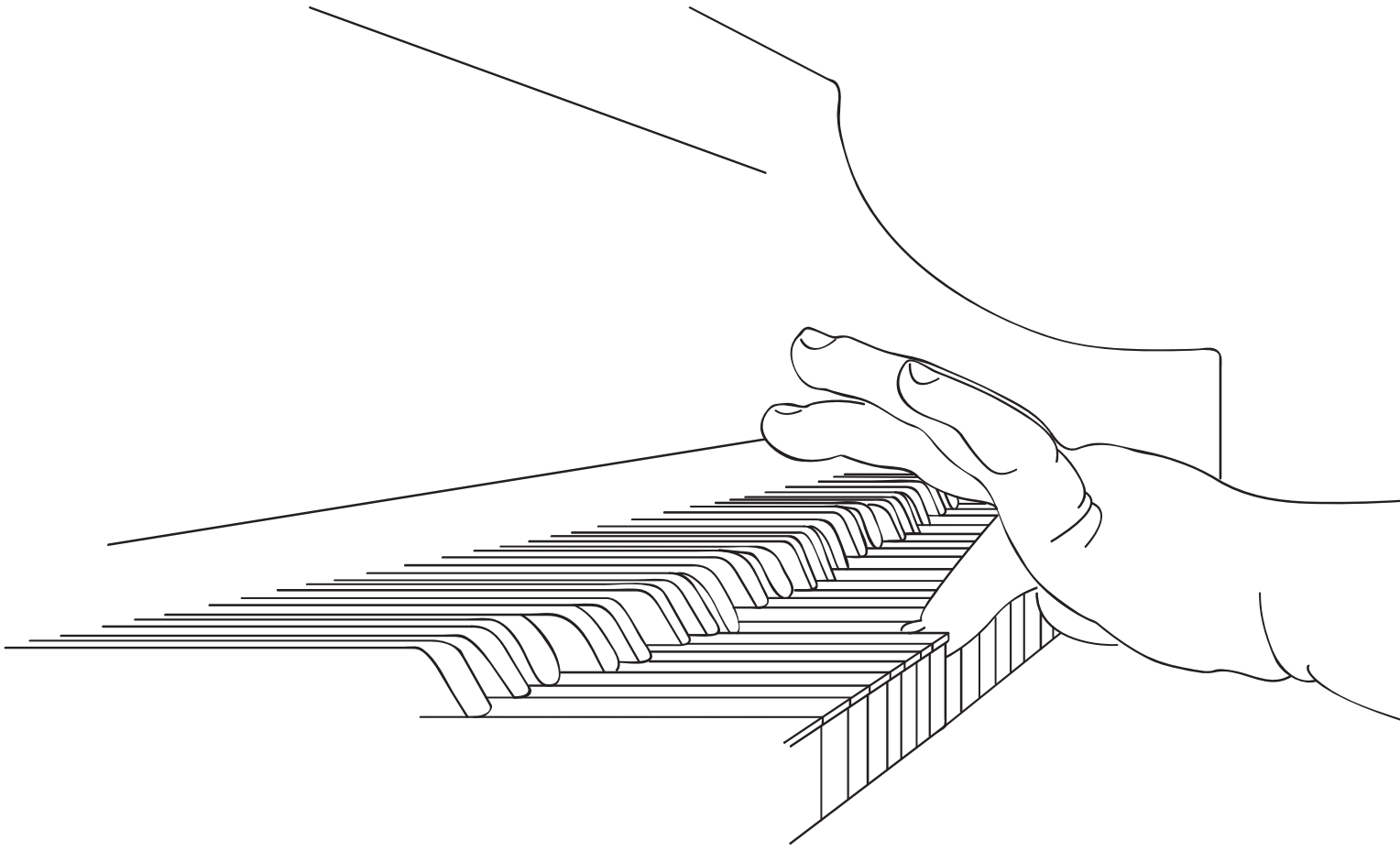
Elena Biondi

M-SCAPE

PHYSICAL AND IMAGINATIVE TOOLS FOR MUSIC EDUCATION



LUND UNIVERSITY

M - SCAPE

Physical and imaginative tools for music education

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This final project is dedicated to my parents: a mix of the passion and knowledge that they have always passed to me.

ABSTRACT

It has been proven that music education can have many benefits to the development of children. It can improve communication, reasoning, memory, coordination, spatial intelligence and mathematical skills as well as enhancing emotional and intellectual development.
The current market provides a broad range of instruments and professional devices, but it lacks creative tools useful to educate in music theory and its abstract principles.
By giving physical shape to a musical composition this project aims at helping users to literally “see” its underlying architecture, through the association of musical elements with three-dimensional and visual shapes for educational purposes.
The research phase consisted in the analysis of academic literature on cognitive psychology of music and sound perception as related to different sensorial stimuli, visual or tactile.
Once children were identified as the target group, a further research on didactics, educational methods and a market analysis of toys and didactic games as case studies were conducted.
Interviewing a music teacher, it was found how two major difficulties in early music education is with feeling the underlying pulse and understanding how rhythmic values are related to each other. Rhythms can be sub-divided, and a visual subdivision can help to grasp this concept. Also pitch, harmonies and dynamics, more related to emotions and feelings, could be visualised in different ways.
Following these principles, the first ideas were sketched, and a first user-test was conducted.
The final prototype was then developed and successfully tested with a child. The result is a didactic tool which consists of various blocks of wood, representing different rhythms and dynamics. The blocks can be moved around in a display to visually devise a “musical landscape”.
Wood, as a material, also becomes a simple percussion instrument for rhythmic exercises.
This product - system is meant to be used by the teacher as a help to perform a diverse range of exercises with the child, attempting to create a more accessible, playful and imaginative experience for early music learning.

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.1 INTRODUCTION

Music Education

This project started with the purpose of exploring the subject of educational design and creative learning methods using a multi-disciplinary approach to design, exploring the specific topic of music education, in line with a personal background in music and interest in didactics.
Design research may find opportunities in unexplored design subjects which can address an issue or improve certain situations. In this case, the focus was to use design methodologies not to create another instrument or improve professional music tools, already well-designed and complete as they are, but reframing the principles of teaching music basics, developing didactic tools.
Music didactics is a subject that has barely been explored by industrial design, which have the potential to make it physical and more accessible, adding useful products in a "blue ocean" market.
We live in a society in which we are no more used to truly listen, so much our "soundscape" is polluted.
The sense of hearing seems to be less important than the sight, but listen to music and even more, play music, affects our brain greatly.
Music education is an essential part of a person development and it comes naturally.
Children who can play an instrument, have better academic results as music helps developing communication, attention, coordination and motor abilities, as well as analytical skills.
Someone trained to distinguish sounds and evaluate them, is more conscious of the sound environment around us and more focused when it comes to analyse other kinds of situation.

The problem with learning music is the complexity of the subject itself which makes it obscure at first sight.
Digital technology can now help doing many things in musical terms: there are programmes to discriminate sounds and create musical pieces that seem to work without having any knowledge of the music basics.
It is possible to compose and play digitally without any formal music education, although this doesn't help having the right insights in the subject and doesn't explain the theory behind that sequence of sounds and rhythms.
This project questions if this is a good way to learn and understand music from scratch and what could be, instead, a more effective and interesting learning scenario.
There are several issues in the beginning of one musical education and as in all learning scenarios, there are many ways to explain the same theories and principles effectively.
Associations, for instance, have been used in didactics to enhance abstract thinking and help memorisation.
E.g. There are correlations between different medias: the visual sense is related to touch, sight and hearing.
Hearing a certain melody creates emotions that can be translated into an image, a shape, a colour.

This project tries to achieve a feasible and simple design solution based on these findings.

Demarcations

Music education is a broad topic and demarcations have been set during the research phase, although the general initial idea that started the project has then shaped the entire design process: find a three-dimensional way to visualise and explain a composition and how the music is “built”.
The final goal was to enhance abstract thinking by materialise complex abstract principles in a simple, accessible way.
The brief, based on this broad idea, involved the importance of physical interaction opposing digital applications for learning.
The physicality of things has become more essential throughout the process as children were identified and confirmed as a target group after the research phase.
Children need to be constantly stimulated by playing and physically interacting with the natural and artificial world around them.
Music might seem scary because of its complexity, but the initial issues could be solved by simplify the way we see its construction and play hands-on with it.

Brief

“To design new educational tools to explain and understand the music composition.
These tools would be visual and three dimensional and they would try to de-compose music and its layers, possibly avoiding the use of one sense or using a combination of senses (visual, tactile).
This interaction between different media, would occurs before or while listening or playing, increasing awareness of the construction of sounds”

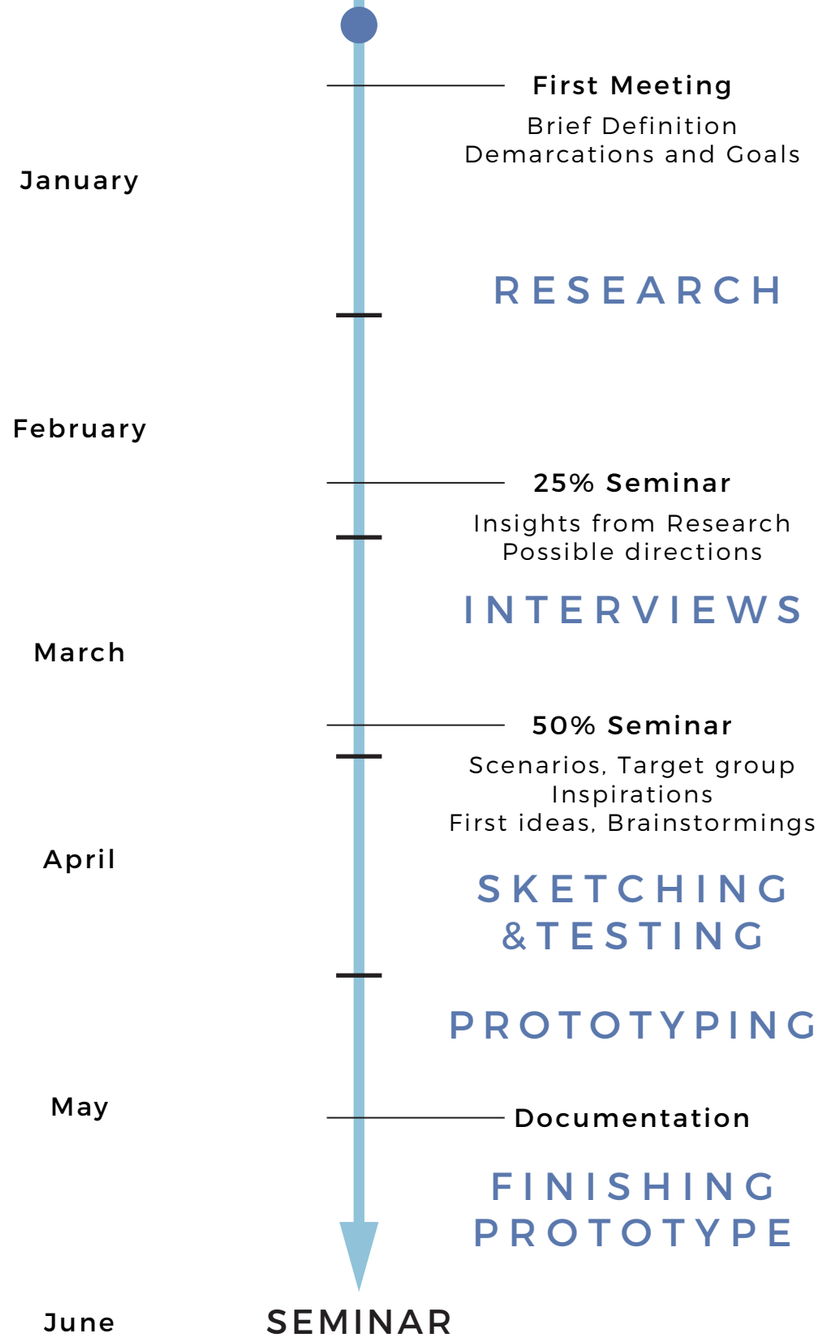
Methods

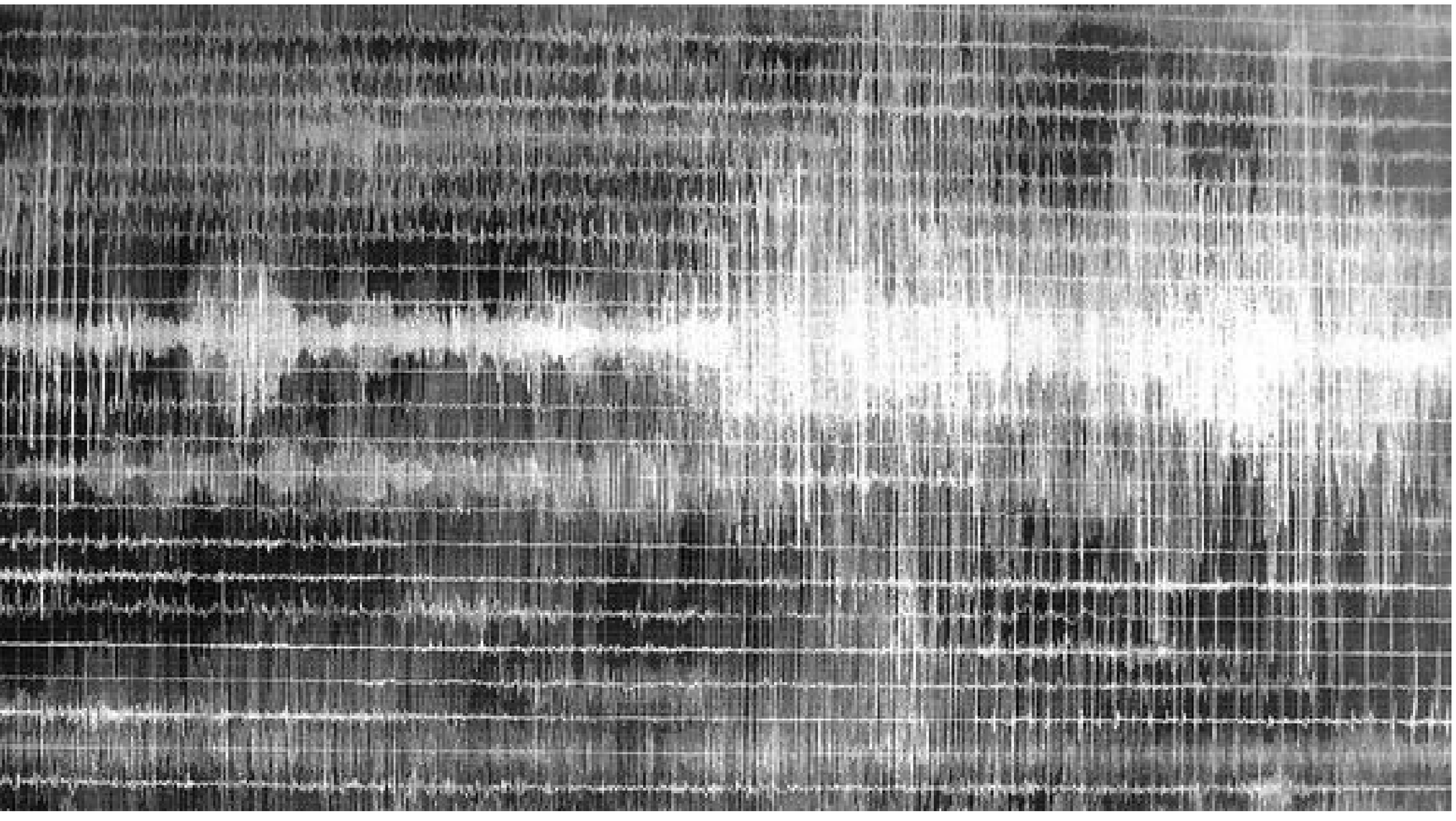
The project was structured in three different phases.
- A first research phase in which music perception and aspects of cognitive psychology were analysed, including findings on associations from sound to visual.
Furthermore, a research on education methods for music and on didactics in general was conducted.
- A second ideation phase comprehensive of an analysis of possible directions and user testing.
- A final prototyping phase of the final design, which was presented to the open seminar as a full-scale prototype.

Post-seminar work was based on more product specifications and testing, with a storyboard of the ideated product-system.

The methods used were the following:
- Qualitative research (literature, articles, reports) on perception, cognitive psychology and didactics.
- Two interviews, one at a children rehabilitation centre, one with a music teacher.
- Market analysis and case studies of different products for music and other learning tools.
- Mood boards for inspiration of shapes, colours and materials.
- Analysis of possible directions and ideas generation through brainstorming, sketching and mock-ups.
- Two user tests before and after the seminar which led to adjustments and shape development in CAD (3D models, renders).

Project Management

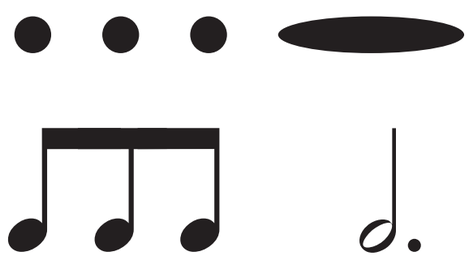




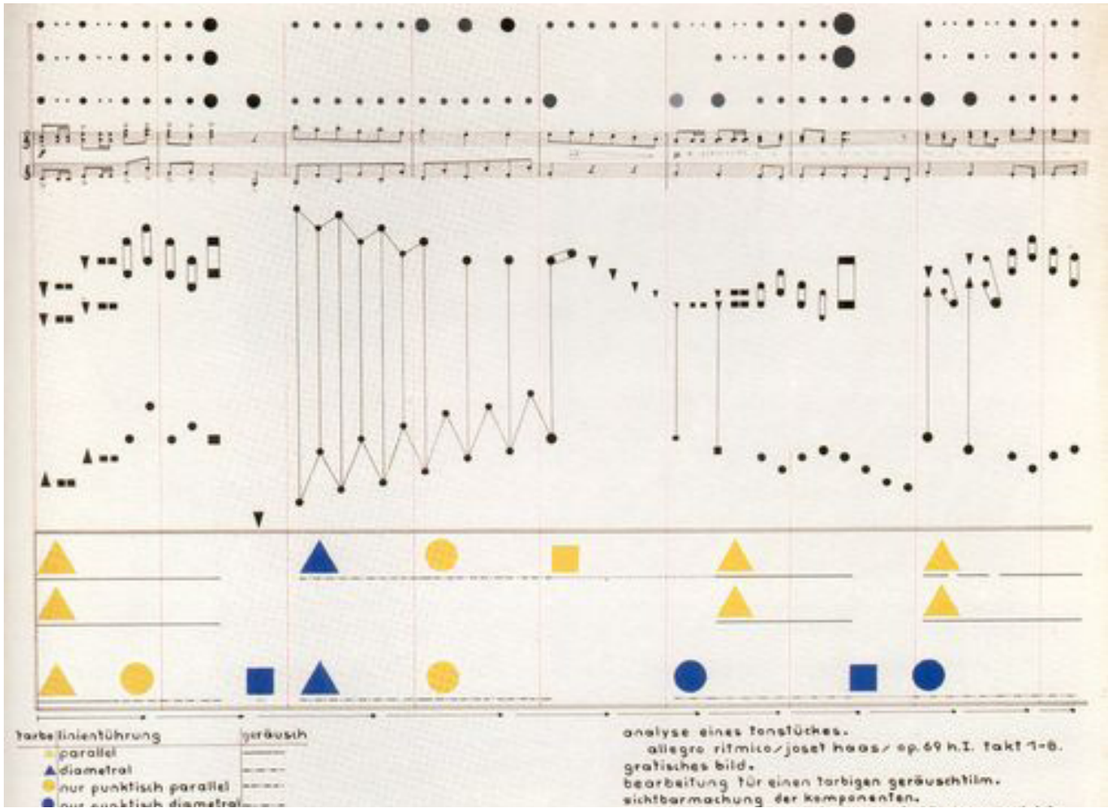
How do we grasp music?

Music Perception

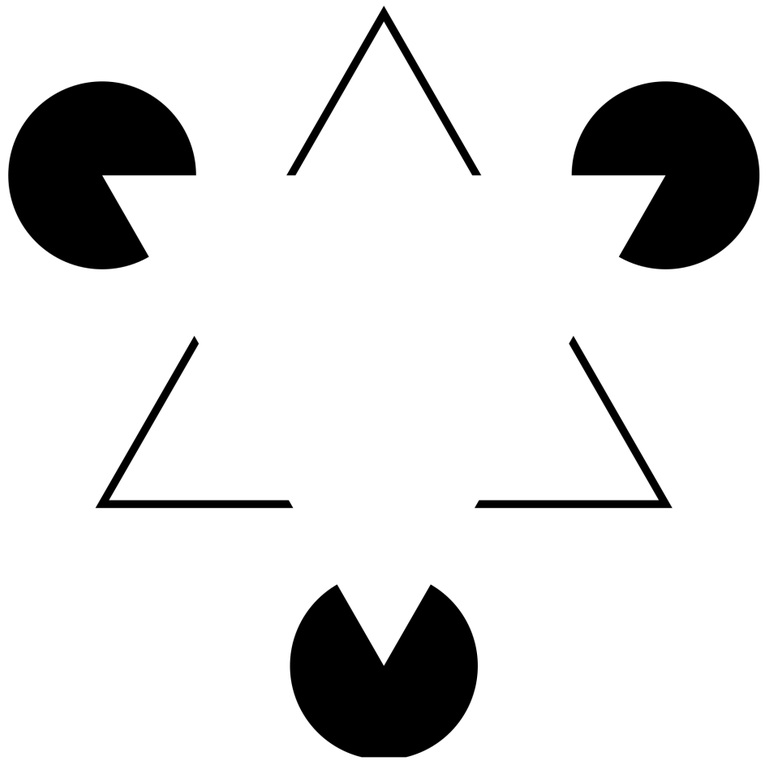
Everybody is born with a “musical intelligence” and everybody can universally understand it.
This skill comes since before birth, recognising the mother voice, feeling her rhythmic heart beats and the sounds outside the uterus. The “acoustic element” is primitive and essential and it accompanies humans every day, surrounding both natural and artificial environments.
Therefore, here comes the belief that the ears should be trained to understand sound and its aesthetical organisation, that is, Music, or organised sound waves.
How do we perceive the music we listen? What is the psychology behind the understanding of music?
Humans perceive music in the same way they perceive the rest of the reality.
In the book *Conceptualizing music: cognitive structure, theory, and analysis*, it is stated that “the musical understanding relies not on specialized capacities unique to the processing of patterned sound but on the specialized use of general capacities that humans use to structure their understanding of the everyday world.” (Zbikowski, 2002, Preface)
This means that humans analyse the musical events in terms of basic categories.
For instance, motives are basic categories and the rhythmic profile is an attribute of the category.
When in the Beethoven 5th symphony we listen to the famous motive, we can suddenly recognise the rhythmic profile, that is: short, short, short, long (Fig.5).
The book *Musical creativity: multidisciplinary research in theory and practice* highlights how listening carefully to a piece of music should lead to the construction of a schema with identifiable patterns that stand out and become firmly memorised as one listen (Deliège and Wiggins, 2006).



5 - Beethoven 5th Symphony pattern



6 - Rhythmic profiles - Visualisation



7 - Gestalt psychology - Visual Perception

Visual perception

We perceive a piece of music as a “whole” and not as a series of disconnected sounds.
This statement is part of the theories of the Gestalt psychology and can be applied not just to the acoustic experience but also to visual perception.
We see the ensemble, not singular shapes and colours (Fig.7).
To continue with the analogy the “similarity of form in the visual field could translate into the similarity of sounds with their different musical parameters: register, timbre, articulation, intensity” (Deliège and Wiggins, 2006, p.68)
And the concept of proximity in the field of vision is transposed into time-space when we are speaking about music (Deliège and Wiggins, 2006).
As explained by Tighe and Dowling in the book *Psychology and music: the understanding of melody and rhythm*, “a melody is not just a collection of independent notes, but an integrated whole whose parts are inseparably related in an organic structure. A change in one part of the melody inevitably affects the way the rest of the melody is perceived. Perceiving a melody invokes a context of actual and possible events that adds meaning to what is heard” (1993, p.1).

Soundscape

We experience music also in relation to our cultural background.
The Western European tradition of music is based on tonal music and this is applied to sound design in the urban environment as well, as explained by Schafer in the book *The soundscape: our sonic environment and the tuning of the world* (1994).
Cars, bells and other of the sounds in our traditional European soundscape are based on tonal harmonic principles. For instance, in the tonal framework certain pitches are stable and other are unstable and require a resolution to more stable ones and so we experience the end of a melodic frame.
It's the same as perceiving a sentence, we can feel when it is going to end or feel the incompleteness.
The listener knows the structural frameworks for melodic patterns that are found in the musical culture and found them familiar, since used to listen to them since childhood.
Consequently, the more the listener is experienced in listening to music, the more will understand the structure of it and perceive it consciously, building implicit knowledge.
The knowledge of music and ear training bring to more awareness in terms of sound recognition and analysis.
The hearing of a musician is more sensitive to soundscapes and sound pollution, as well as to good or bad music.
Are our ears trained? Or do people listen without listen?

8 - Western European soundscape

9 - Melody in Nature

Melody

Humans recognise and appreciate melodies from the cradle onward and this is culturally universal.
Our sense of melody is very strong and when a familiar melody is played, we recognise it almost immediately, even if it's in a form that we have never heard before.
Melodies can be easily compared and can remind us of personal experiences or create other types of emotional associations.
Melody is strictly connected to rhythm, so, how do we integrate melody and rhythm?
As explained by Tighe and Dawling in the chapter *The Integration of melody and rhythm*, "The rhythmic organization of a melody is, if anything, more important psychologically than is the pitch pattern. In his 1890 work, Principles of Physchology, William Jones observed that melodies can be recognised from just the rhythmic pattern alone. And as Jones observes in the following chapter, distorting the rhythm of a tune makes it difficult to recognize it. In fact, changing the rhythm of a familiar tune turns it into a new tune".
And next, "pitch and rhythmic pattern are not just separable aspects of a melody that can be considered in isolation. (…) A melody is an integral whole composed of rhythmic and pitch patterns" (1993).
It's interesting to see how also animals produce sounds with a pattern that has usually communication functions, as sound is a communication system in the natural world (Fig.9).
In the civilised world, melodic themes have been used for different communicative goals pushing on recognition and predictability and this has influenced how humans experience music (objects, sounds, commercial jingles etc.).

From a strictly technical point of view, the pitch, that is determined by tone frequency and by frequency relationships, gives the melody and the time gives the meter and the rhythm.
We can perceive, if we are well trained, the "ups" and "downs" in pitch.

Rhythm

The rhythmic structure includes three temporal aspects of music: “tempo” or “beat period” that mostly remains constant; “meter” or the pattern that the listener should understand clearly; “proper rhythm” or the temporal duration of the patterns (Tighe and Dawling, 1993).
We can perceive melodic accents and temporal accents, that let us follow the music flow.
That’s why we have the tendency to move while listening to something rhythmic, although this is not just all about rhythm.
Music is a composition based on many different elements besides rhythm, such as melody, harmony and timbre. In most of our Western music all these components work together and interact in complicated ways. There is always timbre of some kind, associated with the musical instruments or voices that are used.
“There is practically always melody and rhythm and there may be harmony. (…) It is hard to avoid the impression though that rhythm is somehow basic in the musical process. (…)
Music takes place in time, and the temporal organization of the sound events achieved through rhythm simply must be of fundamental importance. In fact, there is no melody without rhythm, but rhythm doesn’t presuppose melody” (Tighe and Dawling, 1993, p.93).

As previously mentioned, we perceive the rhythm as a pattern, as a “whole”, a group, not as a series of isolated events.
“If somebody claps or plays a rhythm and asks you to reproduce it, you can usually do this without any conscious reflection regarding how many claps there were or how they were organized, you just clap the pattern” (Tighe and Dawling, 1993, p.95).
We can accent on one or more members of the pattern.

10 - Rhythm doesn’t preppose melody

11 - Neil Harbisson

12 - Alexander Scriabin

Associations

We can associate different sensorial stimulus.
For instance, in language and literature we can say that a tone is “sharp”, or a colour is “loud”.
Humans spontaneously make correspondences.
There is an actual disease, called synaesthesia, which it is described by Miller in *Eye hear the visual in music* as a special case of a general condition. This general condition is related to the fact that everyone can experience how major art forms stimulate, either directly or indirectly, more than one sense (2013).
This means that it is not always a clinical disease, but a way to experience reality.
Synaesthesia can be used on purpose by technology as a help for disable patients.
It is the case of Neil Harbisson, a man born with an extreme form of colour blindness that results in him seeing only in greyscale (Fig.11).
He has currently implanted an antenna in the skull that allows him to feel and hear colours as audible vibrations.

Among children, the instant association with other senses, like colour with sound, is common and it’s related to creativity and feelings.
Through associations we experience reality in another way.
For instance, when we listen to music, two different pieces can have similar patterns and we can visually connect them.
The pattern can be shown by associate the sound with the length or the size of the elements of a visual pattern, so the beats or the pitch with colour.
The pulse is usually connected with the sound progressing in circles.
The silence can be connected to a black space and so on.
The composer Alexander Scriabin, among other artists who worked on the aesthetical meanings of synaesthesia, designed a colour chart in which each colour was associated to a note (Fig.12).

What are the teaching methods?

Didactic methods

There are several didactic methods for music education.
The traditional methods are based on first teaching the basics of music theory and then on the actual learning of the chosen instrument, that requires hours, days and years of practice to master.
However, there are other experimental methods invented by a few musicians and teachers over the last century.
The Suzuki Method, for instance, was created by the violinist and pedagogue Shinichi Suzuki (Fig.13) and it's based on a "learning by doing" philosophy and the belief that every child has musical talent.
Exactly as it happens when learning a language, the music learning can start listening to a piece and repeat it using hands, body and voice.
This would develop motor coordination and enhance memory skills, being the method based on imitation and improvisation.
The didactic approach developed by Carl Orff, German musician and composer, was based on the same idea: every child is potentially able to play and appreciate music.
The activities are playful, avoiding the pressure of performing.
Orff considered rhythm a basic form of human expression and he used simple percussion instruments and tools for rhythm: xylophones, marimbas, metallophones, drums and non-pithed percussion instruments.

Other innovative teachers and theorists to mention are Gordon, Dalcroze and Kodaly.

"Musical ability is not an inborn talent but an ability which can be developed.
Any child who is properly trained can develop musical ability just as all children develop the ability to speak their mother tongue. The potential of every child is unlimited."

Shinichi Suzuki

13 - Shinichi Suzuki

Active pedagogy

Not specific to music education, it's the Montessori method, focused on the education of the senses.
The method works on simplicity and practice using objects that attract the spontaneous attention of the child, who can "exercise" alone (Fig.14).
These objects are designed to recognise the thickness (thick or thin), the length (long or short), size (objects, larger or smaller) and to develop the chromatic sense.
Part of the method is also the discrimination of sounds using 13 tonal bells (Fig.15), as well as using other attractive instruments like drums and simple strings to train the sense of rhythm, not the musical tone.
Montessori believed that these tools are useful for the child muscular sense, muscular memory and sensory memory.

The theory is based on the idea of a simple interaction where the child can move freely and interact with the objects, staying in a set environment.

14 - Montessori Method - Objects

15 - Montessori Method - 13 Tonal Bells

Educational design

Munari was an Italian artist and designer who worked on creative workshops and products for children.
A good example of his work is a project called “Prelibri” (Fig.16) or pre-books that had the purpose of teaching how to read and gain a desire to read by becoming familiar with books as objects.
These books are only “sensorial” without neither text nor images.
The format is small, and the materials are different, with different colours and bindings.
The invention of the story is left entirely to the child, who, working from the book, can construct games, stories, and inventions using the power of imagination.
The books aim was to develop the child’s sense of touch and sight and curiosity.

This was an inspiration for making something interactive, simple but effective, something that can make the child curious.

“Children have the awareness of the surrounding environment through all their sensorial receptors and not just sight and hearing, they can also perceive sensations of touch, heat, material, sound, and smell.”

Bruno Munari

16 - Bruno Munari - “Prelibri”

17 - Dumle

Music as therapy

Music can be a powerful therapeutic tool.
Using music as therapy was considered as an option for this project.
Can education and therapy be integrated to help people with disabilities?

An interview at the Children Rehab centre, "BarnReHab Skåne" connected to Dumle (Fig.17), a centre in Lund that works with children with disabilities, was conducted.
The focus of their work is on communication, cognitive assessment, motor physical training, memory, rehab from brain injuries and other disabilities.
The centre employs a music therapist who sometimes comes and work with children.
The children have a hard time concentrating, they struggle having a connection with reality and they are difficult to motivate.
The music therapy is done in groups, they listen to music pieces and repeat songs, they perform simple rhythms actively using drums and other tools.
Music is seen as a mere leisure and playful activity. This is because music can deconcentrate during rehabilitation exercises.
It does help disable children with group activities, communicating with each other.

Medical rehabilitation and music therapy are not done together for technical reasons.
They are both useful, but in different ways.
Although some games with strong feedbacks and association of colours and sounds are used with very young children.

The difficulty of integrating medical rehab and music, was the reason why this project was then developed following another route, not connected to physical and mental disabilities.

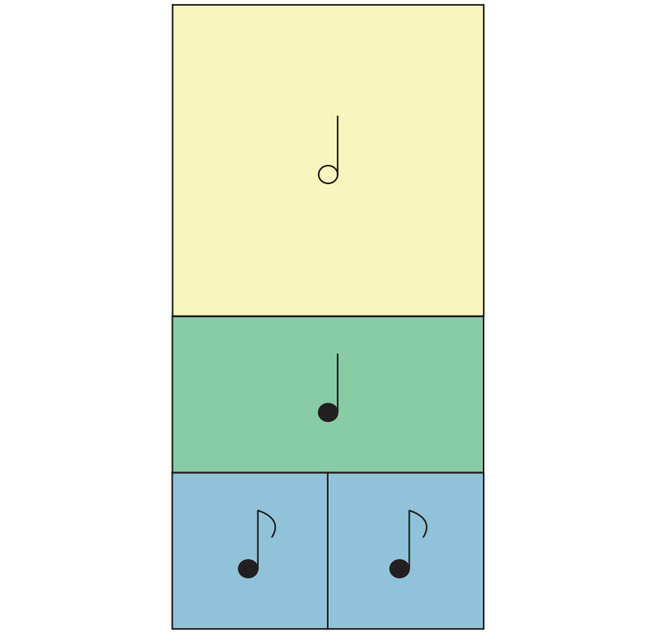
A music teacher

Another interview was then conducted with a music teacher working in LIMUS Musikskola.
This helped to see the physical tools and methods they use in the school and understand which parts of music theory and practice are the most difficult to teach.

These are the main insights:

- There are very different approaches when teaching music to children and adults.
- They use cards with colours and different sizes for teaching rhythm: association of size / shape / colours help the recognition and understanding of rhythmic values (Fig.18).
- They use a repetitive method: the child listens and then repeats.
- There are individual classes using many methods, that change depending on the person.
- Visualise, touching and movement are all fundamental to the learning process.
- The pupil practices one single thing to get it right or the teacher asks to do the same thing in different ways.
- Musical memory is essential: listening to short melodies and then repeating them singing and finding the right notes in short ranges.
- The teacher names things in a different way to make it interesting (marketing) or picture something (e.g. staccato: burning finger)
- Problems in feeling the pulse and rhythm, can be trained hearing a rhythm all the time and do it many times.
- It's helpful to break things down, one part at a time, step by step.
- If you repeat a melody how do you know if it's right without a teacher?
Would a digital device help?

Many methods are taken from Suzuki, Orff and the other innovative theorists mentioned in this research.
Some of the tools are "improvised" or DYI as the design markets provides simple instruments and professional instruments, but specific tools to explain music theory don't currently exist.



18 - Reproduction of the cards used in the school to teach rhythm

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CONTEXT

What is the project scenario?

Target group

The research on the psychological processing of music and music education showed the importance of early learning of music principles and practice.
Nevertheless, children were not chosen as a target group since the beginning of the project as other alternatives were selected and analysed.
The fundamental question raised was: who would most need this project?

Would children starting their music education the ones who would benefit the most from it?
Or disable children / adults using music as a therapy?
Or adults who wants to learn music later in life?

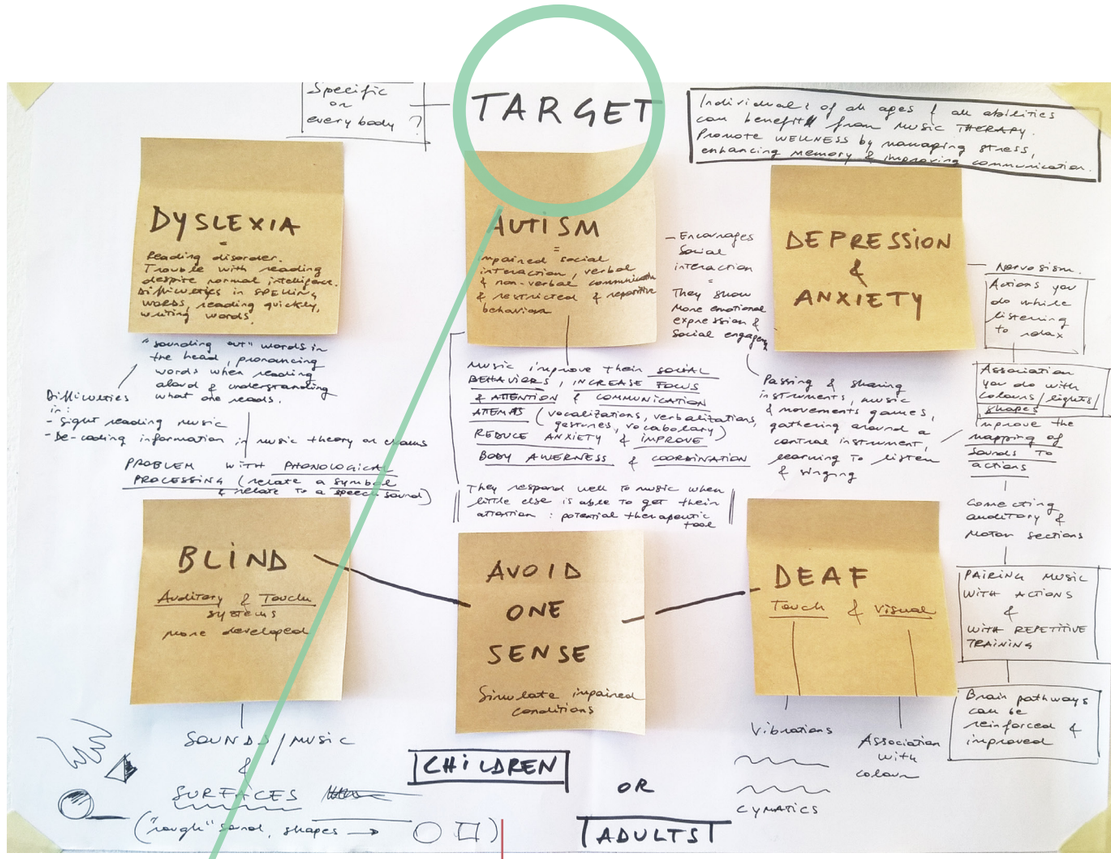
In the previous chapter the possibility of working with disabilities was already discussed.
Individuals of all ages could benefit from music therapy, promoting wellness by managing stress, enhancing memory and improving communication.

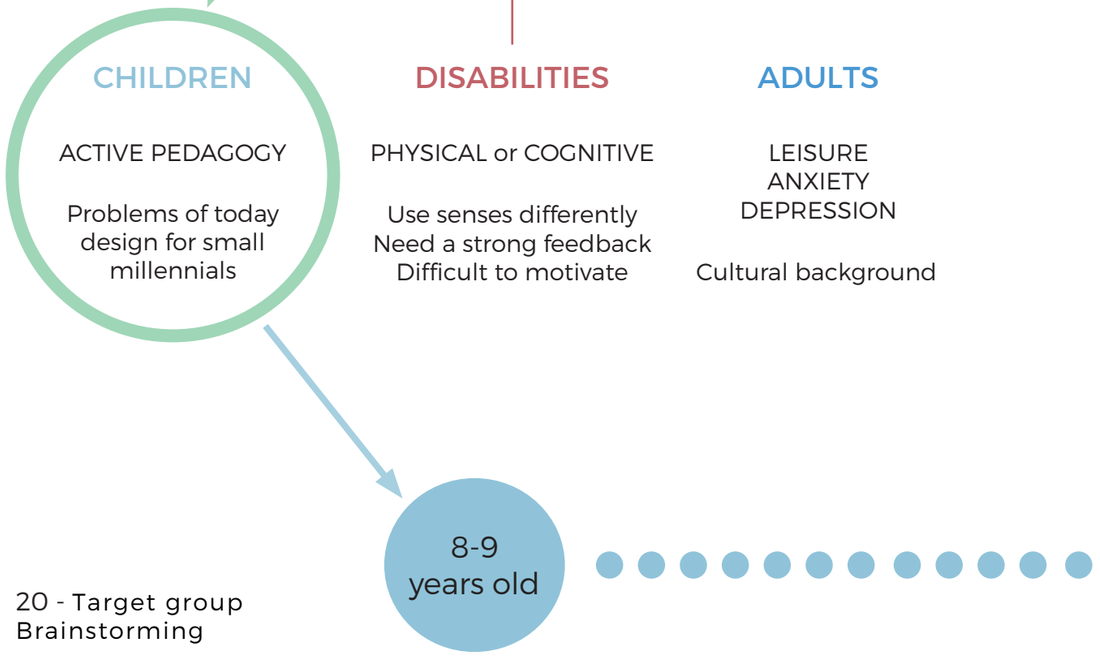
Although, the complexity of the subject and the many implications from a design point of view considering the lack of time and resources, made the decision of not considering this target group as the chosen one.

Children starting their education at an early age were chosen as a defined target group.
The main reason was due to the many possibilities that creativity could create within the world of childhood, both from an educational and an imaginative point of view.

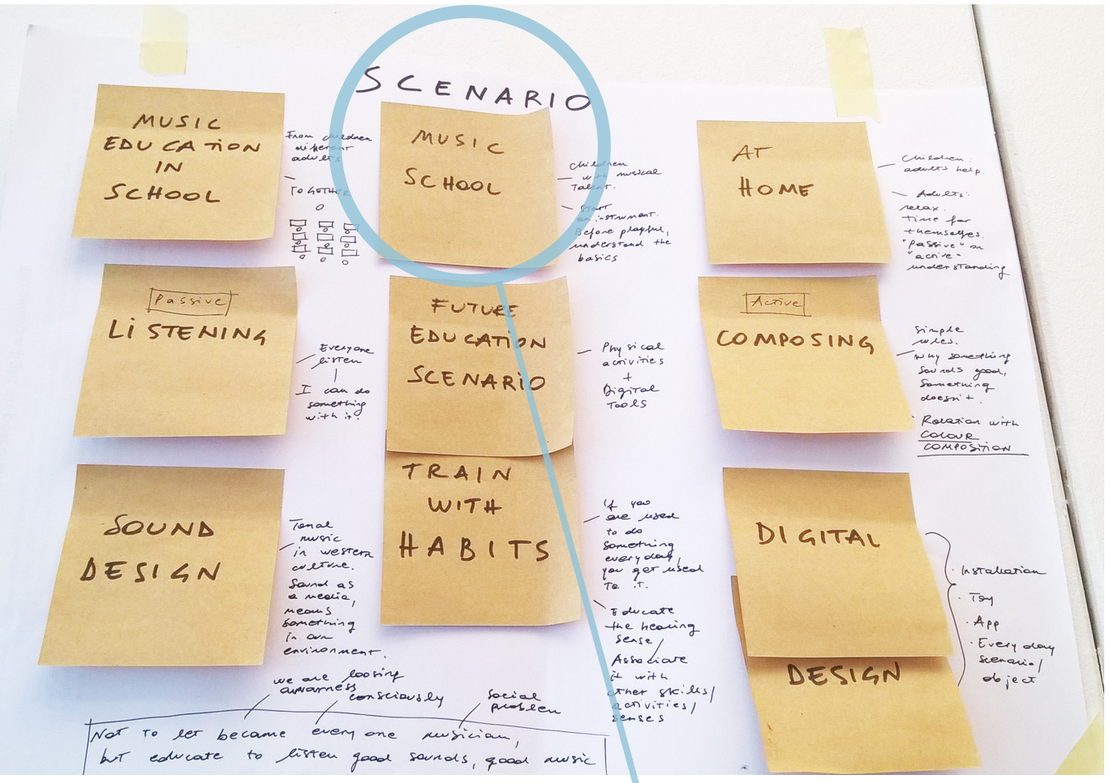
What age range would be the most appropriate?

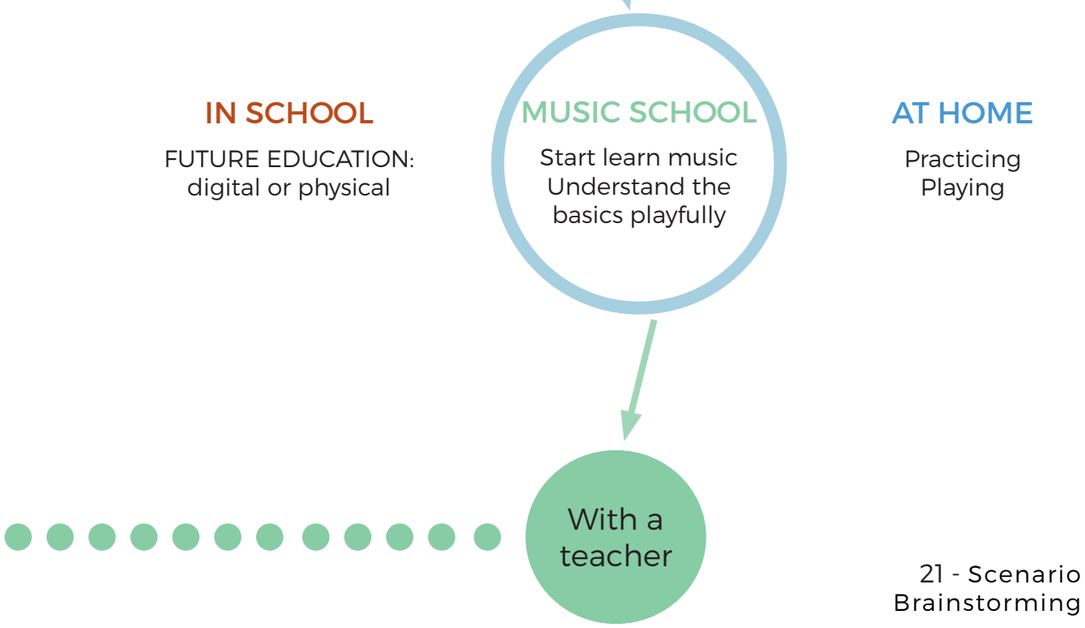
Children must be already old enough to be conscious while listening, be able to understand abstraction or associate things easily at a certain level.
That's why normally parents let children start their musical education around 8-10 years old.
This range was finally chosen while focussing on the design persona and scenario.





20 - Target group Brainstorming





21 - Scenario
Brainstorming

Scenario

In which situation would anyone need to understand music with new tools?

Possible scenarios were analysed, and different options were considered.
For instance, future education scenarios in public schools in which children have group music lessons or music schools itself could be the project focus.
Would training at home be an option as well? Or during other activities?
While thinking of the possible scenarios, questions connected to design issues were raised.

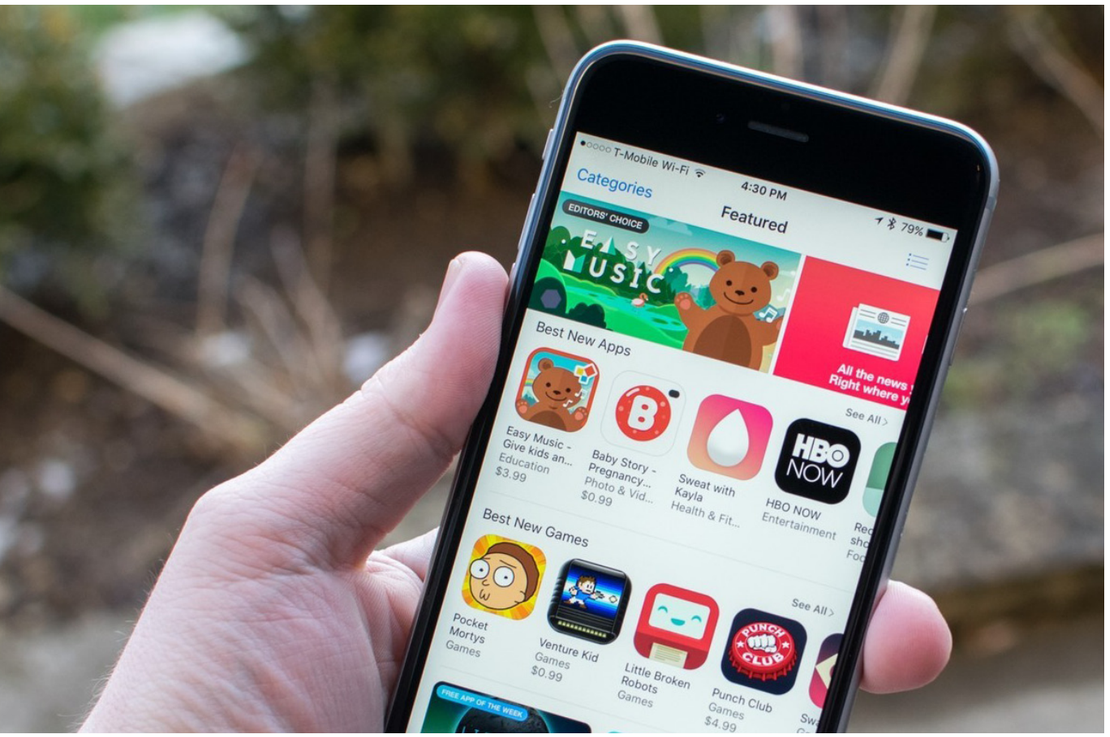
Would the training be for ear training, listening, composing or playing?
Would it involve also some sort of digital interaction or would it be completely low tech?

The learning process would need to be developed in a situation in which the child is focused on the training activity.
An initial guidance would be needed, and that's why music schools or music lessons in schools where children are followed by a teacher, were chosen as the best scenario for this project.

The current market

The focus of this project was not to create another instrument, but rather research on music theory and early learning methods.
Nevertheless, most of these didactic methods use simple instruments, and the market of children instruments was briefly analysed to have a general overview of design in past and present didactic objects in terms of materials, colours, shapes and functionality.
Simple percussions and drums are part of Orff's approach, following his belief in rhythm as a natural treat of human expression (Fig.22).
The music played with these instruments is very simple, being the percussion instruments mostly non-pitched.
From a design point of view, the objects based on this approach are mainly made from wood, in different sizes, easily transported and stored.
These are often colourful, making sounds by friction or beating.

22 - Orff instruments



23 - Digital applications for teaching music to children

Digital and interaction

We live in a digital world and a variety of digital applications to teach music is currently on the market.
The purpose of these games is mainly entertaining children by composing without previous music theory knowledge. The interaction, in this case, is only on screen.
A product named “Cubetto” (Fig.24) was designed to provide a different kind of user interaction.
This product was analysed as an example of innovative didactic game, even though it is not related to the music subject.

Cubetto is a wooden robot and it is meant to teach the basics of computer programming to children.
Part of the kit are “coding blocks” that correspond to an action.
The child can physically interact with the blocks on a display and the robot will follow the actions as commanded.
This project is an example of how an apparently friendly and playful toy can help enhancing abstract thinking, useful to understand complex subjects such as coding.
Can this be applied to other subjects: math, geometry or music?

24 - “Cubetto”

Inspirational products

The main goal of this project was to design for children old enough to understand a higher level of complexity by working on tactile and physical interaction. For this reason, other inspirational objects for kids were analysed.
“16 Animals” (Fig. 25) designed by Enzo Mari for the company Danese is a good example of a simple toy that can stimulate creativity by de-composing and composing shapes that create a puzzle to solve and to play with.
“More or less” (Fig.26) designed by Bruno Munari is a game of adding layers that can create different stories.
The “Rulers” (Fig.27) used in school to teach math, help visualising numbers with different lengths.
“Synchrony” (Fig.28) is a product that help parents and autistic children by feeling music vibrations.

The results of this research can be summarised with the importance of a simple way to play with shapes that can raise curiosity towards an object.
The creative mind can then build personal stories with those shapes.

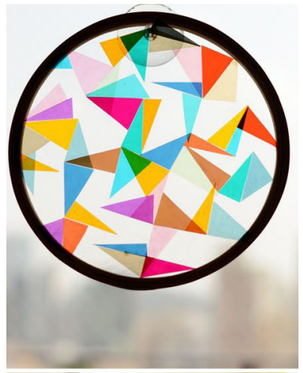
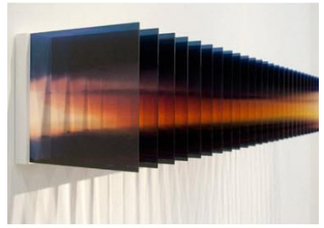
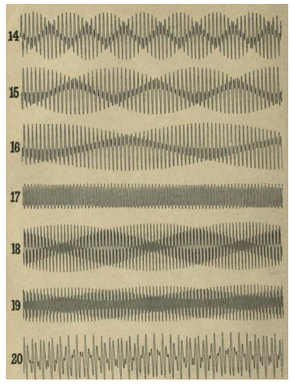
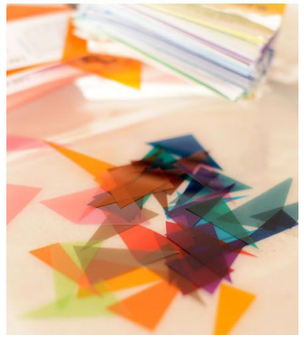
25 - “16 Animals”

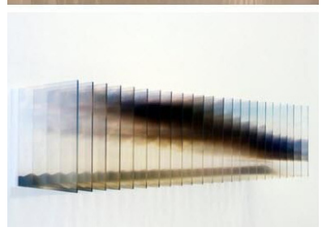
26 - “More or less”

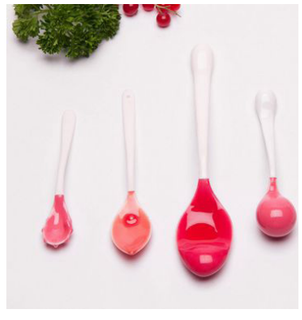
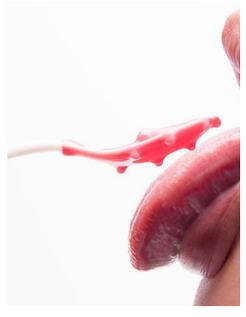
27 - Rulers

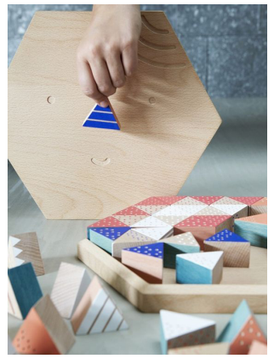
28 - “Syncrony”

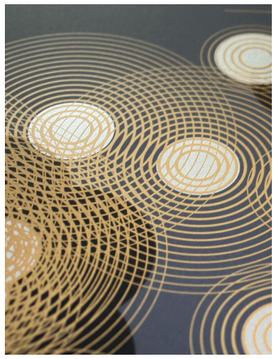
Moodboards: tactile and visual

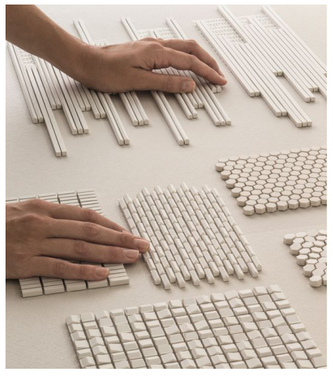


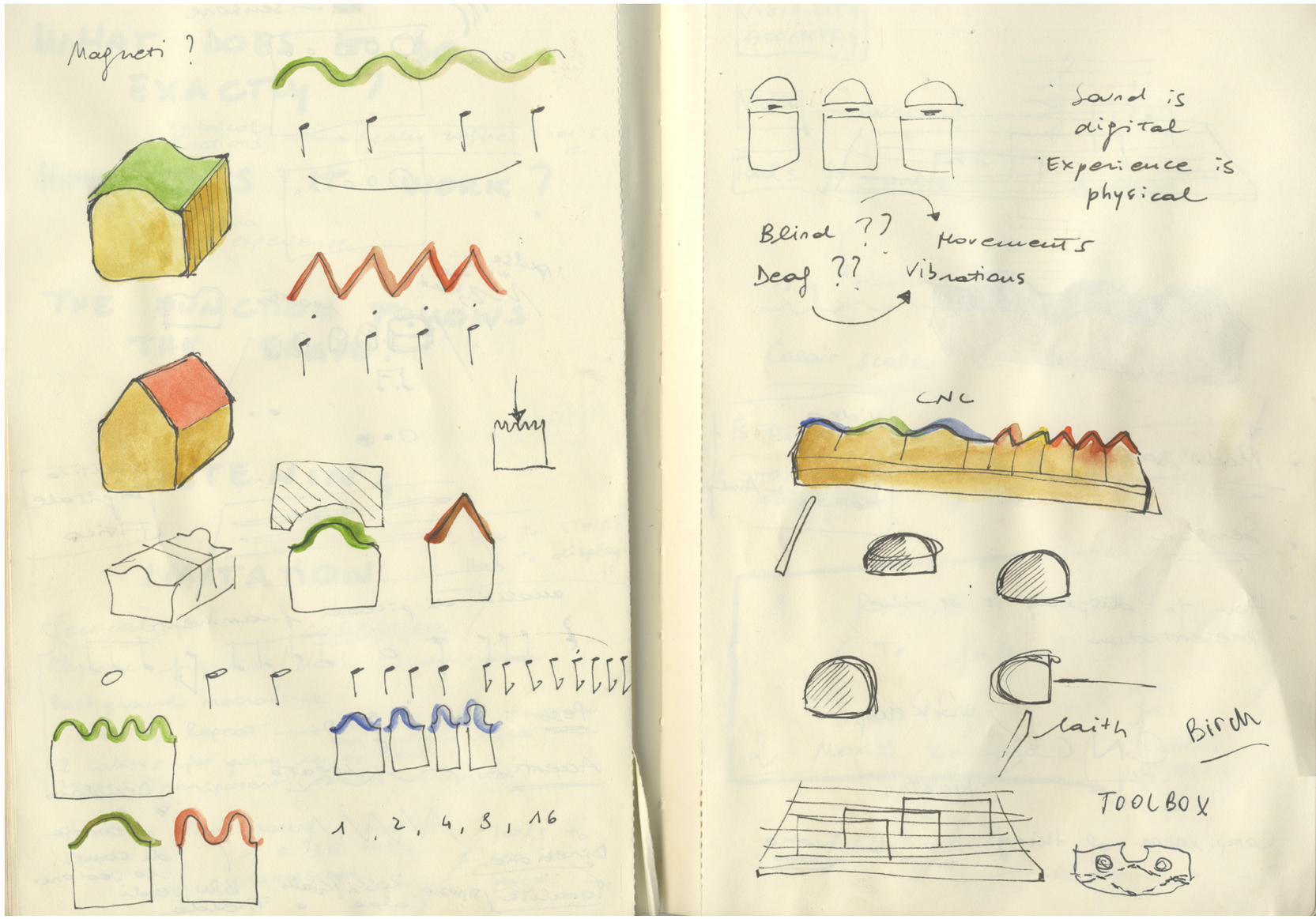




IDEATION

5.


Magneti ?
1 , 2 , 4 , 8 , 16
Sound is digital
Experience is physical
Blind ?? Movements
Deaf ?? Vibrations
CNC
Faith
Birch
TOOLBOX

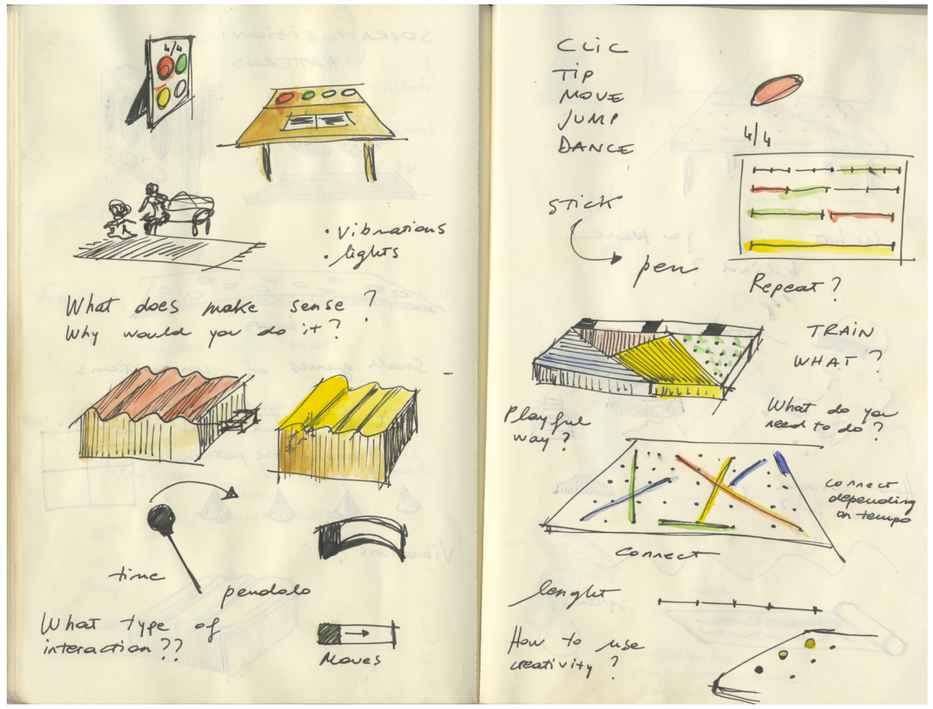
How can rhythmic structures be visualised three-dimensionally?

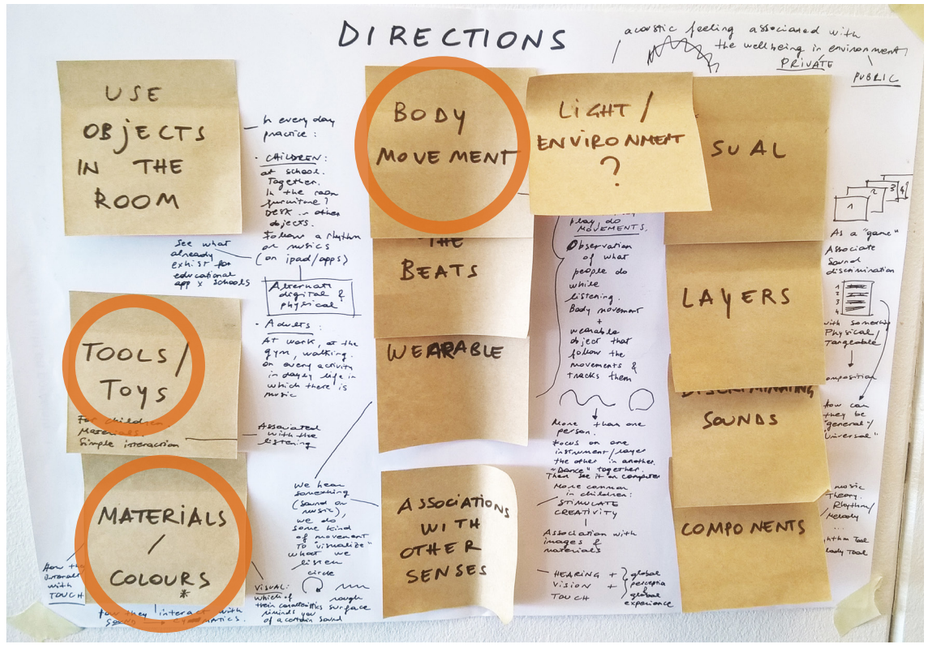
Directions and first ideas

Many directions were considered in the beginning of the ideation process. They had all in common the purpose of using associations to connect the sounds with something graphical or physical to better understand it.
The main goal was to make the end user "touching" music, understanding its construction by making it "real".

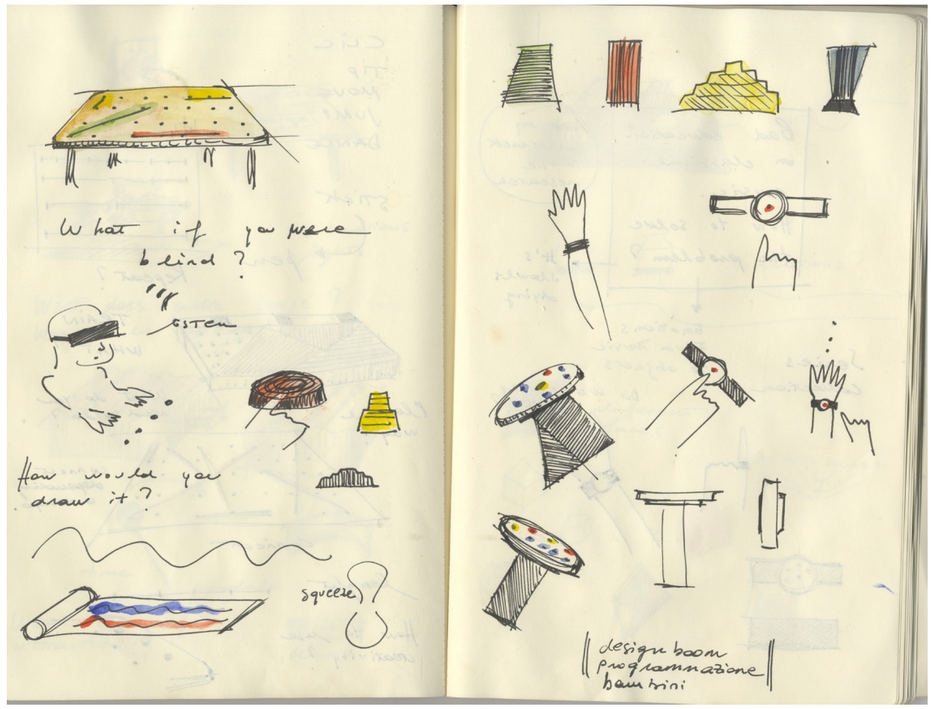
What exactly would be trained?
The options were, for instance, body movement and coordination, discriminating the instruments of a composition, training how to feel the pulse, analysing rhythm.

How could this be associated with sight, touch and movements?
How to use colours, patterns and different materials?
Would digital appliances be integrated in the final product? Or would the result be completely lacking any kind of technology?





45 - Brainstorming - Directions



Back to the basics

Coming back to the basic principles of music and keeping the project as simple as possible were the main demarcations set before the concept generation phase.
Thinking of a situation in which the child is starting to learn music, following the insights taken from the interview with the music teacher, the first thing that is studied in music theory was analysed.
That is, rhythm.
What if it would be possible to associate musical notes, harmonies and rhythms with physical objects that can be matched with the music written and played?
What if we can associate the length of a note with the size or the length of a physical object?
Why not using a visual subdivision to grasp rhythmic concepts?
Repetition and a step by step process are the key to help children learning effectively.

Simple geometrical figures that can be associated with sounds were sketched.

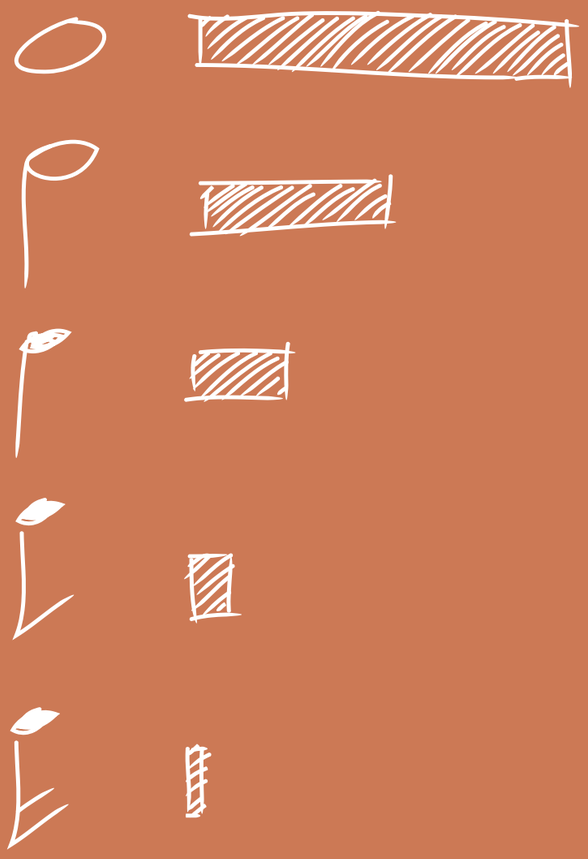
Rhythm and subdivision

Rhythmic values or subdivision are mathematical, objective.
They are fractions, numbers that can be explained with shapes following the same hierarchy.
The longest note will be the biggest one, the second note in value, will be half its size.

The length could be visualised either by showing a subdivision in pieces (Fig.48) or by showing the length (Fig.49)..
The pulse, the internal subdivision, could be shown by adding cuts to the pieces (Fig.50).

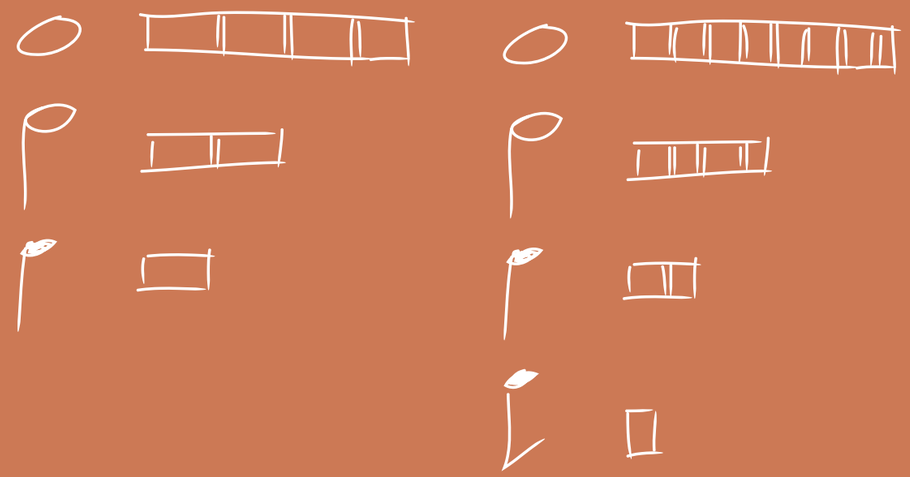
48 - Subdivision in pieces

Lenght of the note = Lenght of the figure

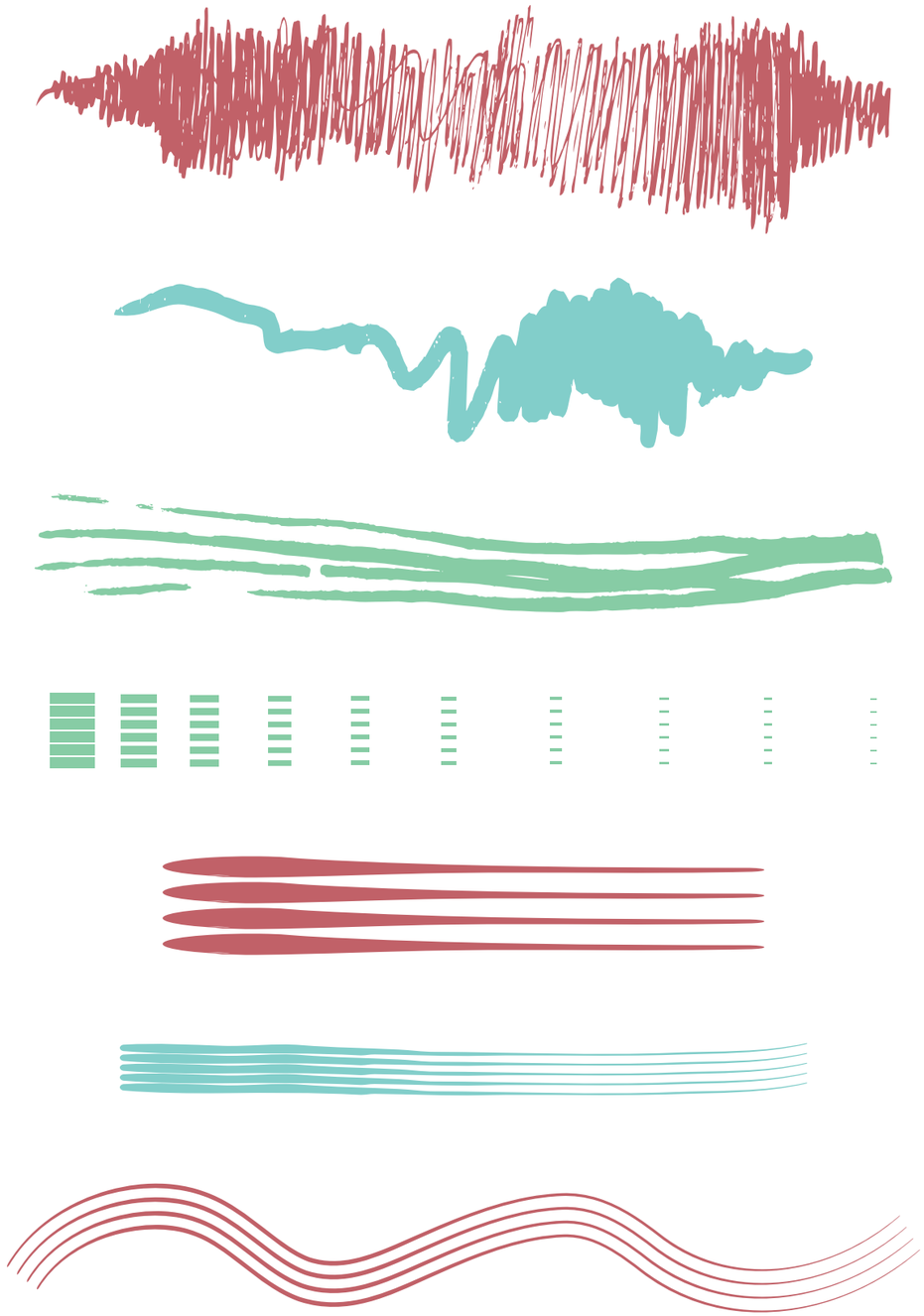


49 - Length of the piece

Pulse - Subdivision = Texture



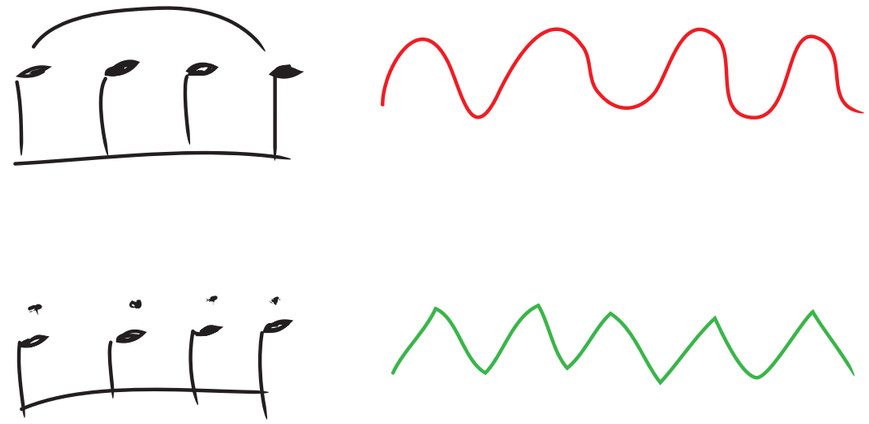
50 - Internal subdivision



51 - Experiment - Reproduction of the drawings created by listening to different melodies

Feeling the melody

When it comes to melody, feelings and subjective perceptions are involved.
“Sharp” or “smooth” sounds are related to emotions.
An experiment was conducted.
A person was asked to draw the melody on a paper while listening to different kinds of music.
The lines drawn changed with the melody and clearly showed edges or rounder lines according to the music (Fig.51).
A melody can be visualised in a personal way, but there are similar associations from different people.
For instance, It can be perceived if the pitch goes up or down and this could be associated with colours, patterns and curves.
Fig. 52 shows the differences in graphical visualisation when there is a “legato” (connected notes) or a “staccato” (disconnected notes).
Visualising melody could help perceiving the dynamics by studying them for then play or listen consciously.



52 - Differences in graphical visualisation of “legato” or connected notes and “staccato” or disconnected notes

User test

A series of rough wooden blocks of different sizes and shapes was made, these representing basic rhythmic figures (Fig.53).
Then a test was conducted.
The user was an adult without any previous music knowledge.
The result was successful on a didactic point of view.
Step by step, the person was able to recognise the basic principles of pulse and rhythmic values, associating the sound length with the dimension of the blocks.
At the end of the session, the user specifically said that it wouldn't have been as easy to understand the apparently complex graphical signatures in a music score.
The physical figures proved to be a different, but efficient tool for a first music lesson.

The principle is to let listen to something very simple and then ask the user to pick the right blocks.
Next step is repeat the rhythm on the blocks, using them as an instrument.
Displaying them on a surface at the right distance (the same distance of the sounds), it is possible to "see" the music structure.

The rough tool built included wooden blocks and a "display", as in, a place to place the blocks.
A pencil was used to tick on the blocks and make sounds.
So, the action of recognising the right length was then followed by the action of "play" with the blocks.

Visually, the blocks create a pattern, a configuration.
The configurations are different depending on the sounds length that need to be visualised.

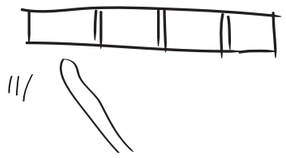
53 - Test - Rough wooden blocks

Listen to metronome for pulse

Repeat it with the wood block

Listen to a note

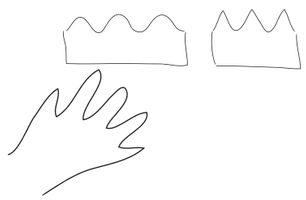
Count how long it is



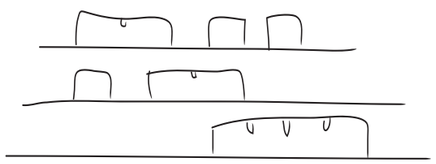
Place the piece
Repeat following the texture

Listen to rhythmic patterns

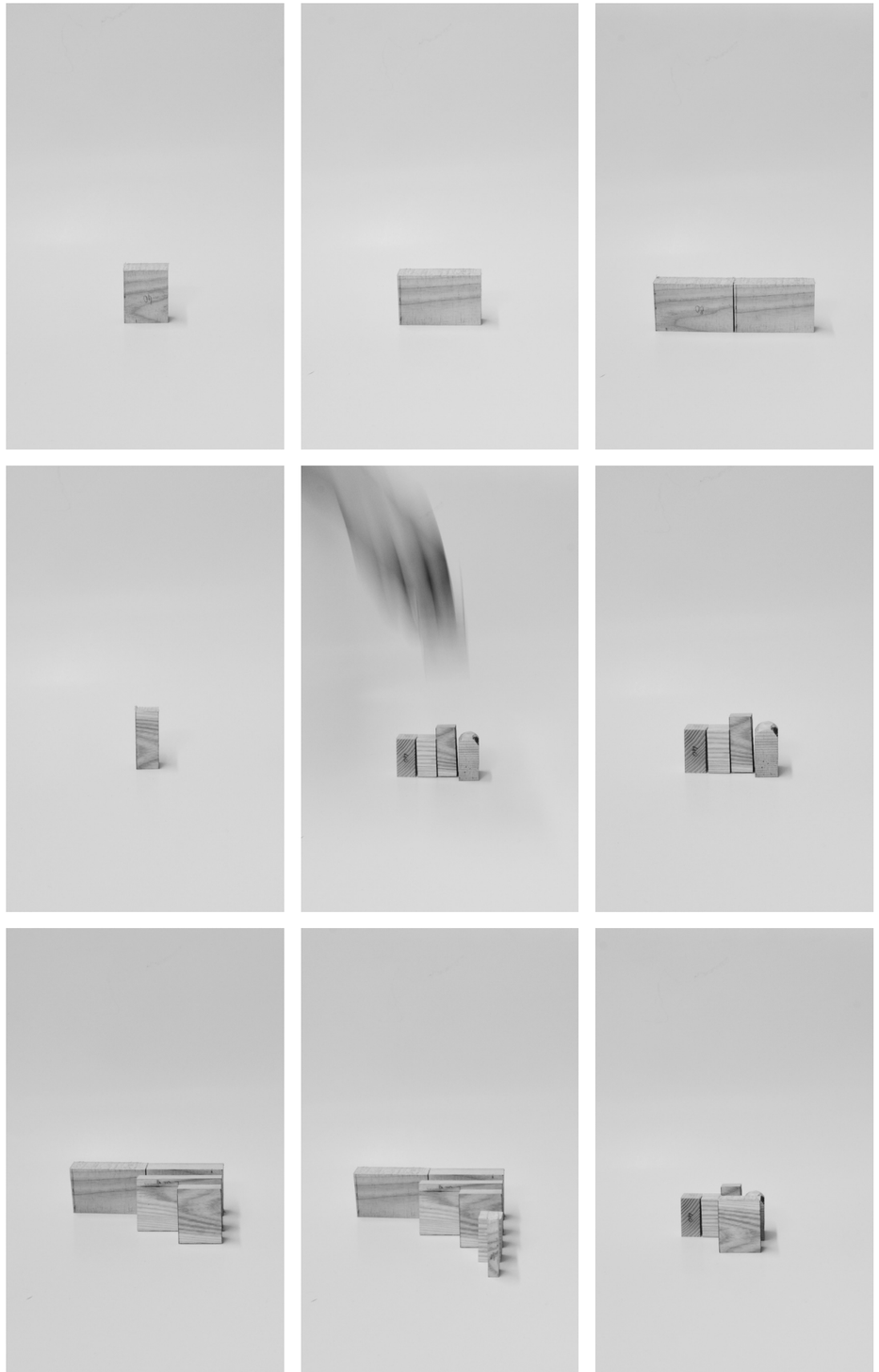
Place them and do it again

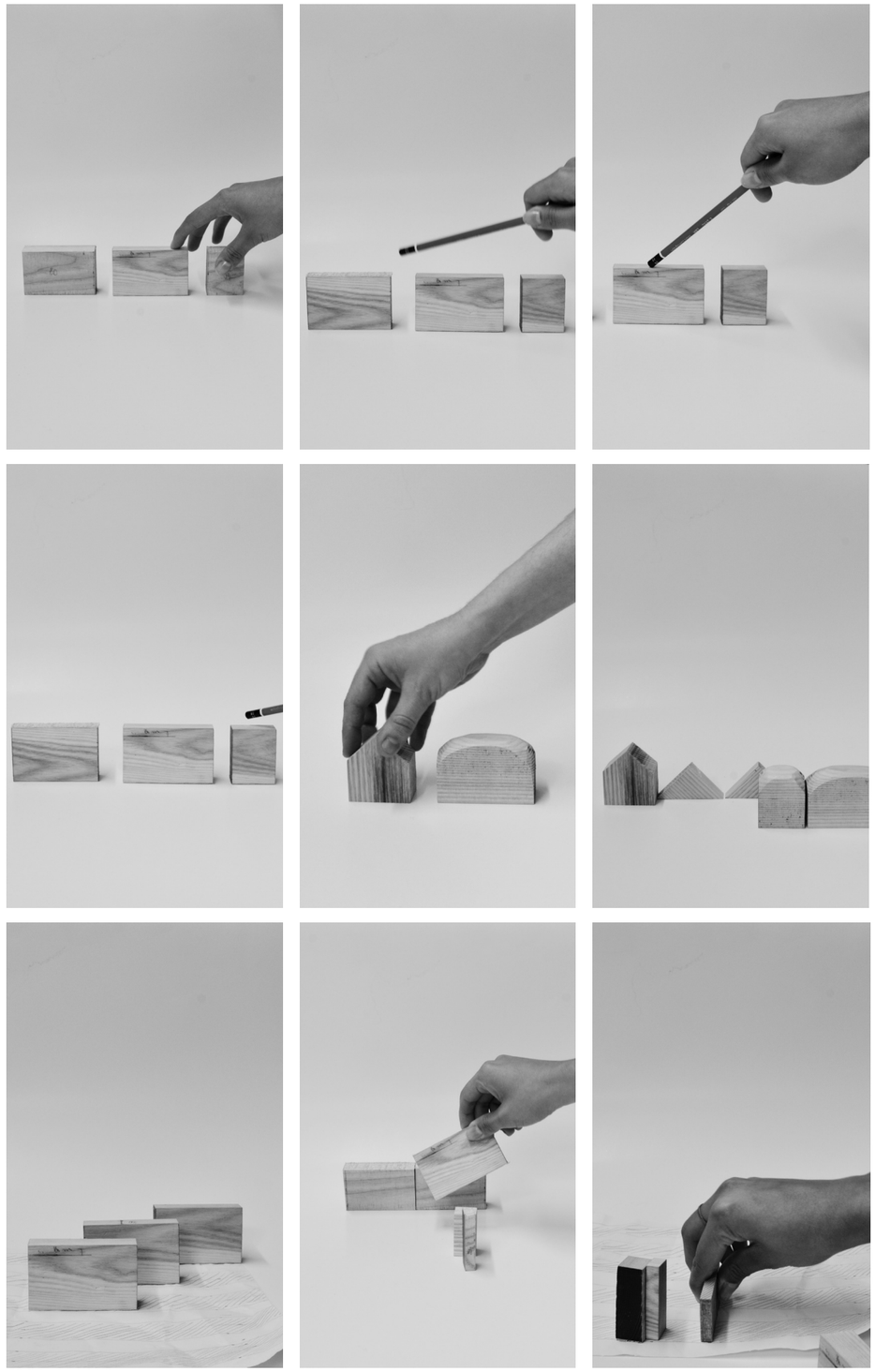


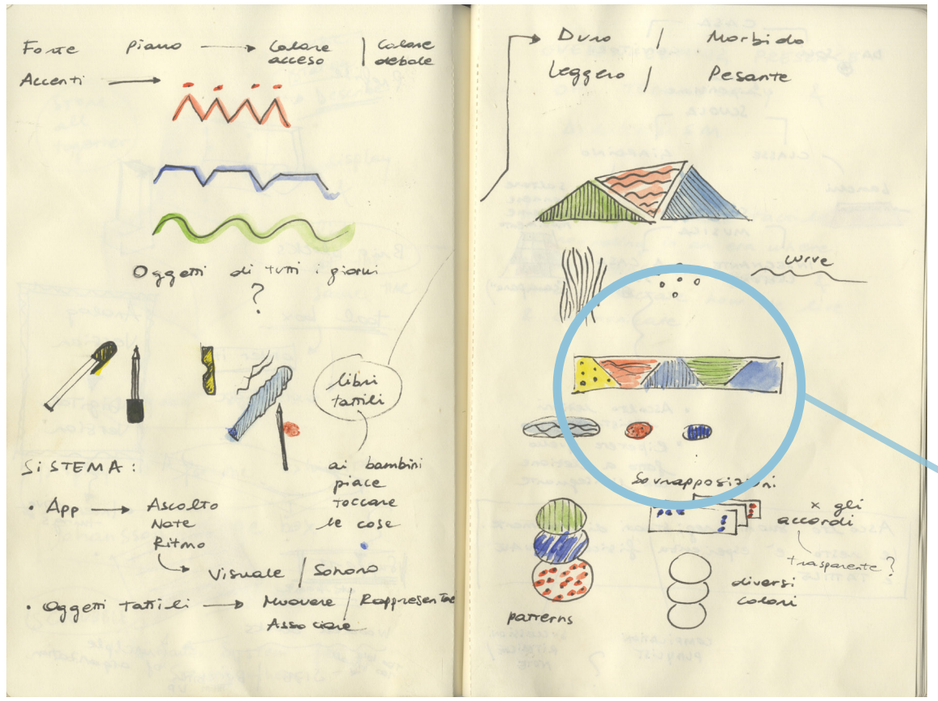
Feel the melody flow

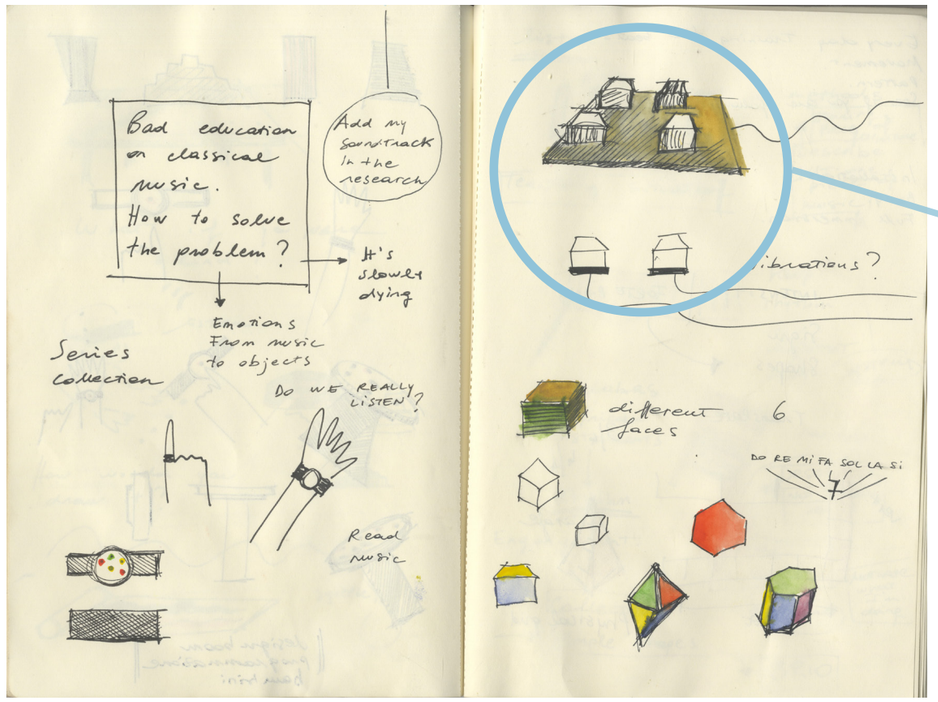


And so on









Initial ideas

The user test unveiled many opportunities both from a didactic and design point of view.
Ideas for tools and objects were sketched to think of possible design objects that could enhance understanding of music principles without playing music.
The rough prototype previously made was of wooden blocks and the sketches started from there.
For instance, the blocks could be coloured and textured in a way that could attract the child attention.

The texture could produce sound itself, by ticking or rubbing.
The use of a display that would outline a set environment were to learn and play with the objects, was considered essential for a successful learning outcome.
The child had to be free to play with imagination, but in a specific environment, with basic rules.
Montessori's objects are based on the same principle.
The interaction is playful, but with set outcomes.

TEXTURE AND COLOUR

Interact and build

DISPLAY OPTIONS

Set environment for exercises

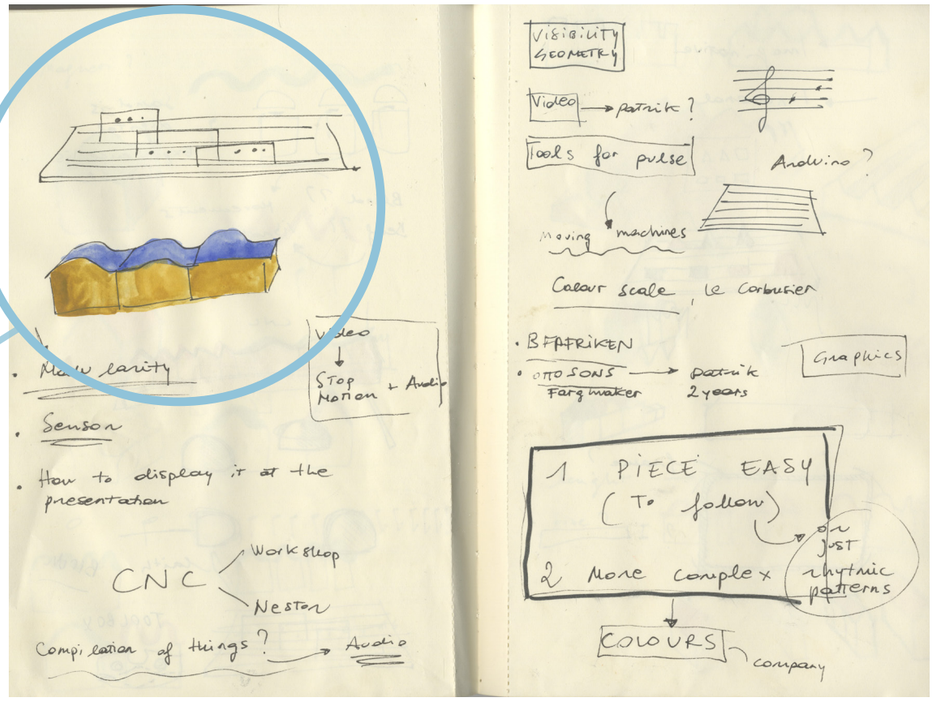
Idea Development

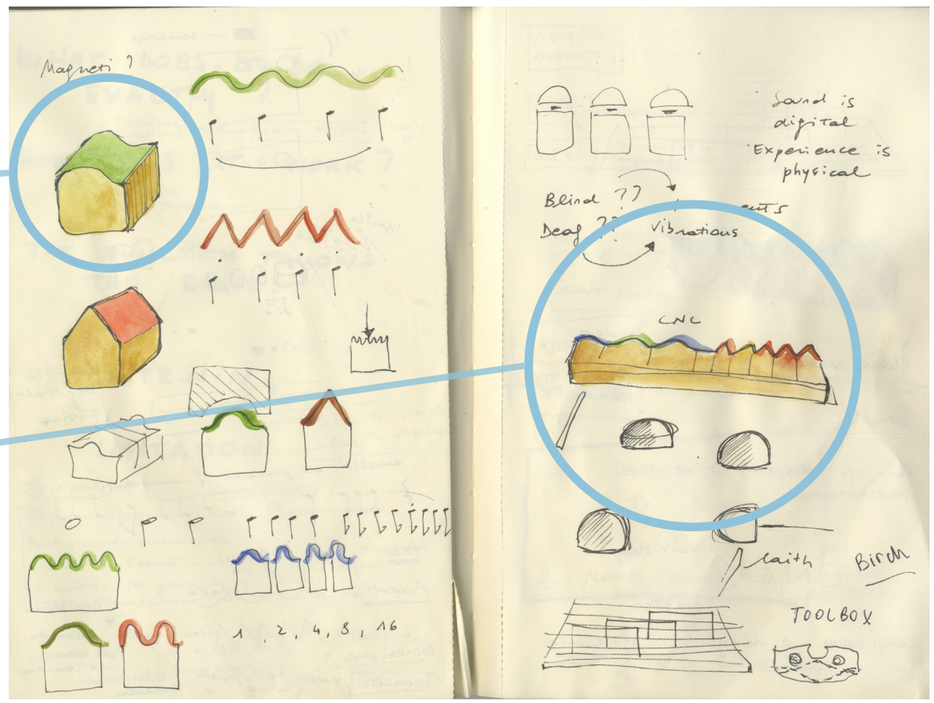
The idea of building blocks and display options was developed further.
The blocks had to create patterns and make sense both alone and while connected.
The shapes needed to be simple, but with a meaning.
The possible configurations needed to be aesthetically pleasant.
The idea of visualising a three-dimensional scenery while building the correct patterns was developed.
First, by associating the length with the mathematical value of the music.
Second, by trying to visually see the melody with its colours and dynamics.

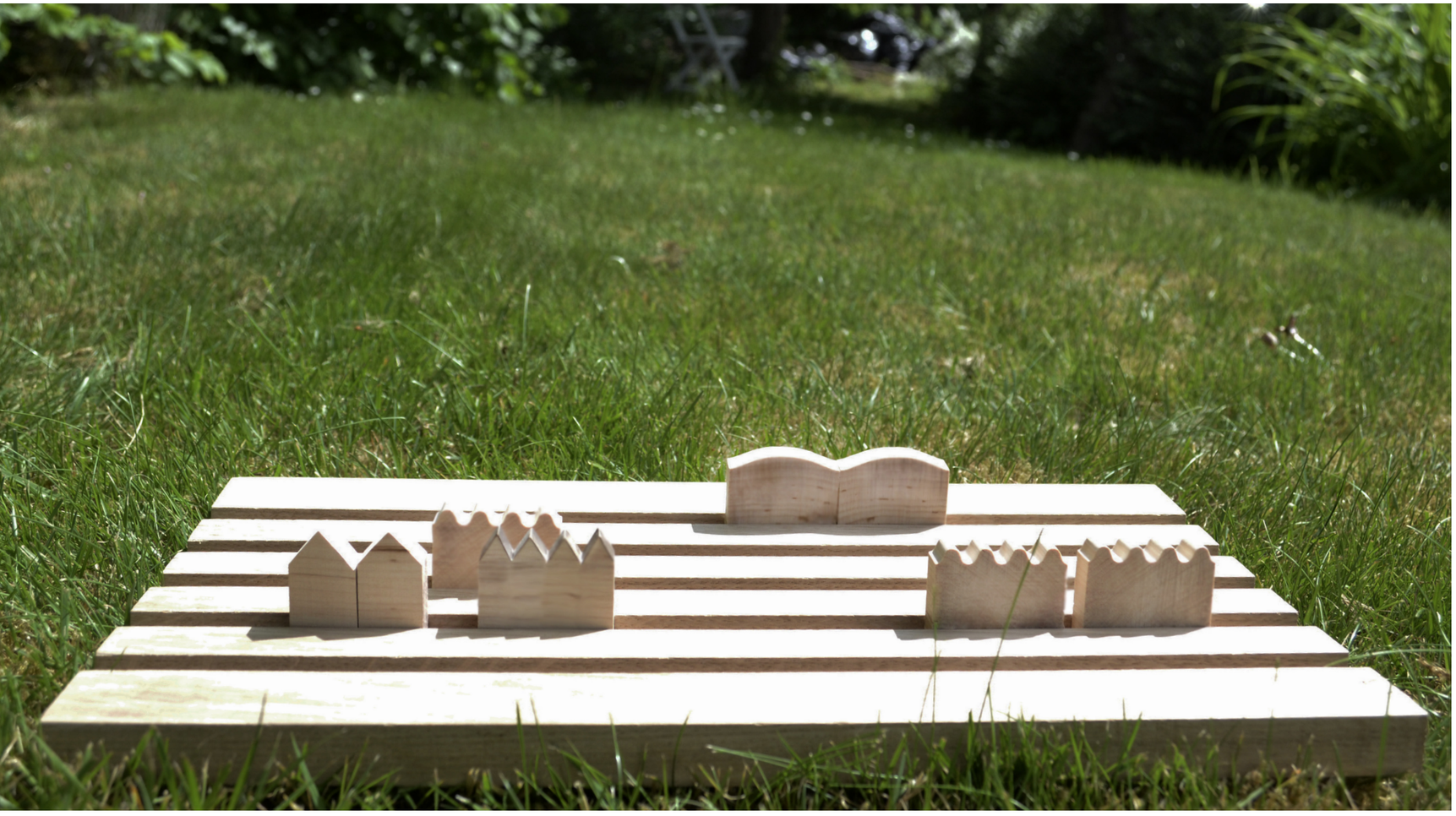
BUILDING BLOCKS
Separate and connect

SHAPES WITH A MEANING
Associate sounds and visual

CONFIGURATIONS
Patterns creation







Disassociating music from the hard music theory and associating it to known shapes, that create a “landscape”

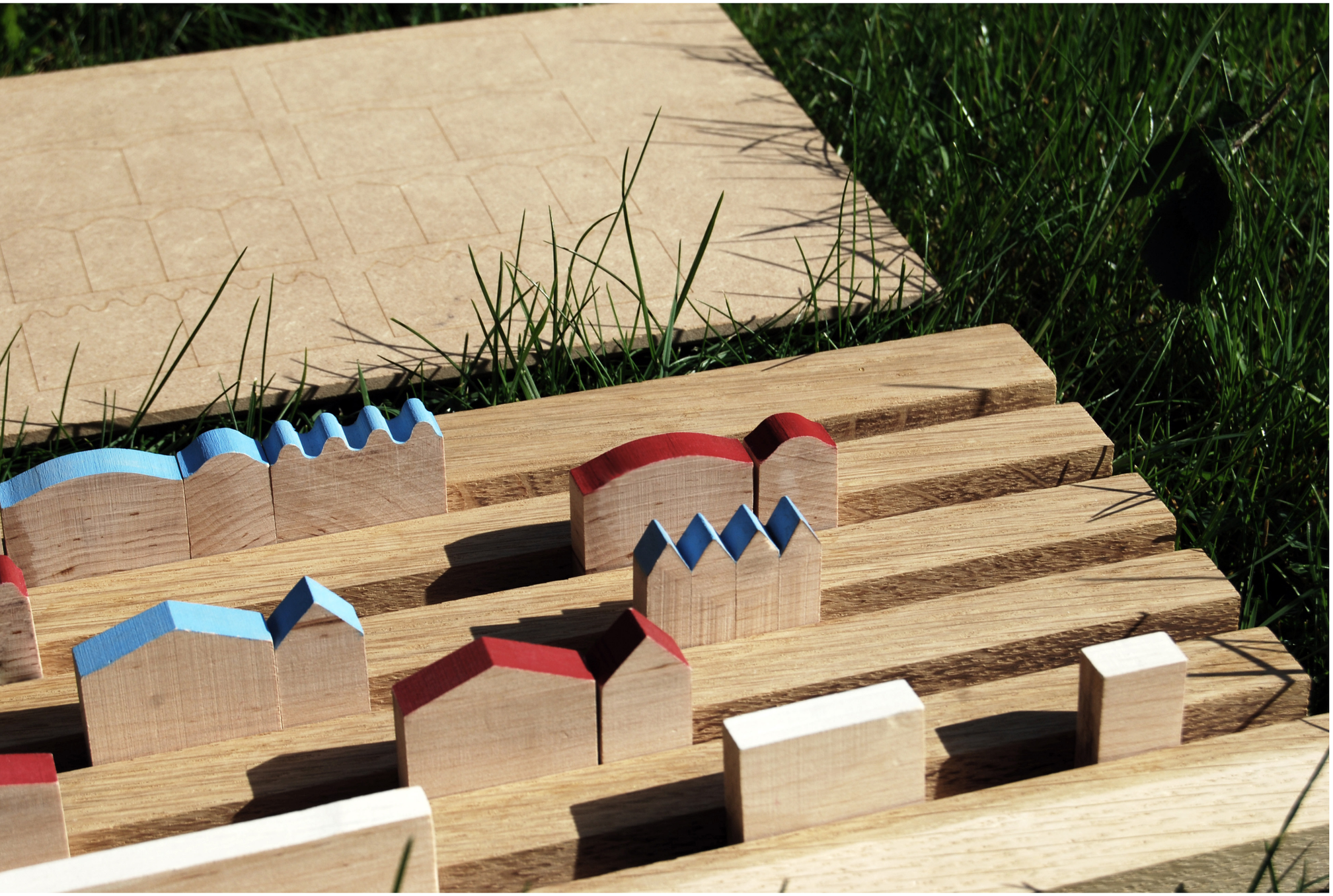
M - Scape : a musical landscape

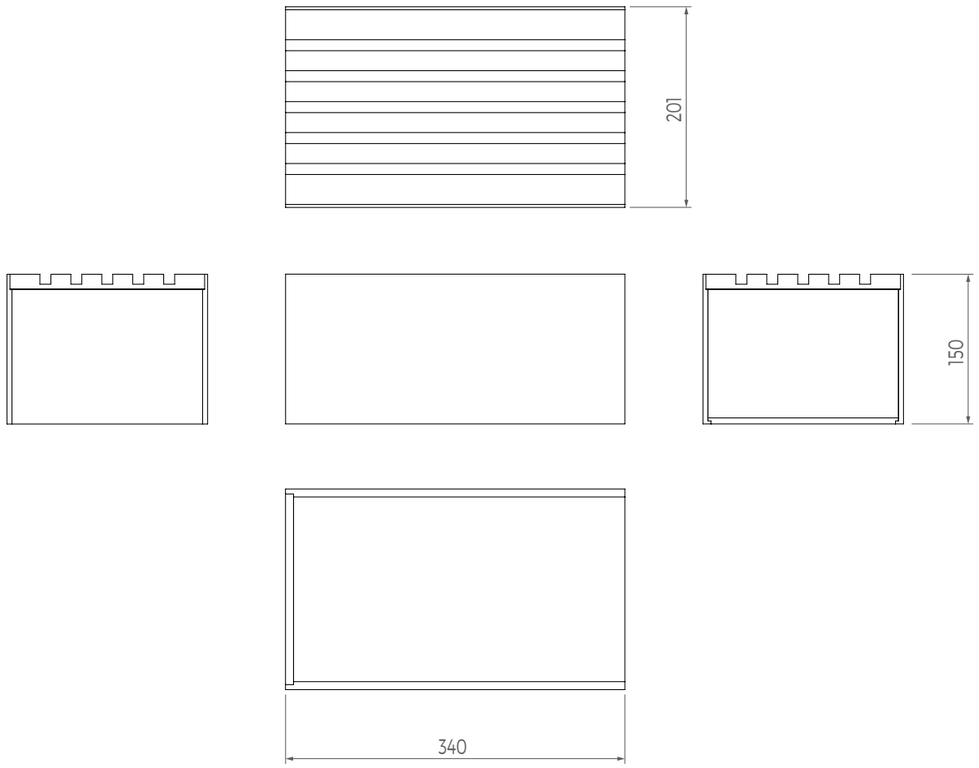
The result of this project design research and development is an educational learning tool for children which consists of various blocks of wood, which represent different rhythms.
These blocks can be moved around to either try and visually imagine what a musical passage might be like or to visually devise various musical ideas.
One major difficulty is with understanding how rhythmic values are related to each other. Many rhythms can be sub-divided; i.e. for each crotchet there are two quavers.
The tools designed use a visual subdivision to grasp this concept.
Elements of mathematics can be explained with shapes and in the same way music can be visualised with different shapes. Also notes, harmonies and dynamics could be visualised in different ways.
“M-scape” stands for “Musical landscape”.
The tools have the purpose of disassociating music from the hard music theory and associating it to known shapes, that create a “landscape” (Fig.76).
Abstract elements become physical, touchable, three dimensional.
This allows to interact and play with modular blocks, building patterns with a meaning.

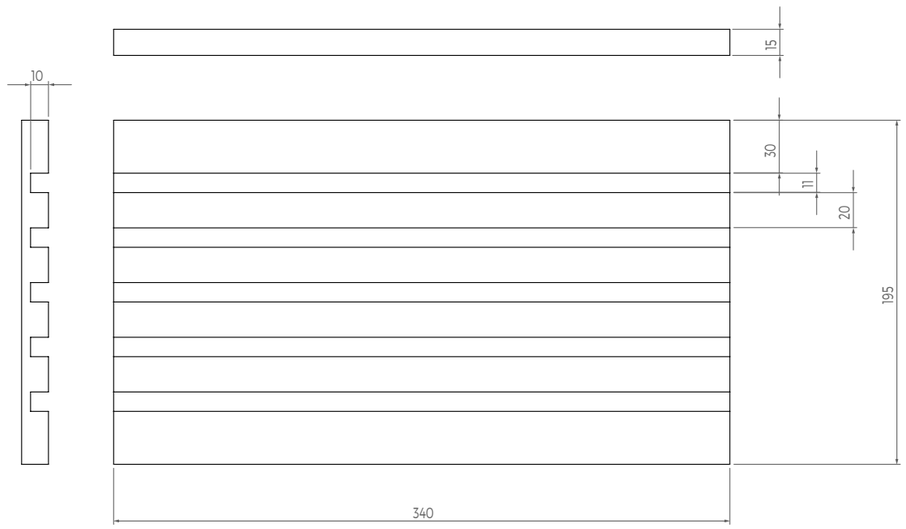
The tools are meant to help the music teacher in the very beginning of the child music education.
By following the music score or listening to a rhythmic pattern or melody played, the child can build the same construction of sounds with the blocks.

**The tools are meant to help the music teacher in the very beginning of the child music education.
By following the music score or listening to a rhythmic pattern or melody played, the child can build the same construction of sounds with the blocks.**

76 - M-scape or Musical Landscape





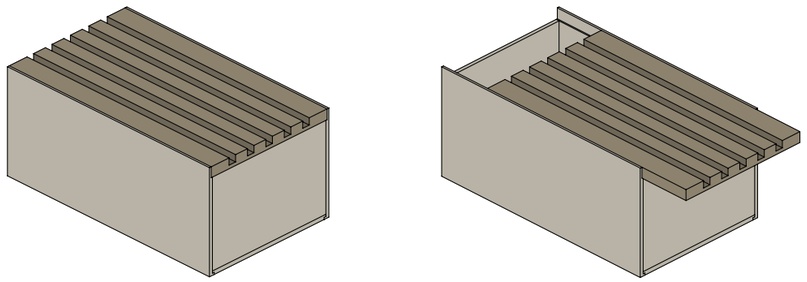


80 - Box dimensions

The components

The musical tools kit is based of different elements, all contained in a wooden box (Fig.80).
The box top cover will be the display where the user interaction takes place (Fig.81).
The bottom cover will be the reference table where musical values and shapes are written (Fig.82).

Both elements slides from the box sides.
The blocks are placed inside.
The choice of a box to contain the elements was taken to keep the design clean and simple, referencing to old children toys and to Montessori's didactic tools.



81 - Top cover - Display

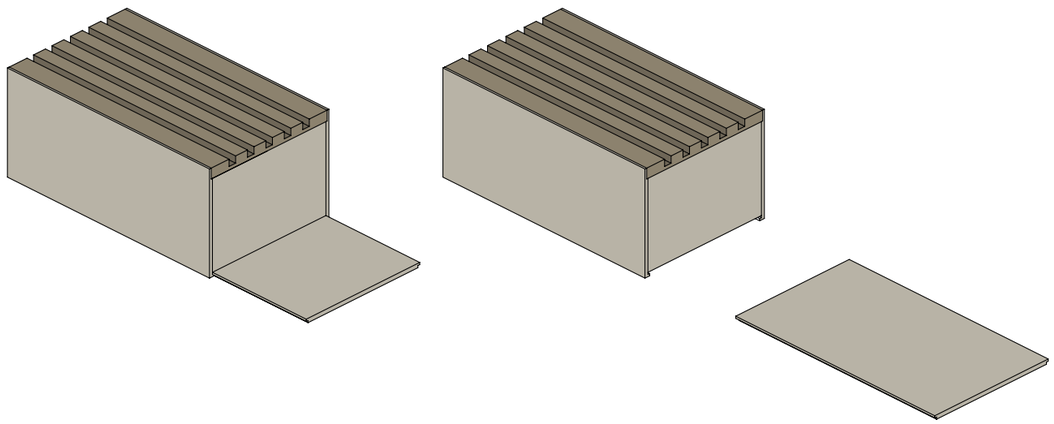


Fig. 82 - Bottom cover - Shapes reference table

The blocks: symbols

The reference table shows the outline of the blocks and their meaning (Fig.83).
It is a basic rhythmic subdivision.
A semibreve is the longer block.
A minim is half a semibreve.
A crochet is half a minim.
A quaver is half a crochet.
The note is drawn on top of the outlines on the table.
The choice of not drawing the values on the blocks instead was taken for a reason.

Graphical notes, or “notation”, are only a symbol of rhythm.
The blocks are a symbol as well, but a physical one to interact with.
They are both different ways of visualising the same, not visual, thing: sound.
This process helps memorisation and enhance abstract thinking.

There are many blocks of the same kind to allow the creation of different configurations (Fig.84).

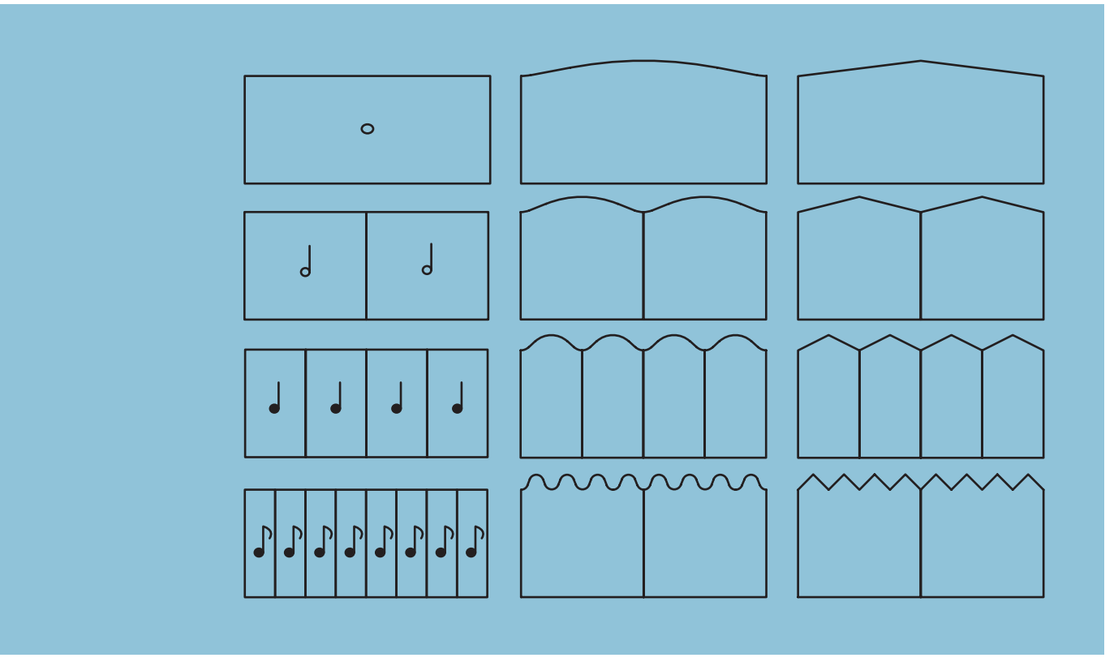
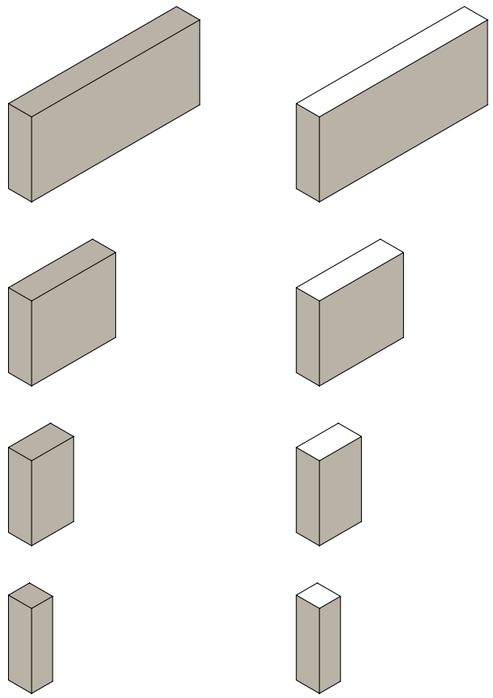


Fig.83 - Reference table - Rhythmic subdivision

84 - Loose Blocks

Rhythmic blocks

There are two kinds of block shapes in the kit.
The first one is related to rhythm.
The rhythmic blocks were painted white on top to distinguish them from the others.
Besides, the white can be used for “pauses”.
There are plain blocks for the understanding of the first simple subdivision (Fig.85).
The rest are blocks with cuts that further subdivide the block on top.
This could be viewed as an unnecessary complication.
These were added in the light of a further development in the child musical education.
Once the basic theory and rules are understood, the game of symbolisation can go further.
Rhythmic blocks can be, then, be divided internally in four or eight (Fig.86).
These are the basics to understand quavers and semiquavers.
The design gets more complex with more complex concepts.
The teacher involved can decide if using them or not to explain mathematical values.



85 - Rhythmic blocks - First Subdivision

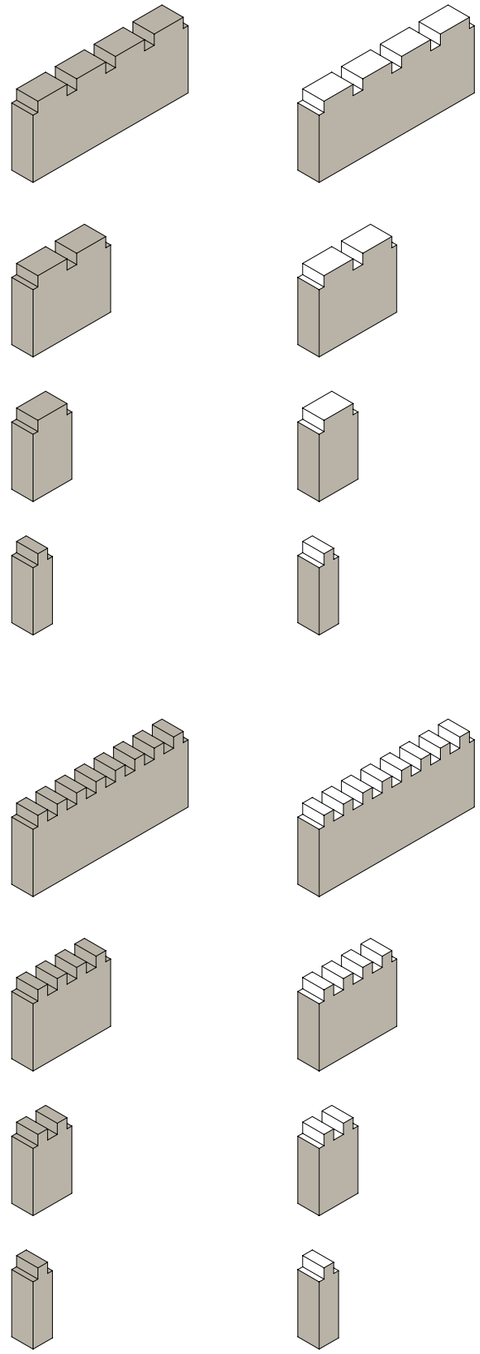
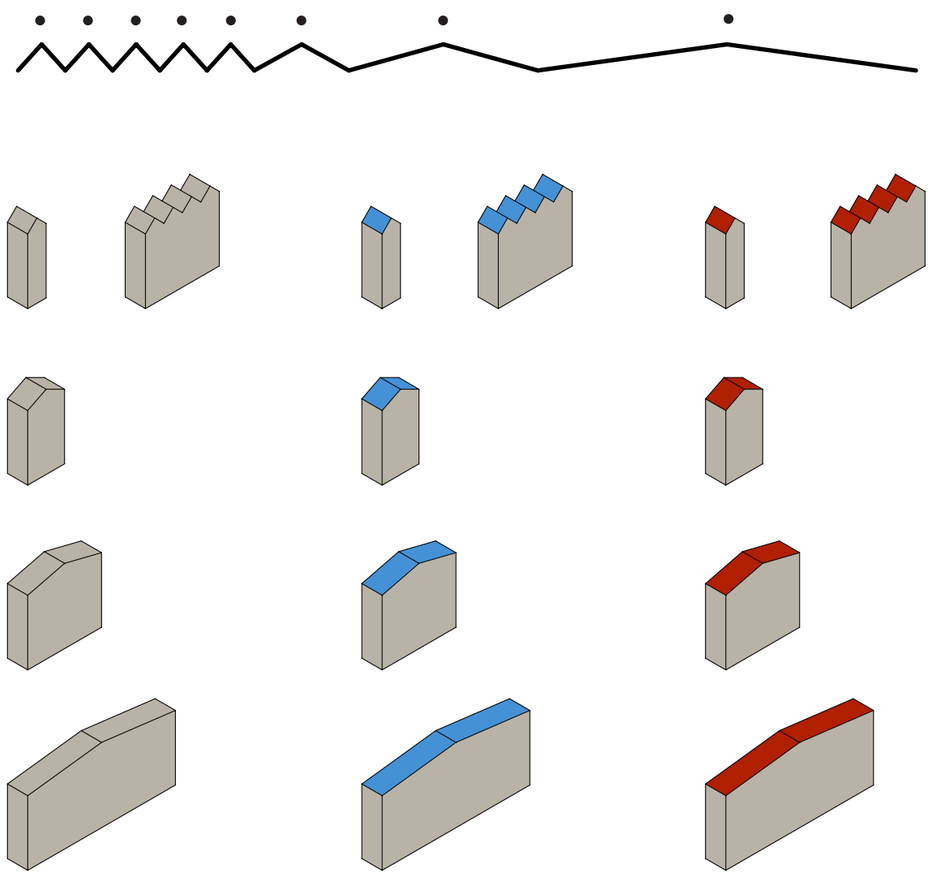


Fig.86 - Rhythmic blocks - Further Subdivision

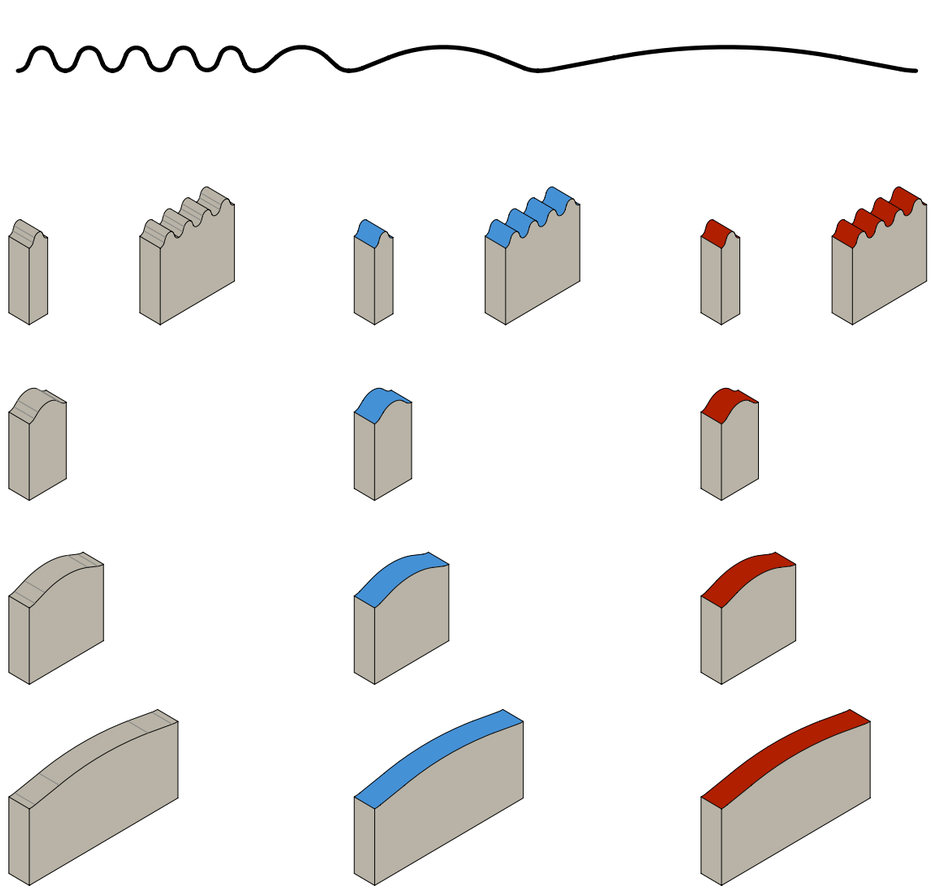
Melodic blocks

The second block shapes are related to melody.
While rhythm is mathematical and logic, melody is related to feelings and perceptions.
The musical score is filled with what are called “colours”.
Sounds can be sharp and detached, or they can be round and bound together.
Each educator uses ways to explain these concepts, that are the basics of musicality, as important as following the correct sequence of notes on the score.

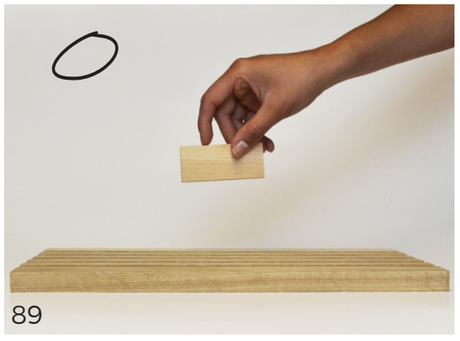


87 - Melodic blocks - Sharp sounds

Detached and sharp sounds are here visualised with sharp edges (Fig.87).
Rounded and softer sounds have, instead, curved block tops that creates a longer and various curve when together (Fig.88).
Colours were chosen to identify a melody that have low sounds or higher sounds.
There have been many artists and musicians who tried to give a colour to each sound.
Kandinsky and Scriabin to mention only two of the most important.
The colours in this kit are primary colours: blue and red.
The choice of using one or the other to visualise a sound is subjective.
Colours are used here to understand that there are these differences and to make the physical pattern more varied and interesting.



88 - Melodic blocks - Round sounds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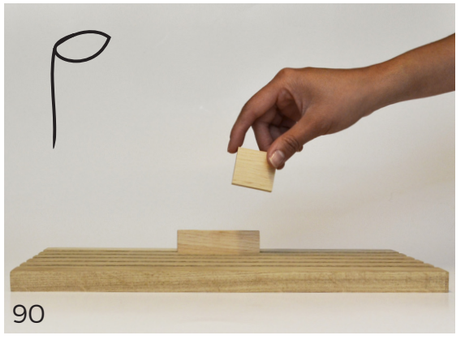
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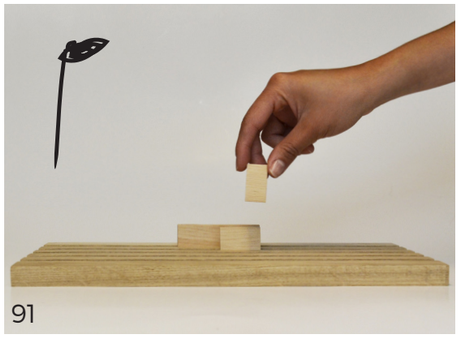
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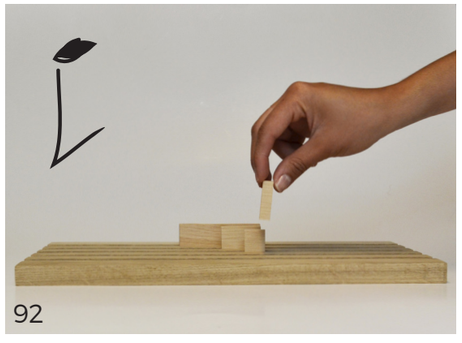
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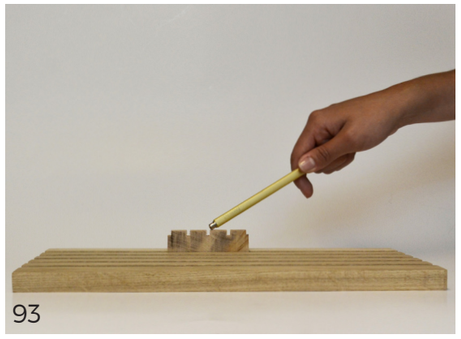
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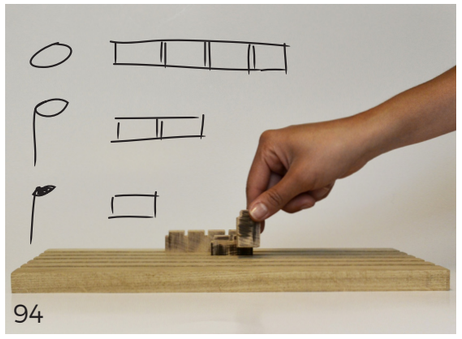
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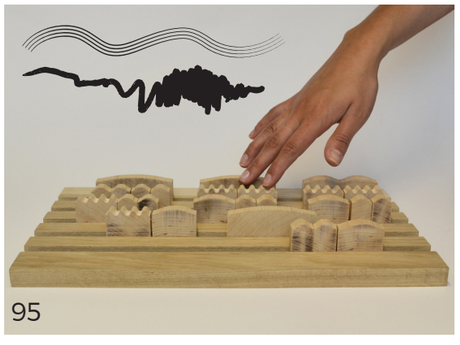
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Interaction: blocks and display

The tool is meant to be the starter of a creative, playful activity as it can be used for different exercises.
The blocks of different lengths and shapes are fitted in the display according to the pattern that should be created.
By placing the blocks, one next to the other, it is possible to see the differences corresponding to the differences in music rhythm.
The melodic blocks can create various patterns that represent how the melody is going (Fig.95).

The re-creation on music in a physical display can happen in two ways, either by listening to a simple composition played by the teacher, or by looking at the music sheet and then reproducing it on the physical display.
This will help the child thinking on what to place in the display, where and why.

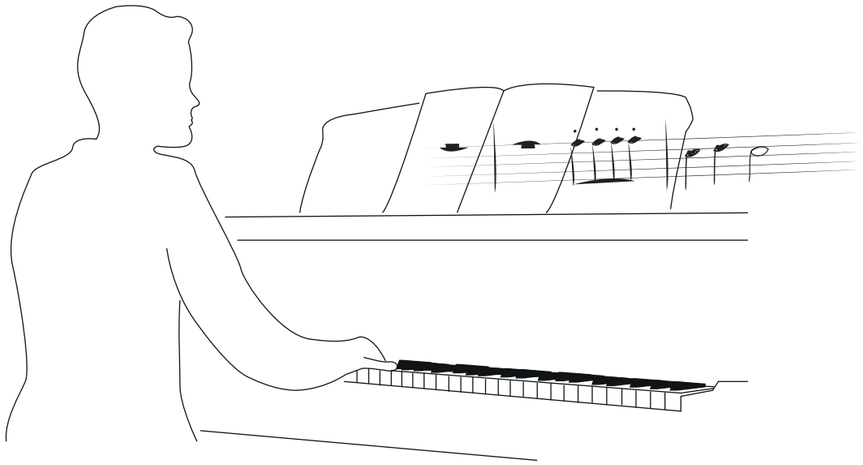
It is possible to tick on the blocks to reproduce the rhythmic pattern, using them as a percussion instrument (Fig.96).
Since the first rhythmic blocks are not wide enough to firmly tick on them and they are not hollow to create a sound box which can let the sound vibrate enough through the wood, other tools were designed to be more suitable for this purpose.
This will be explained in the next chapters.

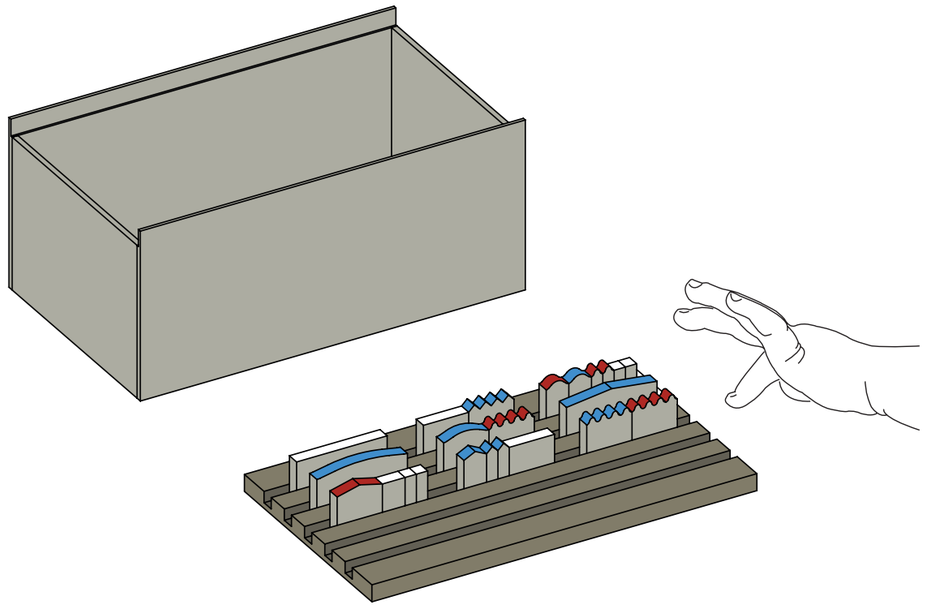
Possible exercises

The tools are modular, therefore, they allow the users, teacher and child, to use them for various exercises.
For instance:

- A melodic or rhythmic pattern can be heard, then to work on hear training, the pattern could be asked to be reproduced on the display, by placing the right blocks in the right places on the board (Fig.97).

- A music score can be used to find the correct note values, then reproduced on the display.
- The five cuts can represent the music score, so the rhythmic values can be placed according to their pitch.
- Ticking on the block to create the sound of a metronome.





97 - Exercise - Reproducing the pattern

User test

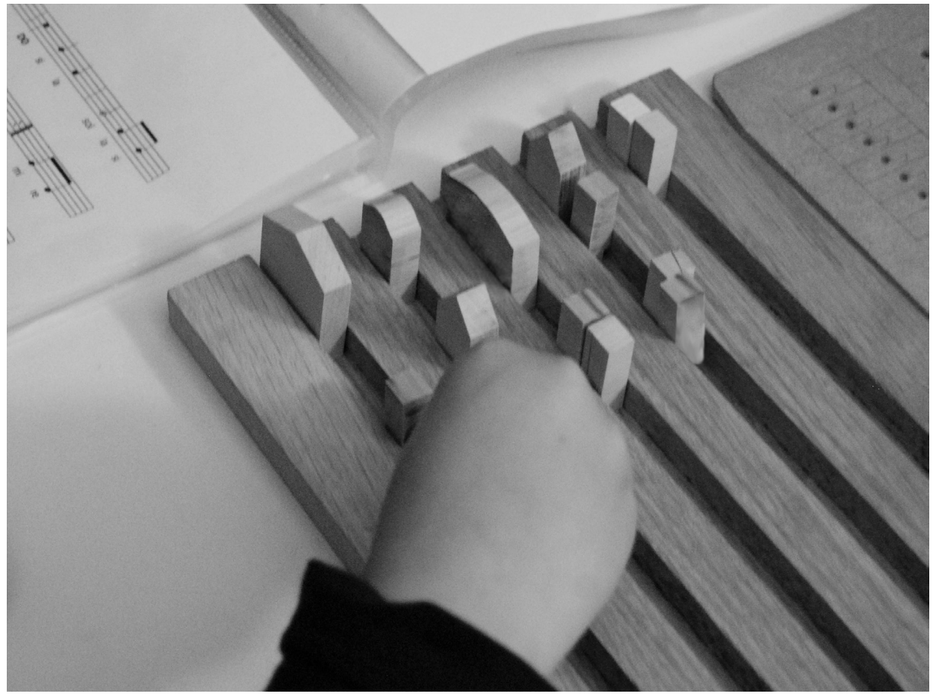
Children are highly creative and flexible.
They naturally associate things by using a strong fantasy that adults do not have.
The second user test was easier and more successful with a child rather than the first user test conducted on an adult with no knowledge on music theory basis.
The child suddenly understood the creative process and was happy to play with something that it was normally supposed to be studied.
When a block was missing and it was not possible to finish creating a pattern, the child excitedly exclaimed "We miss a crochet!".
The crochet, the rhythmic value, has easily become a wooden block in a child hand (Fig.98).
Once the pattern was created on the display, the user took the flute and managed to play the same music on the score, not knowing it by heart, by only looking at the shape created on the wooden display.

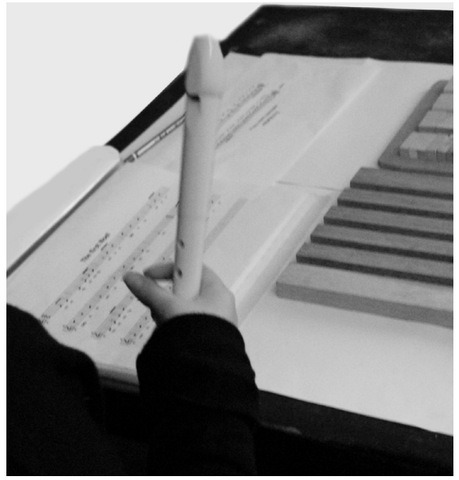
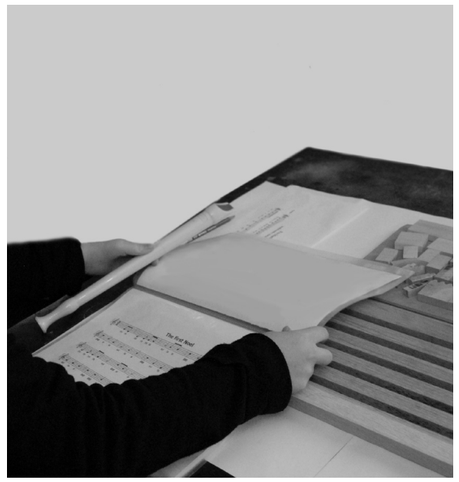
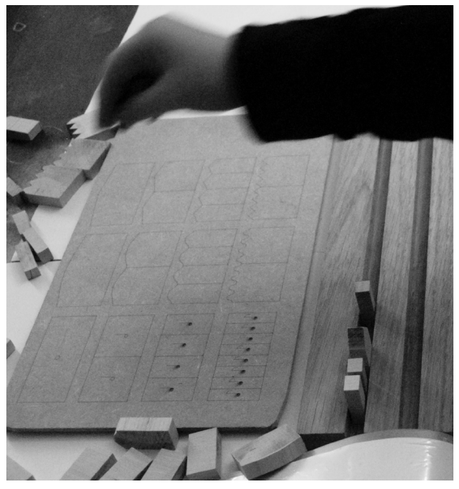
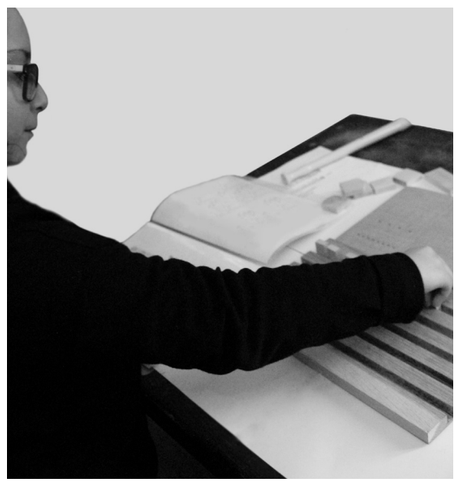
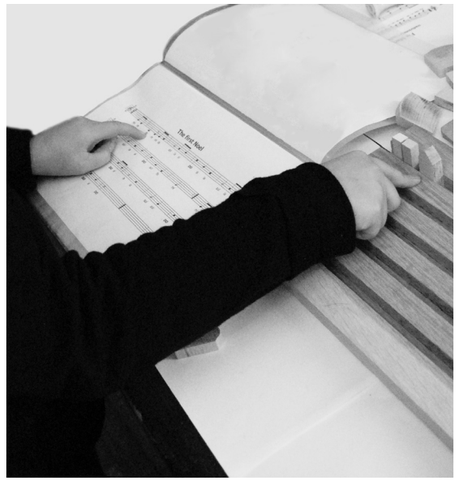
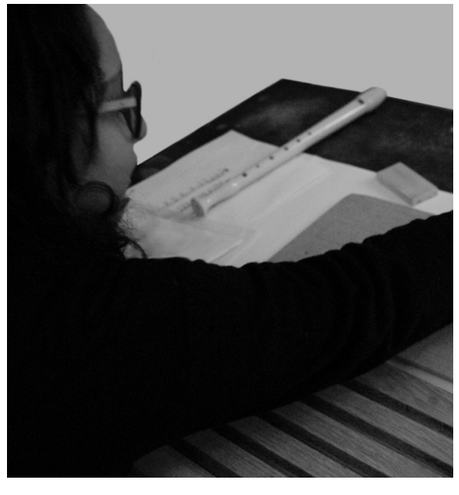
These kinds of exercises help memory, concentration and conceptualisation.
Didactic tools can enhance abstract thinking in a playful way, helping the teacher to better explain conceptual ideas.
At the same time, the child enjoys more music learning.

In this case, the tools helped the user playing a melody with the real instrument afterwards.
The melodic pattern was repeated without looking the score.
Besides, the child enjoyed moving and interacting with the objects.

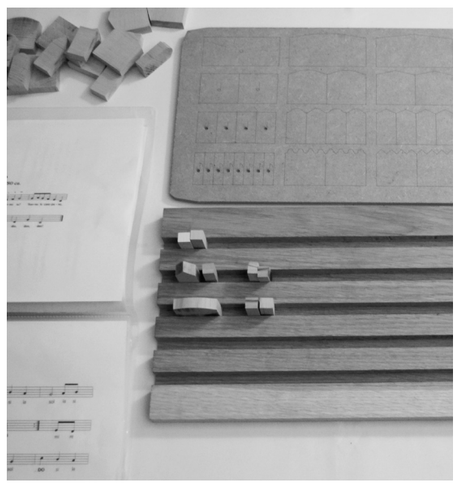
An app could do the same, digitally, although this project was about the importance of physical interaction.
A concept sticks better in mind if manually touched, in the same way writing by hand helps memorising better than writing on a computer.
Both methods are needed, but different areas of the brain are involved.

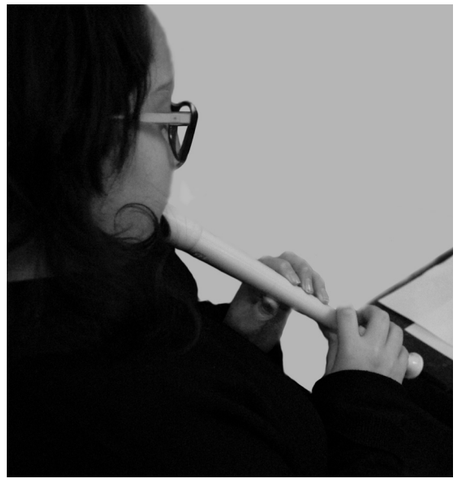
"We are missing a crochet!"

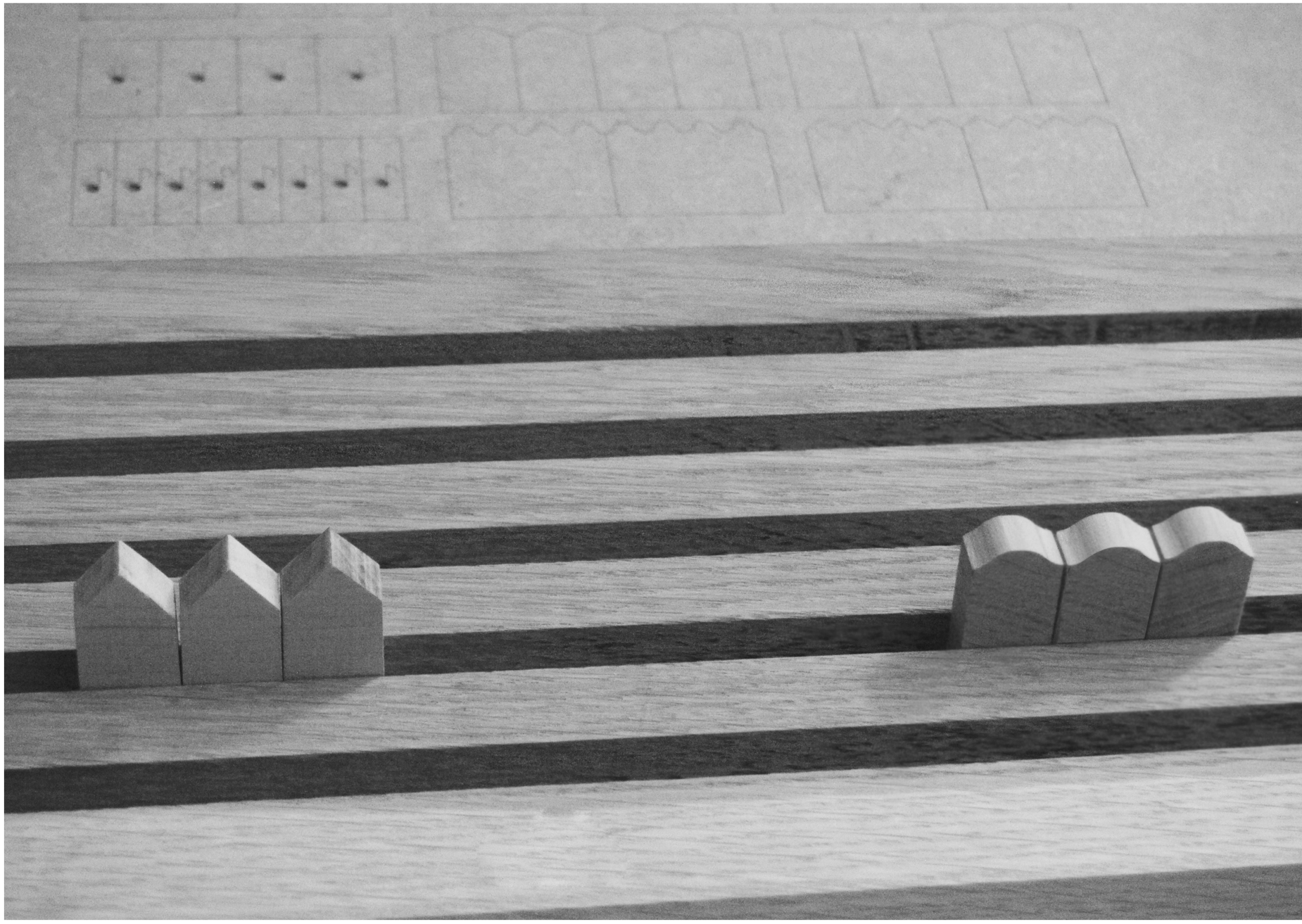






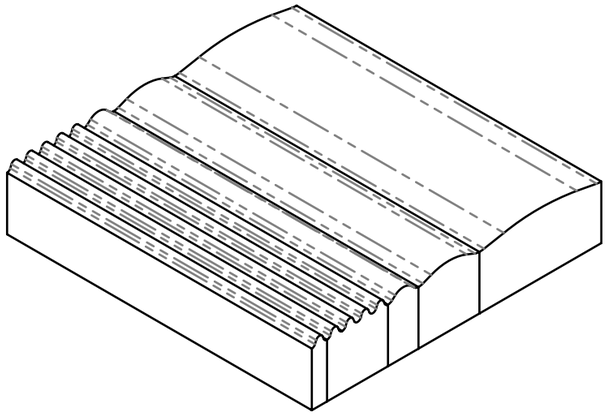


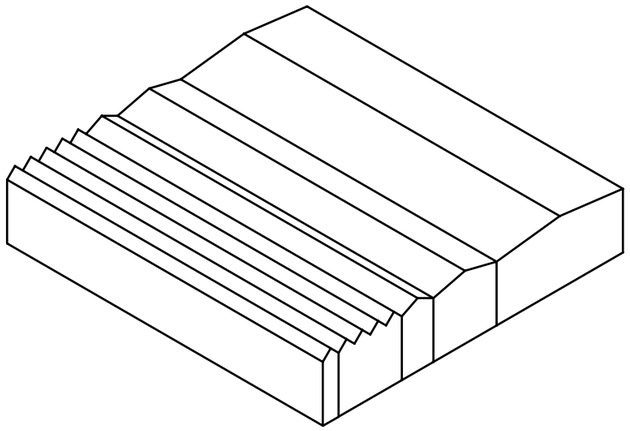
Prototyping

CNC milling was used to create the melodic blocks.
They all come from a big block that has then been cut to obtain the right blocks length (Fig.113, Fig.114).

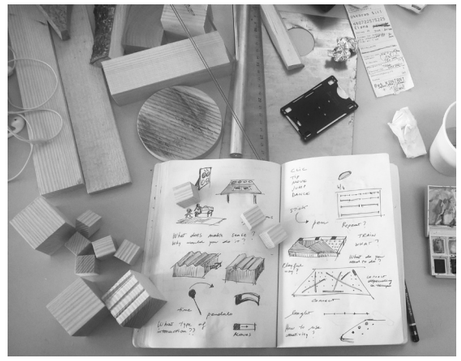
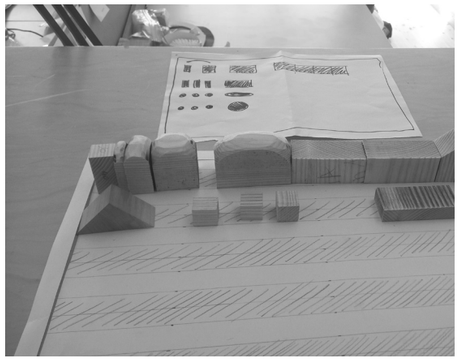
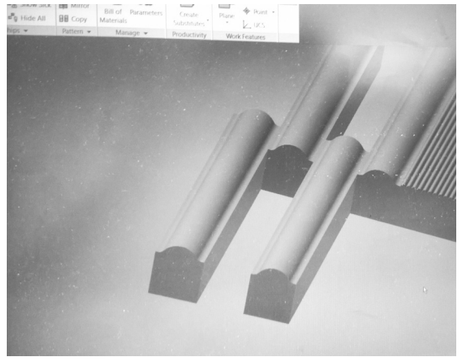
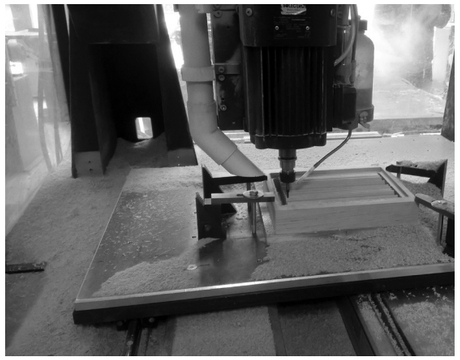
The bandsaw has been used for both the blocks and the display.
In a real mass production setting, the blocks would be cut using either laser or water jet cutting.

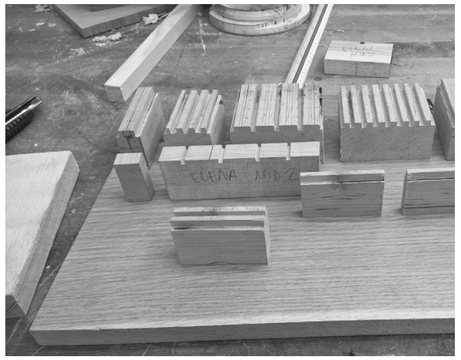


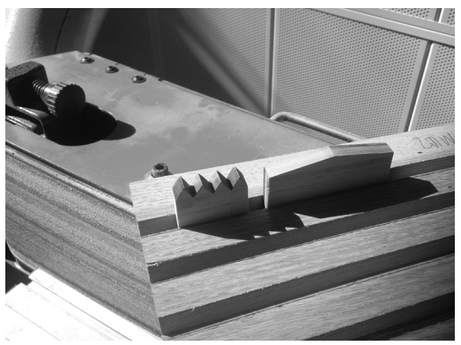
113 - CNC - Round blocks

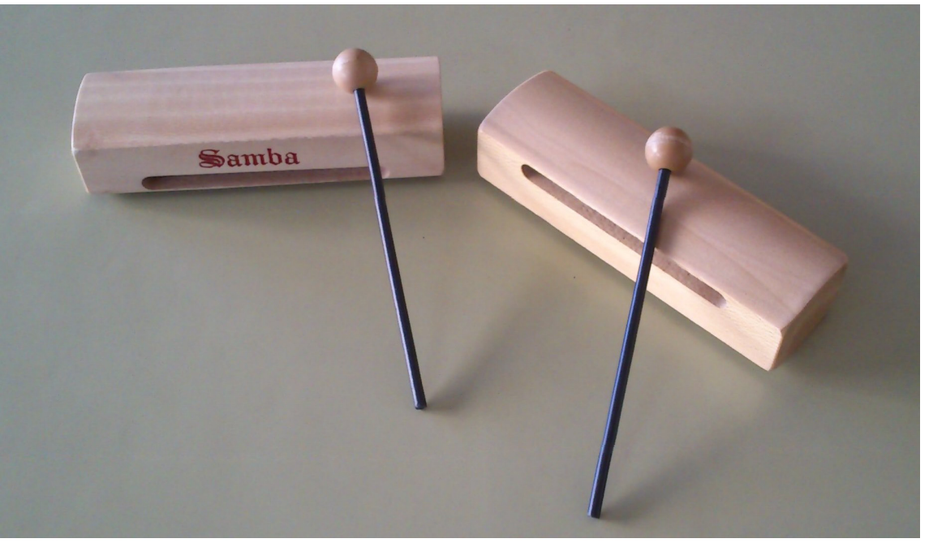


114 - CNC - Sharp blocks







123 - Wood blocks for Samba

124 - Hardwood drum

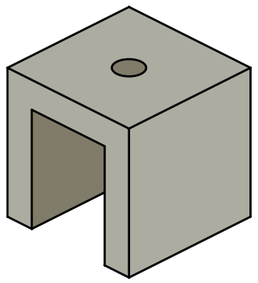
Further development: wood sound

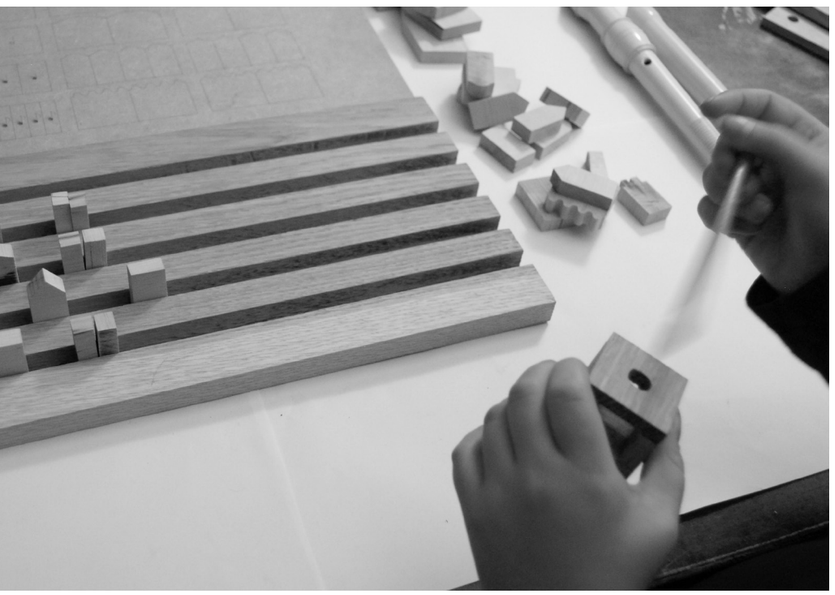
M-scape is a visual and physical tool to understand rhythmic structures, but it can also become a simple instrument as the wood could make sounds when hit with a stick.
Simple wooden percussions have existed since the beginning of the concept of music in history, still used by teachers or in ethnic music (Fig. 123, Fig. 124).
What it will be different here, it is the idea of have them sized as music structures, which will allow to beat the rhythm and visually seeing it in the display, as a "wooden music score".
The actual dimension of the prototyped wooden blocks makes it difficult to beat them to produce sound.
Further development on this part of the tools kit has been done.
The focus was on research on wood sound and the purpose was to find a simple way to complete the tools with this feature.
Wood is a perfect material for instruments, both strings and percussions, because it is resonant.
Good woods for music are called "tone woods" because they have tonal properties.
The design should be hollow to let the wood sound more effectively.
Inspiration was taken from simple percussion instruments used in other cultures, Africa or South America, for instance.
The round melodic blocks designed are inspired by the Guiro, a Latin American percussion instrument that makes sound by rubbing the surface (Fig.125).

125 - Guiro - Percussion instrument

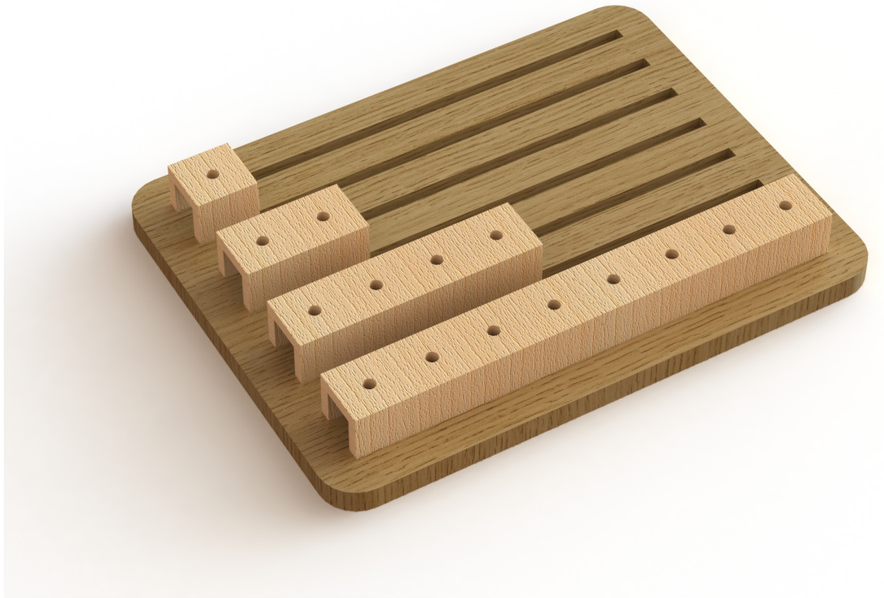
Complection of the tools

Following the same design for the display and overall concept, more rhythmic tools were conceptualised.
Hollow blocks were designed to allow the child playing with them while learning rhythmic structures (Fig.127).
The concept is the same as the blocks in the main music kit, but this time, being them hollow, they can be played by beating them on top.
The display would need to add extra grooves to fit the three different block dimensions (Fig.128).
As for the previous rhythmic blocks, the length represents the length of the note (Fig.129).
The blocks are of three different dimensions with one, two and four holes in the middle to have a better sound and identifying the subdivision (Fig.128).
These blocks can be used only in rhythmic exercises, right in the beginning of the lessons.



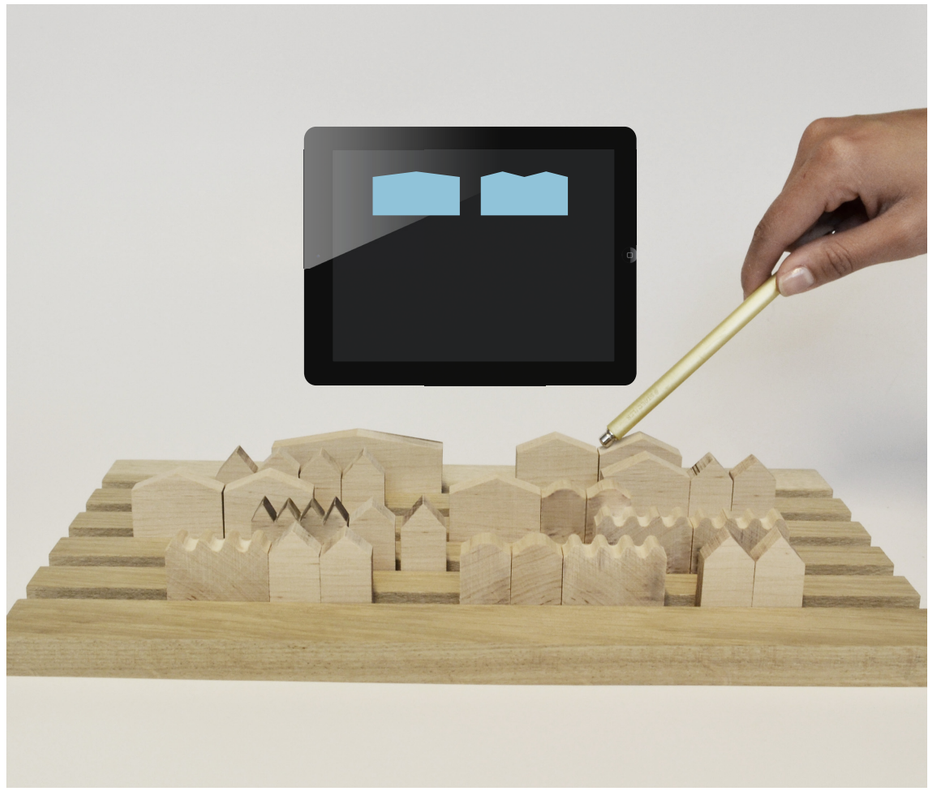


127 - Hallow block



128 - Display with extra grooves and hallow blocks

129 - Three dimensions - 1,2,4 holes



130 - Blocks and possible digital application

Conclusions

The possibility of the tools being used associated to a digital tool, like an application on the phone or tablet, was considered, but lack of time and resources and the concept idea of keeping the project simple, resulted in the decision of not following this route.
However, this could be a future possibility.
Sensors could be placed on the blocks.
A digital application could visualise the same setting and by placing the block on the display, the application could tell the user if the block is in the correct place on the display.
The melody could be played on the phone and then requested to be re-created on the board.
A sound feedback would tell the child if the exercise is done correctly.

The reverse could happen as well: by placing the blocks in a certain position, the application could play the pattern created.

Technology enables many activities and way of learning, although, it could make the child dependent to it.
The child imagination, was thought, is better stimulated with simple physical objects.
Finding the right pieces makes “making music” like a game.
Thinking what pieces are missing, helps memory.
With this purpose, a digital feedback could be the next step for this project, but the tools were successfully tested to work in a mere physical setting.

APPENDIX

Musical terms

RHYTHM: The systematic arrangement of musical sounds, principally according to duration and periodical stress.

MELODY: The aesthetic product of a given succession of pitches in musical time, implying rhythmically ordered movement from pitch to pitch. Attention to a piece of music is naturally drawn to it.

PITCH: The quality of a sound governed by the rate of vibrations producing it; the degree of highness or lowness of a tone.

DURATION: The time during which the note continues.

BEATS: The basic unit of time, the pulse or regularly repeating event.

METRE: Regularly recurring patterns and accents such as bars and beats.

DYNAMICS: The variation in loudness between notes or phrases.

TIMBRE: Different for each instrument, it is the perceived sound quality of a musical note, sound or tone.

TEXTURE: It is how the tempo, melodic and harmonic materials are combined in a composition.
A thick texture contains many 'layers' of instruments.

HARMONY: Composition of individual sounds, or superpositions of sounds. Usually, this means simultaneously occurring frequencies, pitches (tones, notes), or chords.
It is the "vertical" aspect of music, as opposed to melody, or the "horizontal" aspect.

SCALES: Set of musical notes ordered by fundamental frequency or pitch.

CHORDS: It is any harmonic set of pitches consisting of two or more (usually three or more) notes (also called "pitches") that sounds simultaneously.

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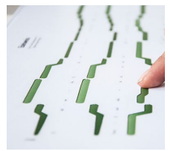

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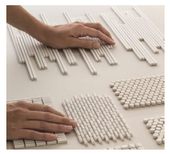
Fig.39



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wall-tiles-
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Fig.40

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Fig.41

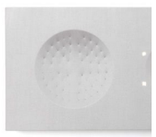

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Fig.42

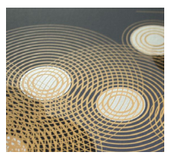

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Fig.123

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Fig.124

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Fig.125

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