Sound Analysis

An intelligent device produced with CAD and state of the art CNC machinery, using Industrial design and product development methods, made for analyzing environment sounds.

This Master Thesis resulted in a new product inspired by the human ear. The test showed some remarkable increase of the sound gradient which would interest the client, IPsense to file for a patent.

A market to start look into was obviously the surveillance market since it is clearly an interesting one for this product to exist in, but others could also be considered such as environmental, transport and the industrial.

When you start looking at the surveillance market you will quickly conclude that the product that dominates right now is different variations of cameras. Partly from the previous model type CCTV who traditionally appears in many contexts, but also newer systems that are networked based (via IP-technology). What strikes with clarity is that this approach to surveillance could appear a bit primitive. It seems to be based more on the need to calm the fears by recording the environment or looking at the events on-line, at least when it comes to incidents based on crimes.

Picture 1 A bank robbery being made

This market has exploded in a short time which is clearly perceived when companies in the industry employ many people over a short period of time due to high demand. Thoughts that appear: whoever shall be monitoring and reporting incidents on a screen will be a person. Could humans ensure that this always happen? At the moment there are some software solutions that subsequently could be used to analyze the sequence of events, with various results I have learned. At the same time that we need to control our environment, based on our concerns, the paradox is growing of the reduced integrity because of surveillance. How should the market deal with this?

At home, in urban areas, on transportation vehicles, in every single environment that can accommodate people will soon have surveillance systems set up. Right or wrong, it is extremely lucrative to create technological innovations in order to gain control of the fear that people and organizations seem to be suffering from. But even if so, will people really get the help they need by installing a camera? Does it lead to more incidents being reported, or is it becoming a self-fulfilling prophecy, with the result that more incidents occur because of this?

These are questions to ponder on and require being investigated. This thesis has shown that there are ways to facilitate monitoring with additional technology, not only by using an “eye” but also the “ear”. Does this mean that we will hear what people will be saying? No, this is not at all the case. But by doing a sound analysis on a location we may collect information that could help us make decisions about whether it is required to report an incident or not.

The thesis evolved by performing a market-analysis survey. This was done asking expert groups on internet within surveillance, technical and ergonomic type questions. The answers were distilled and a list ranking the needs was put together. The list formed the basis for the target specifications that was going to be analyzed, systematically. This was done to decide upon which specifications as of functions and sub-functions will be needed for the product at a system-level design.

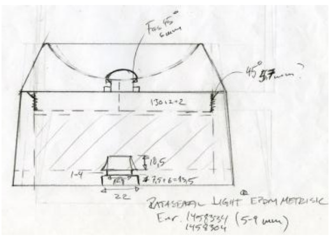
At this point ideas started to arise and industrial design methods such as using a mood board were made to inspire the design within style, feel and flow.

Picture 2 Moodboard

Sketches were then being made to suggest a concept. Systematically analyzing the functionality was performed using Ulrich & Eppinger methods regarding screening and scoring. This means that the specifications were numerically weighted towards a reference product to nominate a winning concept. The concept was design to be modular and was going to be used in an indoor environment, office type or industrial making the product water resistance and tamper proofed.

Picture 3 showing winning concept.

After the concept was nominated some handmade drawings were made to fine-tune functions and optimize the size of the housing to produce the α-prototype.



Picture 4 Drawing of α-prototype

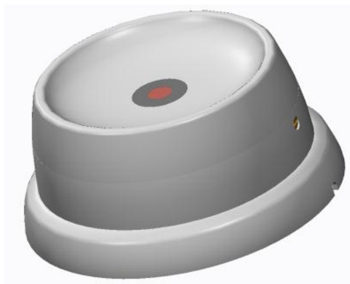
The prototype process was first to make one prototype manually an evaluate design aspects, then make one using CAD/CNC.

Picture 5 showing final α-prototype

The design was adjusted in regards to outline features and functionality such as: inside attachment point for the electronic, ventilation hole using Gore® membrane and cable feed through using a waterproof Rutaseal® cable fitting. The adjustments were made when the prototype was made in CAD (using CREO 1.0).

Picture 6 Final outline design in CAD

Having the design settled the files were then post processed before making the β-prototype in CNC lathe and mill. Autocad was used for the outline curve and some programming was made in the Heidenhain guiding system. The β-prototype was made by making three different parts, the bottom housing, the top lid and a design cover ring placed on the outside.

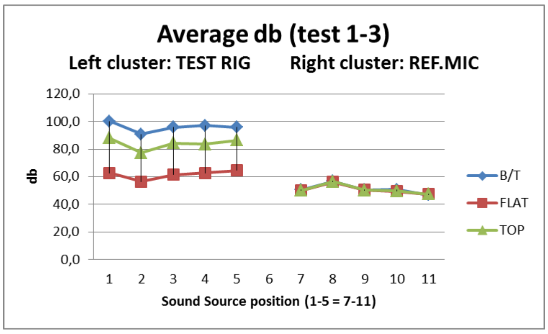


Picture 7 The final β-prototype design

After the prototype was ready it was tested in relation to sound, water resistance and heat. The sound test was performed using an audio-dead room having the prototype attached on top of a 2 m pole including a reference microphone outside. The sound source (loudspeaker) was then placed parallel to the test-rig and moved around in five different fixed locations testing 200Hz, 500Hz, 1000Hz and 2000Hz. The idea was to test whether the dish-design would increase the sound gradient (dB). Three different tests were concluded: 1. complete housing incl. microphone 2. microphone without housing 3. top-lid only incl. microphone.

Picture 8 Test-rig incl. complete housing

The result from these test showed that due to the dish-design an increase of the sound gradient was obtained. The sound gradient would gain approximately 34 dB, due to the design causing the sound waves to be more focused in the center. The housing would also generate some self-resonance adding some 11,8 dB compared to the top-lid alone being 22,1 dB. Looking at the different fixed location it is clear that this test shows an increase of the sound gradient. This occurs when the sound source is moved further away in an angle related to the test-rig.



Picture 9 Average test results in dB from three different sound tests made

The water resistance test was made using a water jet then spraying the β-prototype during 3 min with a distance of 3 m, testing for IP66/65 coding. The test result showed some leakage inside. This was probably caused by the outer O-ring seat for the microphone being un-tight.

Picture 9 Water test using water je

The heat test was made by having the CPU (electronic circuit) run at 100% for 1 hour inside the housing. After approximately 30 min the temperature had stabilized. The result showed no problems as to be overheated, having the housing in a 50°C environment if had to.

Summarizing the project in total the thesis was made according to the plan during 20 week generating some interesting result. IPsense being the client has showed interest in further development and as well filing for a design patent.

July, 2012 by Michael Rapp

Reference: Product Design and development by Karl T. Ulrich and Steven D. Eppinger, chapter 4-7, Fourth Edition, McGraw-Hill Education 2008