PROJECT REPORT

MUSICIANS AND HEALTH ISSUES

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IN1060

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1 Introduction

Hearing can be identified as the ability of the ear to perceive sound by detecting vibrations and changes in the pressure, and convert sound waves into information the brain understands and interprets as sounds. Sounds above 88 dB are considered to be harmful and can damage hearing (Bauman). Musicians are exposed to the loud noise and are more likely to have a noise-induced hearing loss. As human ear has a vital role, our group AHAAR aims to help the DJ's to prevent the ear damages.

1.1 Target group

At the beginning we did not have ideas about the target group. As a result of brainstorming and discussion, we identified few interesting user groups (musicians, mother with small children, home nurse and older people who cannot use the net bank). We discussed further the pros and cons of every group and decided that it would be easy for us to get access to musicians. One of the group members could get access to her friends-musicians easily. In addition, everyone in our group is interested in music. Firstly, we chose our target group *"Musicians"*, but we realised that it is a very vast group. We wanted to focus on one context. Secondly, we narrowed target group to the *"DJs"***.** DJs are the primary users those likely to be 'frequent hands-on users of the system'. Other people in the club are 'tertiary users, the one who is affected by the introduction of the system' (Joshi, 2018).

1.2 Topic

The topic for our project is *"Musicians and health issues"*. To come forward with this topic we took two semi-structured interviews with the musicians. The interview was general in order to get ideas about the topic and the field where we could work. After two interviews we discussed all possible topics and decided that our topic will be musicians and health issues.

1.3 Aim of the project

The aim of the project was identified as making a product with the help of Arduino which could improve the quality of DJ's life. Since designing a solution, which fulfils the user's needs, is of importance, we needed to identify issues and to discover these needs. Therefore, we decided to find answers on the following questions:

What kind of problems are DJs facing while playing the music?

What are the consequences DJs can have as a result of being exposed to loud noises for many hours?

Based on analysis of obtained data, we defined issue of the project as: How can we use Arduino to help DJs to prevent ear damages which can occur from loud noise?

1.4 Group members

Our group consists of five members: *Ranjana KC, Han Yu, Artiom Gubaidulin, Aleksander Krolikowski and Oleksandra Chornous*. Our group members have the following personal traits, knowledge and skills which helped to gain the project's object.

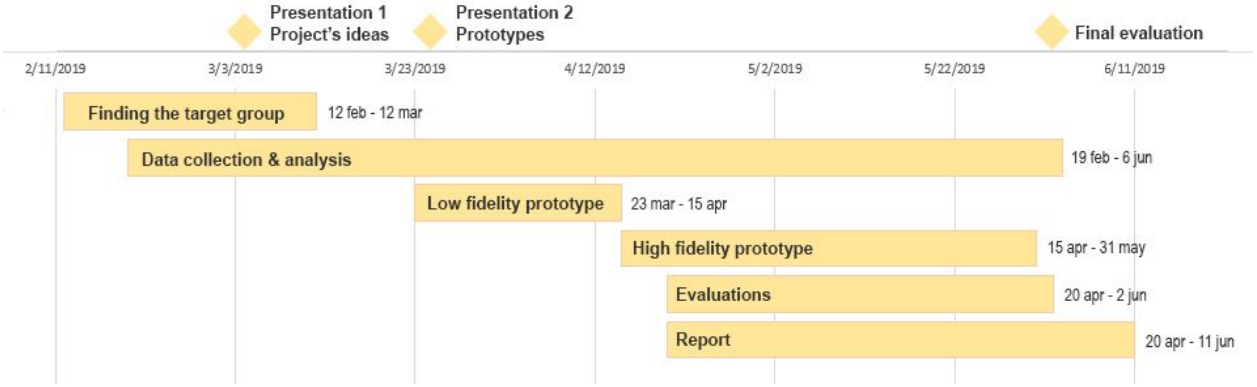
Ranjana KC has experience of data collection and report writing. Han Yu has experience of programming and statistics. Artiom Gubaidulin has experience with Arduino and programming from other projects. Aleksander Krolikowski has experiences of programming as he takes many programming courses at the UiO. Oleksandra has experience in doing the interview, conducting research and analytical skills. Most of our members got theoretical knowledge in IN-1050 what was helpful in making this project. We also got benefits from language skills of our group members (English, Chinese and Russian) when we made the research of the products, which are similar to our prototype. Together with creativity, our skills turned out to be useful throughout all design process.

2 Plan

2.1 Milestone plan

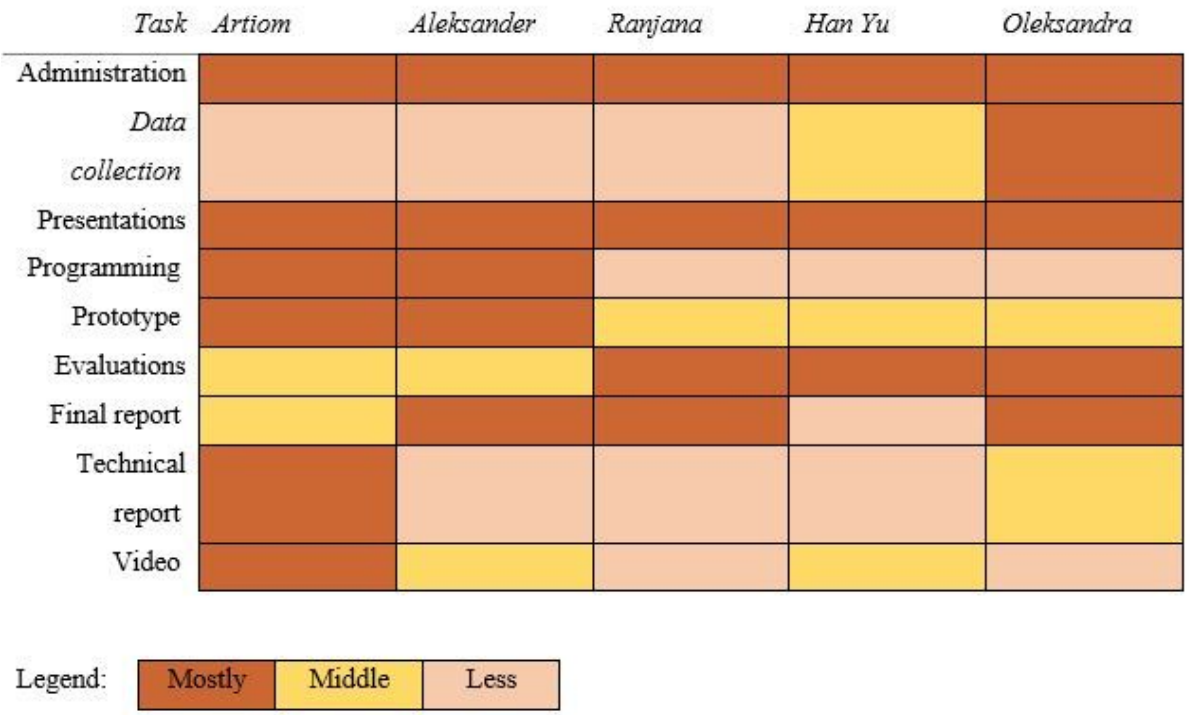
Milestone planning is focused on milestones, the key events that allow assessing performance of the project. Since we got a project which includes many changes, we did not foresee all the activities at the beginning of the project.

When we identified the subject of our research, our main questions **at the initial planning stage** were what kind of results the project should achieve (a milestone plane) and how, and in which order the results and the sub-results could be achieved (activity plans). Every stage of activity plan got a name, which could tell us what we are doing at specific part of the project. Our project had a tendency to change the direction regularly. **Our milestone plan** could be presented in the following way.



2.2 Organization of work

At the beginning we made an agreement and established a plan for coordination of work process in our group. We specified conditions of our meetings and divided the tasks and responsibilities among the group members. Therefore, everyone could work equally and make equal contribution into the group project according to his/her talents and ability. The tasks were divided in the following way:



2.3 Cooperation in the project group

We decided to contribute in the project on the share-based ground. The project became for us "a common pot" where everybody put something (according to his/her possibilities) to make our project running. We have been cooperating on every stage of our project because each of us is different and is good in different fields. But we have the same goal – to do our best to be successful in carrying out the project. Our group members have had the same priority for the project what helped us to avoid the conflicts. All group members have been willing to use enough time to do the project in the best possible way.

2.4 Evaluation of planning skills

We could say that our planning occurred to be successful because we were able to finish our project on time and to make all tasks which we planned to do. We also increased our meetings from 4 hours per week to more hours on the stage of making the prototype because we were writing a report simultaneously. As regards *a **project planning***, we learned to be flexible, to leave space for changes between the main stages, and to be open to new opportunities/options in the project but to follow its aim and milestones. As to ***project management***, we learnt to share work capacity according to the talents and abilities of the members. We also learnt to help each other and to be like a team with one goal and the same interest to reach it successfully.

3 Research

This chapter includes the examinations we have performed throughout the project and different data collection methods we have used.

3.1 Research of use and user

As the user-oriented design is about the users, their needs and their participations in the design process (Bratteteig, 2019), our goal was to involve the user throughout the study and design process. Foremost, we had to understand the users and their needs. We employed the method of qualitative analysis, investigating the issue how to prevent noise-induced hearing loss by DJ with Arduino's help. We carried out six semi-structured interviews throughout the study which allowed us to be flexible to go into the details in order to get the deep knowledge about the user and their needs. As the main user, DJ was contacted several times for interviews. As a result, the interviews let us to discover the user's point of view on selected topic. In addition, we also conducted direct observation in the field. To ensure that the study uses different perspectives and to be effective in collecting important data, we were two group members which went on each interview and observation. We also used triangulation (combination of several research methods) to overcome the problems (particularly, biases) that occur as a result of using a single method.

3.2 Semi-structured interview

Semi-structured interview was the main data collection method in our project. We started with making the interview plan and interview guide with five key issues based on our topic (Joshi, 2018). The aim was to ensure consistency throughout the interview process. The questions were prepared to meet our goals. We identified the main subjects of the conversation but we did not plan all possible questions. They could be asked depending on previous answer. We began with introduction and our goals so that the interviewee could feel more comfortable and relaxed throughout the interview. We also took the consent from the interviewee for having possibility to record the interview. We decided to focus on some of the things which could help us to obtain reliable information from the user and to make the interview more fruitful. We kept the questions short and clear and avoided the double-barrelled questions which was understandable to the interviewee. We also avoided the leading questions in the interview. We listened to interviewee carefully and let them talk so that they do not feel that they are controlled by us. There was no big necessity to give a reward in the form of payment to the

interviewees in our case. We appreciate that they gave us their time and attention. So, we gave each interviewee a little attention and treated them with something nice, like coffee and pastry.

3.3 Direct observation in the field

Observation in the field provides with details about user behavior and use of technology, that are not elicited from another forms of investigation (Sharp, 2015). Through observation we can find the things that could be improved or to give the new solutions (Bratteteig, 2019). We conducted direct observation in one of the night clubs in Oslo where DJ played the music. Since observation in the field could be complicated by unexpected things, we prepared a framework for structuring and focusing our observation. It also helped us to organize the observation and data gathering activity. The main aim of observation was to understand the user context and task.

3.4 Findings and learning

Applying different data collection methods, we gathered useful information from the users. The information was crucial for finding out about the user's needs and requirements, and for the development of prototype that meets the user's needs. Observation gave us understanding of the user's job role and his/her activities, while the interview helped us to find out the problems and the preferences of the user.

In the process of both observation and interview, we got deep knowledge about the topic and learnt new things. Firstly, we managed to bring the user back into our topic when they deviated from the subject of conversation. We also learned to be ready to change the strategy of the interview and to be clear for an interviewee. Secondly, preparation to the meetings and interviews became our priority. As our target group were DJ's, we had to be aware of musical terms that could be used in conversation. So, we researched them forehead going on the interview.

Minimization of the Hawthorne effect helps to obtain reliable data. So, changes in behavior of participants when they are aware of being observed affect the data of observation as well. Furthermore, observation can be complicated by the fact that one can see what they are looking for, and to interpret it in his /her own way (Bratteteig, 2019).

4 Design

4.1 First iteration

The aim of the first iteration was to gather information through semi-structured interviews, to get to know our target group, to understand their needs and requirements and to find issues.

4.1.1 Information gathering

We started with interviewing two professional musicians separately. The first interviewee was a young boy, 21 years old, who plays guitar, rock style. While the second interviewee was an older man in his 65, who plays American country music on the guitar in a band. Both of our interviews were semi-structured for around 30 minutes each.

4.1.2 Presentation of data

Here are some quotes from the participants which we found was important and interesting:
"I am having trouble remembering to pack all my equipment before heading off to my friend's house where we rehearse […] it's annoying to drive to your friend realize that you forgot something then drive back to get the item."
"I like easy to use technology, not some advance new… technological thing with extra unnecessary function that I have to read manuals to simply turn it on. I like basic, easy to use technology (…)"
" (…) sometimes we play loud, and I don't realize it until we stop playing, but it causes hearing loss… it lowers my hearing sense."

4.1.3 Analysis and findings

We transcribed the interviews and coded data which we found interesting and important. Further we had discussions and brainstorming on different topics in order to find out user's problems. Finally, we got a few initial ideas.

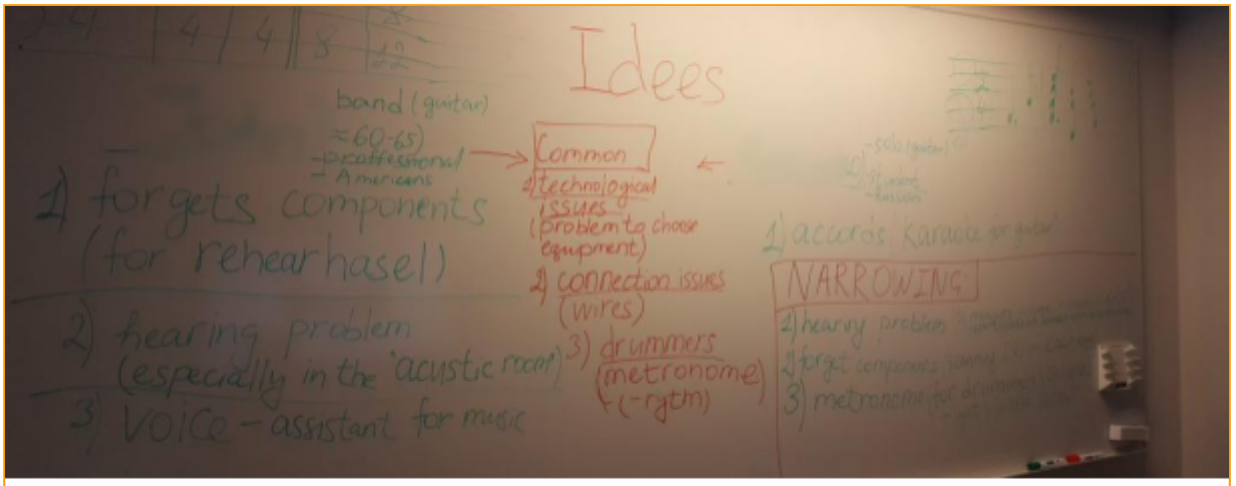


Image 1: Brainstorming and Analysis

4.1.4 Ideas

We came up to definite ideas from our findings through scenarios and conceptual models.

Problem 1: missing by the users separate parts of musical equipment when they are on the way to rehearsal/concert.
Prototype 1: Our solution is to create a checklist of the equipment by putting RFID stickers on the items and scanning them with Arduino device. The output would inform the user about scanned item and remind them of any missing items.

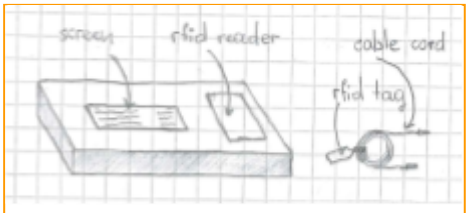


Image 2: Prototype of checklist

Problem 2: damaging of hearing as a result of playing loud music on the concerts/rehearsal.
Prototype 2: A broad variety of our solutions includes a lamp, which would change colors for informing the user about dangerous level of volume. Thus, the user can take precautions for it.

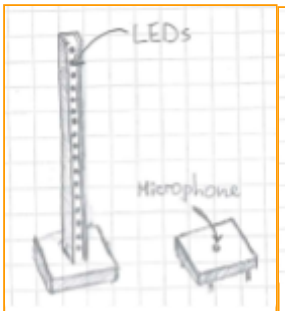


Image 3: Prototype of LED lamp

Image 4: Prototype of watch

Prototype 3: The second solution to problem 2 was to create wearable, small, lightweight device that user could put around his/her hand (watch or bracelet). It would warn the user about dangerous level of sounds by vibrating and showing dB value on a built in mini-screen.

4.1.5 Way forward

After the first presentation we realized that creating something so universal would be hard. It was important to focus on one context. Musicians have different playstyles, make different kind of sound and use their instruments differently. So it was important to nail down a more specific target group. So the next step was to find a new target groups and have more interviews and observation.

4.2 Second iteration

Based on the data obtained from two previous interviews, we decided to focus on hearing loss caused by loud noise, and use it, as our research topic. So, we started a new round of research with brainstorming and discussion. The goal for this iteration was to clarify who could use the prototypes (target group), where (user context), and what kind of music we are targeting at. Altogether it would help us to generate new ideas about prototypes.

Compared to other musicians, DJs have to work with the loud sound systems, on average, 5 hours 2 times per week in conditions when everything vibrates from high decibels. As a result, they suffer a lot from hearing damage. We were lucky to get free access to DJ who is plagued by noise and ear disease. Thus, we narrowed our target groups to DJs.

4.2.1 Interview

We took a semi-structured interview with the DJ at her house. We asked her a set of forehead prepared questions. Extended questions followed the DJ's answers when it was necessary. The interview focused on identifying the user problems, needs and requirements.

Image 5: DJ's earplugs

4.2.2 Presentation of data

Among the key points from this interview could be mentioned the following:

"[...]I used always to listen to music with my headphones [...] a lot and I don't do that anymore since I was diagnosed with this. [...]"

"I have custom made plugs, that have filter inside ,25db filter I believe it's called which is the highest filter that you can get in your ear. [...] Even just by having those plugs in, this is still time I have to hold my ears."

"That really helps with the DB meter[...] that you can see how loud it is in the club, but a lot of clubs do not have that. [...] I need to know how hard I am standing and how hard it is for audience, because I don't want to damage their ears."

"I don't really trust the DB app in phone [...] It is not easy to put the phone on the DJ booth[...]Being around the loud sound all the time [...] And I need to protect myself all the time. So I need to bring earplugs with me."

4.2.3 Direct observation in the field

We also took the direct observations of DJs in a field (in the nightclub "Jeaeger", Oslo). The aim of the observation was to understand them as users, to observe the working environment, to identify the user's role and task.

Image 6: Observation in club

Two DJs worked cooperatively in a small semi-open space. They came out to check the music equipment sometimes. They were especially focused on the DJ booth.

4.2.4 Analysis

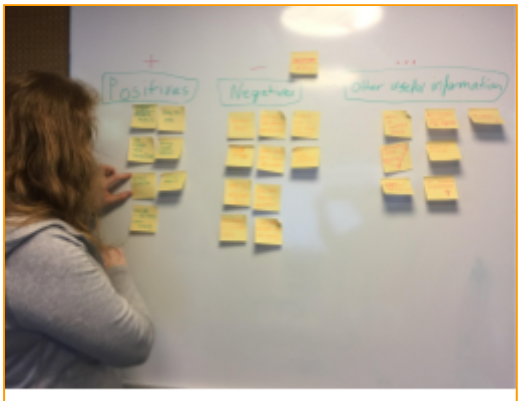


Image 7: Affinity diagram

The aim of the analysis was to investigate the gathered information. We began to do it by transcribing the interview and using open coding. We went line by line through the text, categorizing important elements by marking them with different colors. We ended up with three different categories: positive (things the interviewee liked), negative (things the interviewee did not like) and interesting information (neutral information from the interviewee which we could use in study). These data were used later in our second analysis activity axial coding, a deductive analysis method, in which we tried to figure out if/how those categorize are related to each other. As a result,

we could be able to see a ‘bigger picture’. We also included the information we gathered during observation. Lastly, our group met for creating an affinity diagram (technique to systemize the information we analyzed so far) and had a discussion around it. We categorized the things as presented below:

Positives	Negatives	Interesting information
Love music Love her profession Feel lively Enjoy	Anxiety Uncomfortable in ears Small space Lost plugs Costly devices Bad quality sound monitor No headphones at work Loud sound systems	DB meter Db filters Earplugs DJ booth

4.2.5 Findings

We tried to connect different categories together and found the following. The user enjoys her profession and wants to continue the same style of life. Simultaneously, she got hearing issues which limit her possibilities to work with loud music. The DJ has discomfort in one of the ears after being exposed to loud music for a long time. Sometimes it leads to anxiety. The user also mentioned that she does not have dB meter in the workplace which could show the level of sounds. Another issue is about the high price of good headphones for minimizing a sound level which she uses occasionally. The DJ also underlined that she feels discomfort about frequent losing or forgetting these earplugs. Based on the findings for the analysis we established the needs and requirements of the users.

4.2.6 Needs and requirements

Taking into account *Maslow's hierarchy of needs* (Joshi, 2018), we categorized the user’s needs from the analysis and findings in the following way.

Safety needs:

1) Need to protect ears from being damaged.
2) Need to maintain good health condition physically and mentally.

Self-actualization:

1) Need for achieving her full potential.

We tried to be user-centered in identification requirements, taking user's ideas and needs into consideration. Knowing the user's needs helped us to set the following functional and nonfunctional requirements for the prototype.

Functional requirements	Non-functional requirements
System should: - notify the user when the music is too loud - be chargeable - count the time for how long the music is loud	System should: - not to be easily visible to others by its look - be easy to use by not having too many unnecessary buttons and functions

Based on the above mentioned needs and requirements we formulated following issue: *"How can we use Arduino to help the DJs to prevent ear damages which can occur from loud noise?"*.

4.2.7 Prototypes

Taking into account the user's needs, we came up with a few different design ideas: watch, LEDs-lamp, wristband, a pin for an arm and headphones. These ideas served us as a basis for understanding how to build our prototypes.

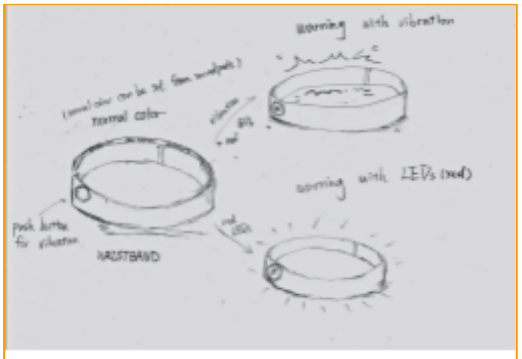


Image 8: *Low-fidelity prototype - Wristband*

As the *Participatory design* provides the user involvement in the whole design process, we wanted to involve the user in making the choice about the prototype. We showed our ideas to the DJ, and asked her preferences and preferable additional functions in the prototype. The user preferred wristband and also wanted to have something to store her earplugs. So we decided to go with a wristband and add a case where the user could store her earplugs.

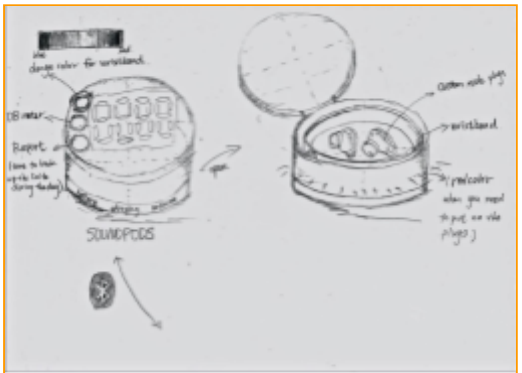


Image 9: Low-fidelity prototype - Case

Prototype: Wrist Band with separate case

Case: Will show dB level in the room with screen or 7 segment display. (Gives information about the different sound level recorded while playing the music).

Wristband: Can give warning with LEDs and vibration. Prototype can give a simple signal to inform about high sound level without distracting the DJ. Wristband and Case can communicate via Bluetooth: Wristband could send data about the sound, and Case could handle the data.

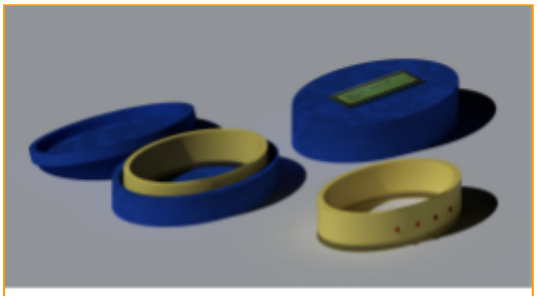


Image 10: low-fidelity 3D model of first prototype

Prototype: Headphone

The idea of the headphones was the opposite of "hearing aid". Hearing aid helps user to hear sound louder, but with headphones we could make that the sound would be quieter if it is too loud. Headphones can collect sound from all surrounding environments. When the microphone detects that the sound is too loud, the headphones will automatically reduce the sound level to protect ears.

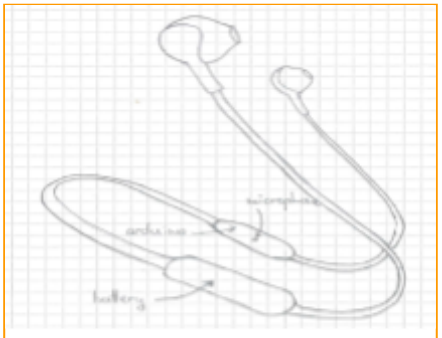


Image 11: Headphones idea

Since the user already got hearing problem, she did not like the headphones which would minimize the sound. So we decided to go with the wristband and a case.

Concept and form concept

Finding a concept for our prototype became an act of creation and a 'complex mental process of reflective abstractions' for us when we tried to set forth an idea of prototype. One of the user's requirements was that the prototype should be in harmony with his/her work environment. Taking into account our target group (DJ), a night club, as user context, was chosen. This is a darkened place with flashing lamps, like the artificial stars in the universe. Therefore, we thought we could make something in style of night-life - dark and flashy.

As a result, we identified our concept as a mini star map in a watch-like form. Stars are associated with dreams, eternity, ordered system and prediction of future. Some people believe that dreams come true in the night. DJs, as musicians, are dreamers that create music. People also use star sky to predict future based on the present data, like position of stars, planets, etc. *Our mini star map helps to identify*

the sound's level and to understand the consequences of it. As a result, people can apply precautionary measures if they want.

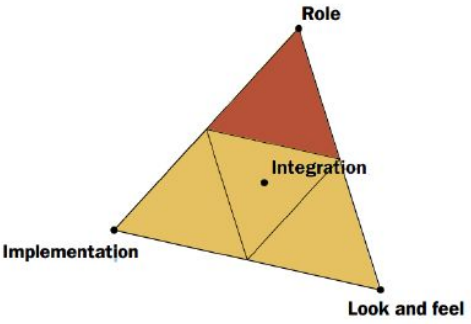
Chih-ming Shih (2004) noted that: "Concept, as a generator of the design process, produces both discursive/verbal and non-discursive/visual models of activity" (Chih-ming Shih, 2004). *Verbal design concept c*ould be described in our project as: elegant, affordable, unisex, safe, precise, unusual (interesting/creative and decent). *Visual design concept* correlates with form of prototype and includes the following positions for our prototype:

- style/motif: mini star-map;
- color schemes: colors of dark night and flashes of stars;
- texture: soft, safe and pleasant for body, light;
- shape: well-rounded, streamlined.

Understanding criteria of our prototype's form forwarded us towards aesthetic dimension, functional, technical and spatial design issues.

Role

"Role" refers to questions about the function that an artifact serves in a user's life—the way in which it is useful to them (Houde & Hill, 1997). Our prototype was more based on the role and implementation and less on the look and feel. It mainly describes the functionality that the user will get benefit from rather than how the artifact would look and feel.



4.2.8 Way forward

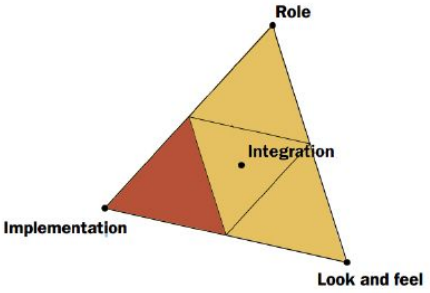
The next step was to make the high resolution prototype and evaluate our prototype with our target group.

4.3 Third iteration

4.3.1 Prototype

In this iteration we wanted to make a high-fidelity prototype from our previous ideas. Because of shortage of necessary resources for prototype, we decided to start prototyping the implementation dimension of Houde and Hills triangle model, in which "refers to questions about the techniques and

components through which an artifact performs its function—the "nuts and bolts" of how it actually works" (Houde & Hill, 1997). Therefore, we decided to start working on the wristband and to wait for other equipment which was necessary to build the case.



We prototyped mostly the functionality and interactivity dimensions (Joshi, 2018) like:

- Implementing a microphone sensor that could take input from its surroundings.
- A function that converts the microphone input into dB (sound level measure).
- LEDs that change color based on dB, to give feedback to the user
- A vibration motor vibrating based on dB, to give feedback to the user

We chose to prototype the implementation part first because we were not sure if we could implement the functionality and make it work correctly. If it would be impossible, we still would have enough time to start from scratch. In addition, the functionality/interactivity parts, were the core functions of our project that were meant to fulfill the user's needs and requirements. We also got problems with parts which did not work properly (e.g., microphone) or were not delivered on time. Finally, we were able to connect the different parts together and make a prototype which could function.

4.3.2 Evaluation

We decided to do the first evaluation of our prototype by ourselves (one of us pretended to be the user) just to test if everything is working how it is supposed to. We did not follow the specific method of evaluation and DECIDE framework, as we only wanted to find out if it works or not. But we tried to create the natural settings (the club) by playing loud music. We tested it by playing low-high music to see if the LED colors changes according to the sound level, and if we could feel the vibration when the sound level is high.

Image 12: Prototype with duct-tape

4.3.3 Findings and way forward

The LED's worked properly and the colour changed as expected but we could not feel the vibrations so well. We created a band using a duct tape. From our evaluation, we realized that we need to find

better material for wristband. Thus, the next step was to find a good material for the prototype and conduct evaluation with the real user.

4.4 Fourth iteration

4.4.1 Prototype

We tried with different materials and finally got the idea of the reflective band for our prototype. As the inner part of reflective band contains metal, it provided more vibration. It could be felt better. This time we decided to make a formal evaluation with the user in order to get feedback from him/her. As the prototype is a wearable device, we prioritized to get feedback on its shape and size and if it was comfortable to wear. This evaluation would also helped us to find out the user experience with our prototype.

4.4.2 Evaluation

We decided to conduct the evaluation with the real user following the DECIDE framework (Joshi, 2018). Since DJs were not available for evaluation, we decided to have evaluation with a guitarist. The evaluation was done in the natural environment (the studio). We showed our prototype to the user and explained how it works. Further, we asked him to use the prototype while playing the electric-guitar. This helped us to get information about user's feeling while using the prototype. Simultaneously, we could observe how the product works. When the user finished playing music, we conducted semi-structured interview to collect the feedback.

Image 13: Evaluation with a guitarist

4.4.3 Presentation of data

Some of the quotes, said by the user, are presented below.

"[....] ohh it's comfortable[.....]"

"[....] in a way is useful because…. you can realize when is too much[.....]"

"[....] you feel more vibrations because you are concentrated playing and you don't focus to the light[....]"

"[.....] the light is so fancy to wear,... and people should be curious about it[...]"

"[....] it is not heavy or tight, so.. it didn't feel actually[....], but it looks like...hmm dangerous with all the instruments and wires.."

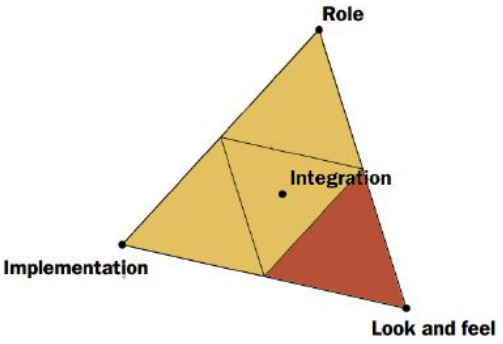
4.4.4 Findings and way forward

From the evaluation we learned about the user experience that he was satisfied with the shape and size of the prototype. Though the prototype was called "comfortable to wear", the user did not like visible wires and equipments. The user also said that he could feel the vibration but could not see the LEDs while playing.

During observation we realized that the prototype did not work properly as it showed only green light most of the time. We discovered some problems with our code what had to be fixed in the next step together with the appearance of prototype. We also got an idea to add the buttons on the wristband for choosing LEDs or vibration, and to increase or decrease the brightness of LEDs.

4.5 Fifth iteration

From the evaluation in the iteration four with the user, we got the feedback on the appearance of the prototype. So the main goal of the iteration five was to increase the user satisfaction through the prototype's appearance, its "look and feel (Houde & Hill, 1997) in order to make the prototype more attractive to the user. We also were lucky to receive the remaining parts of Arduino. So, we began to work on our case-prototype.



4.5.1 Prototype

We measured all parts for the case and printed its 3D model. Further the case was covered with fiber vinyl. It brightened the case what would help to find it faster in the darkened room. Screen was placed on the top of the case. Bluetooth is used for data transferring.

In wristband we needed to add a Bluetooth module to make these two devices work together. And based on the information we received from previous evaluation we added two buttons to control LEDs brightness and modes. Then it was time to cover all components with textile in order to hide all technical parts of the wristband from the user. More details about components and how they are connected you can find in technical report (on page 4). We also found and fixed a bug in the code.

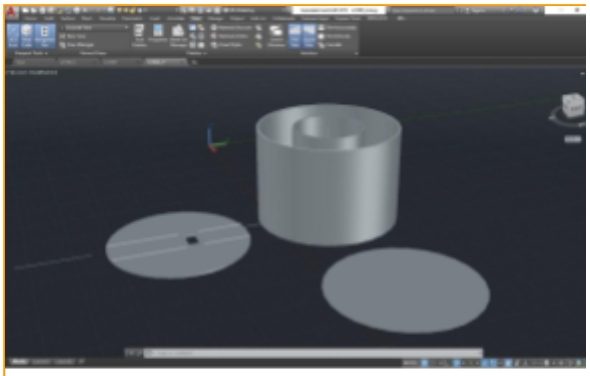


Image 14: 3d modeling

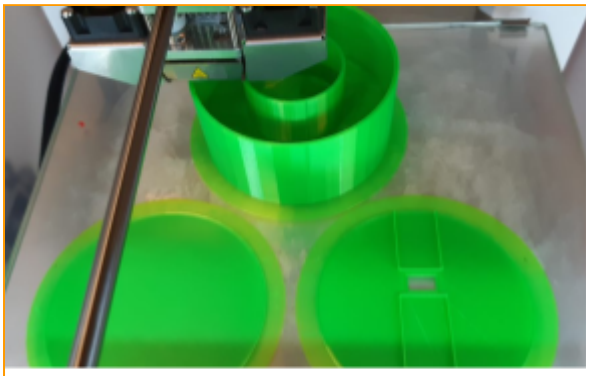


Image 15: 3d printing

Image 16: High-fidelity Prototype of Wristband

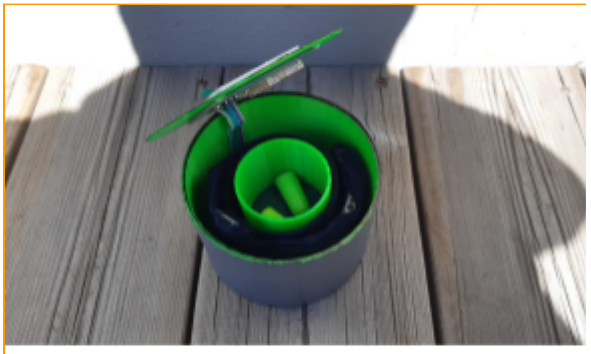


Image 17: High-fidelity Prototype of Case

Image 18: case with the screen

4.5.2 Evaluation

We decided to make evaluation with the DJ in the controlled setting. As Bluetooth connected the wristband and the case, it was important for the user to understand how they work together. Therefore, we did usability testing. We explained the user about the connection between the case and the wristband and functionality of the two buttons. We played loud music and asked the user: to turn on the wristband and case, and to change the modes (only vibrations, only LED's and both). We also asked her about the dB levels which were shown on the screen. After testing, we asked the user certain questions about the prototype's appearance and functionality.

4.5.3 Findings and way forward

We discovered several problems from this evaluation: 1) buttons for the brightness and modes were identical what confused the DJ 2) difficulties to press the buttons because of their small size; 3) difficulties to read the information because the dB digits behind the decimal point filled the entire screen.

Positive findings from this evaluation are the following: 1) comfortable texture of the wristband's cloth (soft and light) makes it pleasant to wear; 2) black color made wristband to look unisex, and added a cool contrast with the green/red LED lights what stimulates DJs to wear it in his/her context; 3) grey color of the case made it look modern and was also fitting to the environment.

Our next step was about fixing the negative findings from above mentioned evaluation. Results would be checked by conducting a final evaluation.

4.6 Sixth iteration

In the sixth iteration we made a few changes in our prototype according to the feedback, which we got from the last one, and conducted the final evaluation with complete product.

Prototype

Based on the feedback from user from previous evaluation, we made the following changes in the prototype:

- Changed/updated information on the cylinder screen.
- Replacing the buttons with the large one and marking them in such a way that it would be easy for the user to find them.

5 Final evaluation

As it was the final evaluation, we decided to conduct summative evaluation to assess the success of a finished product. We conducted the evaluation with the real user in the natural settings to increase the ecological validity. We chose a DJ who was playing in the nightclub. We explained to her about the product and its function and how to use it. The DJ wore the wristband and played the music. While we focused more on testing such dimensions of our prototype as implementation and role, we also took

into account look and feel. We conducted an interview with the DJ to get feedback about our prototype the next day.

5.1 Findings

The interview went quite well and the user was satisfied with our product. She mentioned the following positive things about the product:

1) its functions (including the usefulness of having two buttons for choosing "vibrations/LEDs"): particularly, the user told that vibration would be constant and not comfortable for her hand; so, she turned off the vibration mode; the user also mentioned 'cute but useful' change of LEDs lights 'red-green' when she tried to decrease the sound level;

2) its cool appearance, light and comfortable feeling for the body;

3) functionality of the case with identification of sound levels and the space for the wristband and earplugs.

Image 19: Evaluation with DJ

Image 20: Evaluation with DJ

6 Technical solution

Our final product consists of two following devices.

A wearable bracelet that notifies the user about too loud sounds by vibrating and/or changing the colour of lamps. This is an Arduino powered device made of 8-LEDs . The LEDs are placed in a center around a microphone-sensor. Along with these, the product contains of a vibration motor, battery, two buttons, switch, a Bluetooth module (BT05), charging module and cables connecting everything together.

The microphone sensor detects the sound in its surroundings and sends the information to Arduino. By the use of some functions the information is converted into decibel values (dB) which is in this sense used as measure for sound levels. When dB value is under 88 the LEDs light green. When it gets between 88 and 93, the color is yellow. Lastly, when it gets over 93 the color changes to red and it starts vibrating. There are two buttons on the side. One button is used to adjust the brightness of the LEDs by pressing it multiple times. The second button is used for turning vibration or LEDs on or off. In addition, it has a charging module, making the battery easy to charge with a micro-USB and a switch to power the device on or off. Lastly it connects automatically through Bluetooth with our second device, sending the dB value to it.

Our second device is *a tangible case* with a lid on the top. On the lid we have a screen which gives the user information about how long you have been listening to/playing different sound levels. A case has a place inside for the wristband and earplugs. The device receives the dB values from the bracelet through Bluetooth connection and calculates the duration of each sound level that was detected. It prints these values on the screen with relation to letters G for good sound level, M for medium sound level and L for loud sound level. It also shows the dB on the bottom of the screen. Like the bracelet it has also a charging module to charge it up with.

We came across many challenges in the development of our prototype, here are just some of the important once :

- It was hard to find microphone sensor that worked correctly. We tried many different microphones but most of them gave us wrong information or did not work (the one that worked was borrowed from Joshi).
- We had problems connecting both Bluetooth modules together as master/slave. Because some of their configuration commands were different depending on the module, so we had to find the right once.
- The first cables of our prototype were too solid so after some exploitation they began to break. So we had to replace them with more flexible once.
- We made a small mistake in the code (forgetting to define variable int in a for loop) which caused us to waste a lot of time on finding it.

7 Conclusion

Through this project we have explored hearing loss by DJs as a result of listening to loud music for a long time. One aspect we have found especially challenging, has been integrating technology into a context of health issues in such a way that technology would help to prevent ear damage in enough aggressive musical environment. This highlighted the importance of surveys about health issues, characteristics of sounds and music, users and peculiarities of usage context to achieve optimal integration in the context.

By doing this project we learnt the value of good planning, choosing appropriate working methods, group work and roles. In general, the project was very fruitful for each of us. We started with a little knowledge and ended up with a product which could be useful for DJ, musicians and other people which are exposed to loud noise for a long time.

Our project had a tendency to change direction regularly because we depended on the user's schedule for making interviews and evaluations, got problems with finding some details for our prototype or delay in delivery. We managed to reach the final stage of the project as it was planned in the milestone. Correlations between project success and project planning became obvious for us.

Working in an iterative process was new and interesting to everyone in our group. It helped us not only to acquire new knowledge but to solidify knowledge about user-oriented design. Our individual work also went in synergy with group work.

The aim of the project was to make a product with the help of Arduino which could improve the quality of DJ's life. We cannot definitely write that this goal has been met. At the same time, as evaluations show, DJ could get a reliable and valuable warning about the status of sound and necessity to use prevention measures.

Issue of the project was defined as: How can we use Arduino to help DJs to prevent ear damages which can occur from loud noise? As one of the solutions, we thought about headphones that would reduce the sound if it is too loud (something the opposite of "hearing aid"). Discussing data from our research in media and the interview, we understood that there are two things that contradict to the applicability of such product in future: 1) DJ uses a special headphone in one of the ears while playing music; 2) some users already got hearing problem and use "hearing aid" headphones. Thus, the users

will not be interested to use headphones for reducing the level of sounds. Thereby, we developed another prototype in this project.

We are thankful to our teachers for their time and attention on how to improve our project. Their valuable recommendations helped us to improve the design process of our prototype.

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