American Society for Engineering Education, Lafayette, Louisiana, 1–7.
- [18] Joost Raessens. 2006. Playful identities, or the ludification of culture. *Games and Culture* 1, 1 (2006), 52–57.
- [19] Miguel Sicart. 2014. *Play matters*. MIT Press, Cambridge, Massachusetts.
- [20] Brian Sutton-Smith. 2017. *Play for life: Play theory and play as emotional survival*. The Strong, Rochester, New York.
- [21] Mattia Thibault and Juho Hamari. 2021. Seven points to reappropriate gamification. In *Transforming Society and Organizations through Gamification*. Springer, Berlin, Germany, 11–28.
- [22] Mattia Thibault, Artur Vasconcelos Cordeiro, and Martijn de Waal. 2020. ROOK-Urban Play and Data Visualization. In *Proceedings of the 2020 DiGRA International Conference*. DiGRA 2020, Digital Games Research Association, Online, 1–4.
- [23] Melanie Woods, Mara Balestrini, Sihana Bejtullahu, Stefano Bocconi, Gijs Boerwinkel, Marc Boonstra, Douwe-Sjoerd Boschman, Guillem Camprodon, Saskia Coulson, Tomas Diez, et al. 2018. Citizen sensing: a toolkit.