



D5.2 CRITICAL MAKING OPEN HARDWARE PROGRAMME

About this document

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LIST OF ABBREVIATIONS

CM	Critical Making
CNC	Computer numerical control
D	Deliverable
DIY	Do it yourself
ICT	Information and communications technology
KPI	Key Performance Indicator
RRI	Responsible Research and Innovation
SDGs	Sustainable Development Goals
STEM	Science, Technolog, Engineering, Mathematics

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EXECUTIVE SUMMARY

The Critical Making mentorship program aimed to support global makers and innovators in shaping a sustainable future of making. Over the span of nine months, 18 mentees received guidance and input from our esteemed teachers on key principles of the sustainable making framework for their projects: Make Things That Make Sense, Share How You Make, Include Ecosystem Services, Integrate Local Knowledge, Build for Continuity.

This deliverable is two fold:

1) it documents the process on how to design and run the open hardware programme, which is open and free to be adopted by other organizations worldwide

Key components of the programme:

- Reflection interviews with mentees in a small group setting;
- Teaching sessions to cover one of the five areas, always including a recording to allow mentees to complete the session in their own time;
- Guidance for peer-to-peer exchange in audio calls and in a community support group;
- Connection to a global community of makers and innovators;
- Financial support to participate in the programme, and to create the prototypes and remuneration for documenting the projects;
- Visibility for and celebration of the mentees in a demonstration event and social media campaign.

This deliverable highlights how important the co-design phase and a communication campaign surrounding and preparing the application period are.

2) It includes an Open Hardware projects catalogue featuring the project documentations resulting from the mentoring programme

The catalogue features an inspiring range of open source hardware projects in the context of open science hardware, social innovation, and environmental sustainability. The twelve projects show a diversity of used materials, needs that inspire the solution, complexity and production-readiness. All projects show a short description, pictures, relevant RRI dimensions, the lead maker, the materials and the tools needed.

I. INTRODUCTION

This report outlines the process of designing and conducting an open hardware development program in the Global South adhering to the principles of Responsible Research and Innovation (RRI). The Open Hardware Development Programme aimed to support makers and innovators worldwide in creating a sustainable future of making. The program lasted nine months and provided guidance and input from respected mentors in critical making principles, including open science hardware, social innovation, and environmental sustainability.

This report is divided into two sections. The first section details the open hardware mentorship programme and open hardware prize and how it can be adopted by other funding organizations worldwide. The second section presents the Open Hardware projects catalogue, which features

the projects that are showcases of critical making projects that follow RRI principles.

The report includes a description of the Open Hardware Mentoring Programme and the Demonstration Week, which aimed to promote Critical Making as a means of creating solutions that make sense.

The Open Hardware Mentoring Programme is comprised of various activities, including co-design, application period, kick-off events, the critical making mentoring sessions, and the demonstration week. The report provides details of the programme's calendar, including the various training and mentoring sessions that were conducted.

Additionally, the report outlines the programme's structure, which includes an entry interview, monthly updates, online workshop series, and prototypes presentation session. The workshops were designed to allow mentors to provide insight into topics they have extensive experience in and to foster greater discussion between mentors and participants via interactive sessions. The workshops were conducted in a group mentoring setting, allowing participants to learn from the mentors and each other.

Overall, the report provides a detailed account of the Open Hardware Mentoring Programme, providing a useful reference for other funding organizations interested in implementing similar initiatives.

II. OPEN HARDWARE MENTORING PROGRAMME

Co-DESIGN

Co-design is a collaborative approach to problem-solving and innovation bringing together diverse stakeholders, including designers, users, experts, and community members, to develop and implement solutions jointly. Co-design recognizes that individuals from different backgrounds and perspectives have unique insights and knowledge that can contribute to creating better, more inclusive outcomes. By working together, co-design teams can build a shared understanding of complex problems, identify new opportunities, and create innovative solutions that meet the needs and aspirations of all stakeholders.



Figure 1: Mentoring Programme codesign participants

The importance of co-design lies in its ability to create more effective and equitable solutions rooted in the needs and aspirations of the people who will use them. By involving end-users and other stakeholders in the design process, co-design can help to ensure that solutions are relevant,

accessible, and inclusive. Co-design also has the potential to foster greater engagement, trust, and collaboration among stakeholders, leading to more sustainable and impactful outcomes¹.

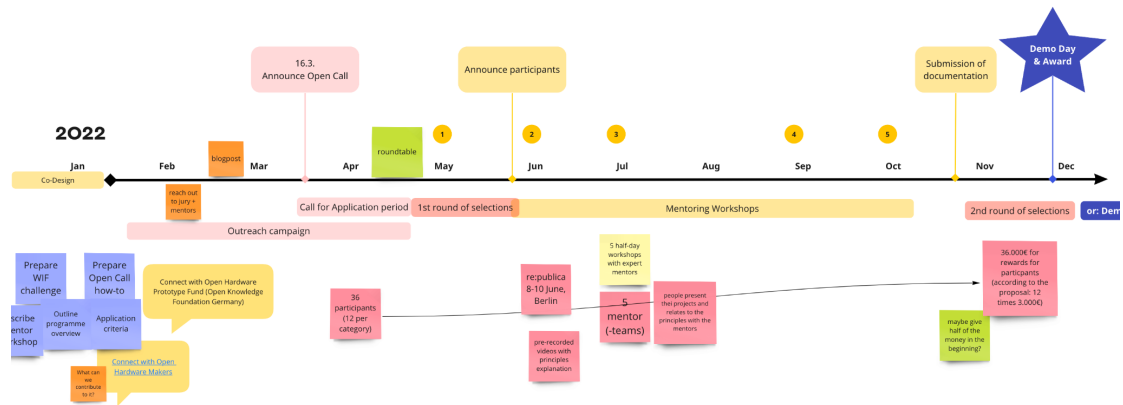


Figure 2: Codesigning the mentoring programme timeline

In the Critical Making Openness work package, two co-design sessions were held in December 2021 and January 2022, to collectively plan the actions for the Open Hardware Mentoring programme. The fifteen participants in the co-design process were from Brazil, Canada, El Salvador, Finland, Germany, India, Indonesia, Italy, Portugal, Spain, Zimbabwe and the UK. They ranged from fashion and UX designers, hub leaders, and professors to Foundation leaders and neuroscientists — and their actions around makerspaces and innovation hubs for community engagement and collaborative knowledge development were crucial for inviting them to join the co-design session. Two 3 hours-long co-design sessions were held online as a video/audio call, using a collaborative whiteboard tool to grab responses in sticky format. These co-design sessions, with participants selected based on their extensive experience and knowledge about the theme, who would be either target group of the mentoring programme as participants, mentors or jury, were

¹ Zamenopoulos, Theodore & Alexiou, Katerina. (2018). CO-DESIGN AS COLLABORATIVE RESEARCH.

- Is the most important participant benefit clear?
- How do you know what the participants need or want?
- What does the participant experience look like?

Also important to note that, based on classifications suggested by the participants in the co-design session, the critical making eligible categories related to 9 of the Sustainable Development Goals. Are them:

- SDG 2 - Zero Hunger
- SDG 3 - Good Health and Well Being
- SDG 4 - Quality Education
- SDG 5 - Gender Equality
- SDG 6 - Clean Water and Sanitation
- SDG 7. - Affordable and Clean Energy
- SDG 9 - Industry, Innovation and Infrastructure
- SDG 12 - Responsible Consumption and Production
- SDG 13 - Climate Action

The main change to the envisioned programme was the elimination of the price concept. Rather, the 15 co-design participants wanted to create a programme that valued each participant equally and share the available funding as a fee for participation in the programme that allows to cover material costs and to support the creation of the open hardware documentation, a task that takes a long time but is of immense value to the open hardware community.

Co-design session participants also advised for the creation of a model that allows for participation for those with low internet bandwidth and availability, as well as to be open for inexperienced makers as people might not have had the resources yet to create prototypes but will have other qualifications and high motivation. This was realized through asking

for an on-going hardware project or a concrete project idea the applicants would like to work on during the mentoring phase.



Figure 4: Codesigning themes and submission categories

Checklist: Which areas to work on in preparation of such a programme:

- Categories for submission: Which topics can potential participants apply for?
- Logistics: Which platforms to use for application, online sessions, for keeping in contact in between?
- Communication and Outreach: How to spread the Call for Applications? How to disseminate results during and after the programme (these might be different channels and target groups)
- Criteria and Eligibility: Who can apply, what are the selection criteria, what is the weighting of the different criteria?
- Application Submission: Define content and format of the application form, the duration of the call for applications

- Rewards: Which rewards should there be when joining the programme and when ending the programme?
- Ask: Anything we've missed?

APPLICATION PERIOD

The application period for the Critical Making mentoring programme started in March 2022 and ended on the 31st of May 2022. Applicants were required to fill out a quick application form with ten questions, and a template² was provided to help them prepare their applications on their own computers before going to the online application site. All info on the application and mentoring programme was assembled on one website.³

The application form asked for a project or prototype description, personal motivation for participating, and an optional one-minute video submission showcasing the project. The call was open to participants associated with a makerspace or an active maker group, and willing to openly share and demonstrate their impact on the world. Additionally, the call sought experienced Open Hardware makers who wanted to be more critical and sustainable about their projects. The call also asked for proposals from people working on fostering sustainable innovation in three categories: Open Science Hardware, Social Innovation, and Environmental Sustainability.

The call received 34 submissions. The team went through the submissions, reached out to applicants who didn't complete their application for a followup and sorted those out that didn't have a hardware aspect in their project or didn't submit a project idea at all. In the end, 13 submissions were incomplete or not hardware related.

² Template for the application:

<https://docs.google.com/document/d/1NrRYsAmwwfNZeLGA2xB0TEpQeK1jBfelfegsj4ZziKg>

³ <https://criticalmaking.eu/the-critical-making-mentoring/>

Critical Making
mentoring programme

How can you advance your product innovation based on openness and critical thinking?

We are inviting makers & innovators globally to take part in the journey towards shaping a sustainable future of making.

All mentoring sessions will take place online, so you can participate from anywhere in the world.

meet the teachers

Saad Chinoy
Make things that make sense
In the first workshop, the general sense of maker projects will be considered. What are the problems you are trying to tackle with your making? How to consider ethical aspects when making?

Emilio Velis
Share how you make it
In the second workshop of the series, questions of sharing and reproducibility of makes are considered. Sharing is not a simple task, if you wish for others to be able to remake and remix what you have made.

Aravindh Panch
Include ecosystem services
The third workshop of the series focuses on the environment you are working in.

Georgia Nicolau
Integrate local knowledge
In this workshop, you will learn about different solutions that could be found through co-design or other human-centered design practices, where the local knowledge beyond your makerspace can be utilized.

Bahar Kumar
Build for continuity
The last workshop of the series focuses on financial questions. How to make your making financially sustainable? In this workshop, you will get tools to build a self-sustaining, continuous making practice.

Programme Outline

- First Deadline for applications**
May, 22nd
Secure your spot early!
- Information on acceptance to the programme**
May, 31st
First round of projects acceptance
- Final Deadline for applications**
May, 31st
It's now or never!
- Information on acceptance to the programme**
June, 15th
Second round of projects acceptance
- Entry Interview**
20 - 24, June
this is a place for you to stop and think about your project, the sustainability values you are currently promoting and various ways in which your project could be even better
- Workshop series**
June to December
Each workshop has a different mentor, so during the series, you will learn from many distinct perspectives and themes. In a group mentoring setting, you will learn not only from the mentors, but also other mentees
- Demo Week**
December
Finish your documentation and present your results to the world. Isn't it great?
- Exit Interview**
January
Another chance to reflect on your making practical! In the exit interview, you will get to reflect on how your making has changed during the mentoring program together with other attendees.

criticalmaking.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101010285

Figure 5: The Critical Making Call for proposals ad poster

The outcome of applications was disappointing as the team thought to offer a great programme and put a lot of effort into sharing about the opportunity. We think that a longer campaign before actually starting the application period would have been beneficial and in hindsight we would recommend reviewing strategies that online-businesses use for successful launch campaigns. These include starting at least 6 months before the launch with: seeding the topic, creating a subscribers list/audience, creating free online events around the topic, creating free resources that

are so attractive that people would sign up with their email to receive them, paying for social media advertisement or mouth-to-mouth marketing.

Additionally, it's really good to check if the application process and questions themselves can be made even shorter and clearer. Many applicants seemed to have a hard time filling out the applications "correctly", and that left us wondering whether we were too demanding. Some ideas we have for a next call for applications: offer even more support in completing the applications, allowing for only video applications, creating a shorter form, and allowing for email submissions instead of an online form service.

Originally, we had assembled a wonderful jury to then select the participants out of those who qualify. But as the programme should be open to a maximum of 36 people, we decided to take all 18 applicants into the cohort.

The group of participants was fascinating, consisting of individuals from diverse backgrounds, cultures, and with a wide range of skills including hardware repair, software engineering, architecture, and mixed media art.

These individuals sought mentoring support for their projects, desired to open up the scope of their makerspace or hackerspace and upgrade their skills to combat social and environmental issues. They also wanted to make their design globally accessible and translate it to local contexts, resolve tensions between sustainability and market acceptance, and take the subsequent steps to scale or reach market viability.

Overall, the mentoring program did not meet the proposed KPI of 50 project applications and 36 participants. Because of this shortcoming, the

team took into account results from the co-design process and feedback received during the outreach phase and ideated on how the program could be better amplified. The outcome was that the program's concept was changed to be more public-facing, so that anyone interested could benefit from the mentoring workshops.

The first workshop was thus live-streamed on Youtube as a part of a big Kick-off campaign to attract makers globally. The following sessions were recorded and published as videos on YouTube as well. In addition to the live participation of the mentees, the mentoring videos were watched over 36 times and trust this was worth the efforts.

REWARDS IN THE PROGRAMME

During the co-design session, stakeholders decided that a competition for a prize was not the best format for collaborative work between the mentees. Instead it was decided to share the prize resources with all the mentees, so it would be a way to potentialize all the creations on the ground. To share resources equally, instead of making all the participants run to win the prize, was a fundamental turning point in the mentoring programme. It enabled some participant's participation in the first place, as they might not have had the resources to build their prototypes otherwise. So this was also a major upgrade in the accessibility of the programme and supporting makers with limited financial resources.

Furthermore, this sharing perspective fostered a mindset of the commons in the mentees, stimulating collaborations between them and partners from outside the programme.

MENTORING PROGRAMME CALENDAR AND CONTENT

In the Critical Making Mentoring Programme, the 15 mentees participated in workshops on maker projects and sustainability values. Each workshop

consisted of a talk (live or pre-recorded) from a mentor with extensive experience in the theme and an interactive session to discuss the mentee's projects further. The workshops were collective, so the mentees learned from the mentors and other mentees as they got to discuss the themes together. The topics covered in the workshops included ethical considerations in making, sharing and reproducibility of makes, utilizing local knowledge, and financial sustainability.

The mentors leading the workshops came from diverse backgrounds and had extensive experience in various areas related to maker projects and sustainability.

During the workshops, the mentees learned ways to make their prototypes financially sustainable and build a community around their project. Additionally, they learned about solutions constructed through co-design or other human-centred design practices, where mentees could utilize local knowledge beyond their makerspace. The workshops also covered the importance of considering their working environment and incorporating ecosystem services. The program provided an excellent opportunity for the mentees to stop and think about their projects, the sustainability values they were promoting, and various ways their project could be even better for themselves, their community, the ecosystem, and the world.

Most events were held at 1 pm UTC to allow people in most time zones to join, meaning 3 pm EAT, 2 pm CET, and 9 am in Brazil.

August: Entry interview

Despite the name, this was more than an interview: this was a place for mentees to stop and think about their project, the sustainability values it was currently promoting and various ways in which mentees' projects could be developed on the journey about to start. They were organized as

small group interviews, so the mentees already had a chance to meet some other participants, but with a maximum of 4 participants it was still small enough to be able to speak about details and not be intimidated by a big group. The entry interviews led to research data used by the academic partners in the project.

September: Kick-off session

The Mentoring Programme kick-off session on September 7, 2022, was used to present the project's aims and tools and showcase the selected prototypes to the Critical Making Mentoring Programme. During the session, consortium partner Global Innovation Gathering presented their work and roles in the Critical Making project and explained all the details about the mentoring programme, including its concepts, timeline, teachers and participants. Furthermore, Consortium partners Wikifactory introduced its community platform and long-term strategies and the importance of using the Wikifactory platform as a central documentation platform for the mentees and their projects.⁴

September: Make Things That Make Sense

In this workshop that was held on 6th October 2022, Saad Chinoy, an esteemed maker and co-founder of several makerspaces from Singapore, discussed the general sense of maker projects. Participants explored the problems they were trying to tackle with their making and considered ethical aspects. Saad is the co-founder of [SpudnikLab](#), a Singapore-based frugal innovation startup that addresses the digital divide through digital skills education and effective use of low-cost technologies. Saad is also involved in initiatives like the [Storytellers' Kitchen](#), the [EdibleMakerspace](#)

⁴ Recording of the Kick-off: <https://www.youtube.com/watch?v=OOx9PFOzgxQ&t>

[community](#), and [SalvageGarden](#), an assistive technology makerspace. The video of this workshop is available on youtube.⁵

October: Share How You Make

Emilio Velis, the Executive Director of the [Appropedia Foundation](#) in El Salvador, led this workshop on 11th October 2022.⁶ Participants explored questions of sharing and reproducibility of makes. Sharing is not a simple task, especially if you wish for others to be able to remake and remix what you have made. Emilio's work spans different areas of the open movement for social impact, with a special focus on sustainability and international development.

November: Build for Continuity

This workshop focused on financial questions. Leading this workshop on 2nd December 2022⁷ was Bahar Kumar, the previous Director of [Impact Hub Kathmandu](#), a dynamic community-based innovation hub supporting bold changemakers to convert their ideas into success. Bahar designed the hub's flagship [I-Cube Business Incubation Program](#) providing business masterclasses, coaching, and mentoring for Nepali entrepreneurs.

In the session, mentees learned how to map their community to build impact and sustainability, how to cultivate meaningful relationships and partnerships that are mutually beneficial and not based on existing power dynamics and how to ensure their solution is relevant, iterative and adapted to future trends. Mentees were equipped with tools to build a self-sustaining and continuous making practice as well.

⁵ Saad Chinoy: Make things that make sense

<https://www.youtube.com/watch?v=oVHZ9hIhIvY&t=13s>

⁶ Emilio Velis: Share how you make https://www.youtube.com/watch?v=IUZ_b_ps_io

⁷ Bahar Kumar: Build for Continuity <https://www.youtube.com/watch?v=eQyPO3y3YIM>

November: Interactive session for SDG training

If mentees wanted to reflect further on the SDG implications of their projects, they could join the SDG training. In two training sessions, held on 16 and 30 November, 2022, Hanna Saari and Maria Åkerman from VTT Finland first presented the SDGs and related them to the maker movement, discussed the relationship between SDGs and maker projects and presented ways of measuring SDG impacts of making. The second part was a workshop that gave participants new ideas about how to rely on the SDGs when talking about the impacts of their projects, gave space for interaction with other participants. The results fed into the research side of the Critical Making project. The training and workshop were completely voluntary and open to all Mentoring Programme participants.

December: Integrate Local Knowledge

In this workshop, Georgia Nicolau from Instituto Procomum in Brazil introduced participants to different solutions that could be found through co-design or other human-centered design practices where local knowledge beyond their makerspace could be utilized. Nicolau is a Brazilian creative professional, researcher, writer, trained facilitator, and consultant in the areas of social organizations, collective action, innovation and culture, and arts. She is working in everything related to a transition to a fairer, egalitarian, and cooperative world. The recording of Georgia Nicolau workshop is available online.⁸

January: Include Ecosystem Services

Due to personal reasons of the mentor foreseen for this workshop on Ecosystem Services, it was rescheduled from January to March and then cancelled. The team's effort to find a replacement teacher did not produce

⁸ <https://www.youtube.com/watch?v=oEvpPfRWkgs&t=8s>

a good result so the hope is that the teacher will still be able to do the session within the time frame of the project.

February: Finalizing documentation

In parallel with the workshops that they participated in, mentees worked on their projects throughout Sept 2022 to January 2023. In February, mentees were asked to complete the documentation of their projects and to create short video snippets for the Demo Week.

March: Demo week

The demonstration week was a crucial platform for mentees to showcase their final prototypes and project documentation. Moreover, it provided them an opportunity to gain a deeper understanding of the critical making mindset, which encompasses a strong emphasis on values such as inclusivity, openness, and reflexivity. Mentees were encouraged to finish their documentation on the Wikifactory platform and present their results.

A vital aspect of the week was the presentation of the mentees' open hardware projects and their initial results and learnings. Majority of demo talks began with a self-made video of the mentees answering several engaging and informative questions related to their projects and their personal views on critical making. The videos were casual, engaging, and friendly, with a maximum length of two minutes. The target audience was the general public, makers, and civil society. These were the guiding questions for the video:

- Who are you? Where are you from?
- Why is making things important to you?
- What does Critical Making mean to you personally?

- Showcase your prototype and demonstrate how it can be used on video!
 - What are your inspirations and goals behind your project?
 - What problems do you aim to solve through it?
 - Who is the intended user?

After presenting the video, mentees live-presented their prototypes and their documentation online. It allowed mentees to share their projects with the broader community and gain feedback from diverse perspectives.

Possible challenges during the demonstration week included technical issues with the videos, poor internet connection, and difficulties in effectively conveying the significance of the mentees' project. However, guidance was given to mentees to help them address these challenges and present their prototypes effectively.

The demonstration week was a significant aspect of the Critical Making Mentoring Programme. It provided a platform for mentees to showcase their work and learn from each other, inspiring them to become critical makers themselves.

Videos from the demonstration days are available on Youtube.⁹ A playlist with all the videos shared by the mentees can be accessed on Youtube.¹⁰

The documentation provided by the mentees about their projects can be found at the dedicated group in the Open Hardware platform Wikifactory.¹¹

⁹ Day 1: <https://www.youtube.com/watch?v=Luj8SvmUfqs>

Day 2: <https://www.youtube.com/watch?v=kWBud1W3O-g>

¹⁰ https://www.youtube.com/playlist?list=PLUGM9odWOqO4PrfQp0AxtKPNU_dIHNLi5

¹¹ <https://wikifactory.com/+criticalmaking/projects>

March: Exit interview

At the program's culmination, mentees had the opportunity to engage in a reflective exercise to gain a deeper understanding of their making practices. The exit interview was used to gather research data to compare the statements with the entry interviews and allowed mentees to contemplate how their making had evolved and transformed throughout the mentoring program alongside other attendees.

This exercise was providing mentees with a reflective perspective and the ability to identify their strengths and weaknesses as makers. In addition, by reflecting on their journey, mentees could gain insight into their progress and the areas they could improve on and where they had improved on already.

Furthermore, as they were done in a small group setting, this reflective exercise also allowed mentees to learn from their peers and share experiences, leading to a greater understanding of the diverse range of practices within the community. Finally, by participating in the exit interview, mentees gained a deeper appreciation of their making practices inside the critical making mind-set.

COMMUNICATION CHANNELS

Wikifactory Community

In the Open Hardware community platform Wikifactory, participants created their own account in the beginning of the programme, and could then use a forum to exchange with other mentees and mentors and to publish their projects. The first task for mentees was to create a story post with the prompt: "What inspired you to create your project, how did you come up with your idea?" These stories were then used in the public kick-off presentation and for social media outreach.

Regular forum posts and stories from the mentoring programme were shared by the organisers. As all posts in the Wikifactory group were public, mentees were refraining from using it for questions and updates and instead asked for a private channel.

Using the platform with the mentoring group provided a lot of feedback on mobile usability, usage in low connectivity settings: some participants were struggling with the complex platform so that the team organized a separate onboarding session to explain the features and functions.

Chat Group

As requested by the participants, the Mentoring Programme established a peer-to-peer communication channel on 10/10/2022 in a WhatsApp chat group. Using a chat group for peer-to-peer communication among people from all around the globe with different backgrounds and different access to connectivity provided several benefits:

1. WhatsApp is a widely used communication platform; most people can access it on their mobile devices, which makes it an accessible and convenient option for participants with different levels of connectivity. In our mentoring group we had many people with low connectivity and electricity access, so we opted for the option they were using already.
2. A chat group can provide an informal and relaxed atmosphere for communication, which can encourage open and honest dialogue between participants, helping to build mutual trust and respect.
3. It can facilitate more efficient real-time communication and collaboration, which can be crucial when working on time-sensitive projects. Participants can quickly share progress updates, ask for feedback, and offer support to one another, regardless of their geographical location.

4. It can foster community among participants, similar to social media platforms. Participants can connect with others with similar interests and passions, exchange ideas and experiences, and build relationships beyond the mentoring programme.

During the Critical Making Mentoring Programme, the WhatsApp chat group was vital for communication and collaboration among the participants. In addition, it was a way to share progress updates, project ideas, and feedback among the participants, mentors, and the wider community, helping to foster a sense of community among the participants. Through the chat group, participants could connect with others, exchange ideas, and receive feedback from diverse perspectives. The chat group played a crucial role in the success of the Critical Making Mentoring Programme, providing a space for participants to collaborate, connect, and showcase their work. Communicating in real-time has been particularly valuable for addressing questions and challenges as they arise and for fostering a supportive and collaborative learning environment.

Monthly check-ins with participants (video/audio call)

As part of the Critical Making Mentoring Programme, monthly check-ins were conducted with participants through video and audio calls. These check-ins were designed to provide mentees with ongoing support and guidance as they worked on their projects and to help ensure they stayed on track with their goals.

During these check-ins, mentees could discuss their progress, ask questions, and receive mentor feedback. The calls were also an opportunity for mentees to share any challenges or obstacles they were facing and receive guidance on overcoming them. Additionally, the check-ins always consisted of peer-to-peer exchange in smaller break out rooms. Tasks in these breakout rooms included, explaining their projects

to each other, giving each other feedback on their published story, sharing their draft documentation with each other, etc. Usually it was possible to match people with the same language or areas of work, so that the exchange was easier and inspiring.

The monthly check-ins were essential for participants working remotely and needing access to regular online meetings with mentors. Participants received the support and guidance necessary to conduct their prototypes by conducting these check-in calls. The monthly check-ins were an essential component of the Critical Making Mentoring Programme, providing mentees with ongoing support and guidance throughout the programme. They also helped to ensure that participants stayed on track with their goals and successfully completed their projects.

Social Media platforms

Social media platforms have become essential tools for disseminating information to a broader audience. In the Critical Making Mentoring Programme context, social media platforms effectively reached out to the wider community, through the Critical Making twitter account and the Global Innovation Gathering channels (Instagram, facebook, Whatsapp group chats, twitter, LinkedIn). By sharing updates and announcements about the programme on social media platforms, the organisers were able to generate interest and awareness about the programme among a diverse range of people. Additionally, social media platforms allowed the organisers to connect with relevant communities and organisations interested in participating in or supporting the programme.

Furthermore, using social media platforms also allowed the Critical Making Mentoring Programme to collaborate and amplify its message throughout the Consortium partners' social media channels. By cross-promoting each other's posts, the programme reached an even

broader audience, increasing the visibility and impact of the activities. Social media platforms were crucial in promoting the Critical Making Mentoring Programme and raising awareness about the importance of maker culture and innovation. By leveraging the power of social media, the programme was able to connect with a diverse range of individuals and communities, fostering a sense of belonging and encouraging knowledge sharing within the maker movement.

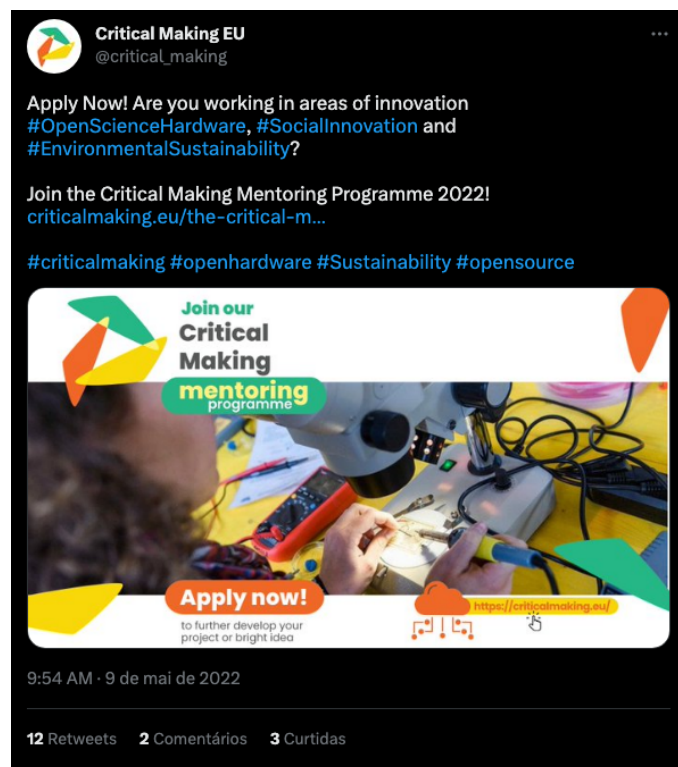


Figure 6: One of the mentoring programme social media post

LESSONS LEARNED

Below you find our key take-aways and tips to anyone who wants to promote similar mentoring programmes.

1. Importance of clear expectations: Establishing clear goals and expectations for mentors and mentees in a mentoring program is crucial. Clear goals help ensure everyone is on the same page and working towards a common objective.
2. Need for flexibility: While having a structure in a mentoring program is important, it's also essential to remain flexible and adaptable to the unique needs and circumstances of individual mentees.
3. Value of mentor training: Providing training and resources for mentors can help them feel more prepared and confident in their role, ensuring mentors provide the best possible guidance to their mentees.
4. Benefits of networking: A mentoring program can provide a valuable opportunity for mentees to network with experienced professionals in their field, leading to new connections and career opportunities.
5. Importance of feedback: Regular feedback from mentors and mentees can prove that the mentoring program is effective and meets the needs of all participants. Regular feedback sessions can also help identify areas for improvement and inform future program iterations.

III. OPEN HARDWARE PROJECTS CATALOGUE

The mentees in the mentoring programme came from diverse backgrounds, which meant they had varying levels of technical knowledge and began their open hardware projects from different stages of development.

Out of the 18 mentees selected for the programme, only 12 open hardware projects were included in this catalogue. Some participants were unable to submit their final documentation or complete their prototypes in time for the report's delivery.



Figure 7: Index of Open Hardware Project Catalogue

As part of the programme, participants were required to share their projects' documentation through the Wikifactory community dedicated to the Critical Making project.¹² As some participants were experienced with other platforms, they also shared documentation on Github. On the other side of the spectrum some participants did not have the capability to

¹² <https://wikifactory.com/+criticalmaking>

publish Open Hardware documentation yet and in the end needed to share Word documents.

The online and interactive version of the Critical Making Open Hardware projects catalogue will continue to be available in the Wikifactory Community linked above.

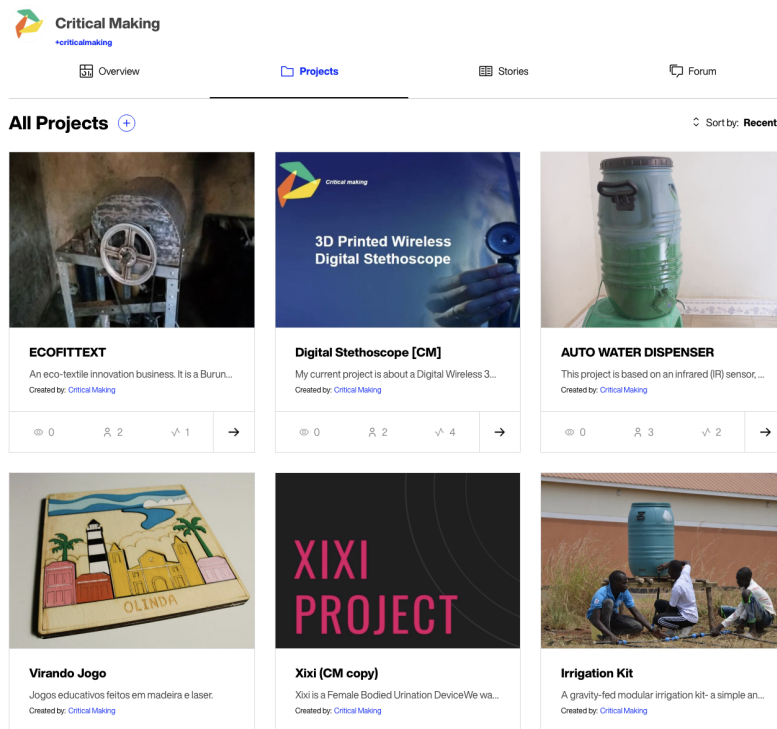


Figure 8: Critical Making's main project page on Wikifactory

The full open hardware project catalogue can be found below in Annex A of this report.

IV. CONCLUSIONS

In conclusion, the Critical Making Mentoring Program was a successful initiative that aimed to foster a community of makers, thinkers, and innovators. The mentoring program was collectively created through a

co-design process, making it more inclusive, accessible, and effective in supporting the professional growth of makers from diverse backgrounds.

The program's application period provided opportunities for makers to apply and participate in the mentoring program, where they received guidance and support from experienced mentors in various fields. In addition, the mentors provided valuable insights and feedback on participants' projects, helping them to refine their ideas and achieve their goals.

To a large extent, the Critical Making Mentoring Program demonstrated the importance of community building, collaboration, and co-design in fostering an inclusive and supportive environment for makers. The program's success highlights the need for more initiatives prioritising equity, diversity, and inclusion in the maker movement, ensuring everyone has access to the resources and support needed to succeed.

The more detailed evaluation will be published as a separate report as part of the Evaluation work package.

V. ANNEX

Annex A: Open Hardware Project Catalogue



**Critical
Making**

Open Hardware Project Catalogue





Executive Summary

This catalogue features an inspiring range of open source hardware projects in the context of open science hardware, social innovation, and environmental sustainability.

These projects were created by mentees of the 2022-23 Critical Making Mentorship Programme.

The Critical Making mentorship program aimed to support global makers and innovators in shaping a sustainable future of making.

Over the span of nine months, mentees received guidance and input from our esteemed teachers on key principles of the critical making framework for their projects.

Open Hardware Project Index



[3D Printed Water Filtration Kit](#)



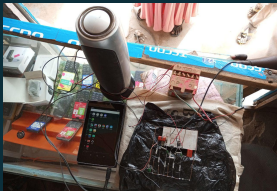
[Automatic Water Dispenser](#)



[Digital Wireless 3D Printed Stethoscope](#)



[DIY Solar Phone Charger](#)



[DIY Ultra Bass Amplifier](#)



[Early Alert Pregnancy Wristband](#)



[Eco Star Extension Cable](#)



[Ecofitext Ecological Fiber](#)



[Gravity-fed Irrigation Kit](#)



[Open Source Modular Housing](#)



[Virando Logo](#)



[Xixi Urination Device](#)

3D Printed Water Filtration Kit

This 3D printed water filtration system provides STEM education to rural girls in Lamu, Kenya. The project uses fun and engaging STEM kits to expose learners to unconventional careers and increase water efficiency through a portable, scalable, and easily replicable layered filtration unit. It inspires young learners to be creative in solving local challenges and can be used in other low-resource settings.



Lead Maker:



Christine Kutwa

RRI Dimensions

- Anticipation: Building a desirable future of creating STEM opportunities for females
- Responsiveness: Fostering impactful youth education

T

Tools

- CNC milling machine
- SolidWorks software
- Aspire software
- Drill

M

Materials

- 6 millimetre thick plywood
- 300 millilitre plastic water bottles
- Big rocks
- Small rocks
- Pebbles
- Coarse sand
- Fine sand
- Wood Ash
- Charcoal
- Cotton wool
- 10 millimetre wide pipe (60 centimetres long)



For more details, please see project's documentation:
<https://wikifactory.com/+criticalmaking/stem-water-filter-kit>

Automatic Water Dispenser

To address hygiene issues during COVID-19, this low-cost infrared sensor-based water dispenser promotes hand hygiene in schools in refugee settlements. The IR sensor detects hand presence and activates the pump, eliminating the need for touching a traditional tap and minimizing germ spread. The project also promotes e-waste and plastic waste recycling in local communities.



Lead Maker:



Maliamungu Richard

RRI Dimensions

- Responsiveness: Acknowledges societal and ecological problems and aims to address them through product.

T

Tools

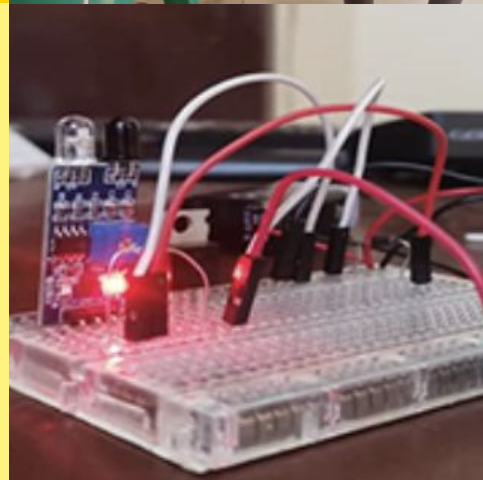
- Soldering gun
- Cutter
- Scissors
- Power



M

Materials

- TIP32C PNP transistor
- IR proximity sensor
- Batteries/ Power bank
- Capacitors
- Diode 0.7v
- Circuit board cover
- Jumper wire
- Circuit board
- Wires
- LED Light
- 5v motor/pump
- Water Container
- Bread board

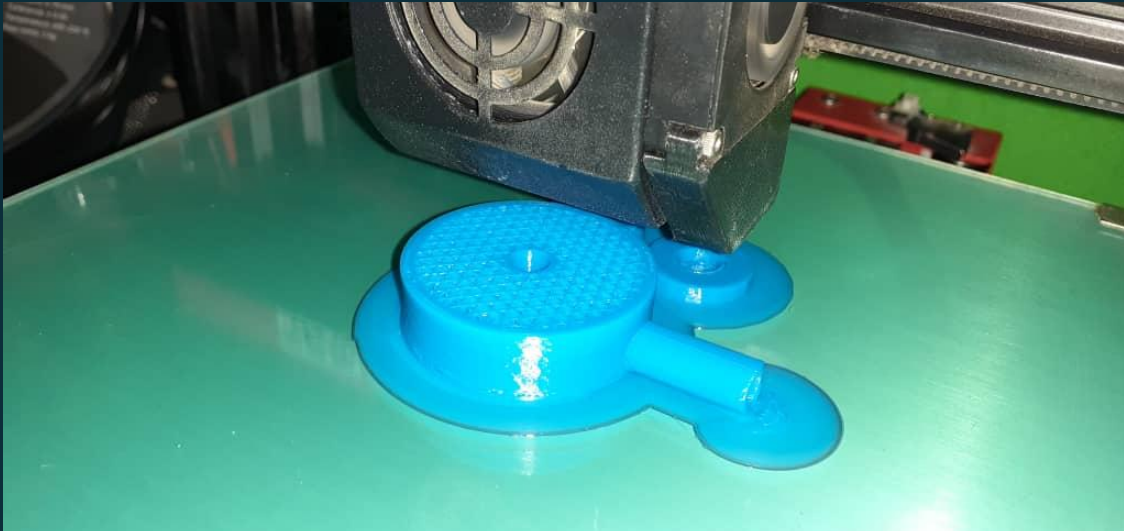


For more details, please see project's documentation:

<https://github.com/maliarich/AUTO-WATER-DISPENSER-2/blob/main/README.md>

Digital 3D Printed Stethoscope

This 3D digital stethoscope aims to tackle the challenge of making healthcare equipment affordable in low-and middle-income countries. Compared to traditional expensive stethoscopes, this innovative stethoscope is also designed to limit contact between healthcare professionals and patients. It can be used by the patient and interpreted by the practitioner remotely, providing a low-cost and safe alternative for medical professionals.



Lead Maker:



Jafsia Elisée

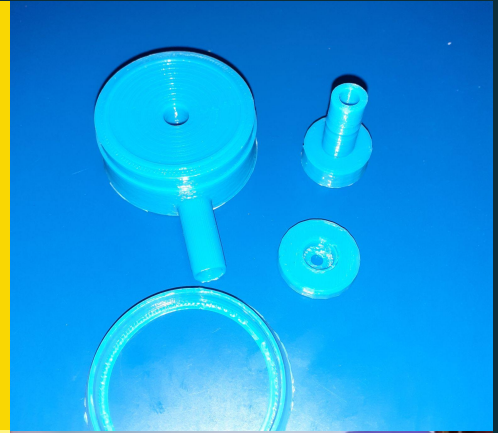
RRI Dimensions

- Responsiveness: Acknowledges social and ecological problems and aims to address them through product.

T

Tools

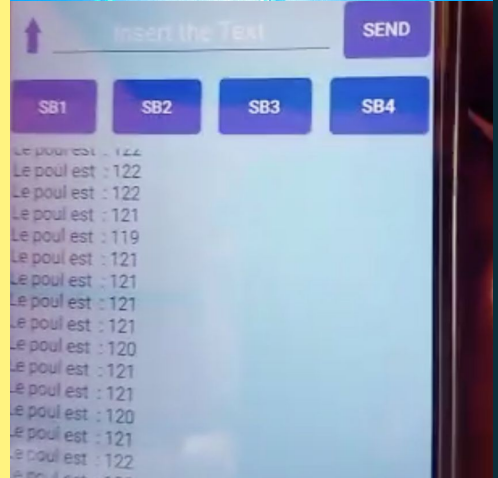
- SolidWorks software
- 3D Printer



M

Materials

- Arduino Uno
- Bedboard
- Lm 393 module
- Bluetooth module
- Connecting wires
- Android Phone
- Omnidirectionnal Microphone
- Bluetooth earphones
- Transparent plastic



For more details, please see project's documentation: <https://wikifactory.com/@elja/digital-sthetoscope>

DIY Solar Phone Charger

Uganda is among the top 100 energy poor countries with only 15% connected to the grid. This DIY solar mobile phone charger uses locally available upcycled materials to charge phones in rural areas without electricity. The project empowers women in Rhino Camp refugee Settlement to build their own chargers, avoid long-distance travel to access energy sources, and stay connected with their loved ones.



Lead Maker:



Dawa Edina Hilary

RRI Dimensions

- Responsiveness: Acknowledges social and ecological problems and aims to address them through product
- Inclusiveness: Locally-based & community-based making

T

Tools

- Soldering iron
- Soldering wire
- Soldering grease
- Helping hand
- Sucker
- Scissor
- Multimeter
- LED tester



M

Materials

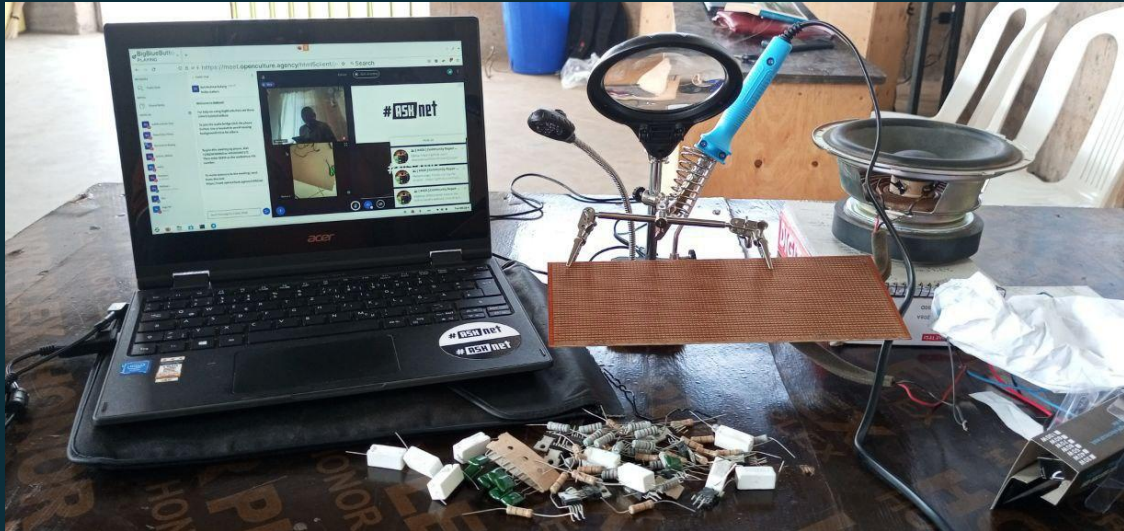
- Solar panel of (10v)
- Diode
- Resistors
- Regulator(5MA-20AM)
- Capacitors of (10-100)
- LED light of (2v or 3v)
- Jumper wire
- Circuit board
- Bread board
- Wires (red and black)



For more details, please see project's documentation:
<https://wikifactory.com/@dawaedina27/diy-solar-phone-charger>

DIY Ultra Bass Amplifier

The DIY ultra bass amplifier education project aims to provide refugees and underprivileged youths with electronic repair skills and knowledge for sustainability. Youths and refugees in Adjumani district are especially vulnerable due to their low education levels, high poverty, and unemployment. The DIY ultra bass amplifier project seeks to empower these youths and contributes to reducing unemployment and poverty in the region.



Lead Maker:



Wafela Andrew

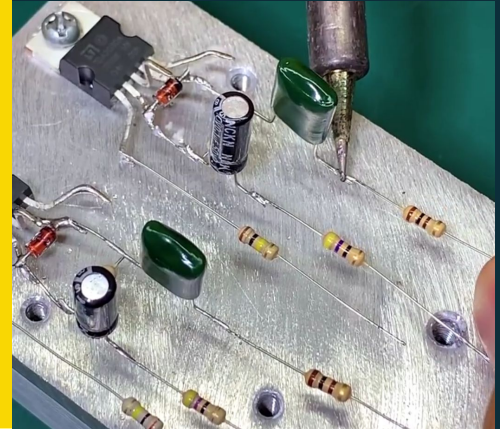
RRI Dimensions

- Inclusiveness: Locally-based and community-based making
- Responsiveness: Fostering impactful youth education

T

Tools

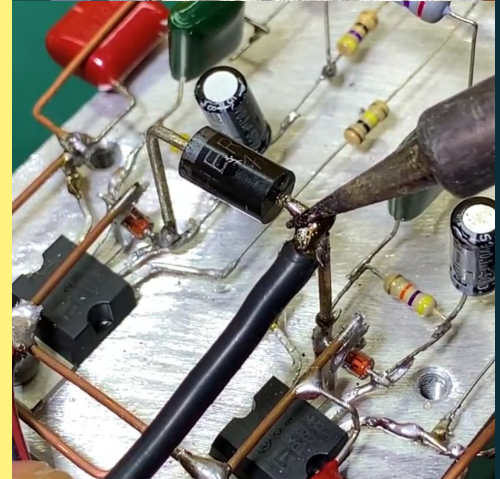
- Multimeter
- Long nose
- Radio set(screw drivers)
- Helping hand
- Tweezers
- Pliers
- Non electric hand drill
- Soldering gun/iron



M

Materials

- Transistor
- Capacitors
- Resistors
- Ceramic capacitor
- Jumper wire
- Ceramic capacitor
- Audio lines
- Power line input
- Aluminium shock absorber
- Battery/accumulator
- Bass speaker
- Circuit boards
- Soldering wire
- Diodes



For more details, please see project's documentation:
<https://github.com/chardso/Building-a-DIY-audio-ultra-bass-amplifier>

Early Alert Pregnancy Wristband

The Mother of Nations project provides pregnant women with an early alert pregnancy wristband that monitors vital pregnancy signs, reducing the likelihood of premature births caused by preventable factors. Aimed at strengthening maternal and child health, the solution emphasizes early pregnancy registration, risk awareness, and community participation through wellness activities and workshops.



Lead Maker:



Helena Le Grange

RRI Dimensions

- Reflexivity: Development of innovation, with a sharp awareness of how chosen strategies might influence people or environment

Project Technicalities

T

Tools

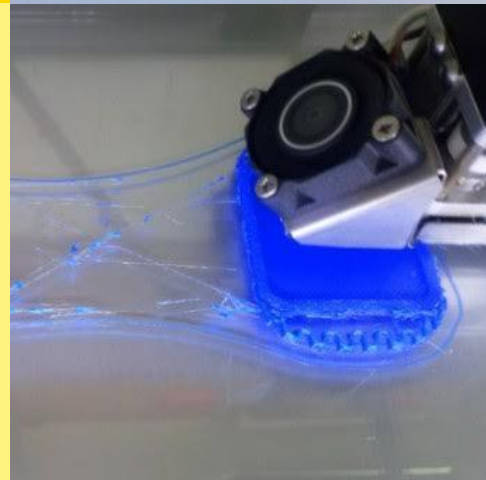
- Pencil
- Scissors
- Paper
- Rotary Punch
- 3D printer
- PLA filament



M

Materials

- PLA
- 2mm EVA foam sheeting for prototype (More flexible SBR composite foam for end product)
- Lithium Polymer Battery



For more details, please see project's documentation:
<https://wikifactory.com/@helenalegrange1967/stories/mothers-of-nations>

Eco Star Extension Cable

The Eco-star wooden power extension cable is a sustainable solution that replaces plastic cables with locally-sourced, cost-effective wood to reduce carbon emissions and landfill waste. It inspires youths to embrace local innovation and address climate change, while promoting self-reliance and circularity. Upcycling and reuse practices create sustainable and transformative economies.



Lead Maker:



Mathew Lubari

RRI Dimensions

- Responsiveness: Acknowledges ecological problems and aims to address them through product

Project Technicalities

T

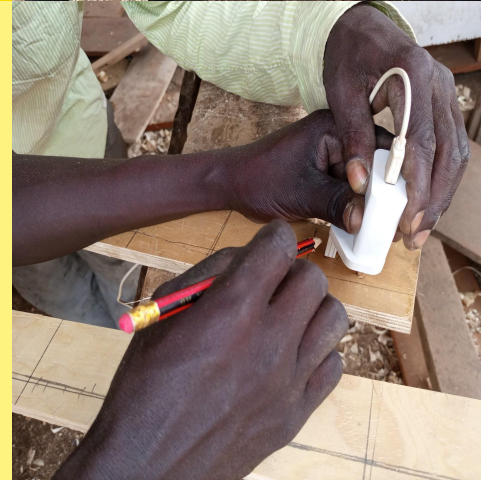
Tools

- Screws
- Wood
- Shine paper
- Whoop iron
- LED light
- Connecting wire
- Plug/Socket

M

Materials

- Cutting saw
- Drilling machine
- Tape measure
- Pencil
- Measuring ruler
- Screwdriver
- Hammer
- Smoothing machine
- Soldering iron



For more details, please see project's documentation:
<https://wikifactory.com/@mathewlubari/eco-star-extension-cable>

Ecofitext Ecological Fiber

Ecofitext promotes a circular economy in the textile industry by creating biodegradable, recyclable, and reusable products from banana fibers. The project aims to build a thriving circular economy in Burundi and work towards sustainable and greener solutions in Africa. Ecofitext aspires to be a major supplier of natural fibers and ecological products for the textile and fashion industry.



Lead Maker:



Oscar Ndayisenga

RRI Dimensions

- Responsiveness: Acknowledges ecological problems and aims to address them through product
- Anticipation: Building a desirable greener future for Africa

Project Technicalities

T

Tools

- Cloner
 - Saw
 - Gas Welder
 - Hot air soldering
 - Soldering Station
 - Drilling Machine
 - Drill
 - Drill
- Drill
 - Roller
 - Head extractor

M

Materials

- Frame
- Engine
- Bearing
- Pulley
- Steel
- Nails



For more details, please see project's documentation:

https://docs.google.com/document/d/1cFUK-m4aaVFL7InWc2FrVXi0ylwsZZGH9WLMrA6sM4E/edit?usp=share_link

Gravity-fed Irrigation Kit

The Gravity-fed modular irrigation kit is a locally made, automatic, low-tech solution that supports vegetable production in a user-friendly and efficient manner, contributing to the overall nutrition and well-being of refugees. The project aims to promote the use of this kit in as many households as possible to support refugees in watering their vegetables while reducing water wastage.



Lead Maker:



Ira Emmanuel

RRI Dimensions

- Responsiveness: Understanding contextualised societal needs and responding to them
- Anticipation: Building desired self-sustaining futures in refugee communities

T

Tools

- Hand saw
- Bow saw
- Hammer
- Robe
- Tape measure
- Metallic steel pipe

M

Materials

- Water tank 200L
- Pvc pipes - 4 meters $\frac{3}{4}$; 12 meters $\frac{1}{4}$
- Cap lock for $\frac{1}{4}$ pvc pipe (3)
- Cap lock for $\frac{3}{4}$ pvc pipe (2)
- Elbow connector (1)
- T-shape connector (3)
- Tap (1)
- Poles 4



Open Source Modular Housing

This Responsive Open Source Modular Housing Prototype (ROSHOP) explores sustainable and modular community housing using Ghanaian designs and eco-friendly materials like maram, stone dust, and clay soil. It aims to become a modal institution for ICT and open source research, providing a shared space for idea-sharing and workshops to empower South Sudanese refugee youth.



Lead Maker:



Vuga William

RRI Dimensions

- Responsiveness: Acknowledges social and ecological problems and aims to address them through product
- Inclusiveness: Locally-based, community-based making

T

Tools

- Spade
- Wheel Barrow
- Hoe
- Wooden compression tool
- Wooden Pole
- Plain Board (Honor Plex Brand)
- Watering can



M

Materials

- Marram
- Stone dust
- Clay soil
- Sand soil
- Pit sand
- Cement



For more details, please see project's documentation: <https://wikifactory.com/+criticalmaking/roshop>

Virando Jogo

Casa Criatura, an innovation hub, designed laser-cut wooden educational games to provide education access to communities facing a lack of technology during the pandemic. These games feature cultural icons and references from the local heritage to instill a sense of belonging and cultural identity in children. The games are designed to be easily used at home by children.



Lead Maker:



Juliana Rabello

RRI Dimensions

- Reflexivity: Development of innovation, with a sharp awareness of how chosen strategies might influence people or environment

T

Tools

- Autocad
- Laser machine



M

Materials

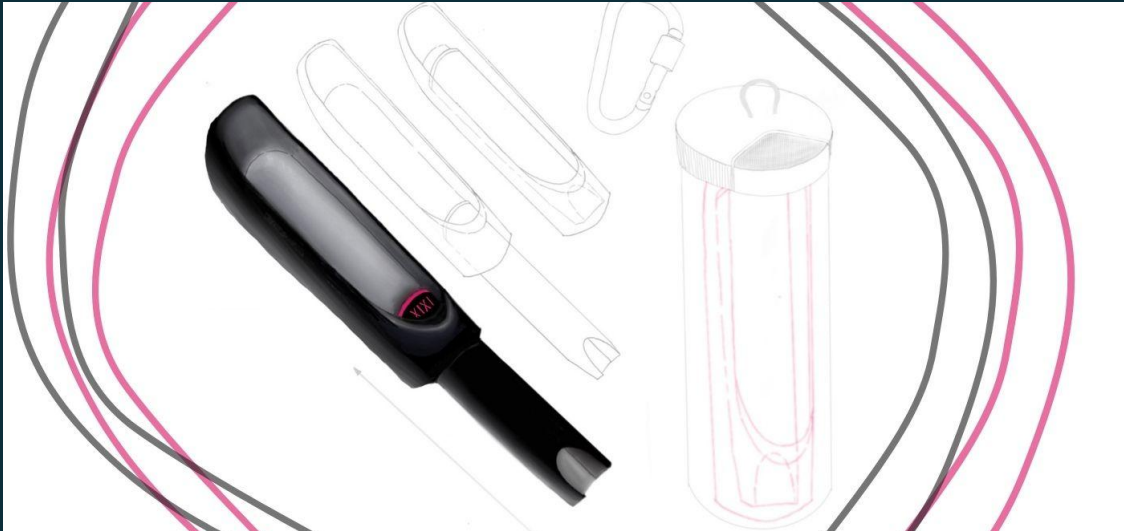
- 16mm reforested pine plywood sheet - yields 44 educational games
- Two sheets are glued together for the final assembly of the game



For more details, please see project's documentation: <https://wikifactory.com/+criticalmaking/virando-jogo>

Xixi Urination Device

Xixi is a urination device that aims to reduce sexual assault and harassment in vulnerable areas such as streets. It offers a secure and dignified way for women, non-binary, and trans-masculine individuals to relieve themselves while challenging gender-biased taboos. Additionally, the device supports a shift towards a circular and regenerative city by using urine to grow plants and food through a bottom-up-cycling approach.



Lead Maker:



Sara Ameijeiras de Castro & Patricia Schneidewind

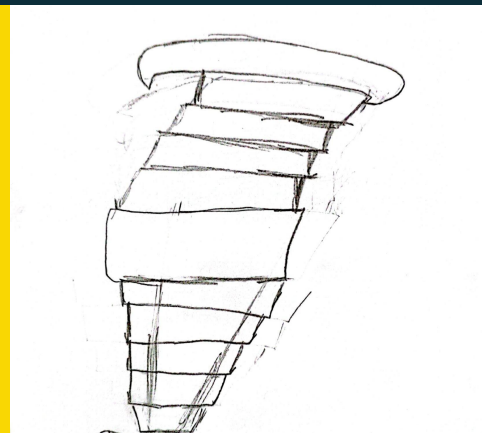
RRI Dimensions

- Reflexivity: Development of innovation, with awareness of how it might influence people or environment
- Inclusiveness: Reflection on gender exclusion structures in society

T

Tools

- Autocad
- 3D printer



M

Materials

- Sustainable/ recyclable material (e.g. silicon or recycled plastic).
- Harder material for outer spout & softer for inner spout
- Superhydrophobic antibacterial polymer coatings
- Moisture repellent coating



For more details, please see project's documentation: <https://wikifactory.com/@xixi/xixi>