

KidBeats

green Guidelines

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GREEN GUIDELINES for the creation of the KidBeats device

by prof. Sara Michieletto

1 - Abstract:

These guidelines are meant to be principles that should be acknowledged regarding nature preservation and the environment during the development of the content, the design, and dissemination of the final product of the project KidBeats, a device for children to interact with music in early age (aged 3-6 years old).

The purpose of this text is to help making the prototype and the process as much as possible environmentally sustainable.

As we will see, two main principles should be taken well in account on these purposes: the connectedness to nature and the new technologies challenges.

The first will be mainly pursued through the use of the biophilic design and an attention on the musical contents, the second will be related to finding a compromise between what is sustainable, safe, pedagogically correct and what is affordable in order to make the device accessible to as many people as possible.

The device should contain not only the possibility for pre-school children to listen to music, but also the opportunity to engage with an object that offers them a design that can bring them closer to a sense of belonging to Nature: improving people's connection with nature is crucial for real sustainability, as pro-environmental behaviour that arises from an inner drive is much more effective than that which arises driven by an “external”, learned, fear of damaging the Earth.

2 - Introduction:

KidBeats is building a methodology that helps connect musicians with their pre-school-aged target group in a sustainable, innovative, and engaging way. This project enables sound-based media play for children built on research, testing, and development of digital tools, with consideration for environmentally conscious materials and 21st-century solutions.

Bringing a new device into life involves many considerations in terms of environmental sustainability, as whatever new we create has an environmental load that has effects on living beings (i.e. organisms) and on their non-living environment (i.e. soil).



Creating a new device is, also, a challenge in terms of attention to the environmental impact as there is little agreement and much contention surrounding how to implement ecological sustainability in a resource management context. Some have argued that sustainability is neither a realistic goal nor a useful concept, while others have argued that it is the only strategy leading to a viable long-term pattern of human resource use (Dale et al. 2000). We need to let this interesting philosophical debate in mind while creating a new device like the one we are ideating with the KidBeats project.

To imagine a viable long-term object we need to support the feeling of connectedness with Nature in the people who will use it. For example, feeling this connectedness may develop in children a mentality where disposability is once again considered a waste, not a virtue. Connectedness feelings would allow behaviors arising from an inner need, not from an outer, imposing, law.

While the planet is finite in its biophysical sense, infinite growth in human existential values, such as beauty, love, and kindness, as well as in ethics, may be possible. Society is currently experiencing limits to growth because it is locked into defining growth in terms of economic activities and material consumption.



What KidBeats device will therefore need to contain is not only the possibility for preschool children to listen to music, but also an opportunity to deal with an object that offers them natural sensoriality, closeness to natural shapes and colors and a feeling of belonging to Nature.

Moreover, we must remember that technology is never neutral as it can model our thinking systems, reason for which we have to think accurately on what we propose to our children, (also in terms of encouraging them in feeling to be part of the Nature, and not separate beings).

The device that we wish to offer to pre-school children as a mean of listening to music, contains environmental approaches that are linked to the kind of materials they will touch, to the kind of design we will think of, to the kind of music they could listen to, to the environmental impact of such listenings.

In this paper we will analyze how to reduce the environmental effects of creating this new technological device and how to minimize the human carbon footprint in terms of music diffusion, trying to build an object bonding children to their Natural part.

3 - Background:

After conducting a review of the existing literature on the subject, I suggest to take into consideration the following principles and strategies in order to create a device with the least possible ecological impact:

- a) Biophilic design - Technology is not neutral, it has political properties, thee need of a design connecting to nature;
- b) Folk/traditional music - Folk/traditional music integrates the ecology of an area with its history and geography, becoming an integral component of individual and collective identity;
- c) Materials to be used - Some ideas to minimize the ecological impact;
- d) Music streaming versus downloading - in terms of carbon emissions;
- e) Dissemination / open licenses - in order to make KidBeats device available widely embracing open licenses and platforms.



a) Biophilic Design

Kidbeats device aims to be an innovation in the way pre-school children will approach music. Anyway, we must be conscious that *“every innovation passes through the political choice of 'yes or no' (to adopt or not to adopt? To make it part of society or not?), or, in most cases, through that of 'yes, but in what way? With what limits, in what forms? How do we actually plan its implementation? " From a specific technical device, we must move on to a project that understands it and puts it at the service of society's needs.”* (Langdon Winner, "Do Artifacts Have Politics?")

Stephanie Hare, in her book “Technology is Not Neutral” makes a convincing argument for the importance of ethics when designing and developing technology, trying not to recreating a nature/culture binary, but a sense of belonging and unity, since, as the philosopher U. Galimberti writes, *“technique is not neutral, because it creates a world with certain characteristics that we cannot avoid inhabiting and, by inhabiting, contracting habits that ineluctably transform us.”*

Langdon Winner, in his above- mentioned paper, reminds us that there are cases in which it is not very clear how much a certain outcome is intended or not. Take, for example, he adds, the case of the introduction of a tomato harvesting machine which, by drastically increasing the number of fruits picked per day and influencing the quality and method of cultivation, reduced the number of tomato growers in California in the 1960s from 4,000 to 600 in the space of 17 years.

He continues explaining that, for example, the ability to build infrastructure such as bridges, tunnels, railways, must be organized in an urban planning project. Between the 1920s and the 1970s in New York (Long Island) a series of bridges under which roads passed were built by Robert Moses. It is an emblematic case: the height of the bridges was sufficient for the low cars of wealthy whites to pass, while blacks who normally travelled by public transport (and therefore by buses, which were much higher) were kept out of the neighborhood. A deliberately contrived architectural barrier. And with obvious political significance.

This means that there is always a political aspect in the implementation of a technological innovation and choosing the right design linked to our purposes is very meaningful.

Disconnection from nature is considered one of the major problems facing nature conservation. The term ‘connection to nature’ is frequently used to describe our enduring relationship with nature, including emotions, attitudes and behavior.

Research shows that people with a greater connection to nature are more likely to behave positively towards the environment, wildlife and habitats.

Developing an enduring relationship between people and nature, connecting people, may be critical for future nature conservation.

There is also increasing evidence of a positive relationship between a person’s connection to nature and their health and wellbeing. Experiencing nature is thought to provide health and wellbeing benefits. This is a potential ecosystem service that could start a positive feedback loop between health, wellbeing and connection to nature that leads to benefits for biodiversity conservation.

We should look for a design that seeks to connect our inherent need to affiliate with nature in the way we project modern devices.

An extension of the theory of biophilia, **biophilic design** recognizes that our species has evolved for more than 99% of its history in an adaptive response to the natural world which is instrumental to people’s physical and mental health, fitness, and wellbeing.

To keep in mind the ecological side, we therefore understand how much important the design is, the way KidBeats device will be realized should have a close reference to the biophilic design.

Connectedness to nature is a concept that reflects the emotional relationship between the self and the natural environment, based on the theory of biophilia, the innate predisposition to the natural environment. However, the biophobic component has largely been ignored, despite, given its adaptive functional role, being an essential part of the construct.

Biophilic design encourages contact with Nature, which in turn facilitates regeneration from mental fatigue, improving concentration and recovery from stress. The presence of plants and natural elements can help reduce the symptoms of respiratory diseases and improve sleep quality. Interaction with natural elements within buildings can stimulate creativity and innovation.

Theorists, research scientists, and design practitioners have been working for decades to define aspects of nature that most impact our satisfaction with the environment. An international reference point in terms of biophilic design, the sustainability consulting firm Terrapin Bright Green, wrote a paper that moves from research on biophilic responses to design application as a way to effectively enhance health and well-being for individuals and society. They identified “14 Patterns of Biophilic Design” to articulate the relationships between nature, human biology and the design of the built environment so that we may experience the human benefits of biophilia in our design applications. **The Patterns** lays out a series of tools for understanding design opportunities, including the roots of the science behind each pattern, then metrics, strategies and considerations for how to use each pattern.

According to one of the most international expert on biophilia, Giuseppe Barbiero, “*the biophilic design dedicated to the creation of objects doesn’t exist yet. The biophilic design started as building and urban redevelopment design, that is, on a larger scale. But nothing prohibits thinking about guidelines on a smaller scale.*”

The list of the 14 patterns follows, with some tips and ideas (to be developed and discussed) on how to apply them to the design of the KidBeats music device.

1. Visual Connection with Nature

A view to elements of nature, living systems and natural processes.

I suggest to insert in the device the image of flowering plants or calm non-threatening animals, maybe one of the birds described by the songs of the band Kaláka, like a woodpecker (Harkály kopogtat) or a sparrow (Nádiverebek), or even some insects (a ladybird).

2. Non-Visual Connection with Nature

Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.

I suggest to insert in the device music list the sound of birds (as in the Kaláka songs). Maybe some scented kind of wood (like sandal or cedar from legal, sustainable harvesting) could be used as a material for the device. Wood is also great for the touch. Definitely the material to realize the device should be wood from a sustainable source (reclaimed or seriously certified).

3. Non-Rhythmic Sensory Stimuli

Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.

That could be represented by a small object that could be moved by the children (a little bell? Or a string?).

4. Thermal & Airflow Variability

Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.

TO BE EVALUATED WITH THE KIDBEATS TEAM

5. Presence of Water

A condition that enhances the experience of a place through the seeing, hearing or touching of water.

TO BE EVALUATED WITH THE KIDBEATS TEAM

6. Dynamic & Diffuse Light

Leveraging varying intensities of light and shadow that change over time to create conditions that occur in nature.

TO BE EVALUATED WITH THE KIDBEATS TEAM

7. Connection with Natural Systems

Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.

This could be realized by inserting in the device a timer that will switches it on when the sun rise and switches it off when the sun sets down, or after 10 pm.

8. Biomorphic Forms & Patterns

Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature. We have a visual preference for organic and biomorphic forms but the science behind why this is the case is not yet formulated. While our brain knows that biomorphic forms and patterns are not living things, we may describe them as symbolic representations of life (vessel, 2012). Nature abhors right angles and straight lines; the Golden Angle, which measures approximately 137.5 degrees, is the angle between successive florets in some flowers, while curves and angles of 120 degrees are frequently exhibited in other elements of nature (e.g., Thompson, 1917). The Fibonacci series (0, 1, 1, 2, 3, 5, 8, 13, 21, 34...) is a numeric sequence that occurs in many living things, plants especially. Phyllotaxy, or the spacing of plant leaves, branches and flower petals (so that new growth doesn't block the sun or rain from older growth) often follows in the Fibonacci series. Related to the Fibonacci series is the Golden mean (or Golden Section), a ratio of 1:1.618 that surfaces time and again among living forms that grow and unfold in steps or rotations, such as with the arrangement of seeds in sunflowers or the spiral of seashells.

Bearing in mind that the first thing to take into account is children's design and safety regulations, we could perhaps imagine a parallelepiped, with smooth curved corners, with a ratio of 1:1.618 between the sides (for example: 20x32 cm). Also, we could take into account the precedent biophormic patterns in order to design and place the different buttons and tools of the device making use of botanical motifs, repeated patterns and rounded lines (Stephen R. Kellert).

9. Material Connection with Nature

Material and elements from nature that, through minimal processing, reflect the local ecology or geology to create a distinct sense of place. Real materials are preferred over synthetic variations because human receptors can tell the difference between real and synthetic, so minimally processed materials from real nature are preferred whenever possible.

The biophilic material par excellence is wood, which is now used to create numerous types of structures and objects.

Fast-growing, easy to work with, sustainable and durable wood could be used as the main material for making accessories (like maple, cherry and red oak). Best would be to use reclaimed wood.

Natural stone also fits perfectly into the canons of biophilic design, and is ideal for embellishing interiors and decorating them with style.

KidBeats device should use materials not only derived from nature, but also safe for humans and animals, and produced with sustainable processes, following the specific law requirements in term of processes and typology.

10. Complexity & Order

Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. Prioritize artwork and material selection, architectural expressions, and landscape and master planning schemes that reveal fractal geometries and hierarchies.

TO BE EVALUATED WITH THE KIDBEATS TEAM

11. Prospect

An unimpeded view over a distance for surveillance and planning.

TO BE EVALUATED WITH THE KIDBEATS TEAM

12. Refuge

A place for withdrawal, from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.

TO BE EVALUATED WITH THE KIDBEATS TEAM

13. Mystery

The promise of more information achieved through partially obscured views or other sensory devices that entice the individual to travel deeper

into the environment. A quality mystery condition does not engender a fear response; the conditions that differentiate between surprise (i.e., fear) and pleasure center around the visual depth of field.

A peek-a-boo window ora a hole, could be inserted in the device, always following the specific international regulation related to holes in games and tools for children.

14. Risk/Peril

An identifiable threat coupled with a reliable safeguard.

TO BE EVALUATED WITH THE KIDBEATS TEAM

The science supporting biophilic design is still emerging. In many ways, it could be argued that the research is really just corroborating the rediscovery of the intuitively obvious. Unfortunately, too much of our modern design is oblivious to this profound knowledge. Deep down, we know that the connection to nature is important. And just to remind ourselves why biophilic design is so important, consider that in the 12,000 years since humans began farming and other activities that transformed the natural landscape, only in the last 250 years have modern cities become common.

Within the last few years we became urban dwellers, with more people living in cities than in the countryside. In coming decades, it is projected that 70 percent of the world's population will live in cities. With this shift, the need for our designs to (re)connect people to an experience of nature becomes ever more important, for our health and well-being biophilic design is not a luxury, it's a necessity.



“Musicubo” could be an example of device with a biophilic design made by an Italian artisan using resonating spruce and olive woods. The wood is soft, and at the same time allows a diffusion of the music with good quality.

b) Content: folk/traditional music

The device Kidbeats will contain music saved in an internal memory. More songs and musical contents freely chosen by the users could be added later.

“*What type of role does music play for children, in relation with the object we are going to create?*” is the interesting question that was asked along the first meetings among the Kidbeats staff. This section will try to answer to this question as well pointing out which kind of music could be more suitable.

When realizing Kidbeats device, it is always important to remember that design and contents should inspire connectedness to nature, remembering that technology is not neutral (as previously explained) and that connectedness to nature makes children grow healthier and keener on protecting the ecosystems surrounding them.

We therefore should pay attention, in terms of ecological sustainability, also to the musical contents of Kidbeats device.

We know how music has many benefits for the healthy development of a child from the earliest ages, but it can also help to create a connectedness to nature that will last their entire lives. Here are just a few ways that music helps kids connect to nature:

- Many sounds in nature, such as birdsong, raindrops, and crashing waves have a natural, rhythmic pattern that music mimics. The slowness of nature matches the natural tempo in a child’s brain.
- It is often hard to express in words the emotions and feelings that being in nature evokes. Music helps express those feelings without words.
- Experiencing music and nature helps kids learn mindfulness – how to be present and in the moment.
- Like music, the sounds of nature help children to listen more carefully and intently. This helps sharpen communication skills and teaches perseverance.
- Songs and music about the natural world help children to develop familiarity and empathy towards plants, animals, and elements in nature, encouraging them to spend more time in outdoors. This develops a sense of harmony and rhythm with nature, and thus a more caring attitude towards it.



Exposing children to music at an early age helps their development in numerous ways and it should not be surprising then, that the natural connection between music and the environment have been around since the dawn of mankind. Since then, the sounds of the natural world have been an integral part of our culture. All the world is sound, or vibration. From bees humming to the sound of falling water, the same vibrations that make music surround us in nature. Aboriginal Australian tribes believe that humans actually sang the world into existence with *Songlines* as they walk the song lines crisscrossing land between natural spaces. Great composers often used nature as the backdrop for their works, such as Vivaldi's Four Seasons.

But especially traditional/folk music is connected to the natural environment: folk songs having nature as their primal thematic crux are most common and plenty.

Dependent on nature for their life and livelihood and spending all their life in close connection with Mother Nature, the rural folks are deeply attached to all the aspects of Nature. Hence, the trees, the seasons, birds, flowers, snow, rain, animals and the entire gamut is found reflected in all their folk songs. All these are representative of the beauty and power of nature, with which the rural folk lie in close, connect.

Traditional songs often encode and model the proper, respectful way for humans, non-humans and the natural and supernatural realms to interact and intersect. Indigenous songs, as detailed bio-cultural archives, are avenues for gaining a more nuanced and complex appreciation of ecosystems, including humans' place within them. There is not only a moral imperative for protecting traditional songs, but also a practical one.

In these times of dramatic ecological and social change, honoring and safeguarding traditional songs has never been more important.

We therefore have three important reasons to choose folk music as a basic musical content for our KidBeats device:

- 1 - traditional/folk music is connected to the natural environment;
- 2 - traditional songs often encode and model a proper and respectful way for humans non-humans and the natural and supernatural realms to interact and intersect;
- 3 - Indigenous songs as detailed bio-cultural archives are part of a cultural biodiversity that must be protected (UNESCO).

Other considerations about the musical contents, not directly related to the green solutions but important to be aware of, can be found at Appendix C.

c) Materials to be used

As fostered by the EU Parliament, it is necessary to change from the actual, linear, economy to the circular economy.

The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended.

In practice, it implies **reducing waste** to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible thanks to recycling. These can be productively used again and again, thereby creating further value.

This is a departure from the traditional, linear economic model, which is based on a take-make-consume-throw away pattern. This model relies on large quantities of cheap, easily accessible materials and energy. Also part of this model is planned obsolescence, when a product has been designed to have a limited lifespan to encourage consumers to buy it again. The European Parliament has called for measures to tackle this practice.

In a circular economy, things are made and consumed in a way that minimizes our use of the world's resources, cuts waste and reduces carbon emissions. Products are kept in use for as long as possible, through repairing, recycling and redesign – so they can be used again and again.

At the end of a product's life the materials used to make it are kept in the economy and reused wherever possible, the European Parliament explains.

In order to create KidBeats device with as little impact as possible, it would be best to try to use existing materials as much as possible rather than buying new ones. In addition, it should be make it easy to repair or replace the components in case of breakage or damage.

I will here write some recommendations only in terms of ecological sustainability, that should be then balanced with the general feasibility and usage of the product, according to the grid created in a previous meetings of KidBeats staff, which contains: sustainability, quality, price, weight, power supply/portability. Despite the ideal indications, we would need the components to be cheap in order to be widespread.

This is followed by a list of the main components (case, power supply, speakers and amplifiers, user manual, memory) and a chapter on the importance of removing obstacles to repair.

1 - CASE

As we have seen on “Point 9” of the biophilic design patterns, the case should be made in wood and the best green option would be to find some good reclaimed wood. By doing so, we could not only do recycling, but more, we will do UPCYCLING, that is taking a product and creating a new use for it, which can be of higher quality or value than the original.

Further considerations on possible ecological solutions in relation to acoustics and case shape can be found in Appendix B.

2 - POWER SUPPLY

The most environmentally friendly way to power KidBeats device would be to plug it into the house power socket, possibly generated by renewable energy.

For various reasons, however, the KidBeats team requested that the device be portable, particularly so that children can also listen to music outdoors. Therefore, remembering that the most sustainable practice is to use what we have, the device could be powered by a battery charger (or a battery pack) or, better still, it could be connected via a cable, ending in a USB port, to be plugged into any type of charger (smartphone, laptop, battery pack, etc.).

The easiest solution for batteries is to use lithium batteries.

Unfortunately, the extraction process of lithium is very resource demanding and specifically uses a lot of water in the extraction process (it is estimated that around 2 millions liters are used to mine one metric ton of lithium).

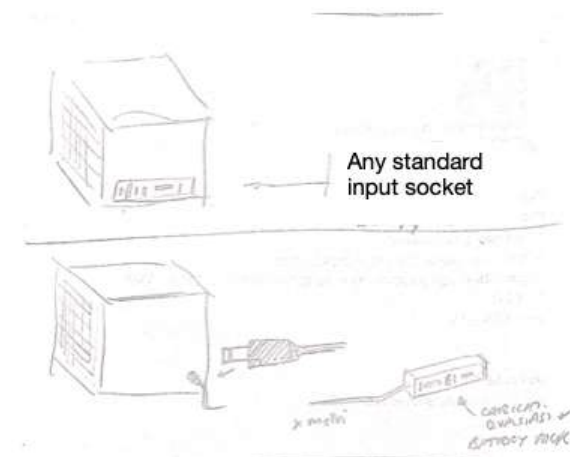
Moreover, lithium-ion batteries contain metals such as cobalt, nickel, and manganese, which are toxic and can contaminate water supplies and ecosystems if they leach out of landfills.

Rather than lithium batteries (or, worse, other types), which we have seen are very polluting, as already mentioned, it would be better to use a cable that is powered by the household electrical socket.

Such a cable could be made to connect a small box with all possible power supply connections (for any device: smartphones of various brands, headphones, power banks, etc.).

In this way there would be no need to buy adapters or batteries, and we could make use of materials that people already have in their houses.

In general, from the point of view of sustainability, it is better to use the power socket because every intermediate step create one more thing to be produced.



Other aspects are to prevent the battery from draining when the device is not in use, and take into account the duration of the batteries.

Unfortunately, for now, it is still cheaper to use virgin materials than recycled, though research is working a lot on this issue, as we can read on an important brand of vehicles [sustainability guidelines](#), the basis of the new recycling factory is an innovative mechanical-hydrometallurgical process that completely avoids energy- and material-intensive combustion processes. Instead, the materials are mechanically disassembled. Subsequently, chemical compounds are broken down to recover especially the valuable components of the battery cell as pure sorted metals. The patented recycling process currently achieves a recovery rate of at least 96 percent to be further increased by 2025 together with technology partners.)

A good news is that in June 2023, the European Council adopted a new regulation that strengthens sustainability rules for batteries and waste batteries. The regulation will regulate the entire life cycle of batteries – from production to reuse and recycling – and ensure that they are safe, sustainable and competitive. Batteries are key to the decarbonisation process and the EU's shift towards zero-emission modes of transport. At the same time end-of-life batteries contain many valuable resources and we must be able to reuse those critical raw materials instead of relying on third countries for supplies. The new rules will promote the competitiveness of European industry and ensure new batteries are sustainable and contribute to the green transition.

3 - LOUDSPEAKERS and AMPLIFIERS

Ideally, "green" loudspeakers and amplifier should take into account not only the amount of materials and other resources used to manufacture it, and hence the impact of the process on the depletion of scarce resources, but also the toxicity of those materials and their immediate impact on the health of customers, workers, and on the global environment. An holistic approach takes into account the entire process of loudspeaker and amplifier manufacturing: from design and manufacturing to shipping and transportation, to the impact on the consumer and the environment in which the consumer will use our products.

From an **ecological** perspective, “green” loudspeakers and amplifiers should be produced with the least amount of non-toxic lumber that is made from recycled materials or lumber harvested from sustainable forests, glued with non-toxic glues, painted with certified "green" paints, loaded with the most efficient set of components, packaged in packaging made from recycled and non-toxic materials, and requires the least amount of non-renewable energy to ship.

Unfortunately this could be quite expensive.

From a **pedagogical** point of view it would be better to use high quality loud-speakers.

To get the habit of listening to sounds with a good quality since small age is very important: a survey made in 2019 has found that the sound quality of music we listen to makes a difference in the positive impact that music has on our lives.

A famous brand making smart speakers and home sound systems, partnered with music experts to conduct the Brilliant Sound Survey which adds to the growing body of research showing how listening to music and podcasts enhances athletic performance, productivity, and relationships.

Better quality sound can help bring out more emotion with the music.

“High sound quality has a significant correlation to stronger positive emotions, a richer musical experience, and general happiness” said Daniel Müllensiefen, who led the survey. *“It is also exciting to note that this is apparently not a culturally influenced effect, since there were hardly any differences in the results between the individual countries.”*

From an **economic** point of view, we have to make the KidBeats device available to as many people as possible, so we have to consider costs and find a compromise between the ideal and the feasible solution.

Finally, it might be a good idea to include in the manual a recommendation to turn off the device (and thus also the speakers) when not in use, to avoid wasting electricity.

Other considerations about loudspeakers and amplifiers, not directly related to ecological solutions but important to be aware of, can be found in Appendix A.



4 - USER MANUAL

If it will be decided to create a user manual, we should pay attention to print it with ecological printing techniques and recycled paper possibly made from 100% reclaimed paper.

Guidance should be included in the manual for users on how to avoid unnecessary energy consumption and how to repair KidBeats device in case of breakage, the cost of the new components and expected lifetime before they become obsolete.

5 - MEMORY

To save energy and also to protect the privacy of the families (user profiling - see Appendix C) the best solution is to save the songs on a storage device and create a small device in KidBeats that plays the memory card.

Established that the easiest to find and most widely used memory devices are the USB flash drive and SD memory card, the question immediately arising is: is it better to use a USB flash drive or a SD memory card? What is less polluting?

According to what I have found, USB stick involves more material usage (but not too much impacting) while the memory is made by silicon which should be not particularly polluting. The USB can be plugged in and unplugged thousands of times, while the SD, on the other hand, tends to be more stable, as it is made to be plugged in a few times.

I didn't find much difference in terms of ecological impact between USB stick and SD card, therefore, probably, from a practical point of view, the USB flash drive could be better for programming and inserting the desired music.

6 - REPARATIONS

According to a report by the International Telecommunication Union, there was a record 53.6 million tonnes of discarded electronic products in 2019, but only 17.4 per cent of these have documentation proving proper recycling. An infographic from the same year, found on the European Parliament website, reports that on average less than 40% of electronic products in Europe are properly recycled, and for computers and telephones, this falls to 14%.

While more could certainly be done to increase these percentages, it is nevertheless important to emphasize that one cannot recycle indefinitely. From an environmental point of view, in fact, the most environmentally friendly device is the one you already own - not to mention the exploitation of rare earths with the damaging mining processes and geopolitical risks this entails.

It is for this and other reasons that reparation becomes a must.

Products are becoming more and more complex, and this complexity is exploited by industrialists to the detriment of people, limiting their ability to intervene in the products they purchase.

There are three main principles related to reparation, for which devices should be designed to be repairable, removing barriers to repair and making repairs affordable to everyone:

1 - Devices should be designed to be repairable, modifiable and upgradeable.

For example, we all have phones in our hands whose battery or screen cannot be easily changed. As soon as these show signs of deterioration, we are incentivized to change devices, instead of replacing them or having them replaced.

2 - Remove barriers to repair.

Companies often make design choices that make it difficult or impossible to repair devices. For example, when replacing an iPhone component, this indicates that there are 'non-genuine' parts that may not work properly. This creates stress and distrust among users towards repairers, prompting them to buy new devices and suggesting that the only safe thing is to buy the whole phone back. This practice is part of the wider practice of 'component association' documented by [Right to Repair Europe](#). That is, when a component is associated with a unique code to the device in question, such that when separated from each other the device will refuse to function properly (unless the manufacturer itself reassociates the new component).

3 - Repairs must be affordable for everyone

To have a popular repair, it must be ensured that fixing a device does not cost more than buying a new one. Many of us have probably found ourselves in the situation where taking a phone in for service is considered too expensive compared to buying a new device.

One last requirement is that people must be informed: it is essential, in other words, to be able to know whether one's device can be repaired, how to repair it, how much it costs and the expected lifetime before it becomes obsolete.

d) Music streaming versus downloading - in terms of carbon emissions

A very interesting research has been conducted in 2019 by prof. M. Brennan and K. Devine, on “The cost of music” in economical but also environmental terms: “*Describing the history of recording music in terms of three main eras – shellac, plastic, data – is not to endorse a teleological or progress-driven model of technological history in which new and better technologies are constantly superseding those of yesteryear, increasing environmental friendliness: a progression from gluey resins, smoke stacks and hard labour to flowing streams, wispy clouds and effortless clicks. Nothing could be further from the truth.*”

Current digital technology gives us flawless music quality without physical deterioration. Music is easy to copy and upload, and can be streamed online without downloading, but even though new formats are material-free, that doesn’t mean they don’t have an environmental impact.

The electronic files we download are stored on active, cooled servers. The information is then retrieved and transmitted across the network to a router, which is transferred by wi-fi to our electronic devices. This happens every time we stream a track, which costs energy.

Is there, therefore, a sustainable way to distribute music in the 21st century? And what is the less ecological impacting way for consumers to listen to music?

We are still far from finding a proper answer to this question. It depends on many things, including how many times we listen to music. If we only listen to a track a couple of times, then streaming is the best option. If we listen repeatedly, a physical copy is best.

Whatever the format, owning copies of our favorite and most treasured music and playing them over and over again might just be the best option for our environment.

For online music, local storage on phones, computers or local network drives keeps the data closer to the user and will reduce the need for streaming over distance from remote servers across a power-hungry network.

In a world where more and more of our economy and social relations happen online, records and other vintage music formats buck that trend. Instead, the record revival shows us what we want to see in our media and material world more widely – experiences that hold their value and with loving care endure. Older music formats have a sense of importance and permanence attached to them, belonging to us in a way that our virtual purchases simply don’t.

The research by the University of Glasgow and the University of Oslo mentioned at the beginning of this chapter concludes that the environmental impact of streaming far outweighs the plastic use of physical products.

A few more disadvantages to streaming music include the massive tracking and privacy policies (see, for example: <https://tosdr.org/en/service/spotify>), and the unethical economical treatment of musicians. Moreover, a disadvantage is also the worse audio quality which is not as high as MP3 files, (though most listeners can barely distinguish the difference), and the fact that subscribing to a streaming music service means you never own the music you pay to listen to.

In a few words, the download (or the purchase of physical media) it is the best way to create a music library, for at least four reasons:

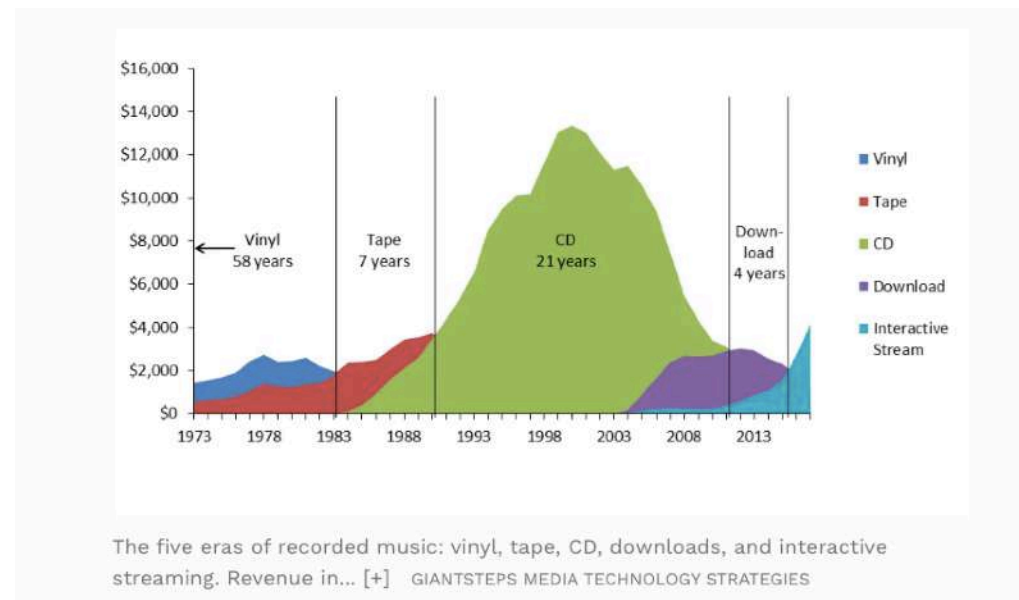
A - Streaming music is energivore, thus generating CO2 emissions.

B - The main platforms are not ethic as they massively track and profile the users.

C - Musicians don't get paid reasonably for their work.

D - Downloading or buying a music makes it possible to own it forever.

KidBeats device should therefore mainly store the music locally.



This chart shows the five eras, which are defined by the music delivery format that produced the most revenue during the period.

The first era was vinyl. Next came the tape era. Eight-track tapes came along in the mid-1960s as a way of playing music on demand in cars. Then, in the early 1970s, cassettes became capable of good sound quality in a more convenient package. Then, the innovation that really lifted cassettes' importance was the iconic Sony Walkman in 1979. This introduced the world to high-quality personal portable on-demand listening; by 1983, cassettes led the industry in revenue. That same year, the CD hit the North American market. CDs outdid both cassettes and vinyl with superior sound quality, easy access to individual tracks, and increased capacity. Music downloads appeared in the late 1990s, at the height of the CD era. In 2004 that Steve Jobs was able to coax the major labels into backing a simple, attractive

e) Dissemination / Open licenses

EU Parliament fosters the change from the actual, linear, economy to the circular economy. But, as 100 % circularity in the economy appears impossible to achieve, we must address another model.

With a graph shaped like a familiar pastry, the 'doughnut economics' model developed by economist Kate Raworth aims to boost the wellbeing of all within planetary boundaries.

Our current economic model has driven societies to extract more resources and produce more products than we need, exploiting labour and nature far beyond their limits.

The doughnut economics model can guide us towards a more sustainable and fair economy: it highlights a range of minimum social criteria and maximum ecosystem limits. The sweet spot in between is the 'doughnut', a safe space where people and nature can thrive together across generations.

According to the doughnut model, the social foundation is at the base of sustainability therefore a safe and just space for humanity will be only possible through the use of ethical platforms and licenses.

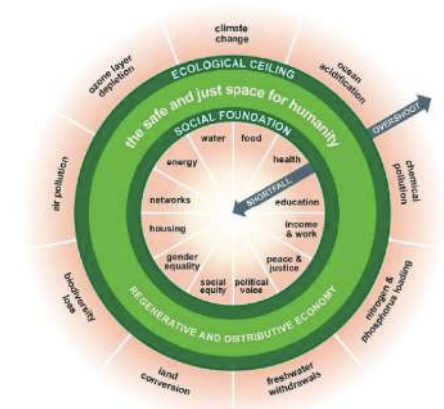
The goal of KidBeats, is to create a prototype through two official tests and a methodology paper that will be a guide so that anyone could download it (uploaded on website) and that it can be mass produced by a company. Innovative dissemination suggests that the materials are accessible to as large an audience as possible.

If appropriate open licenses are not used, while materials may be free to access, they cannot be widely used, modified, or shared.

The best licenses to be adopted, in this case, could be the widely adopted Creative Commons licenses in the format: CC BY, CC BY-SA or CC0 (see image beside), as they are allowing for commercial use.


Variations of these licenses are less permissive and can constrain reuse for commercial or derivative purposes. This licenses limitation, however, prevents the use of materials in many forms of (open) educational resources and other open projects, including Wikipedia.


Careful consideration should be given to licensing of materials, depending on what the intended






The Creative Commons License Options

There are six different license types, listed from most to least permissive here:


- 
CC BY: This license enables reusers to distribute, remix, adapt, and build upon the material in any medium or format, so long as attribution is given to the creator. The license allows for commercial use.

CC BY includes the following elements:
 BY  – Credit must be given to the creator

- 
CC BY-SA: This license enables reusers to distribute, remix, adapt, and build upon the material in any medium or format, so long as attribution is given to the creator. The license allows for commercial use. If you remix, adapt, or build upon the material, you must license the modified material under identical terms.

CC BY-SA includes the following elements:
 BY  – Credit must be given to the creator
 SA  – Adaptations must be shared under the same terms

The Creative Commons Public Domain Dedication

- 
CC0 (aka CC Zero) is a public dedication tool, which enables creators to give up their copyright and put their works into the worldwide public domain. CC0 enables reusers to distribute, remix, adapt, and build upon the material in any medium or format, with no conditions.

outcomes from the project are. Research institutes and funding bodies typically have a variety of policies and guidance about the use and licensing of such materials, and should be consulted prior to releasing any materials.

We can broadly think about sustainability in three buckets: the environmental considerations, economic considerations and social considerations. Yeah, as I say, the first thing to take away is that sustainability is way more than just carbon emissions. So a lot of people come to one thing to make things more sustainable or wanting to tackle climate change. And they're very focused on carbon emissions and that is a fantastic starting point, but I think it's really important for us to all understand that real sustainability is going to be work across those three sectors. So carbon emissions falls into environmental, but we've got economic and social to think about as well.

There are huge parallels between the open source way and what our wider society needs to do to achieve a more sustainable future. Being more open and inclusive is a key part of that.

We need a mindset shift at all levels of society that views digital technology as having growth limits and not as the abundantly cheap and free thing we see today. We need to wisely prioritize its application in society to the things that matter. And above all else, we need to visualize and eradicate the harms from its creation and continued use and share the wealth that it does create equitably with everyone in society, whether they are users of digital tech or not. These things aren't going to happen overnight, but they are things we can come together to push towards so that we all enjoy the benefits of digital technology for the long-term, sustainably.

UNESCO fosters the use of Open Science: "*Open science is a set of principles and practices that aim to make scientific research from all fields accessible to everyone for the benefits of scientists and society as a whole. For example, scientists and engineers can use open licenses to share their publications, data, software and hardware more widely—not only with each other but also with the rest of society.*

Open science is about making sure not only that scientific knowledge is accessible but also that the production of that knowledge itself is inclusive, equitable and sustainable.

By promoting science that is more accessible, inclusive and transparent, open science furthers the right of everyone to share in scientific advancement and its benefits as stated in Article 27.1 of the Universal Declaration of Human Rights.

Open science can accelerate our ability to help solve the complex challenges of our interconnected world.

We need it because: global challenges such as poverty, armed conflict, the climate crisis, environmental degradation and health and humanitarian crises are urgent—and science, technology and innovation can better respond to them if they collect and apply ideas from diverse contributors and knowledge systems.

Research practices that are more transparent, collaborative and inclusive are subject to more effective peer review, increased scrutiny and critique which in turn increases the verifiability and reproducibility of the science produced. This ultimately leads to better science, more trust in science and more relevant and positive impacts of science on society."

This article is based on a longer presentation. To see the talk in full or view the slides, see the post ["How can we make digital technology more sustainable."](#)

Other considerations about using ethic platforms in general, not directly related to ecological solutions but important to be aware of, can be found in Appendix B.

4 - Limitations

As previously mentioned in the Introduction chapter, the concept of green sustainability development very controversial: life itself is a physically consumptive process and the only way we can actually try to preserve things for the future and look after the environment is to change how we live, to use and create fewer resources.

Even renewable energy technologies eventually need to be replaced, according to some studies. While they might be better for the environment, they're not cost neutral. They consume resources over the course of their lifespan and through the systems constructed to distribute the energy they generate. By creating a new device we can only do our best to impact the environment as less as possible.

Other limitations in the green development of KidBeats device are due to other needs, beyond the ecological sustainability, like the feasibility (the fact that engineering has limitations), the psychologic guidelines (we must follow pedagogical advices), the economic side (the fact that if we wish to make KidBeats available for as many people as possible we need to use not too expensive materials), the children design and safety regulations related to the design of a tool (as per KidBeats methodology paper).

Also the need to create the device according to certain timings and the need to fit in the EU schemes are posing other limitations.

Finally, new 'green' solutions are continually entering into the market so it is almost impossible to have an exhaustive view including all the existing innovations.



5 - Conclusions

With this paper I have tried to outline principles that should be acknowledged regarding nature preservation and the environment with a focus on the development of the KidBeats project. As previously mentioned the process leading to the creation of the prototype will need also to take in account different other aspects, such as the pedagogic contents and the economic affordability.

In these guidelines I have therefore tried to balance what is feasible with the ideal green choices.

I believe that the most important thing to move towards a more sustainable future is to change our way of thinking and relating to Nature: if we grow up feeling part of the environment, we will develop respect and love for other living organisms from an inner need, an inner law.

Therefore, especially since we are dealing with children, I have identified biophilic design as one of the main themes described in this article.

As KidBeats is a music-related device, I also described what kind of music could help children to better interconnect with Nature.

In another chapter, I analyzed which materials could be used to minimize ecological impact, always bearing in mind that the best practices to be sustainable are always to reduce, reuse and recycle.

Finally, I pointed out how recent studies show that downloading the music we listen to to a device produces less CO₂ emissions than streaming, and how important it is to use open licenses for dissemination thus reaching a wider audience.

During the process of creating these ecological guidelines, I had the opportunity to meet several times with the KidBeats team and to understand how different branches such as pedagogy, ecology, design, engineering could come together (as in the discussion on inserting the 'mystery' hole in the device - see point 13 of the biophilic design chapter). When I gave the workshop on KidBeats on August 28th, it was interesting to see that some of the suggestions contained in this document had already been implemented in the design of the device, as some of the pedagogical suggestions and some of the green guidelines for improving the connection with Nature in children are strikingly similar.

Finally, not as part of the green guidelines, but something important taking into consideration in the development of Kidbeats device are the three Appendixes.

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APPENDIX A

PASSIVE AMPLIFIER AND SPEAKERS

A passive amplifier amplifies sound (increases the amplitude of acoustic power, sound intensity and sound pressure level) by passive means. In other words, it does so without the use of external electrical power or additional energy of any sort.

The term “passive” refers to the fact that the amplifier does not require a power source, such as a battery or mains power, to operate.

Passive amplification is the use of a device to increase the amplitude of a signal without adding energy to the signal.

The Passive Amplifier

Most of us are consistently walking around with a speaker (or speakers) on our person. These speakers are, in most cases, in our phones. With the rise of portable audio players and smartphones has come the rise of passive amplifiers.

Any smartphone can get louder without headphones or speakers. The built-in speaker can be amplified passively with many techniques.

Sticking the phone in a bowl can make it louder, thanks to the reflections discussed in the amphitheater section of this article.

A sound box can be built to improve sound quality

Different types of wood are used in musical instruments, from maple to ash, rosewood, mahogany and beech.

The sound box requires a stiffer wood that can amplify the sound without absorbing too many vibrations.

For more demanding components, special, rarer and more valuable woods are used.

To date, spruce (*Picea Abies*) is the most suitable wood for making the soundbox of a stringed instrument, i.e. the case that increases the sound by bouncing it off the walls. It is no coincidence that it is called 'resonance' spruce.

The Passive Speaker

A passive speaker, unlike active speakers, do not rely on an amplifier. A passive speaker is not prone to damage or wear out, and they are usually less expensive than full-size speakers.

There are also plenty of pre-built enclosures/horns available, usually designed for a variety of different smartphones.

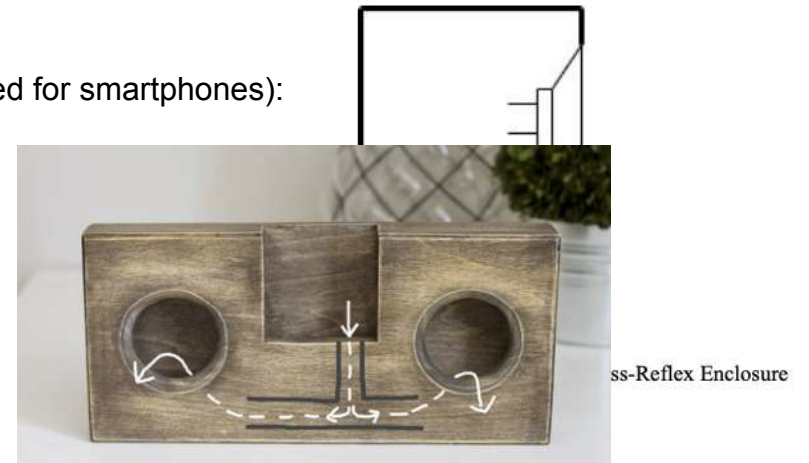
For example, Edison Amp has an awesome old-school horn-style passive amplifier pictured beside.



An interesting example of recycling wood and also of creating an amplifying box is Vaia cube, that uses red spruce (renown among luthiers as the most sought-after wood) from the trees fallen after a disastrous cyclone in Italian forests.



Other brands have simpler but effective passive amplifier as well (these are designed for smartphones):



The Speaker Enclosure

Most speaker units have their driver(s) housed within a box. This box is called an enclosure and, it too acts as a passive amplifier. Let's begin with the basics and describe a speaker without an enclosure.

We've already described the speaker driver as a transducer and know that the diaphragm(s) of the speaker move inward and outward to pull and push air and produce sound waves.

So, then, the speaker driver will push sound in one direction and then the other. It does so many times a second (20 Hz to 20,000 Hz is the audible frequency range).

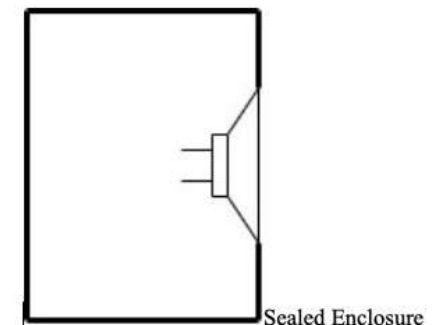
When the speaker pushes forward and creates a change in sound pressure, it simultaneously creates equal but opposite sound pressure to its rear. The sound wave that would be produced, then, is largely cancelled out by the rear "anti sound wave." This phase cancellation is particularly bad at lower frequencies, which are more omnidirectional by nature.

That isn't to say that there would be a complete phase cancellation that would yield complete silence. It is to say, however, that the speaker driver, by itself, is actually pretty bad at producing full and loud sound waves.

So by closing off the rear of the driver (at least partially) from the ambient medium, we can mitigate this cancellation. This is done with an enclosure and, in a sense, is a way to "passively amplify" the speaker's output.

The simplest type of enclosure is sealed. In this design, the rear of the driver is completely sealed.

This, in theory, eliminates all phase cancellation from the rear and, therefore, increases the amplitude of sound that is propagated from the speaker.



The bass-reflex is perhaps the most common ported enclosure type that has a small port in the enclosure to allow sound from the rear of the driver to eventually get out to the listener.

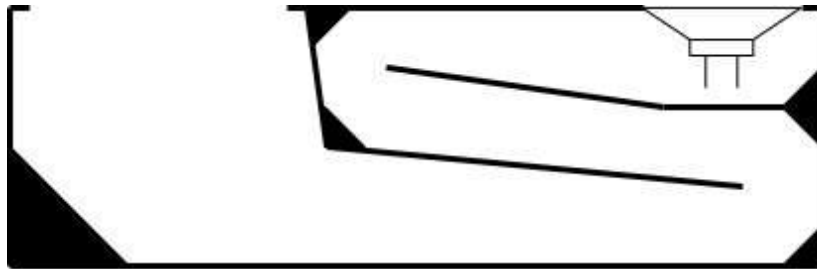
The front port(s) and tube(s) of the bass-reflex enclosure are carefully designed to cause the rearward sound waves to emanate from the speaker in phase with the forward sound waves.

When done correctly, this design yields a louder speaker than the sealed enclosure mentioned above.

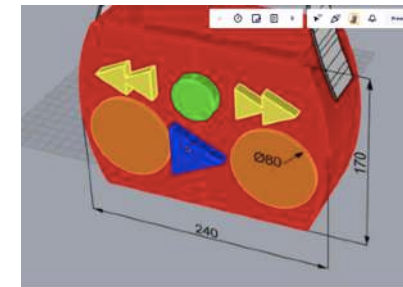
The aforementioned concept of the horn can also be incorporated into speaker enclosures. These enclosures are commonly referred to as transmission line enclosures.

The rearward sound waves from the driver are effectively sent through an acoustic labyrinth that gradually expands its cross-sectional area (link a horn).

These rear sound waves can be carefully tuned and passively amplified to reduce intensity loss throughout the distance travelled. Transmission line systems are among the best in terms of high fidelity, particularly at low frequencies.



Transmission Line Horn-Style Enclosure



KidBeats device first draft project

I include here some considerations emerged from the meeting with the KidBeats engineers. In August we met and discussed about compromise hypothesis for the creation of speakers: their first idea was to use old laptop speakers, but the sound quality appeared to be quite low. If new flat speakers would be too expensive, it could be possible to use the magnete ones.

Consideration must be given above all to the design of safety for children. That said, as in idea, if the shape of the device will be a cube, the two loudspeakers could be placed on the two adjacent sides, to improve the stereo effect (right/left channel).

Or if the shape of the device will be a parallelepiped, following the golden ratio between the side length, the speakers could be placed at both ends (right/left) to be more balanced in weight (for holding) and to have the whole front panel with space available for buttons.

Acoustically it is better to place the loudspeakers at the two ends, perhaps, although it changes little. The sound is a bit indirect (you can hear the source) and the stereophonic effect is more noticeable.

APPENDIX B

Using ethic platforms for the video meetings and in general

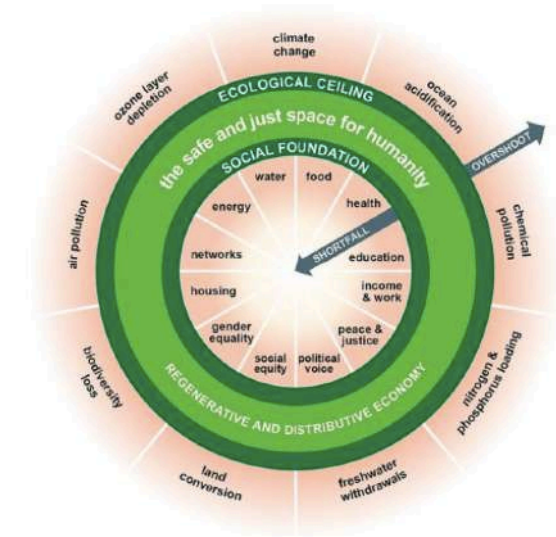
As mentioned in “e) Dissemination and open licenses”, sustainability is not only related to strictly environmental practices, but also to justice and safety. A safe and just space for humanity will be only possible through the use of ethical platforms and licenses.

Therefore, we need to look for ethic alternatives to the main videoconference platforms (like Zoom or GoogleMeet) and the messaging applications (like Whatsapp and Messenger) that are aggressively profiling the users, and selling big amount of their data and metadata.

The video meetings of KidBeats team should be organized through platforms like Jitsi Meet or kMeet, for example.

And the messages should be sent with Applications similar to Signal.

In general, there are three pillars for a digital ethics, that should be kept in account for every phase of the development of KidBeats device:



Digital ethics is developed along three axes

X: Ethics of Data

- **Privacy**
 - re-identification
 - group privacy
- **Trust** in whom?
- **Transparency** of what?

Y: Ethics of Algorithms

- **Responsibility/ac countability**
- **Ethical design** of requirements
- **Ethical auditing** of algorithms

Z: Ethics of Practices

- **Deontological code**
- **Consent**
- **Privacy of data subjects**
- **Secondary use**

APPENDIX C

Music for early age children, the Waldorf perspective

According to Waldorf education, the pentatonic scale plays a vital part in nurturing and developing children's imagination and creativity, especially in their early age (3-6 years old).

The pentatonic scale is a five-note musical scale consisting of the notes D-E-G-A-B. This scale is commonly used in Chinese and other Asian music, as well as American folk songs. Unlike the diatonic scale with seven notes, the pentatonic scale has no discordant notes.

Rudolf Steiner recommended pentatonic music for the young child because of the ethereal and dreamy sound produced. A young child's body spends a lot of energy growing in its first seven years. Steiner believed that maintaining this dreamy state in the early years, instead of awakening higher intellect too soon with academic learning, frees up a child's energy for their physical growth.

Beginning in the early childhood classrooms, it could be beautiful to use the pentatonic (or 5-note-scale) songs that do not fully center on a dominant tone. The pentatonic scale is found in nearly all world cultures including Native American, most Asian cultures, and in Ancient Greece, where Pythagoras based his "harmony of the spheres" on the five planets.

