Detecting and Reducing Interruptions at Work

A Qualitative and Quantitative Experiment

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Abstract

It has been shown that human interruptions are one of the many factors affecting workflow and productivity. Our research question is: can an interactive device with ambient visualization lower the number of human interruptions when workers do not want to be interrupted?
To answer this question, we started with a study involving sixty workers in order to define their needs. Based on that study we built a first prototype which was tested in-vivo for one week with five users. The result of that first iteration led us to the second, more advanced, version of the prototype. This final prototype is capable of sensing interruptions, informing co-workers that the user does not want to be interrupted, and it gives an estimation of the remaining busy-duration. We manufactured five instances of our second prototype which were tested in-vivo over two weeks.
To conduct proper testing, we added sensing capabilities to our devices in order to collect quantitative data. In parallel, we interviewed the users daily to gather qualitative data.

This study is about social relations and behaviour at work, but there is also an important technical part including inter-device communication protocols, design of 3D-printed mechanical hardware parts, different programming languages, sensor data analysis, multi-threading, and the use of different web services.

In total, we conducted a study involving multiple surveys with up to ninety participants, two design-implementation-test iterations of a prototype, and a two-week long experiment in-vivo with five users in a 300-employee tech company.
This article discusses the design of the devices based on survey results, the hardware and software parts required to make it work and communicate with the cloud, the experiment, and the evaluation procedure (both qualitative and quantitative), as well as the limitations of the study.
The analysis of the results shows that it is possible to automatically sense interruptions, and that the device has a positive impact on the number of interruptions when people do not want to be interrupted. In addition, we have shown, that the device is more efficient if it is used for several short amounts of time (*e.g.,* 30 minutes), rather than for a long period (*e.g.,* full day).

Keywords: Interruption; Flow; Productivity; Time, Management; Sensing; Proximity; Analyse; Employment; Software; Hardware; Cloud; AWS.

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1 Introduction

1.1. Motivation and Goals

Interruptions are part of our day. During an 8 hour workday, we experience an average of 6 to 7 interruptions per hour. With an average duration of 5 minutes per interruption, this gives us a total of 250 minutes of interruptions per day [5, 6, 9]. In other words, we are being interrupted up to 50% of the time on a workday. Further studies show that it can take up to 20 minutes [4, 12, 15] to get back to the previous concentration level (or workflow) after an interruption. Under these conditions, we can spend a full day trying to get things done, without reaching the expected goals due to interruptions. Studies also show that being in a high flow state, or to fully focus on a task, not only helps one do the task faster, but the quality of work is also significantly higher [18]. It has also been shown that interruptions engender stress and higher frustration [13].

In our research, we will focus on human interruptions, even though they do not represent all possible types of interruptions. We are omitting Instant Messaging (IM), phone calls, emails and multiple other types of notifications, as they are out of the scope of this paper (see *Improvements & Further Thoughts*). We decided to focus our research on reducing human-to-human interruptions since there exist many software solutions blocking IM, notifications or emails, such as the *Apple* or *Android* "Do-Not-Disturb" mode already implemented in the operating system.

On the other hand, time management is also very crucial in workplaces. It often happens that someone wants to concentrate on writing a document, but switches to another task [15], unable to remain concentrated for the desired amount of time [6]. There exist many courses and sources of advice [3, 14] that teach to manage time, but out of our first survey and interviews, we saw the need of helping workers with time management.

Our goal was to create a physical device that could fit on a desk or be attached to a monitor or a laptop screen so that co-workers could know that they should not interrupt somebody in the "flow-state". Furthermore, the device should have a time-scale, so that the owner of the prototype can quickly see the remaining time of the current task. Additionally, the device should also be able to measure the interruptions to actually monitor its efficiency and not only be evaluated through subjective surveys.

We took a classical approach through on-line surveys to determine the required features, technologies, shape and feel of the device, but we also researched the *State of the Art* to understand what worked and which devices were not successful and why. Based on the research we proposed a first rudimentary prototype and tested it on a desk for a few days. Based on surveys and interviews we created five improved prototypes that were tested over two weeks.

The goal of our research was to analyse if such a device would reduce interruptions and therefore increase productivity of employees without affecting their work behavior. An important condition was that the employee does not have to adapt his or her way of working, but can simply benefit from the a tool without significant learning curve.

1.2. Organization

Introduction

The introduction explains the motivation and goals of this work and includes a short recapitulation of the structure of each chapter along with an overview of the formatting conventions.

Chapter 2: State of the Art

The *State of the Art* gives an overview about the existing products on the market and defines interruptions.

Chapter 3: Design Choices

Our *Design Choices* explain how we iterated and improved an idea to finally create five instances of a prototype used for in-vivo tests.

Chapter 4: Prototype in Depth

The chapter *Prototype in Depth* gives a technical insight (i.e., hardware and software) of the prototype and how it communicates with a cloud service.

Chapter 5: Improvements & Further Thoughts

The fifth chapter suggests improvements for further, more precise testing and emphasises the limitations of the research.

Chapter 6: Evaluation

The main purpose of this chapter is to explain the test-scenario conducted during the experiment and the results of our research.

Chapter 7: Discussion and Conclusions

The *Discussion and Conclusions* chapter resumes our approach and our tests. Additionally, it discusses ideas that came up during the whole process.

Appendix

Contains extracts of artefacts or abbreviations and references used throughout this work.

1.3. Notations and Conventions

- Formatting conventions:

  - Abbreviations and acronyms are used as follows: Amazon Web Service (AWS) for the first usage and AWS for any further usage;
  - `http://human-ist.unifr.ch` is used for web addresses;
- The work is divided into chapters that are formatted in sections and subsections. Every section or subsection is organized into paragraphs, signalling logical breaks.
- Figure s, Table s and Listings s are numbered inside a chapter. For example, a reference to Figure *j* of Chapter *i* will be noted *Figure i.j*.

2
State of the Art

2.1. Definition of Interruptions

The first step was to understand what interruptions truly are. Four types of interruptions exist according to Quintus R. Jett and Jennifer M. George [10]:

- *Intrusions*: unexpected encounter initiated by another person that interrupts the flow and continuity of an individuals' work and brings that work to a temporary halt.
- *Breaks*: anticipated or self-initiated time away from performing work to accommodate personal needs and daily rythms.
- *Distractions*: psychological reactions triggered by external stimuli or secondary activities that interrupt focused concentration on a primary task.
- *Discrepancies*: discrepancies occur when an individual perceives significant inconsistencies between his or her expectations and what is happening within the external environment.

It this research we will try to reduce *intrusions* by informing external people that one does not want to be interrupted, but also reduce the *distraction* time by informing the user that s/he needs to remain focused.

Intrusions are the ones our device should focus on reducing. In this document, the term "interruptions" will refer to the *intrusive* kind of interruptions.

A worker may be extracted from his/her focus-zone by noise, light, touch, smell or temperature changes. In offices a common reason to leave the concentration zone, is noise. It is often a *distraction* mentioned by co-workers speaking together. Our brain unconsciously listens to a conversation and a word, a name or a change in the tone of voice may be a trigger to switch focus to the conversation. Often, the distracted worker only focuses on a few aspects of the conversation and then goes back to his/her current task. However, this trigger can often occur and the worker suffers all day long from small interruptions due to those *distractions*. It would be necessary and useful to have a device capable of informing these talkative colleagues to move to another place. It has been shown that people often do not want to intervene physically to make

Fig. 2.1.: "Please do not disturb" Dilbert banner by CubeGuard Inc.

people move to another place. A device could, for example, act as a moderator and encourage the colleagues to move to another place. This will not be part of our research, though we discuss this situation briefly in the chapter "*Discussion and Conclusions*".

2.2. Existing Devices Improving Work Quality

The second step of the "*State of the Art*" consisted in exploring solutions that already exist to reduce daily interruptions at work. There are many different ways of working nowadays – home-office, open- and closed-spaces or hot-desks – but interruptions are present in all cases [1]. Some companies tried to create devices to reduce these interruptions. We will list a few of them below and comment their functionalities.

- **CubeGuard** (see Figure 2.1) is a non-electronic device in form of a banner blocking people out of the worker's desk. The *CubeGuard* banner comes in different shapes and sizes. This device is cheap and simple to use, yet it does not work for all types of offices. It is meant for closed offices and acts as a door. The disadvantage of such a device is that it physically blocks out people, which is a social barrier, but it does not really stop colleagues of interrupting, since they may speak to you even with the banner. A visible flag would be a nicer, gentler solution that would work on any type of desk or office architecture.
  Website: `http://www.cubeguard.com`
- **CanFocus** (see Figure 2.2) is a simple on-off device that indicates colleagues if they can approach and interrupt or if they should come back later. The device is a lightning switch that the worker can press to change from "Flexible" (*i.e., green*) to "Focused" (*i.e., red*). The colleague should understand, that red light means: "*I'm focusing, if you want to interrupt me, try again when I'm in green mode.*". The *CanFocus* device is not very visible and may be too simple for a technological device, but it comes with a software monitoring the duration in both modes and it produces detailed statistics. In addition, the software is capable of silencing the digital interruptions such as emails, VoIP phone calls, IM and other notifications. This device tried to raise funds on Kikstarter[1], but it did not work out.
  Website: `http://www.canfocus.com`

[1]`http://www.kikstarter.com` is a founding platform for creative projects.

Fig. 2.2.: "Focus or Flexible" The simple one-button device by CanFocus.

- **Luxafor** (see Figure 2.3) is a tiny and cheap device (28 to 31 USD) that consists of six small LED lights, a USB cable and a software application. The device is then attached to the monitor and indicates to colleagues whether the worker is busy or not. This device is affordable, visible, portable (*i.e.,* it can be attached to a laptop), and simple to use, however it would be nice to have a direct interaction (*e.g.,* touch the device to switch the mode) rather than having an to open an application. The provided application works on *macOS* & *Windows* and remains in the foreground with five buttons: Available, Do-Not-Disturb, Auto-Mode (this mode switches to "red" if a productivity application is open), and Active-Mode (this mode notifies the user if there are incoming notifications such as emails or IM messages.). The fifth button is a custom mode, where the worker can schedule "focus-zones".
  Website: `http://www.luxafor.com`
- **Jabra Noise Guide** (see Figure 2.4) is an interesting tool with some embedded intelligence informing colleagues that the ambient office noise is too high. The goal of this device is not to stop or reduce interruptions, but to reduce *distraction*s. When colleagues speak too loudly next to such a device, the *Jabra Noise Guide* switches to red and it informs the colleagues that they should change location or speak with a lower voice. It is useful in the sense that people rarely realize when they are distracting others. In addition, the distracted people often do not feel comfortable enough in order to tell others to move to another place because they are being too noisy. The distracted people prefer to wait until the end of the conversation, which leads to less productivity during that period.
  Website: `http://www.jabra.com/business/office-headsets/jabra-noise-guide`
- **Busylight** (see Figure 2.5) is not really a "*Do Not Interrupt*" device, because the main purpose of *Busylight* is to notify the worker about incoming calls. Kuando (the manufacturer) claims that a lot of calls are missed due to a lack of visibility. In addition, the device informs colleagues that the current user is performing a call and switches color to match the actual state (*e.g.,* available, busy, calling . . .) in an applications such as *Skype*, *Jabber*, *Lync* or other IMs. This device does not fully match our requirements for the *State of the Art*, but their design and approach are interesting and consequently covered here.
  Website: `http://www.plenom.com`

A majority of these products work for a while, reduce noise or interruptions, but they quickly

Fig. 2.3.: Luxafor: A simple LED attached to a monitor and controlled by a software over USB.

lose their intended effect. For the three first devices (CubeGuard, CanFocus and Luxafor), the owner of the device has to set the state (*i.e.,* "Do Not Interrupt" or "Ok To Interrupt"). He or she will do it at the beginning, but the owner often does not feel that the device is working and does not use it anymore after some time. Indeed, the device reduces some interruptions, but not all of them. It is enough to make him/her feel that the device is useless if he/she gets interrupted during the "*Do Not Interrupt*" mode a few times (which is not always true). The effort to set the device in a mode is too high compared to the perceived benefit.

It has been shown that people do not want to be interrupted, but they often misjudge their co-workers' needs and do not hesitate to interrupt others [7]. People tend to over-estimate their reason to interrupt and do not *respect* a banner or a light on a device. One interrupting may *respect* such a device if s/he finds a benefit on his/her work by having such a device. Therefore, we would need all employees to own a device, see a benefit in it and learn to *respect* it without having to set it manually.

A solution to show the owners that the device is fulfilling its task, is to graphically show a decrease of interruptions. This is what *CanFocus* tries to achieve through its monitoring software. In addition, it is important to note that such an adoption process of a new device can take a long time and depends on culture [11].

Fig. 2.4.: Jabra Noise Guide: The device switches to red when the ambient noise is too high.

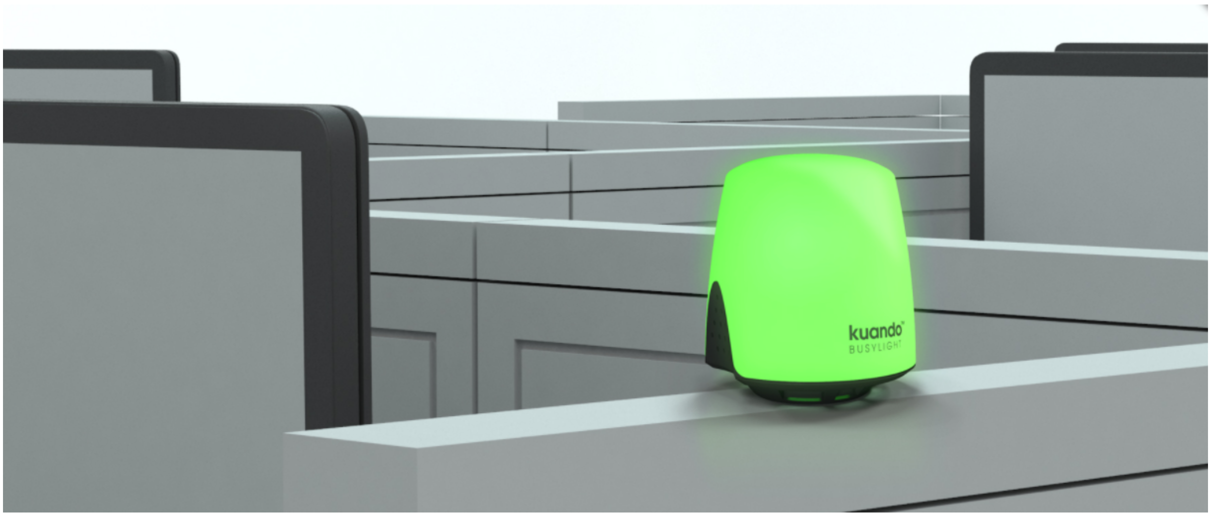


Fig. 2.5.: Kuando: A device indicating the status during a Skype call.

3 Design Choices

3.1. Design Choices

As the state of the art shows people don't want to be interrupted, but they are not bothered by interrupting others. This is the reason that a *"Do Not Interrupt"* device or flag does not work as intended. To be able to still reduce interruptions during a workday, we made an hypothesis: *Let's assume that workers in a company see plus-value in a device and agree to keep it on their desk. If the device then indicates that co-workers should not interrupt, the workers may "respect" it after an adaptation phase. Or at least, reduce the number of interruptions in some case.* Based on that hypothesis, the primary goal of our approach was to make a device that is interesting for the worker and which also reduces interruptions after an adoption process. With simple "on-off" devices as seen in the *State of the Art*, if co-workers do not respect it, the owner will no longer set the device ("on" or "off") and it will quickly be considered as useless. Therefore, our idea was to add plus-value for the user into our prototype. As a consequence, even if the user gets interrupted (i.e., the prototype is not fulfilling its goal), s/he may continue using it for their own benefits (e.g., Time management feature).

We thought about the issue of time management at work, and instead of creating a simple timer that may be stressful because of its precision [16], we decided to implement a simple hourglass with diffused Light-emitting diode (LED) stripes [19]. When one needs time to complete a task s/he does not want to be interrupted. Therefore, once the time is set for a task, the device switches to *"Do Not Interrupt"* mode. This mode turns on red LEDs on top and bottom of the device indicating to colleagues that the owner of the device does not want to be interrupted. If the colleagues do not respect the device (and in the mean time the worker's decision), there is still the benefit of time management as a side effect. With that idea, one may use the device for themselves and eventually the *"Do Not Interrupt"* mode will gain in attention.

Fig. 3.1.: First iteration of the prototype.

3.2. First Prototype

Our first prototype (see Figure 3.1) was built out of the following parts:

- *Carton cylinder*: For the structure of the device. It was the cheapest and simplest way to quickly create a prototype.
- *LED stripes*: We used simple Red Green Blue (RGB)-LEDs to simulate sand in a hourglass.
- *Accelerometer*: We wanted a simple user interface and a small tap on top of the device to turn it into *"Do Not Interrupt"* mode seemed simple.
- *Webcam*: The aim of adding a webcam was to add the ability to set the timer using voice commands. The webcam detects when a user is watching the device and is listening for voice commands only during that time. This removes the need of a trigger word, like *"Hey Siri"* on an *Apple* device for example.
- *Raspberry Pi 3*: The Pi 3 is needed to process the video stream and detect faces with a

Shape	*Score*	Size	*Score*	Material	*Score*
Cylinder	313	20cm	284	Metal matte	52
Fat cylinder	262	10cm	257	Fabric	48
Cone	223	30cm	184	Wood	36
Pencil	218			Metal polished	35
Hexagon	201			Plastic	24
Square	193			Leather	16
Pyramid square	188			Other	2

Tab. 3.1.: Results for the different shapes, sizes and material. Highest score is best. Based on 88 responses.

Fisherface algorithm [2] provided by *OpenCV*[1]. Additionally we use the Raspberry Pi 3 because of its wide connectivity capabilities such as the *WiFi* antenna.

- *Arduino*: The Arduino micro-controller board is necessary to correctly drive the LED stripes. LED stripes need a precise timing that cannot be guaranteed by a microprocessor (as in the Raspberry Pi), because of Central Processing Unit (CPU) interruptions.
- *Fabric*: Design is an important factor for a prototype. The carton envelope looked too ugly with glue all over it, so we decided to pack the device in a clean fabric envelope. Fabric was chosen for simplicity reasons and aesthetics.

After testing the prototype in our research group we saw that voice commands were not suited for office environments due to noise and privacy. Therefore, we changed the behaviour of the accelerometer so that a tap on the left side of the device increases time by five minuets and a tap on the right side decreases it by five minutes. A tap on top of the device was still used as switch for the *"Do Not Interrupt"* mode. Hence, one could set the time with voice (i.e., in a closed office or in a home office) or with manual intervention in an open office.

3.2.1. Survey Results – First Iteration of the Prototype

We tested the modified first prototype with five users from different departments, genders and age groups in the tech company. Every user tested the device for one day and we conducted an interview with each at the end of the day. The overall feedback was very positive and people saw possible extensions of such a prototype (e.g., note taking, presence control, IM-status, desk availability and many more), but participants also expressed dissatisfaction in three major areas:

($P_1$2) "The main goal is not really achieved because people come and ask you what this device is."

This is due to the novelty of the product, once users are familiar with it, this will no longer be a problem [17]. The adoption will take some time.

($P_1$4) "It is a bit cumbersome, it takes much space on your desk."

We had to make the next iteration of the device as small as possible since office desks are often already heavily loaded with paper, monitors, cables and books. Hewever, we had to keep the used technology. Therefore, we went for another internal design in the next iteration.

($P_1$5) "It is not visible from far, and people coming close to see the device are already interrupting me."

[1] OpenCV is a helpful library for image processing.

The second iteration of the prototype had to be much more visible in the *"Do Not Interrupt"* mode, without making it annoying for the testing user. To do so, we worked on light diffusion on the bottom (indirect light on the table) and a LED circle on top of the device that is diffused and visible, but not too aggressive for the testing user.

Additionally, we conducted an on-line survey with 300 employees in the company's building and got eighty-eight answers (see Table 3.1) which helped us choose the size, shape and material for the second version of the prototype.

3.3. Second Prototype

Based on the results of the first prototype we created five identical instances of a new version of the prototype, that were used during two weeks for testing. The second prototype (see Figure 3.2) changed in size and shape, and we also added a new interaction mode using *Soft Potentiometer*s. These *Soft Potentiometer*s are resistive stripes capable of giving information about where pressure is applied. We placed two stripes vertically on both sides of the prototype such that a user can touch them to set the wished focus duration. We choose a fixed scale of one hour, since it is difficult to fully focus for longer than one hour [8].

Additionally, we increased the sensing of the device with eight Time of Flight (ToF) distance sensors all around the device to measure proximity from all sides. The ToF sensors are capable of measuring distances from $2cm$ to $200cm$ and are used to detect if people are close to the device and could potentially interrupt the user. We also added a microphone to measure sound levels. The sensor values were integrated and collected every second. To confirm the sensing data, we added an external switch that can be pressed when a user is interrupted. We added these sensors to be able to gather objective data to test our device. Results from sensors and button presses were meant to be compared with the user surveys.

All sensor data and log files (i.e., external switch and *"Do Not Interrupt"* duration) were sent to a server. We chose to use Amazon Web Service (AWS) for the scalability and ease of use. Reports are made on a hourly basis such that we can follow the logs over time and count interruptions.

We made preliminary tests in our laboratory to check reliability of the sensor data and determine their capability of detecting interruptions.

The next section *Prototype in Depth* explains how we created the second version of the prototype. It includes hardware & software decisions and detail informations about the cloud communication required to evaluate the prototype.

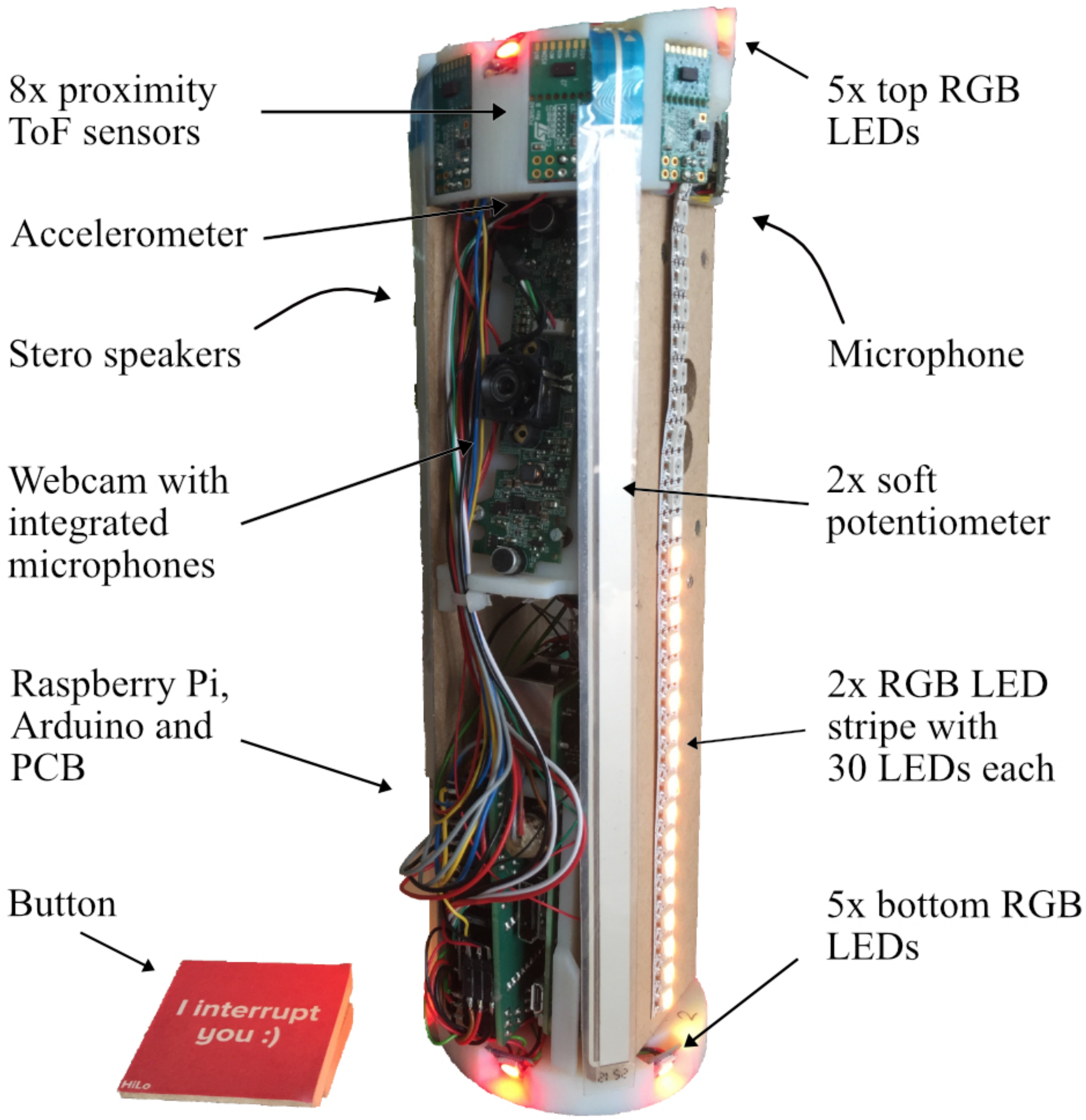


Fig. 3.2.: Second iteration of the prototype with the *"I interrupt you"* button.

4
Prototype in Depth

4.1. Prototype in Depth

This chapter gives a technical insight of the prototype including its hardware and software parts. Additionally, we show how the device communicates with the outside world through a cloud architecture, a web service provided by AWS.

4.2. Hardware

This section is divided into two chapters. The first one, *Mechanical Hardware*, handles all non-electric parts holding the device together to create its physical shape. The second chapter, *Electrical Hardware*, will cover the computing hardware and all electrical driven sensors and logic boards.

4.2.1. Mechanical Hardware

In order to be able to create multiple instances of the prototype, we chose to create Stereolithography Apparatus (SLA) pieces. We could have worked with wood, carton or glue, but it would have been time-consuming, not an elegant solution and less precise than SLA. The huge advantage of SLA pieces is that they can quickly be manufactured at a relatively low cost compared to serial production. Additionally, they are very precise (50µm for our 3D-printer) and we could therefore

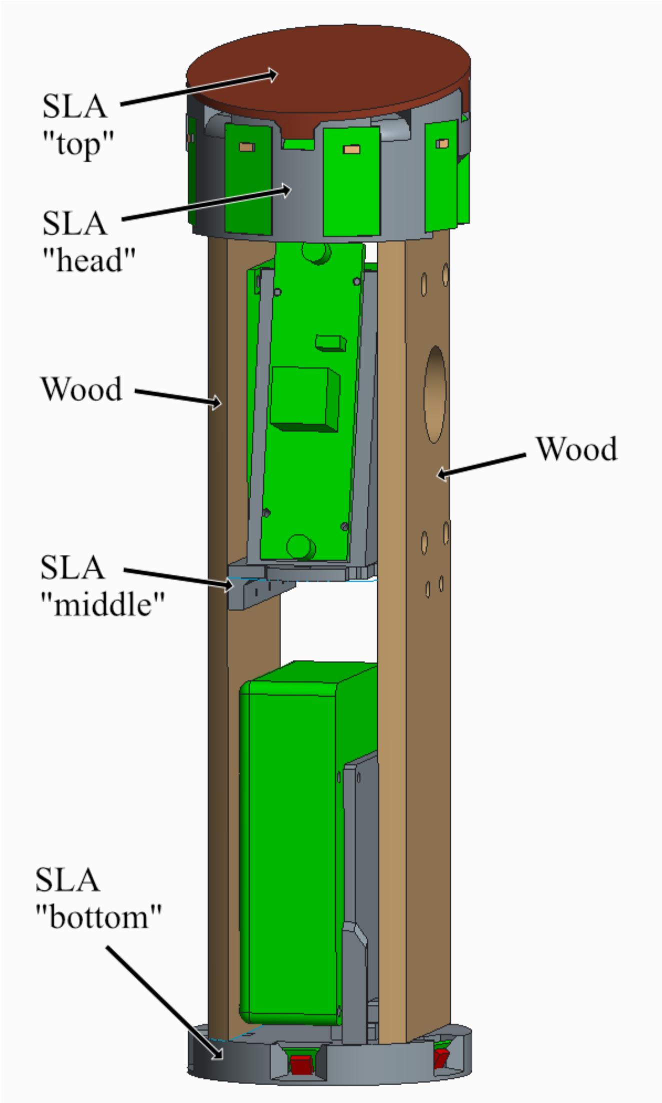


Fig. 4.1.: Rendering of the prototype assembly. With SLA parts (grey & dark brown), wooden structure (light brown) and electrical hardware parts (green).

tighten sensors and parts without the need of any glue. This results in quicker manufacturing of the prototype which can be taken to pieces in case of malfunction.

Figure 4.1 shows a rendering of the prototype where the grey and dark brown parts are the SLA pieces. The green pars represent the electrical hardware (i.e., sensors, webcam, Raspberry Pi, logic boards and LEDs) and the light-brown parts shows the wooden structure holding all the pieces together. We chose wood to manufacture the structure because of the simplicity of the piece and its large size. Large pieces take much longer to manufacture with a 3D-printer and are more expensive.

We designed four different SLA pieces for our prototype to work. The three grey SLA pieces (i.e., bottom, middle, head) are made of solid, white, and non-transparent resin. The topmost SLA piece (i.e., top) is made of transparent, solid resin with the purpose to guide light.

- *bottom*: The bottom piece is the base of the device holding 5 LED lights, the Raspberry Pi with the Arduino micro-controller, our custom Printed Circuit Board (PCB) and the

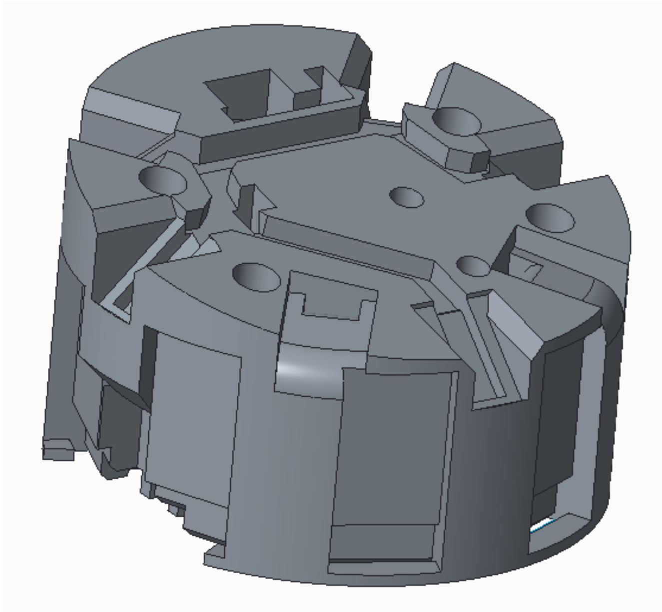


Fig. 4.2.: Head piece of the device. Holding five LED lights, eight ToF sensors, one accelerometer and one microphone. Additionally, the head piece guides the two soft potentiometers.

sound amplification board. In addition, the bottom piece contains an emplacement for a Universal Serial Bus (USB) type B port used to power the device.

- *middle*: The middle stage is used to stabilize the device's structure and holds a *Logitech c*930*e* professional webcam in the correct tilt.
- *head*: The head part (see Figure 4.2) is the most complex SLA piece in our prototype, responsible for holding the accelerometer, eight ToF sensors, five LEDs, two LED stripes and two soft potentiometers.
- *top*: The purpose of this piece is to guide the light of the five LED lights and create a flat surface to "tap" (gently hit) the device.

To finalize the device we cut a $0.5mm$ thin Polyurethane (PU) plate in the form of the round prototype and taped it together in the back to make a solid surface for the fabric. Additionally, we cut out some holes in the fabric to make the ToF sensors "sense" and the webcam "see". We experienced difficulties regarding the nice finish of the holes with fabric due to the wool yarns. Therefore, we went for elegant tape which was much more adapted to cut out the holes. Figure 4.3 shows the PU envelope on the left side and the finished prototype on the right (with turquoise tape).

4.2.2. Electrical Hardware

Figure 4.4 shows the used electrical logic- & sensor-boards and their communication protocol. Additionally, the following list references the boards and parts to ensure proper versions in order to reproduce the whole architecture.

- *Raspberry Pi (model 3)*: The Raspberry Pi has been chosen for its wide connectivity, low price and small size. It is used as the central unit, controlling all other modules. For our

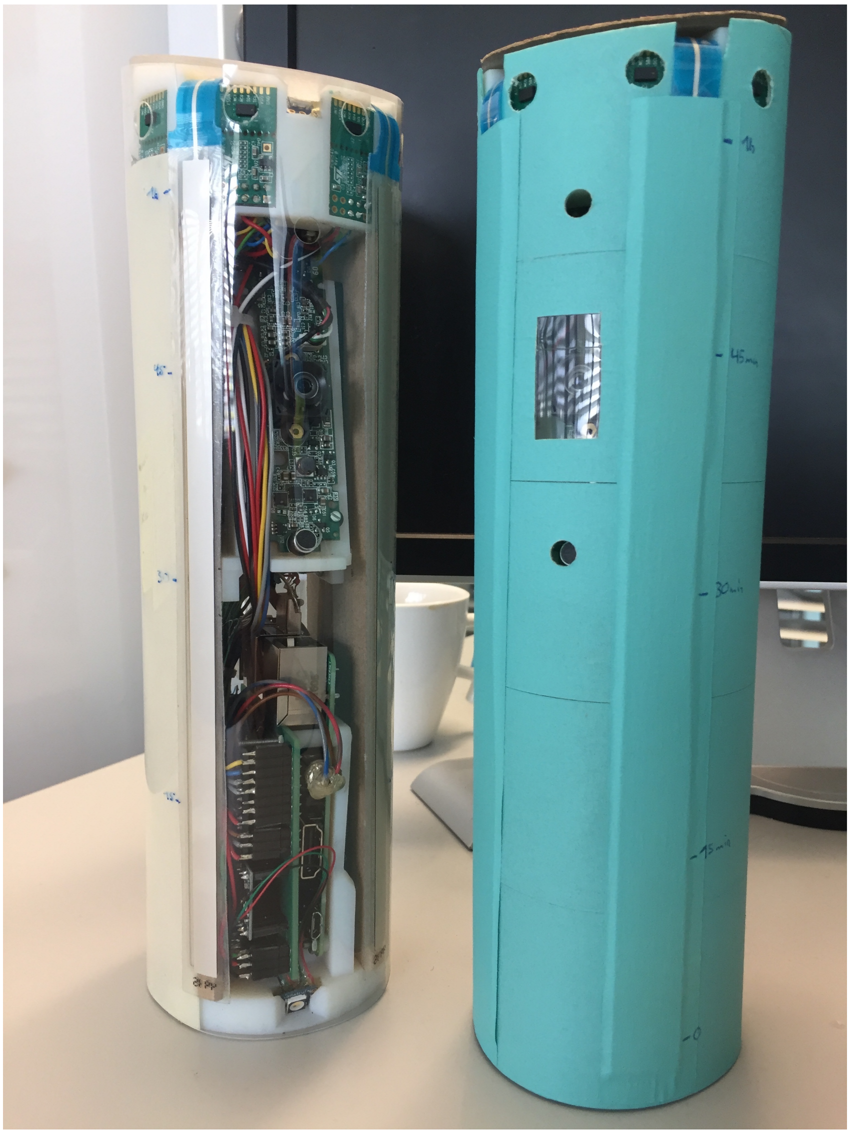


Fig. 4.3.: Prototype with PU envelope (left) and turquoise tape envelope (right).

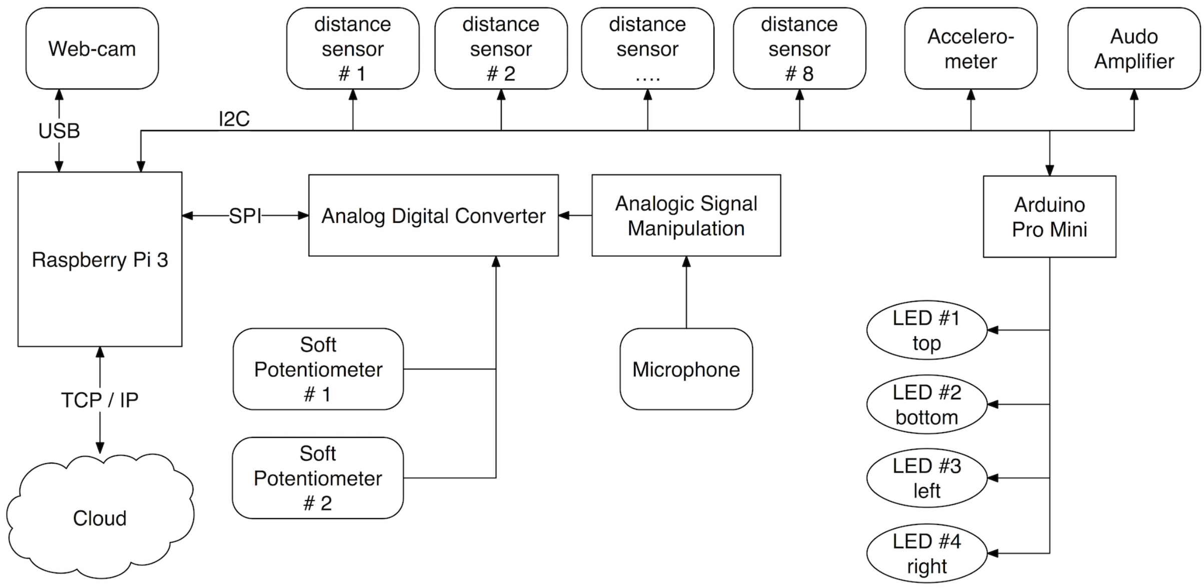


Fig. 4.4.: High level architecture of the device. Communication between the central unit (Raspberry Pi) and the different sensors, controllers and converters.

prototype, we were running a light version of Debian *Jessie* on the Raspberry Pi (Raspbian Jessie Lite 4.4, without the Graphical User Interface (GUI)).

- *Arduino Pro Mini (*$5V$, $16MHz$*)*: The Arduino is used as a LED controller. The LED lights we use need a precise timing to be controlled, which can be guaranteed by the Arduino.
- *Logitech Webcam (*$c930e$*)*: We used the $c930e$ for its wide angle and image quality. For design purposes, we removed four small LED lights on the cameras PCB in order to avoid unnecessary lightning that is visible through the fabric.
- *Stereo Amplifier board (*$TPA2016D2$*)*: We used this Inter-Integrated Circuit (I2C) driven stereo amplifier to be able to change the sound level and balance programmatically.
- *3-Axis accelerometer (*$MMA8451$*)*: This accelerometer board is also I2C-capable and provides two interrupt pins which fit our requirement to detect tap's (*i.e.,* the user hits the device gently).
- *STMicroelectronics ToF distance sensors (*$VL53L0X$ *satellites)*: STMicroelectronics offer accurate and small distance sensors capable of determining distance ranging from $2cm$ to $200cm$.
- *Electet microphone (*$100Hz$*–*$10kHz$*, with 60x preamplifier* $OPA344$*)*: This microphone is used to measure the ambient sound level.
- *RGB LEDs (*$WS2812$*)*: We used programmable LED lights to change the color and the light intensity with ease.

In order to combine all electrical modules, we had to design our own PCB (see Figure 4.5) to lower the wiring complexity. Furthermore, it enabled us to hold the Arduino and sound amplifier board. Additionally, we needed an Analog Digital Converter (ADC) to convert the analog signal received from the microphone and the two soft potentiometers to a digital signal that could be interpreted by the Raspberry Pi (i.e., the Raspberry Pi has no analog input). We

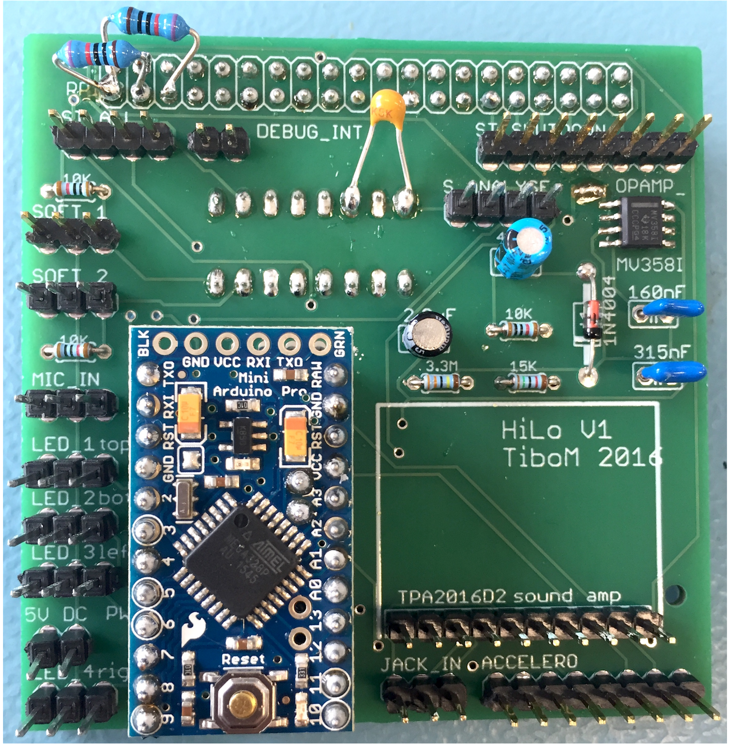


Fig. 4.5.: PCB with Arduino Pro Mini shield and custom sound signal integrator (upper right part).

used the *MCP*3008 (8-channel, 10-bit) ADC chip that could be driven and read through the Serial Peripheral Interface (SPI) bus.

Furthermore, our PCB integrates the sound signal received by the microphone to be able to receive usable data. Indeed, the microphone gives a real-time sound signal. However, because of hardware limitations (busy communication busses), we could only read the signal with a frequency of $1Hz$. Therefore, we decided to create an integrator with an operational amplifier which made a slowly decreasing sound peek ($\sim 2sec$). With that method, we could read the microphone value at $1Hz$ and have a good approximation of the ambient noise level.

4.3. Software

For this research we used multiple programming languages (i.e., Bash, C++, Python, C, JavaScript, HTML and SQL) and technologies (i.e., Node.js, AWS, DynamoDB, OpenCV, I2C, SPI…). Therefore, this chapter will be divided in two parts. The first section, *Prototype Software*, handles the software running on the prototype to make the device work, log data, and communicate with the cloud. The second section, *Cloud Software*, shows the implemented web server running on AWS responsible for displaying and storing data.

4.3.1. Prototype Software

We used *Bash* language to create cron-jobs[1], configure the *WiFi* on the Raspberry Pi and start the prototype's code. Additionally, we used *C*-language to edit and customize the firmware library provided by STMicroelectronics in order to make it work with our architecture. Furthermore, *C++* was used to create an I2C slave running on the Arduino Mini Pro which is responsible for controlling the LED lights.

However, the main code controlling the device is running on the Raspberry Pi and written in *Python*. Figure 4.6 explains the parallel execution of the multiple threads used to make the prototype work. The *main* thread is started by a *Bash*-script when the device is turned on and Raspbian Jessi has finished booting. This thread then starts three other threads:

- *Face-detect thread*: The face-detect thread is responsible for capturing images from the *c*930*e* webcam and applying a *Fisherface* algorithm [2] provided by *OpenCV* to detect faces. Once a face is detected, the face-detect thread notifies the main thread that handles the case by turning on a led (i.e., sending a message to the Arduino board) and listening to the webcam's microphone.
- *Soft-potentiometer thread*: This thread reads the values given by the ADC on a $1Hz$ frequency. If a human interaction is detected, this thread notifies the main thread.
- *Sensor thread*: The sensor thread is responsible for gathering data from the eight ToF sensors and the microphone with a frequency of $1Hz$. The gathered distance and sound level are then recorded in a log file.

In addition to the four threads above, there is a *timer thread* that is shared among other threads. This thread is a singleton, which means, that multiple threads (e.g., soft-potentiometer or main thread) can start, stop or pause it, but there is only one instance. The timer thread is used as a timer and it regularly notifies the main thread which is responsible for controlling the LED lights (i.e., to represent time visually).

In parallel of these five threads, the OS handles a cron-job that can be seen as a thread executing a *Python* script. The executed *Python* script is reading the log file written by the *sensor*- & *main* thread and it sends it to the cloud (i.e., AWS). The log files sent to the cloud contain values for every sensor (i.e., eight ToF-sensors and one microphone) and user actions such as reboot-time, button presses, timer duration, and "*Do Not Interrupt*" mode.

We had to implement multiple mutexes[2] to guarantee proper functionality, especially for the different communication busses to avoid collision and therefore wrong signal interpretation. (i.e., One for the SPI- and another for the I2C-bus.)

4.3.2. Cloud Software

In order to evaluate our experiment we needed to gather and process the sensor data. We developed a web server written in *Node.js*[3] and running on *Elastic Beanstalk*[4]. The advantage of this architecture is that it is scalable and *Amazon* provides multiple tools and Software Development Kit (SDK) to communicate with their services.

[1] Cron Jobs are timed tasks managed by the OS (e.g., execute a script every hour).

[2] A mutex is a locking system to avoid multiple processes accessing the same resource at the same time.

[3] Node.js® is a JavaScript runtime built on Chrome's V8 JavaScript engine. Node.js uses an event-driven, non-blocking I/O model that makes it lightweight and efficient.

[4] Elastic Beanstalk is an AWS orchestration service that can be used to deploy applications on the web.

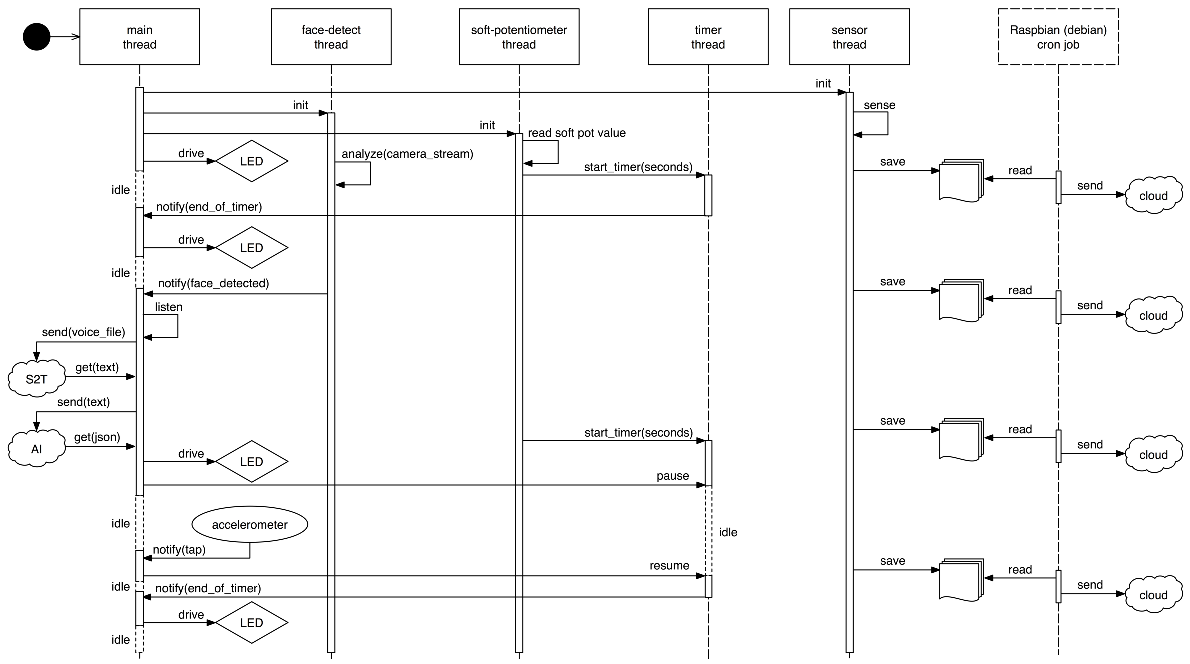


Fig. 4.6.: Parallel threads running on the Rapsberry Pi.

The following list explains the overall architecture of our cloud application that can be seen in Figure 4.7. The numbers in the list correspond to the numbers in brackets on the figure (e.g., [1]).

1. The prototypes sends log data on an hourly basis and the files are stored on a scalable storage provided by AWS called *S3*. We permanently store the log files for archiving purposes.
2. On a regular basis a cron-job executes a task on the web server that is responsible for reading the stored log files which were not already processed. Once the file is processed, it is moved to a folder called "archive" on the *S3* storage service.
3. The program makes a request to the Relational Database Service (RDS) provided by AWS. This database stores the last known thresholds calculated by each prototype. The purpose of this threshold-data is to determine limits for every sensor (e.g., For a ToF sensor the threshold is a distance of the nearest object that should not be considered). This threshold can vary if the device is moved.
   N.B.: Ideally, the device should sense that it was moved and adapt the threshold on the server. However, we went for a simpler solution. The device re-calculates the thresholds on every boot.
4. Once the server has gathered the thresholds and log files, it computes an hourly-based report. Determining the number of interruptions the user encountered during his/her "*Do Not Interrupt*"-mode versus the number of interruptions not in that mode. Additionally, the reports contain the average of the sensor values and the duration in the different modes.
5. This report is then stored in a Not only Structured Query Language (NoSQL) database called *DynamoDB* on AWS. We chose a NoSQL database for scalability purposes and efficiency. Additionally, a NoSQL database has the huge advantage of not being schema related which, in our case, would simplify the addition of further sensors.

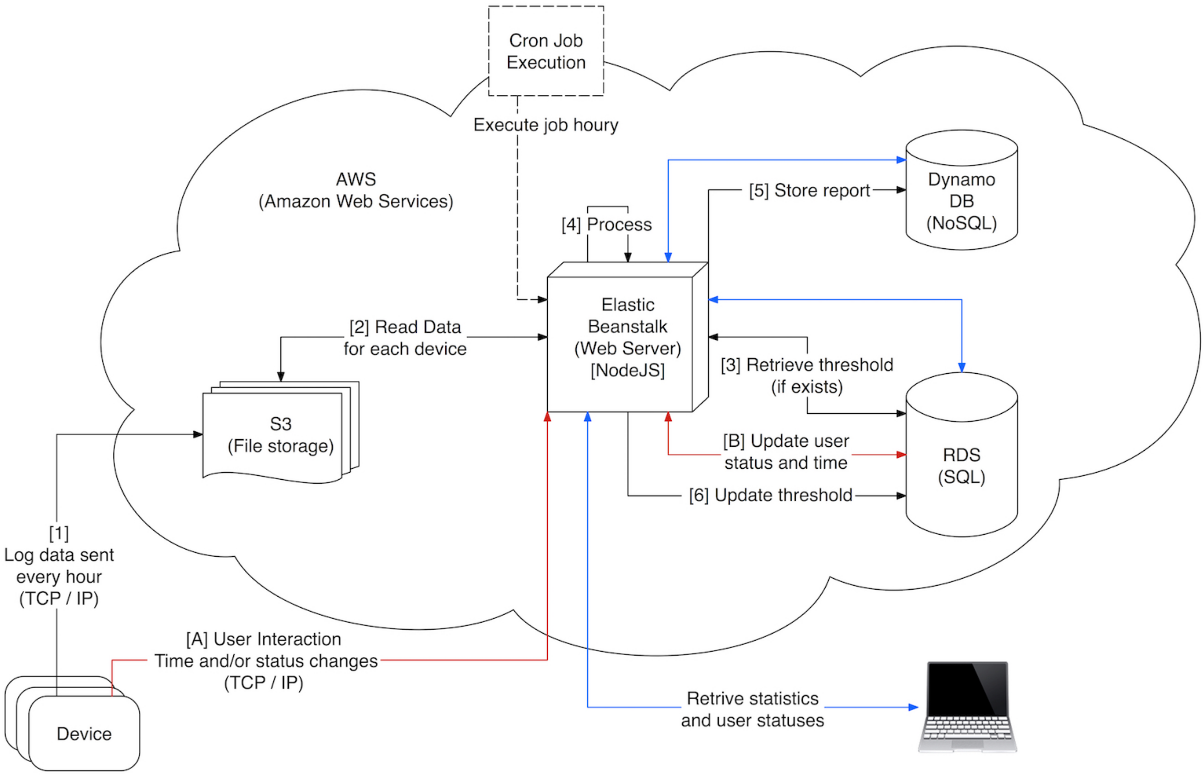


Fig. 4.7.: Cloud architecture. Data exchange between the devices and AWS for log processing and visualisation.

6. If necessary (i.e., the prototype rebooted), the web server is responsible of updating the threshold in the RDS for the next computation.

We then created a simple web interface where we can query the *DynamoDB* database in a certain time frame for a wanted device. To display the results we used a *JavaScript* library called *C3.js*[5] (see Figure 4.8). In Figure 4.7, the blue arrows represent the requests made to the web server and the databases (i.e., NoSQL and RDS) in order to display the data.

Extra Features

In addition to the graphical representation of the log data, we added an extra feature which indicates the availability of the workers at their desk. In Figure 4.7 the red arrows are responsible for that feature. Every time a device enters the "*Do Not Interrupt*" mode, leaves that mode or the timer is set, a HTTP-POST request to the web server is made (i.e., *[A]* in Figure 4.7). The server updates the RDS database (i.e., *[B]* in Figure 4.7) and the website informs co-workers about the status and duration left of their colleagues (see Figure 4.9).

[5]C3.js is an open source *JavaScript* chart library based on the powerful *D3.js* "Data-Driven Document" project.

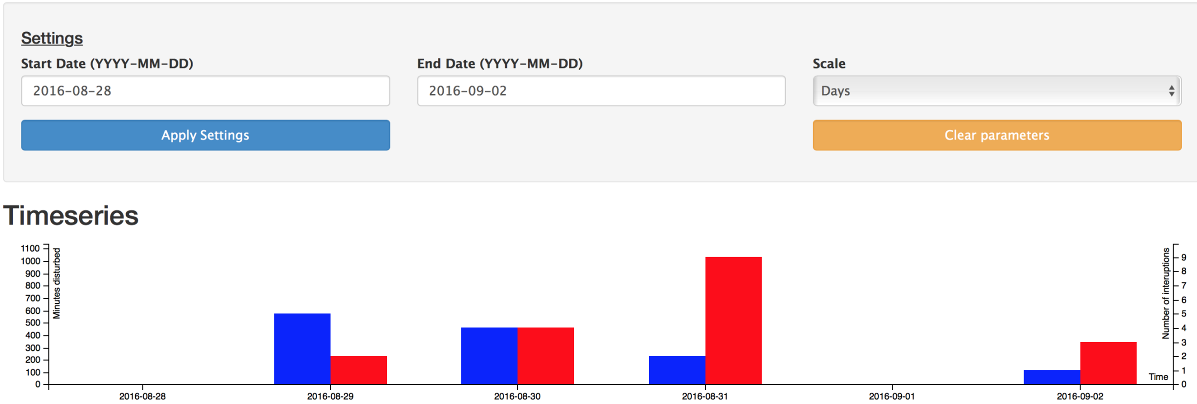


Fig. 4.8.: Web interface with responsive graphs to quickly count the number of interruptions.

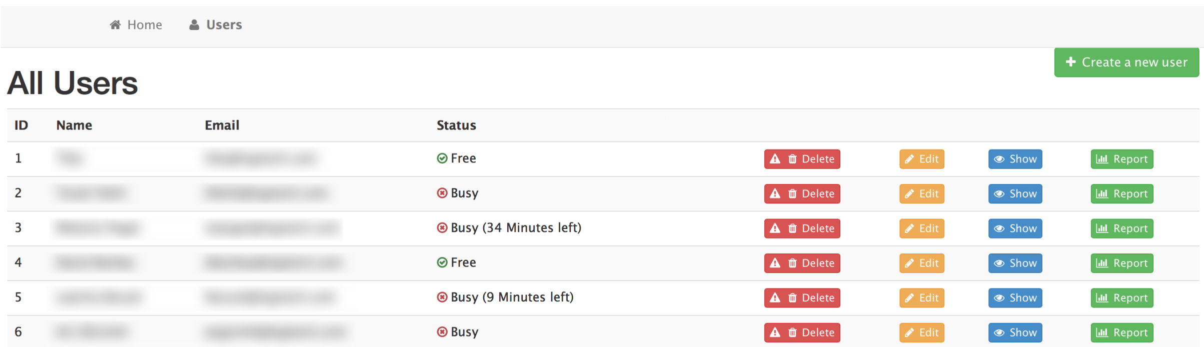


Fig. 4.9.: Live user-status to know who is busy and for how long.

5 Improvements & Further Thoughts

5.1. Improvements to Conduct Further Testing

It has been shown that it is cumbersome for a worker to push a button to conduct tests over a long period of time. Additionally, people have difficulties estimating the number of interruptions at work. Therefore, we need accurate and reliable sensor data to conduct a proper test without the need of human interaction. We suggest the following list of improvements in addition to our test protocol:

- Have the device on the user's desk for one week and let him/her set the time during which he/she does not want to be interrupted. A small LED should then indicate to the user that the device is in *"Do Not Interrupt"* mode and a discrete LED stripe should indicate the remaining time. However, the *"Do Not Interrupt"* status should not be visible to anybody else.
- In the second week, the same behaviour should be applied. However, the *"Do Not Interrupt"* status and remaining time should now clearly be visible to colleagues.

With these improvements it is then possible to compare the number of interruptions in the invisible *"Do Not Interrupt"* mode (first week) versus the visible indication (second week).

5.2. Further Improve Productivity at Work

Our surveys highlighted two additional interesting findings that could help workers improve their work experience:

- *Stuck thought*: One might have an idea or a thought that is not related to the current task (e.g.: "Grab the kids at 5 pm."). This often influences current workflow since our brain has to keep it in mind.
- *Bad time-management*: Even with reminders and calendars people come late to meetings, because they do not have a "remaining time" gauge.

In a later stage we added the ability to talk to the prototype and save current ideas or thoughts in a simple dated list. (e.g., "Remind me to ask Steve about the *doSomething*() function.") Once the current task finished, we can ask the device to send all notes with the voice-command *"Send me my notes."* and the user receives an email with the date, time and reminder. This feature would need further testing to confirm adoption and ease of use. Additionally, the privacy concern should be taken into account. (i.e., One may not want that his/her colleagues know what s/he has in mind.) Preliminary tests about the usage of voice in office spaces has shown some challenges and unwillingness, but we expect good results in closed spaces and home offices.

For the *bad-time-management-problem*, we thought about the prototype accessing the user's calendar (e.g., through the *Google Calendar Application programming interface (API)*) and automatically setting the remaining time (LED's) before the next meeting starts. Therefore, the worker always has an estimation of the available time without any interaction required.

In future research, we would continue to work with ToF distance sensors and sound levels, but we would add a third modality, the camera, to confirm an interruption with image analysis. Furthermore, since offices have different layouts, objects lying on desks and workers have different habits, it makes sense to apply machine learning on sensor data, to be able to detect interruptions and time at the desk with more accuracy and reliability.

6 Evaluation

6.1. Conducted Tests

For the second prototype we developed a more advanced test scenario, which can be seen in Figure 6.1.

First, we sent an email to the whole company to explain briefly that they should not interrupt someone who has a device that lights up red. This email also included a small on-line form called Recruit People & Inform (RPI), based on which we selected five people available to test the device. We selected two women and three men, all from different departments (i.e., Marketing, IT, Design, People & Culture, and Sales). These five people aged between 25 and 45 years are neither "tech-freaks", nor used to test prototypes of any kind regularly. Our goal was to represent as good as possible a workforce in a company, not necessarily in a tech company.

In the second step we informed the five participants that they will have a device on their desk gathering data (sound and distance) for one week. We also added a button close to the device with the label *"I interrupt you"* and asked the person interrupting to press the button. If the person interrupting forgot to press, the user testing the device could also press the button. Additionally, the participants were asked to fill out a short questionnaire called Time-management, Interruptions & Productivity (TIP) every evening. This questionnaire consisted of three questions with answers on a five-point Likert scale. The real purpose of the first week of testing was to calibrate the sensors.

After one week of measurements, the third step was to inform the participants that for week two they could also set a timer and enter into a *"Do Not Interrupt"* mode by interacting with the device. They still had to fill out the TIP every evening. During the second week, we count the interruptions in *"Do Not Interrupt"* mode compared to the rest of the day.

The fourth and last phase of our test process was to conduct interviews with the five participants based on a Usability Questionnaire (UQ) to gain insight into how they interacted with the device, but especially if they found a benefit in using such a device. This interview contained four sections (i.e., Efficiency, Ease of use, Satisfaction and General comments).

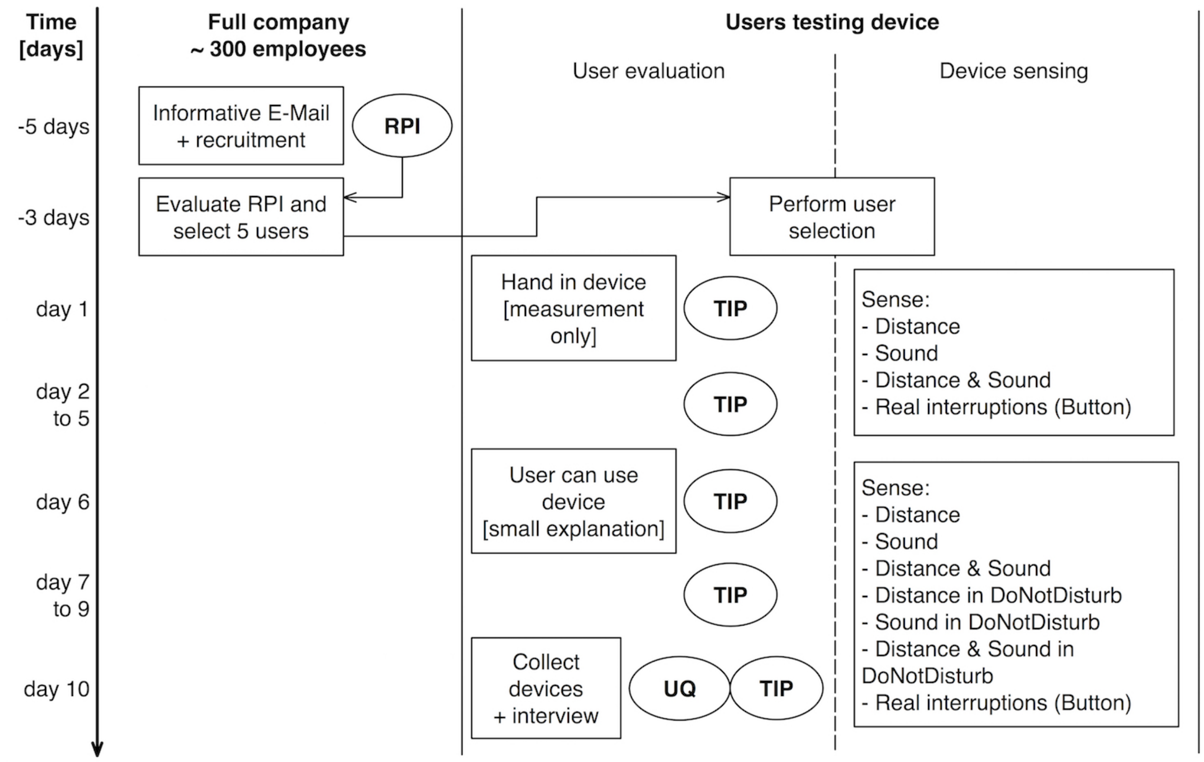


Fig. 6.1.: Test scenario. RPI = "Recruit People & Inform", TIP = "Time-management, Interruptions & Productivity", UQ = "Usability Questionnaire"

6.2. Results

We gathered data from three surveys (*RPI, TIP, UQ*) and two weeks of log data. The *RPI* survey is not relevant for this section since it is about the recruitment of our testers. We will therefore concentrate on TIP and UQ.

The TIP questionnaire had three short questions. We asked the same questions for week one ($w1$) and week two ($w2$). The participants answered on a five-point Likert scale. The questions asked were:

- $q1$: Have you been productive today?
- $q2$: Have you experienced a good workflow today?
- $q3$: Have you been interrupted many times today?

Figure 6.2 shows the average result over all our participants. For our device to work, we expect higher values in the second week compared to the first. The results of question three ($q3$ in Figure 6.2) show that people do not feel less interrupted in the second week, it's even the opposite. However, we did not gather enough data to statistically significantly conclude that the device has a negative impact. On the other hand, data from the TIP survey shows that productivity and workflow improves slightly. Additionally, the comments written by the users in the TIP survey shows that they believe that such a device can improve work and productivity.

In addition to subjective surveys, we gathered objective data through sensors to count the number of interruptions. To see if the device can lower the number of interruptions, we counted the number of interruptions while the user was in *"Do Not Interrupt"* mode compared to usual presence at the desk.

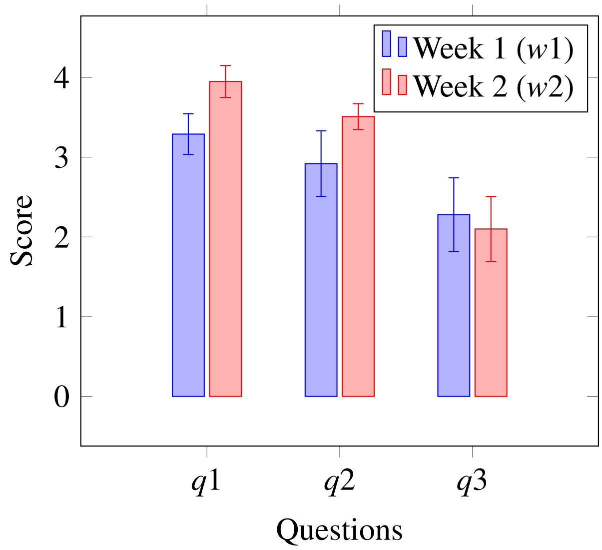


Fig. 6.2.: Results of the TIP daily survey over two weeks ($w1$ and $w2$) with three questions ($q1$, $q2$, $q3$). Highest value is best.

To test the feasibility of automatically detecting interruptions we conducted tests over one week in a laboratory to see if we could correlate the interruptions measured by sensors with the real interruptions. One researcher kept a device on his desk and pressed the button every time he was interrupted. Figure 6.3 shows the measured interruptions by the *Average (AVG) sensors* versus the *Button* presses. Additionally, Figure 6.3 includes the interruptions measured by only the sound sensor and distance sensors. The Pearson correlation between the measured interruptions and the real interruptions is $r_1 = 0.9885$ ($p_1 = 0.0015$).

To confirm that our sensors can detect interruptions, we conducted an in-vivo test for one week ($w1$) with our five devices. We had a hardware issue with tester 4 and therefore removed that data from our findings.

Figure 6.4 shows the interruptions measured by sensors versus the number of button presses by people interrupting in the office space. It is important to note that the button presses are not completely reliable since it is an in-vivo test and we can not guarantee that the button was pressed every time someone was interrupted. In the interview the testers highlighted that they might have forgotten to press the button when they were interrupted. The presented data is an average over one week per user. The Pearson correlation factor between interruptions measured by sensors and the button is $r_2 = 0.9699$ ($p_2 = 0.03$).

Our finding, that we can measure interruptions with sensors, led to the second week with the goal to test if the prototype reduces interruptions. In Figure 6.5 we compare the number of interruptions while the device was in *"Do Not Interrupt"* mode versus when the device was not in that mode. We would expect fewer interruptions while the device is emitting red light (i.e., is in *"Do Not Interrupt"* mode). We computed the average over all our testers for one week and found a slight decrease in the number of interruptions. We can easily count the number of interruptions while the owner of the device was in *"Do Not Interrupt"* mode, however it is more complex to count them while the owner was not in that mode. To compare the two states we need to normalize the data on a fixed time scale (i.e., days), and therefore know how long the owner stayed in his/her office. We approximated the duration of the owner at his/her desk not being in *"Do Not Interrupt"* mode. To do so, we gathered information about time of arrival, lunch times,

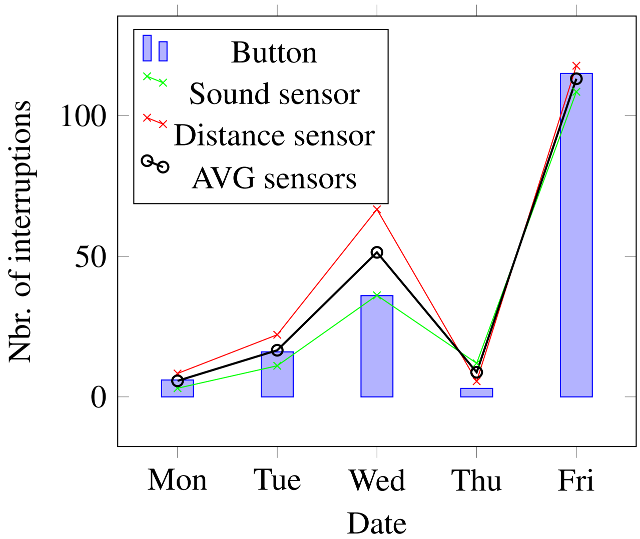


Fig. 6.3.: Interruptions measured by sensor versus button presses by user in laboratory conditions.

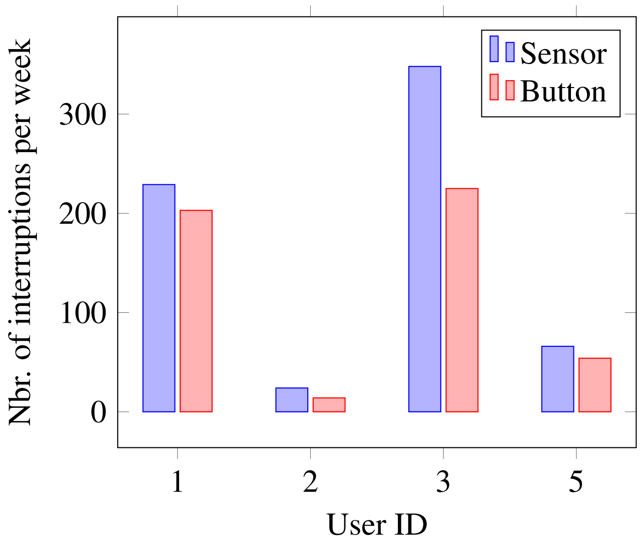


Fig. 6.4.: Interruptions for all users. Button presses compared to sensor data.

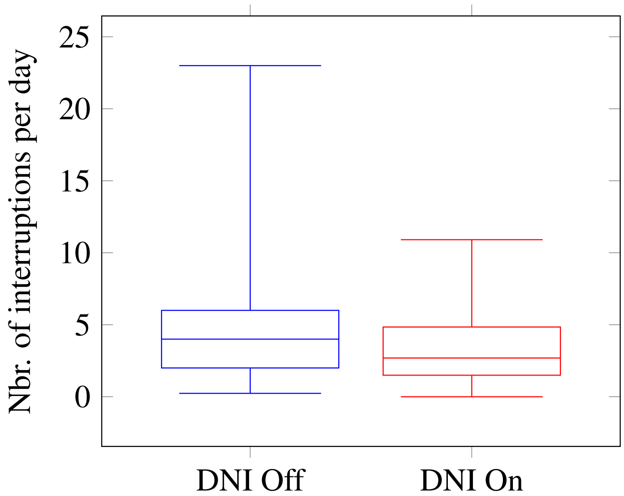


Fig. 6.5.: Interruptions in *"Do Not Interrupt"* mode versus not in *"Do Not Interrupt"* mode. DNI = *"Do Not Interrupt"*.

time of departure and meetings. We could therefore approximate the time the device owner was at his/her desk. To find the time s/he was not in *"Do Not Interrupt"* mode, we subtracted the duration in *"Do Not Interrupt"* mode from the total desk-time.
This procedure is a limitation of our test data. However, this approximation is a lower bound and we expect significance and bigger differences with more precise data. Indeed, we do not consider breaks and desk absence, so our calculation is pessimistic. If one takes a break he/she will not be interrupted in that break-time and the real desk-time is lower than our approximation. In other words, we have more real interruptions per desk-time than we approximate.
Nevertheless, to have more precise findings, we would need a presence indicator. The embedded sensors in the device were not accurate enough to detect the presence of our testers. We make suggestions of improvement in the Section *Improvements to Conduct Further Testing*.

With the results depicted in Figure 6.5 we can not answer our question: *"Can an interactive device with ambient visualization lower the number of human interruptions when workers do not want to be interrupted?"* with significance. However, there is a tendency for the device to reduce interruptions if we concentrate only on objective data.

Figure 6.5 also shows that the device tends to be more efficient for people being interrupted often. The upper bounds decrease from 23 to 11 interruptions per day with the use of the device.

We also investigated the efficiency of the device over time by counting the number of interruptions related to the duration of the device in *"Do Not Interrupt"* mode. Figure 6.6 shows that a device that is in the *"Do Not Interrupt"* mode for longer will decrease in efficiency. (i.e., There are more interruptions per hour for a device in *"Do Not Interrupt"* mode.) An explanation for this may be that when someone needs to interrupt somebody, s/he may be dissuaded from interrupting by the device, but over time, needing information, the person may choose to interrupt despite the workers wishes. Consequently, we encourage having a maximal *"Do Not Interrupt"* duration.

The last part of our result evaluation consisted in analysing the UQ conducted with the five users after their last day with the device. They all liked the interaction, the simplicity and the look and feel of the prototype. However, they also agree in majority that people my not be ready to respect the decision of a co-worker (that they do not want to be interrupted) when it is shown through a device.

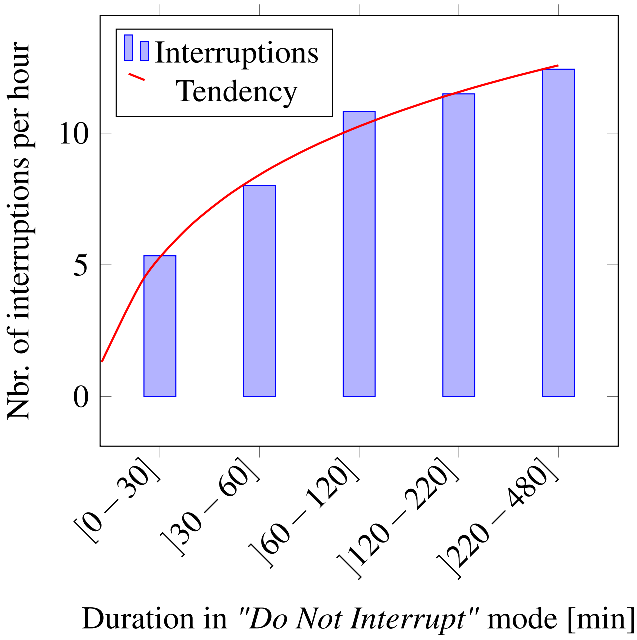


Fig. 6.6.: Nbr of interruptions by duration of device in *"Do Not Interrupt"* mode normalized to one hour.

(P22) "People actually still interrupted me. They are discrete, but they wait instead of leaving, which stresses me even more."

(P25) "Even if people knew they were interrupting me, I don't think the device deterred them. They saw it, recognized I was busy, then interrupted me anyway. Perhaps it's because they know there's little impact to them... They need an answer so they ask the question. They know that I'll answer. They win, I lose. They exaggerate the value of the answer and they under estimate the impact on my flow (or they don't value my flow). Self-interest wins over altruism."

Before having the device, some testers were using headphones to reduce interruptions. They would even wear headphones without listening to music, just to show to their co-workers that they did not want to be interrupted. That idea does not always work, since people tend to stay close and *show* that they want to interrupt until the worker removes her/his headphones. This accentuates the fact that people often do not respect the wish of their colleagues to not be interrupted, when it is through a device.

On the other hand, we gathered promising feedback that such a device could improve work conditions.

(P24) "I would like to have an indication of time left to my next meeting. Just that would improve my time management and would gain many minutes every day not missing my meeting and not leaving too early."

(P25) "The prototype has future! I like the time feature and I would like it to make more. Note taking, help with remembering stuff, etc."

People believe that a time management feature could be useful if automated and synced with the business calendar, to remind them how much time is left until the next meeting. Notifications try to solve that issue, but we have no continuous information with notifications. A time-scale, slowly decreasing until the next meeting, may help workers manage their time without having to set a device.

7
Discussion and Conclusions

7.1. Discussion and Conclusions

We created two iterations of a prototype with the goal of reducing human interruptions and tested it over two weeks. To test it properly, we used qualitative and quantitative data. Figure 7.1 shows five finished prototypes able to detect interruptions. Our findings show that we can measure human interruptions with sensors. Additionally, we show that a device with a visible *"Do Not Interrupt"* feature slightly lowers interruptions at work. Furthermore, our results have shown that the device is more efficient if used for multiple small amounts of time in *"Do Not Interrupt"* mode, rather than for one long period.

We suggest that such a device would improve work quality by detecting presence and inform co-workers about it's availability by setting the IM-status with high accuracy. IM-statuses are guessed by the browser and ofter misjudged (e.g., Drawing on paper in front of the computer. The IM-status will guess 'offline' but the worker is at the desk available.).

The results of our daily survey (TIP) were not as conclusive as expected. We think that these results were biased due to our high-fidelity prototype. Our prototype had a nice and finished look and we tested it in a technology company, therefore our testers may have seen the device more as a product than a prototype. This would have raised their expectations and as a result, negatively influence feedback about the device.

7.2. Improvements

Due to sensor issues on some device (i.e., interferences and lightning problems), we had imprecise values and needed to remove some data points which resulted in less data for statistical

Fig. 7.1.: The five prototypes used for the in-vivo experience.

significant results. A camera could be used to film the whole scene and detect presence and interruption with more accuracy. However, we decided not to film, to avoid altering comportment of the workers by making them feel *watched* around the clock.

7.3. Interruption and Distraction

During our research we had to distinguish between interruption and distraction. The goal of our prototype is to lower interruptions. (i.e., *Less people come to talk to you when you don't want them to.*) However, the device does not reduce distractions. A distraction can be seen as someone talking to a work colleague or making noise that upsets the user. One may not be interrupted, but distracted or the other way round. In a perfect world we would have less distractions and interruptions only when we are ready to accept them.

7.4. Butler at Work

Another interesting point that came out of the interviews, was that people would like to have an assistant helping them with tasks, reminders and time, but especially having a device acting as moderator to lower office noise by informing co-workers that they are speaking too loudly for a long time. The device could for example inform (i.e., with a light indication) chatting colleagues to move to a conference room or another place when they are speaking for over 5 minutes. People tend to forget that they may be disturbing others. In such a situation people feeling disturbed are often too polite to suggest that colleagues should move to another place. A device could automatically detect conversation over a certain duration and act as an informer to avoid potential negative social interactions.

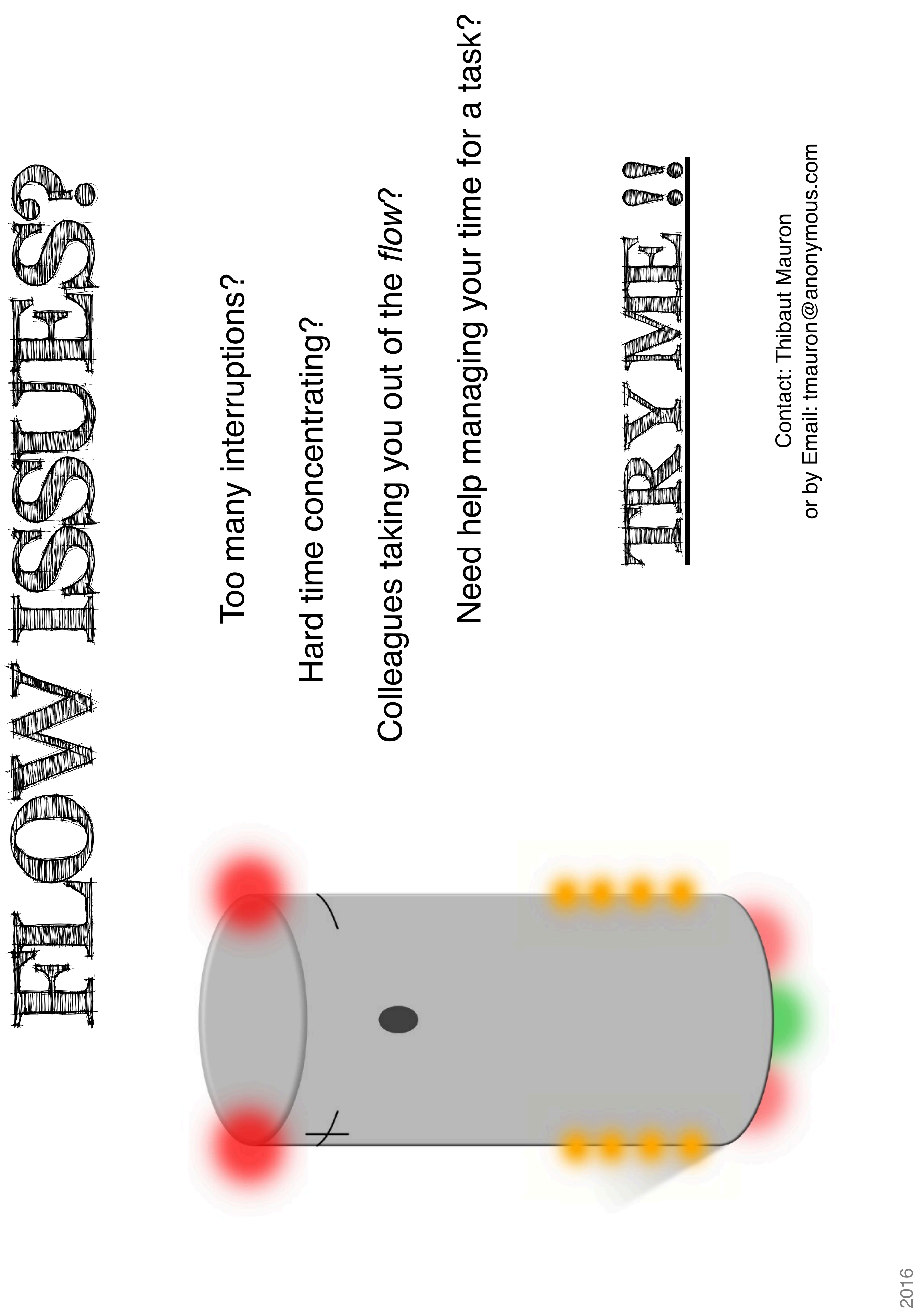
7.5. Social Relations Prime Over Interruptions

People may not want do be interrupted, but they often favour social interactions over productivity in the work places. Workers often come to work to be interrupted, ask questions and discuss their work. Furthermore, they tend to isolate themselves at home or in dedicated rooms to work without interruption. Therefore, even if such a device may reduce interruptions, that feature will not be the most appreciated and interesting for a worker in the early stages. A device acting as a butler, taking notes, setting the correct IM-status and managing time (time left to the next meeting), may increase productivity in a company or in home offices. The future of office architecture in companies may be open spaces with dedicated silent-rooms and devices acting as butlers and time managers…

A
Common Acronyms

ADC	Analog Digital Converter
API	Application programming interface
AVG	Average
AWS	Amazon Web Service
CPU	Central Processing Unit
DNI	Do Not Interrupt
GUI	Graphical User Interface
I2C	Inter-Integrated Circuit
IM	Instant Messaging
LED	Light-emitting diode
NoSQL	Not only Structured Query Language
OS	Operating System
PCB	Printed Circuit Board
PU	Polyurethane
RDS	Relational Database Service
RGB	Red Green Blue
RPI	Recruit People & Inform
SDK	Software Development Kit
SLA	Stereolithography Apparatus
SPI	Serial Peripheral Interface
TIP	Time-management, Interruptions & Productivity
ToF	Time of Flight
UQ	Usability Questionnaire
USB	Universal Serial Bus

B
Posters


FLOW ISSUES?
Too many interruptions?
Hard time concentrating?
Colleagues taking you out of the *flow*?
Need help managing your time for a task?
TRY ME !!
Contact: Thibaut Mauron
or by Email: tmauron@anonymous.com
2016

Flow Assistent - User αlpha Test

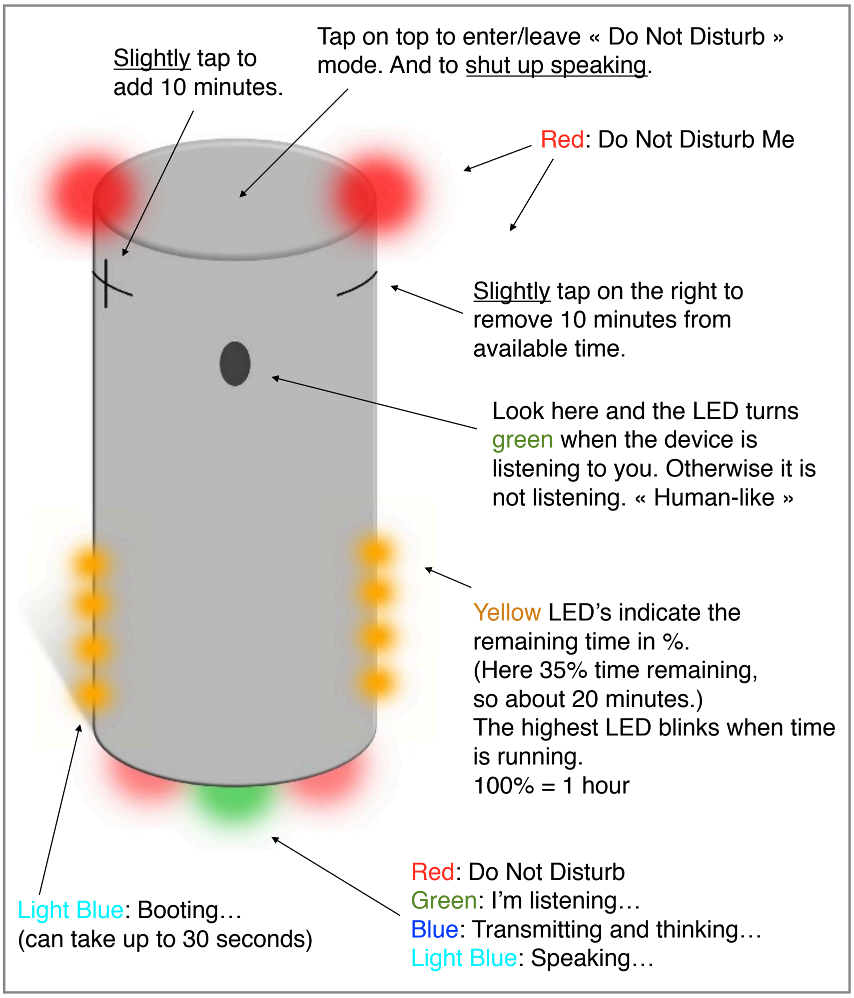
The purpose of this project is to increase your productivity by:

- Reducing interruptions. (Try to tap once on the device to set it in « Do Not Disturb » mode.)
- Managing your time. (Try « I want to concentrate for 10 minutes » or tap on the « + » sign to start a timer.)
- Keeping your mind free. (Try « Remember to ask John which sensor he used for the Montana project. »)

Possible vocal commands:

- « Don't disturb me »
- « I want to concentrate for *duration* »
- « I need a break »
- « Resume »
- « Remember *something* »
- « Send me my notes »
  - Attention, for the alpha tests, all your notes are sent to tmauron@anonymous.com I'll show you the results.
- « What's the weather in Geneva »
  - Try to tap on top while speaking…
- « Calculate 25 divided by 2 »
- « What's the time »

The assistant is in very first stage and we are aware of wrong speech understanding in some cases.



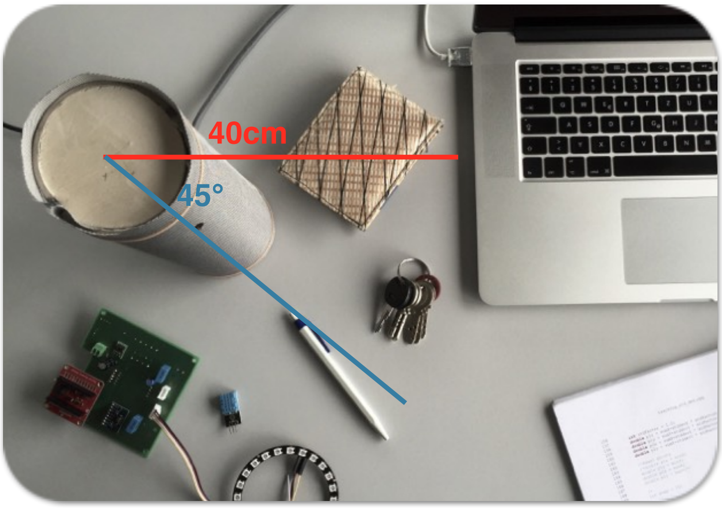
Future work:

- Account per device with settings. (e.g.: Email for notes taking)
- Smartphone app such that people can leave you a « I was here » notification such that you can meet them after your work (if you want).

Upcoming ideas:

- Presence status to let your colleagues know if you're reachable.
- Assistant to whom you can leave a message if the person is out of office.
- Work conditions (temperature, CO2, noise, lighting…).
- …. many more

Place the device next to your computer and about 1m from you.



Important notice:

There is a camera, BUT it is just processing locally to detect if you are looking at the device. We use a 180x320px resolution and no recording is made in any manner. Big brother is not watching you… yet…

For further questions do not hesitate to contact me.
Thank you for testing!

June 2016 FLOW ASSISTANT Thibaut Mauron (tmauron@anonymous.com)

C
Questionnaires

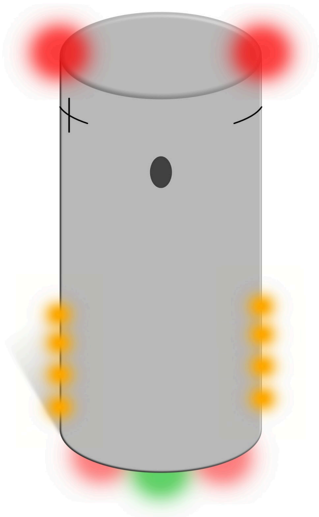
Flow Assistant User Questionnaire

Through the following short questionnaire we hope to learn more about what users think of our device. The flow assistant device (see picture bellow) is placed on one's desk, and aims to increase work flow and performance by reducing interruptions of colleagues. The red lights on the device indicate to others that the user is busy and should not be disturbed. The user can also improve his time management by setting a limited timer for completing a task (max. 1 hour), shown through a yellow light scale.

Your answers will greatly help us in the development of our next prototype. Thank you for your help!

Untitled Section

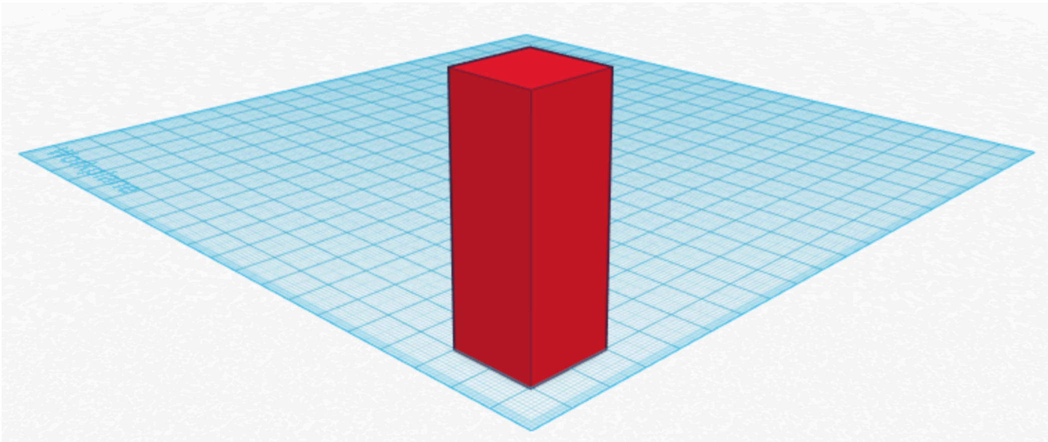
Flow Assistant device



Please look at the following pictures and state your opinion to each.

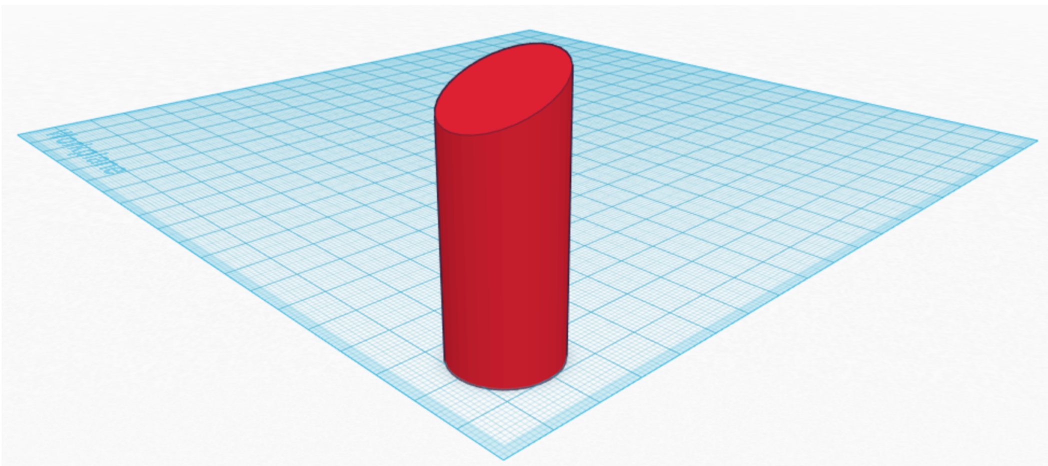
1. **1. I like the shape of this device.**
   Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree



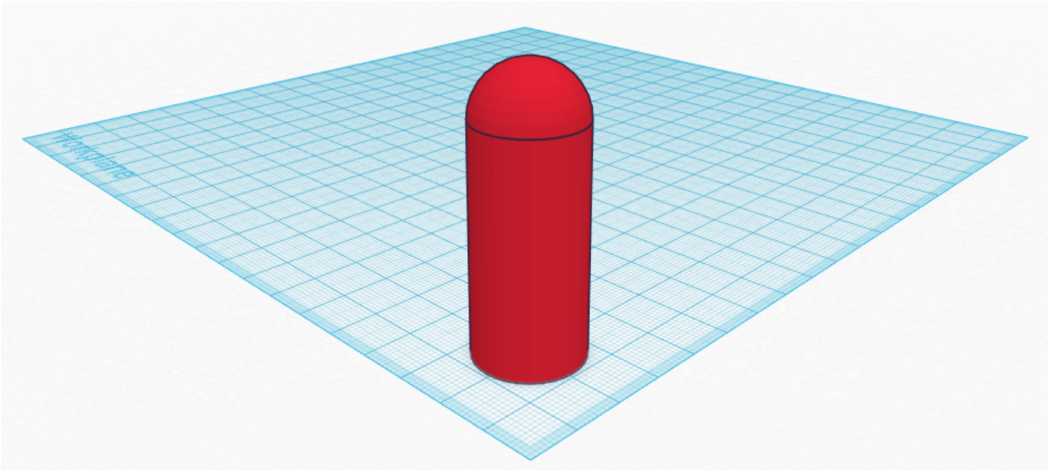
2. **2. I like the shape of this device.**
   Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree



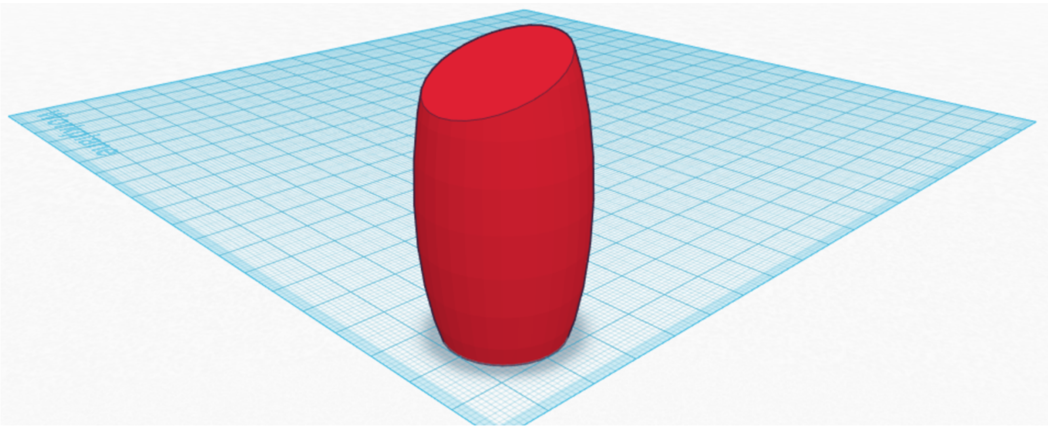
3. **3. I like the shape of this device.**
   Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree



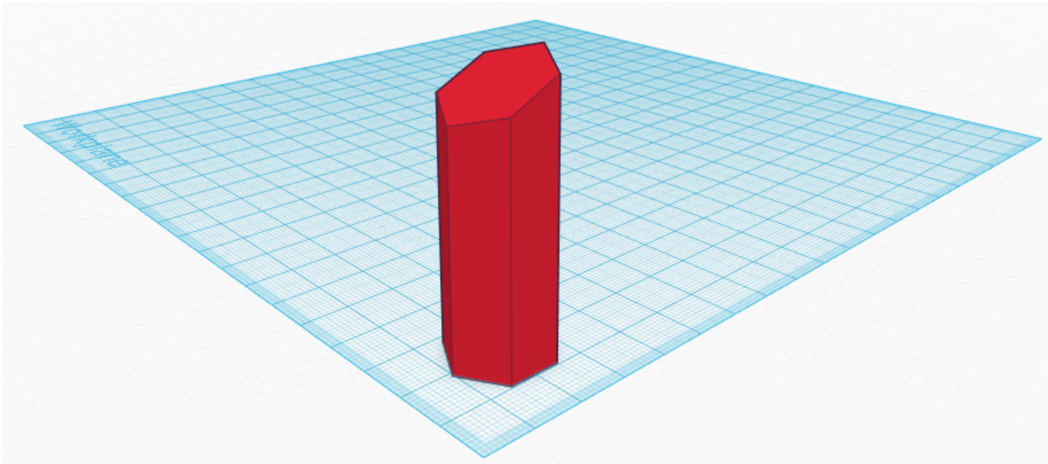
4. **4. I like the shape of this device.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree



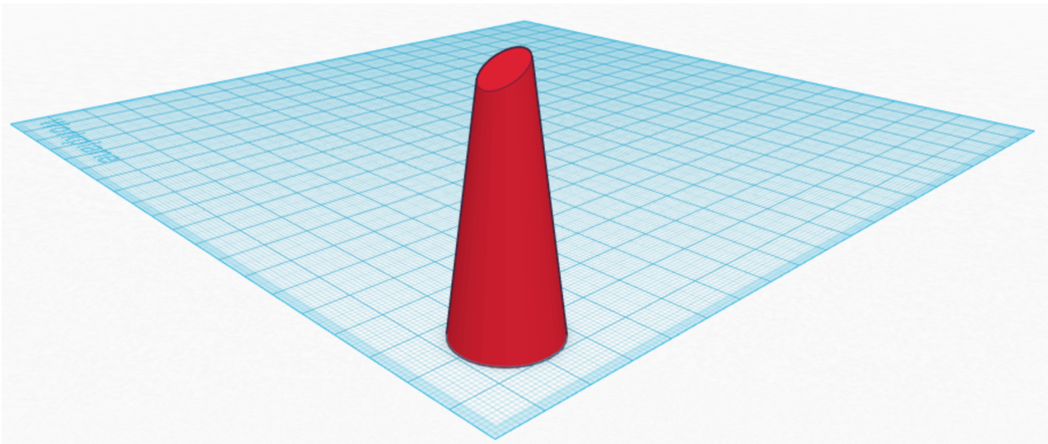
5. **5. I like the shape of this device.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree



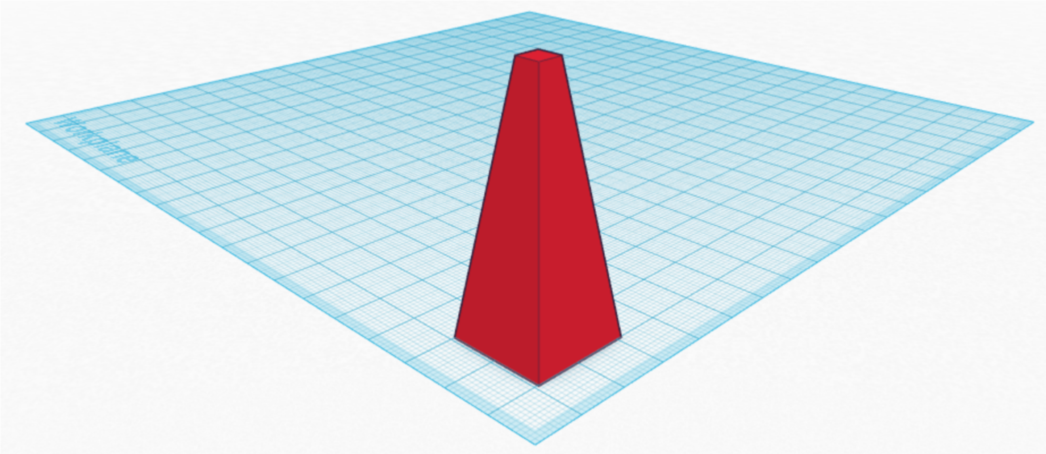
6. **6. I like the shape of this device.**
   Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree



7. **7. I like the shape of this device.**
   Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

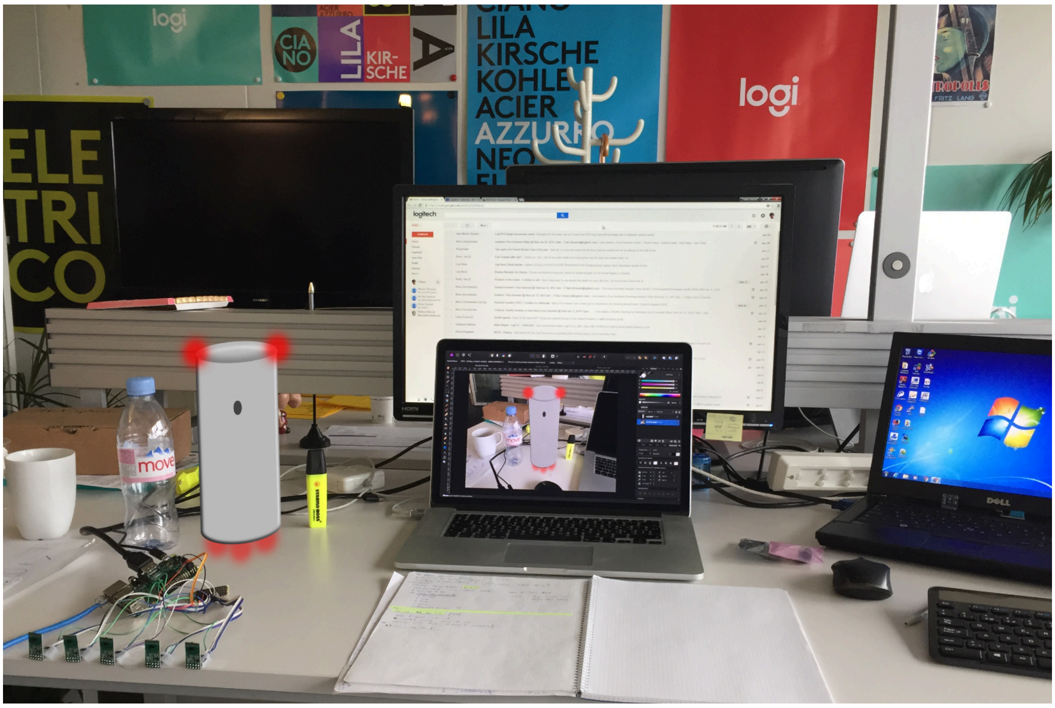


On each of the following pictures please look at the device located on the desk and state your opinion.

8. **8. The size of the device on the table is good.**

   Mark only one oval.

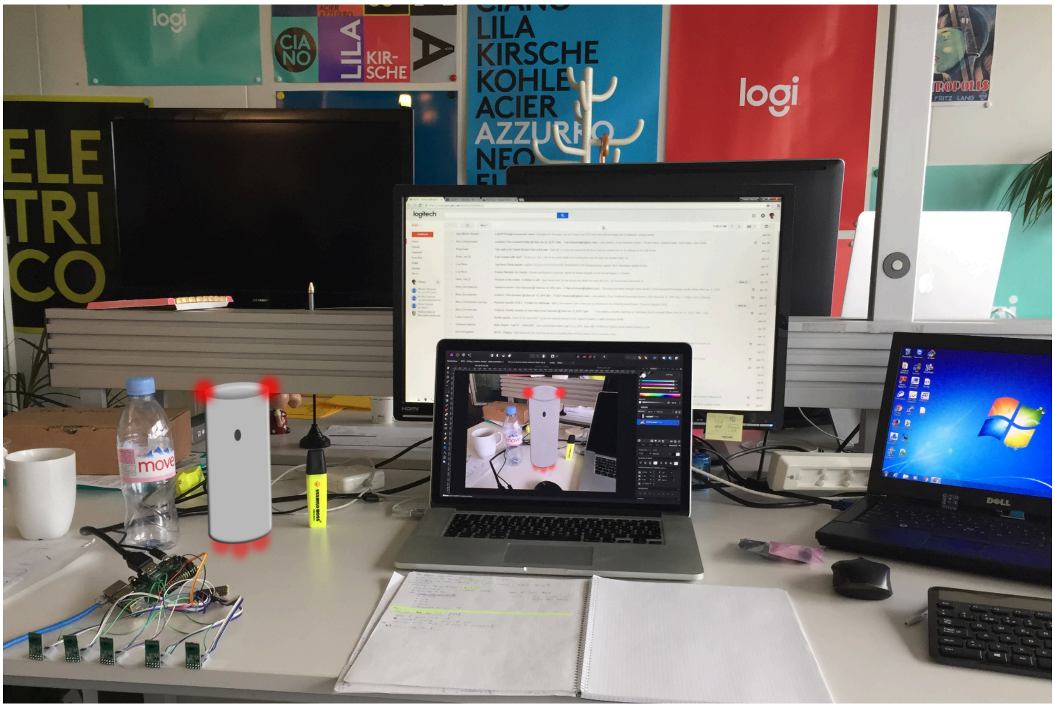
	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree



9. **9. The size of the device on the table is good.**

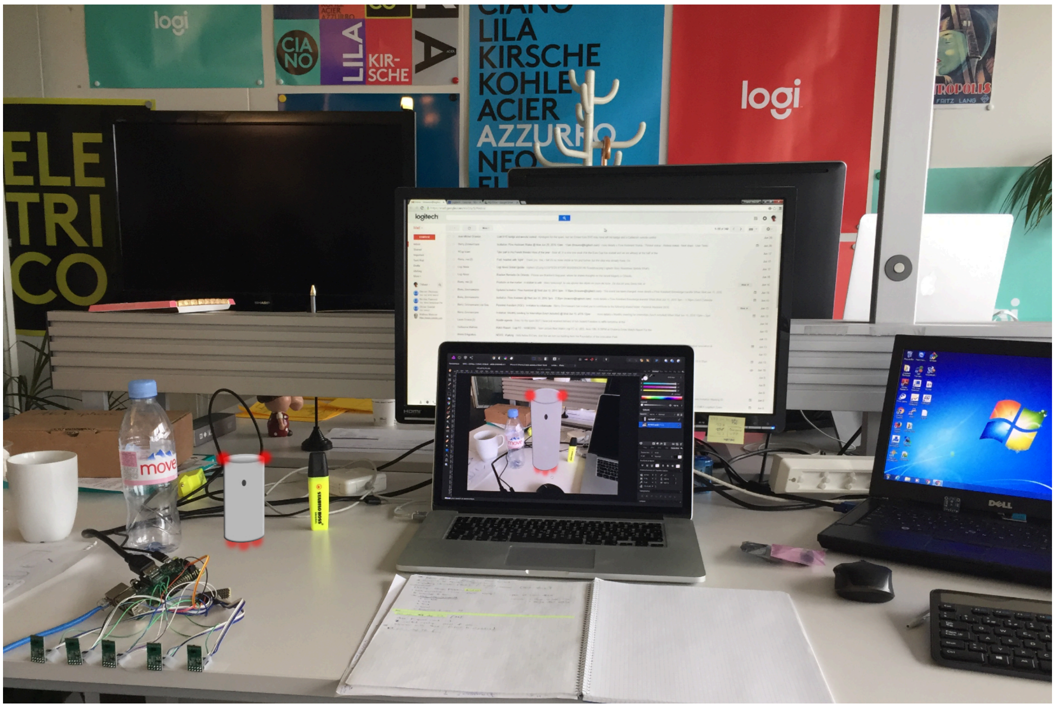
   Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree



10. **10. The size of the device on the table is good.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree



Please read and answer the following questions.

11. **11. I have enough space on my desk for such a device.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

12. **12. I would like the option of personalizing the device. (e.g. attach pictures of my family on it)**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

13. **13. Pick your two favorites. What material would you like the device to be made of?**
Check all that apply.

- [ ] Cloth material
- [ ] Matt metal
- [ ] Polished metal
- [ ] Plastic
- [ ] Wood
- [ ] Leather
- [ ] Other

14. **14. Do you have any other comments or suggestions regarding the device?**

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Google Forms

Participant Recruitment & Information (PRI) - email text

Hi there,

We are planning to conduct usability testing sessions with our innovative Flow Assistant.

The Flow Assistant is placed on one's desk, and aims to increase workflow and performance by reducing interruptions of colleagues. The red lights on the device indicate to others that the user is busy and should not be interrupted ("Please, come later…"). The user can also improve his time management by setting a timer for completing a task (max. 1 hour), shown through a yellow light scale.

Specifically, we measure working conditions and interruptions. Even if you aren't a participant, we would be grateful if you could indicate when you interrupt your work colleague. This visible button (saying: "I interrupt you") will be placed on the desk of the worker who has the Flow Assistant.

Are you being interrupted constantly by your work-colleagues? Do you want to change that?

If yes, then click the link bellow and become a participant in our testing sessions.

Participant Recruitment & Information Questionnaire

Thank you for your interest in our Flow Assistant testing sessions.

The testing sessions you would be involved in would last two weeks. In the first week the Flow Assistant would be placed on your desk but it wont be active; you will only be asked to complete a short short questionnaire (7-items) at the end of every workday. During the second week the Flow Assistant will be active and you will be free to use it. Once again we would ask you to complete our short questionnaire at the end of the day. Lastly, at the end of our two-week testing session we would ask you to complete a usability questionnaire about our product.

If you are still interested in participating, then please answer the follow questions. By means of your answers we will recruit our participants.

* Required

1. **Are you being interrupted frequently by your co-workers?**
   Mark only one oval.

	1	2	3	4	5	
Never	⬭	⬭	⬭	⬭	⬭	Always

2. **Do you spend a lot of time at your office desk?**
   Mark only one oval.

	1	2	3	4	5	
Never	⬭	⬭	⬭	⬭	⬭	Always

3. **What department do you work in?**

4. **Do you have any other comments?**

5. **Your Email (such that I can contact you)** *

Powered by Google Forms

Detecting and Reducing Interruptions at Work - User Tests

Participant Nr. _______________ **Date:__________________**

Thank you for completing our questionnaire. We are interested in examining your perception of your office environment.

Please answer the following questions. We will collect the questionnaires after every workday at your place.

User Questionnaire (TIP)

1. Today I was very productive.

	1	2	3	4	5	
Strongly disagree	o	o	o	o	o	Strongly agree

2. Today I experienced a very good workflow.

	1	2	3	4	5	
Strongly disagree	o	o	o	o	o	Strongly agree

3. Today I was interrupted many times.

	1	2	3	4	5	
Strongly disagree	o	o	o	o	o	Strongly agree

For any questions please do not hesitate to contact ___anonymous___

Usability Questionnaire

Dear participant,
Our usability testing of the Flow Assistant is coming to an end. To sum up we would like to have your opinion on the Flow Assistant's efficiency, ease of use, learnability/memorability, satisfaction and error rates. Could we kindly ask you to complete the following questionnaire.

Thank you very much for your contribution to our data!

Efficiency

1. **It helps me be more productive.**
   Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

2. **I effectively used the time-management function of the Flow Assistant.**
   Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

3. **I effectively used the "do not disturb" function of the Flow Assistant.**
   Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

4. **The Flow Assistant is useful.**
   Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

5. **The Flow Assistant gives me more control over the assignments in my job.**
   Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

6. **The Flow Assistant makes the things I want to accomplish easier to get done.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

7. **The Flow Assistant does everything I would expect it to do.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

Ease of use

8. **The Flow Assistant is easy to use.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

9. **The Flow Assistant is user friendly.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

Ease of use: Learnability (some memorability)

10. **I learned to use the Flow Assistant quickly.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

11. **I easily remembered how to use it.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

12. **It is easy to learn to use the Flow Assistant.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

Satisfaction

13. **I am satisfied with the Flow Assistant.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

14. **I would recommend the Flow Assistant to a friend.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

15. **The Flow Assistant is fun to use.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

16. **The Flow Assistant works the way I want it to work.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

17. **I feel I need to have a Flow Assistant.**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

18. **I feel attached to my Flow Assistant**
Mark only one oval.

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

Error rates & Comments

19. **Did you have any technical issues with the Flow Assistant? If yes please explain.**

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20. **Global comment**

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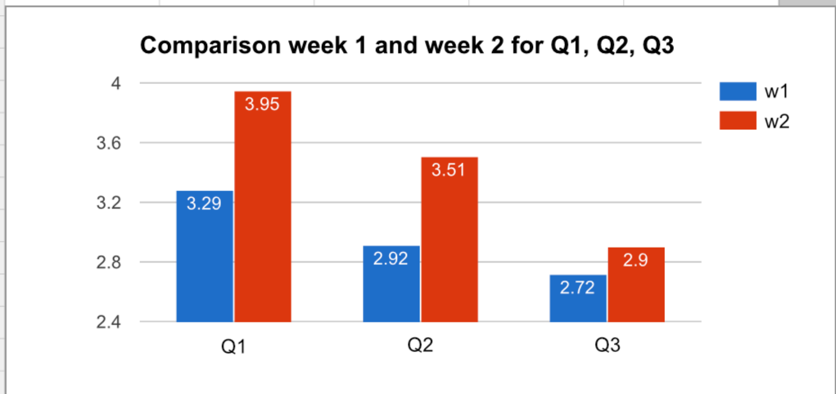
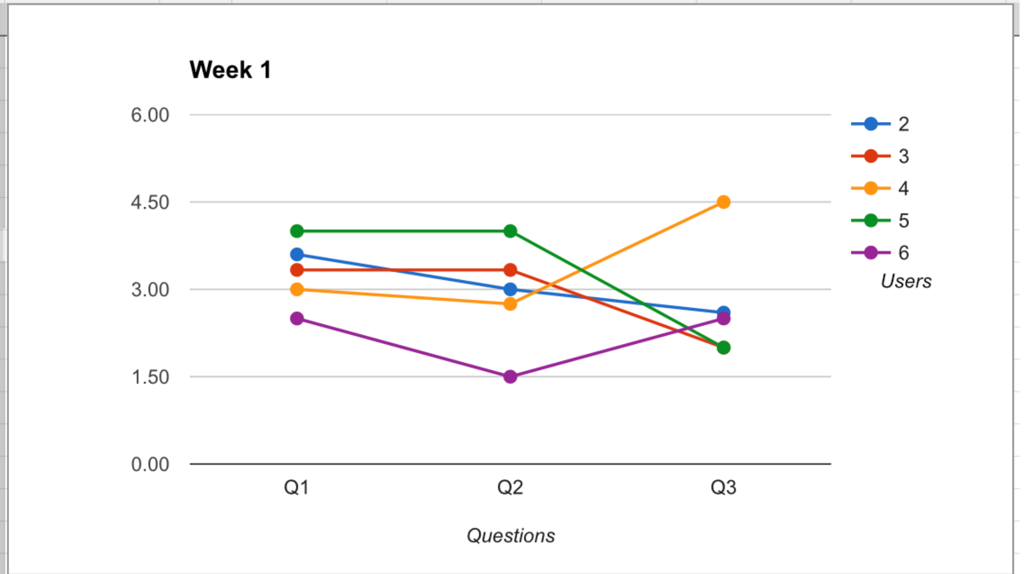
D
Survey Results

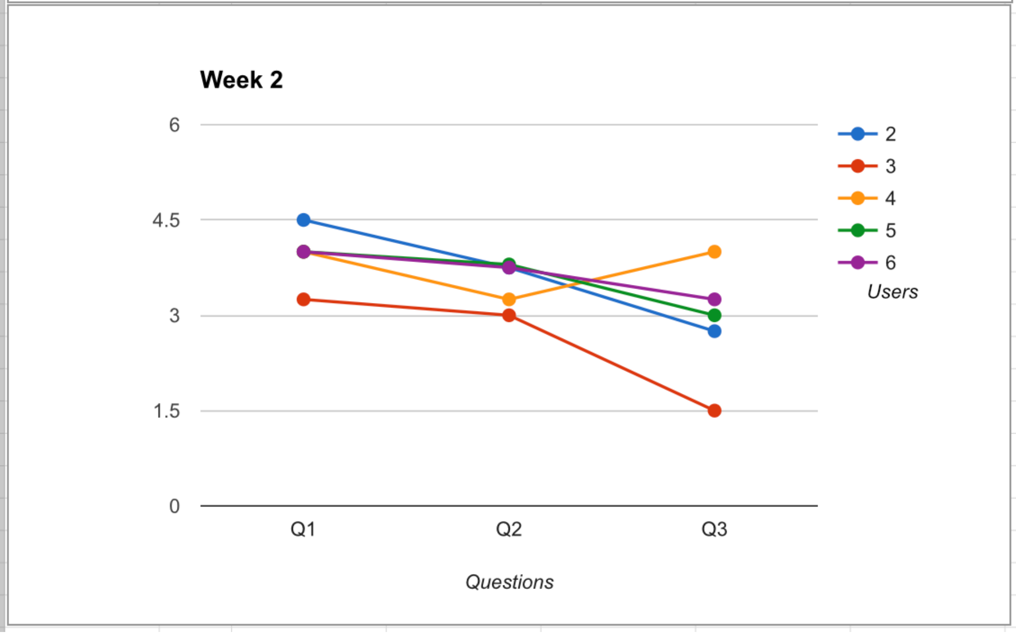
Timestamp	1. I like the sh	2. I like th	3. I like t	4. I like t	5. I like t	6. I like th	7. I like t	8. The s	9. The	10. The	11. I have	12. I wo	13. Pick your two favorites. What mater	14. Do you have any other comments or suggestions regarding the device?
6/23/2016 9:07:42	1	3	2	4	1	2	1	2	3	1	3	4	Cloth material, Wood, Leather	Great job!
6/23/2016 9:13:28	3	4	5	4	2	4	3	4	3	3	4	4	Matt metal, Other	
6/23/2016 9:13:47	1	4	2	4	3	2	1	3	4	1	5	5	Cloth material, Wood	
6/23/2016 9:14:41	3	4	3	2	3	4	3	2	4	2	4	4	Cloth material, Wood	
6/23/2016 9:14:54	2	3	2	4	4	1	1	2	3	4	5	3	Cloth material, Polished metal	
6/23/2016 9:15:25	2	4	3	1	3	3	1	3		3	5	3	Plastic	
6/23/2016 9:15:38	3	4	5	2	2	4	2	4	3	2	4	4	Matt metal	
6/23/2016 9:16:38	4	4	1	2	2	2	2	2	3	4	5	5	Cloth material, Polished metal	
6/23/2016 9:17:10	2	4	1	2	2	3	3	4	5	2	5	3	Cloth material, Polished metal	
6/23/2016 9:17:15	1	5	2	2	1	3	1	1	4	1	1	2	Matt metal, Polished metal	
6/23/2016 9:17:29	1	4	2	4	4	2	2	4	3	1	4	3	Matt metal, Wood	I tried HiLo for a day and I'm more concerned about the fact that it doesn't prevent people from interrupting me and the interaction with the device has some room for improvements. I don't care about it's look as long as it does its job well. I think the bigger the better, or at least it must be clear for people
6/23/2016 9:17:40	4	4	3	2	1	1	1	1	4	1	5	1	Cloth material, Plastic	
6/23/2016 9:19:48	1	3	3	1	2	2	1	1	2	1	4	1	Cloth material	I would not like to use it.
6/23/2016 9:21:18	2	5	5	4	1	1	1	1	5	3	4	3	Matt metal, Wood	
6/23/2016 9:22:22	2	5	2	4	4	2	2	3	4	1	5	2	Cloth material, Matt metal	
6/23/2016 9:23:21	2	4	5	2	2	2	2	2	4	4	5	1	Cloth material, Matt metal	
6/23/2016 9:23:36	3	4	2	3	4	4	4	2	3	4	4	2	Matt metal, Polished metal, Plastic	
6/23/2016 9:23:43	1	4	5	5	3	4	2	1	2	4	4	2	Plastic, Wood	(Bluetooth) speaker function for "work" music would be nice + indicate time.
6/23/2016 9:25:58	2	3	4	3	2	4	3	1	3	2	4	4	Matt metal, Polished metal, Leather	
6/23/2016 9:26:32	4	4	1	2	3	1	1	2	4	3	5	4	Matt metal, Plastic	
6/23/2016 9:27:45	2	3	3	4	2	1	2	2	4	2	4	4	Matt metal, Polished metal	
6/23/2016 9:27:57	1	5	1	1	4	1	1	2	4	4	1	4	Polished metal, Wood, Leather	Think of placing the device on top of the screen. That way it'll be more visible for all, take less place on the desk. But it'll need a change of shape. Make it smaller. Allow the user to change the intensity of the lights on the device so that he won't be bothered. Also allow the user the possibility to switch on or off the voice. Study the possibility to connect the device with bluetooth to the computer or the phone to allow the user to set it more easily and comfortably.
6/23/2016 9:28:37	1	4	2	5	2	2	1	2	3	4	3	3	Cloth material, Polished metal, Wood	
6/23/2016 9:29:02	1	3	2	4	2	2	2	2	2	4	4	4	Plastic, Wood	
6/23/2016 9:29:22	1	4	3	5	3	3	2	1	5	4	2	4	Matt metal, Polished metal	
6/23/2016 9:30:12	3	3	3	3			3	2	4	2	4	4	Wood, Leather	
6/23/2016 9:30:55	2	4	2	4	3	4	2	1	2	5	5	1	Cloth material, Matt metal, Polished me	I LOOOOVE THIS IDEA !!! I NEED IT, I WANT IT!
6/23/2016 9:33:41	4	5	4	2	4	3	2	3	4	5	3	5	Cloth material, Wood, Leather	
6/23/2016 9:34:18	2	2	2	2	2	2	2	2	3	2	3	1	Cloth material, Plastic	I am not sure about the concept. If people keep interrupting me when I am clearly busy behind my double 27" monitors full of programs running, why would they pay attention if tiny LED flashes in red on my desk?
6/23/2016 9:34:27	2	4	2	2	3	2	2	5	3	1	2	3	Matt metal, Polished metal	
6/23/2016 9:38:21	2	4	3	2	2	2	2	2	3	4	4	4	Cloth material, Polished metal	
6/23/2016 9:38:44	1	3	1	5	2	3	1	1	5	3	5	5	Cloth material, Matt metal	There can be other statuses besides the classical one of "busy" and "available". Some funny ones, like "Ready for a party", "Hungry", "Annoyed", "Bored", "Angry", etc. Maybe using icons with different emotions to display the "status of mood"
6/23/2016 9:39:01	3	2	1	3	1	1	2	3	2	1	4	1	Other	
6/23/2016 9:42:43	2	3	4	3	3	3	3	2	4	2	4	5	Matt metal, Polished metal	
6/23/2016 9:43:35	4	2	2	3	1	1	3	3	4	2	1	1	Cloth material, Wood	No
6/23/2016 9:47:34	2	4	1	4	1	3	3	4	5	2	3	4	Matt metal, Wood	Most of the shapes seem rather unstable (elongated in the upward direction). This might be troublesome for clumsy people or people who have a lot of stuff on their desks
6/23/2016 9:48:52	2	3		2	4	2	2	3	2	4	3	4	Matt metal, Polished metal	
6/23/2016 9:49:05	2	4	3	2	2	2	1	2	3	2	2	2	Cloth material, Matt metal	For me the fact that we add another device to our desk is maybe not the best idea. Many time I see my colleagues trying to focus on a task for a moment, they put their headphones ON, in order to be in their bubble. Why not merging your product with an existing one. Our gaming headset have light, a blinking red could notify to everyone around that I am busy and if I have the opportunity to set up a timer, I could have audio feedback or a dedicated sound to notify me when the time is over. Again, personnaly I do not want another device just for this.
6/23/2016 9:49:50	1	5	2	3	1	4	2	1	3	2	1	1	Matt metal, Plastic	I would NOT like such a standalone device on my desk, for 2 main reasons: 1) it would unnecessarily clutter the space, 2) it is not a very prominent place. I would prefer to attach it to one of the top corners of my monitor.
6/23/2016 9:51:27		4	1	4	3	2	2	1	4	2	5	5	Wood, Leather	
6/23/2016 9:52:05	3	3	3	3	3	3	3	1	1	4	2	1	Cloth material, Wood	
6/23/2016 9:58:27	1		3	3	1	1	1	2	2	2	4	2	Cloth material, Matt metal	
6/23/2016 9:58:39	2	5	1	1	1	2	1	3	4	1	2	3	Matt metal	
6/23/2016 10:00:03	1	5	1	3	2	1	1	2	4	5	5	4	Matt metal, Polished metal	Could it display some other useful information i.e. date and time ? Next appointment ?
6/23/2016 10:01:57	1	5	2	4	1	4	2	2	4	1	2	5	Polished metal, Plastic	
6/23/2016 10:03:58	5	3	4	2	1	1	4	4		2	4	3	Matt metal	
6/23/2016 10:04:57	2	3	4	2	3	3	1	1	2	4	3	4	Matt metal, Wood	
6/23/2016 10:11:06	2	3	4	4	5	3	3	3		4	5	4	Cloth material	
6/23/2016 10:12:46	3	2	4	2	2	2	2	1	1	4	2	2	Plastic, Wood	
6/23/2016 10:13:40	2	3	3	5	1	2	1	1	3	4	4	1	Cloth material, Wood	
6/23/2016 10:15:51	4	3	3	2	1	1	1	2	4	3	4	1	Matt metal, Plastic	

6/23/2016 10:17:47	2	4	3	2	2	3	4	3	4	2	3	4	Matt metal, Polished metal, Leather	Polish metal would be nice, but that should not reflect light too much to avoid disturbances. Matt metal may not be easy to maintain (clean) without creating scratches. Meeting reminders would help as well and maybe an interaction with mobile phones and Jabb
6/23/2016 10:17:51	3	3	2	3	3	2	2	4	3	2	5	4	Matt metal, Plastic	
6/23/2016 10:20:58	3	2	3	4	1	2	4	2	3	5	5	3	Matt metal, Leather	
6/23/2016 10:22:13	4	5	3	2	1	5	5	1	4	5	4	3	Cloth material, Matt metal	Enabling and disabling lights should be possible at the device level, don't need a smartphone to run this device. However device should be connected to network so other can see if you are busy or ready, no need to pass by.
6/23/2016 10:32:53	3	4	3	5	2	4	3	2	3	4	3	4	Cloth material, Matt metal	I should be able to personalise its color /behaviour
6/23/2016 10:49:15	2	4	3	5	2	4	2	2	3	4	5	5	Cloth material, Wood	Looking fwd to seeing the next steps ! I like the idea a lot and it would help some of my colleagues for sure !
6/23/2016 10:53:24	1	3	2	2	4	5	2	1	3	5	3	4	Matt metal, Polished metal	
6/23/2016 10:54:56	5	3	2	3	2	3	5	1	1	5	1	3	Polished metal, Wood, Leather	
6/23/2016 10:55:46	1	2	1	4	4	4	3	2	4	1	2	2	Cloth material, Plastic	
6/23/2016 11:14:42	3	4	1	1	1	2	1	1	4	2	4	3	Matt metal, Plastic, Wood	I don't think it would stop me from interrupting someone. Like do not disturb on chat... some people have it on permanently...so you disturb anyway...
6/23/2016 11:17:49	1	3	1	5	2	1	1	2	5	2	5	1	Cloth material, Wood, Leather	It would be nice if it could tell me if someone is available or not.
6/23/2016 11:38:21	1	3	1	5	2	2	1	1	3	4	5	5	Matt metal, Polished metal	
6/23/2016 11:38:52	3	2	3	2	3	1	3		2	4	4	3	Matt metal	
6/23/2016 13:20:45	1	4	1	4	1	3	1	1	5	1	5	1	Cloth material, Plastic	
6/23/2016 14:03:31	3	2	3	2	4	3	3	3	4	2	3	4	Cloth material, Plastic	IT could be useful to me if it could help to do more. If I can get some quick information from it for myself, I would love it. Just informing other is more training from me and I would probably move it away quickly.
6/23/2016 14:38:47	4	3	2	2	2	3	2	2	4	2	5	3	Polished metal, Wood	
6/23/2016 14:43:54	1	4	3	4	1	1	2	2	3	4	4	1	Matt metal, Polished metal	
6/23/2016 15:15:19	1	2	3	2	5	4	1	3	1	5	4	3	Plastic, Wood	
6/23/2016 15:17:53	3	3				3	4	2	4	2	4	4	Cloth material, Wood, Leather	Design should be "iconic" and cool, perhaps add another feature or make it future proof...
6/23/2016 15:20:59	2	4	2	2	3	1	3	2	3	4	4	2	Cloth material, Matt metal	
6/23/2016 16:15:55	3	4	4	2	2	2	2	3	4	2	4	4	Cloth material, Matt metal, Wood	
6/23/2016 17:13:06	1	2	2	2	1	2	1	2	3	2	4	3	Cloth material, Matt metal, Plastic, Woo	Seems you are testing a solution rather than trying to identify the problem or at least to core of the ned / pain. There are very easy ways (other than techno) to prevent voluntary interruptions. The real challenge is interruptions due to envionrment, i.e. not conscious interruptions from someone else.
6/23/2016 17:18:41	2	4	1	5	2	4	2	2	3	4	4	4	Cloth material, Polished metal	
6/23/2016 18:20:31	1	4	4	5	4	3	2	1	3	3	2	2	Cloth material	Would be cool to have an OLED or LED display to write a message
6/23/2016 20:06:14	4	3	3	1	3	3	3	3	4	3	2	2	Matt metal, Polished metal	
6/23/2016 23:17:10	1	4	1	4	1	4	4	2	5	2	4	1	Cloth material, Polished metal	
6/24/2016 11:00:07	3	4	1	1	1	2	1	2	3	4	4	2	Cloth material, Matt metal, Wood, Leather	
6/24/2016 11:00:23	2	3	2	2	2	2	2	3	2	2	3	4	Cloth material	another shape?
6/24/2016 14:47:39	2	4	1	2	3	2	2	1	2	5	4	4	Cloth material, Matt metal	
6/24/2016 17:53:22	1	4	2	3	2	1	1	1	5	4	4	3	Cloth material, Matt metal, Polished metal, Plastic, Wood	
6/27/2016 8:04:22	2	4	3	4	2	2	3	2		3	5	2	Cloth material, Matt metal	You don't ask what we thing about your device.
6/28/2016 9:13:32	4	2	2	1	1	1	1	3	4	1	4	1	Cloth material	
6/28/2016 17:14:48	3	3	4	4	4	4	4	2	3	5	5	4	Matt metal, Polished metal, Wood	Would be great if you offer a device to each employee.
6/30/2016 9:50:06	1	2	3	2	1	1	1	2	4	2	4	3	Matt metal, Polished metal	I have contradictory feelings about how it should look (shape, size, and finish): Somehow it needs to "blend in" my desk stuff (so not too visible) while still being visible enough to be noticed by bycomers...
6/30/2016 12:37:54	3	4	4	4	2	4	2	1	2	3	1	5	Polished metal, Wood, Leather	Have it attached on my screen
7/1/2016 11:06:21	1	5	1	2	4	5	1	1	5	1	3	5	Cloth material, Plastic	
7/4/2016 10:20:42	3	4	3	4	3	4	4	3	3	4	3	3	Wood	
7/4/2016 11:06:26	1	4	3	4	3	4	3	2	3	4	2	3	Polished metal, Leather	
	193	313	218	262	201	223	188	184	284	257	325	272		

	A	B	D	E	F	I
1	**Date**	**User ID**	**Q1**	**Q2**	**Q3**	**OOO**
27	**avg week 1**	2	3.60	3.00	2.60	0.00
28	**avg week 1**	3	3.33	3.33	2.00	2.00
29	**avg week 1**	4	3.00	2.75	4.50	1.00
30	**avg week 1**	5	4.00	4.00	2.00	1.00
31	**avg week 1**	6	2.50	1.50	2.50	3.00
32			**3.29**	**2.92**	**2.72**	7.00
33	**Date**	**User ID**	**Q1**	**Q2**	**Q3**	**OOO**
59	**avg week 2**	2	4.5	3.75	2.75	1
60	**avg week 2**	3	3.25	3	1.5	1
61	**avg week 2**	4	4	3.25	4	1
62	**avg week 2**	5	4	3.8	3	0
63	**avg week 2**	6	4	3.75	3.25	1
64			**3.95**	**3.51**	**2.9**	4
65	T-test (two-tailed, paired)		**0.09568810061**	**0.2682412277**	**0.5927138886**	
66	Error variance					
68	Q1	**Today I was very productive**			Highest best	
69	Q2	**Today I experienced a very good workflow**			Highest best	
70	Q3	**Today I was interrupted many times**			Lowest best	
73						
74	STD error	W1	0.2559513843	0.4116363012	0.4619523785	
75	STD error	W2	0.2	0.1623268308	0.4077376608	







E
Sensor Data

User ID	Date	Device on		# Int DnI	# Int NOT DnI	DnI on durration	OOO	Int / hour DnI	Int / hour NOT DnI	*Minutes at office*
2	2016-08-29	1		1	1	27		**2.222222222**	**0.25**	240
2	2016-08-30	1		0	0	0		0	0	60
2	2016-08-31	1		1	4	19		**3.157894737**	**8**	30
2	2016-09-01	1		7	14	89		**4.719101124**	**4.666666667**	180
2	2016-09-02	1		5	9	48		**6.25**	**4.5**	120
3	2016-08-29	1		22	10	121		**10.90909091**	**3.333333333**	180
3	2016-08-30	1		1	9	36		1.666666667	3.6	150
3	2016-08-31	1		0	0	0	1	0	0	510
3	2016-09-01	1		0	0	0		0	0	510
3	2016-09-02	1		0	0	0		0	0	510
4	2016-08-29	1		38	40	510		**4.470588235**	**6.666666667**	360
4	2016-08-30	1		39	23	82		**28.53658537**	**23**	60
4	2016-08-31	1		0	0	0		0	0	480
4	2016-09-01	1		0	0	0		0	0	510
4	2016-09-02	1		0	0	0	1	0	0	510
6	2016-08-29	1		2	5	23		**5.217391304**	**1.666666667**	180
6	2016-08-30	1		4	4	263		**0.9125475285**	**4**	60
6	2016-08-31	1		9	2	450		**1.2**	**2**	60
6	2016-09-01	1		0	10	56		0	10	60
6	2016-09-02	1		3	1	123		**1.463414634**	**2**	30

F
Integrity Declaration

UNIVERSITÉ DE FRIBOURG
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D E C L A R A T I O N

I hereby declare that I wrote this thesis on my own and followed the principles of scientific integrity.

I acknowledge that otherwise the department has, according to a decision of the Faculty Council of November 11th, 2004, the right to withdraw the title that I was conferred based on this thesis.

I confirm that this work or parts thereof have not been submitted in this form elsewhere for an examination, according to a decision of the Faculty Council of November 18th, 2013.

………………………………..……, the .... 20..........

...……..................................…
(Signature)

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