# [Report]

# Bachelor Assignment

*Industrial design*

***'Design of an alcohol tester gadget'***


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This report is written as a result of a Bachelor assignment executed at the office of 'Escobar Advertising'. The assignment is to design a alcohol tester gadget.

This report is addressed to:

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And in particular to

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# INTRODUCTION

The goal of this bachelor-assignment is to design a device that can detect and display the presence of alcohol in one's body. The product has to cater to the international social trend of the realization that alcohol can be dangerous for the health and it is desirable that the gadget has a link with alcohol use in traffic This trend is a result of the increasing alcohol consumption. This can be illustrated by an Australian research: looking at the age of initiation by five-year age cohorts for persons born between 1940 and 1984, it was found that more than half (56 per cent) of the 1980-84 birth cohort reported alcohol use by age 15, compared to only 16 per cent of those born between 1940 and 1944 (Degenhardt et al. 2000).

There is a focus on designing a product that is smaller than regular alcohol testing devices: a kind of gadget. The consumer must be made aware of alcohol consumption in an indirect way using the small product. The device must not only detect and display the presence of alcohol but also have an additional function, so the function of alcohol detecting is not emphasized (indirect). To achieve this, an inventory of methods to detect alcohol is made: by which principle can alcohol be detected and which system is required to do so? After this, an inventory of markets is needed to determine the market that has potential for the designed product. Which group(s) consume more alcohol in proportion to other groups? Is there a possible opening in that market for the product? A target group that fits the chosen market is analyzed to get a better insight in the kind of additional function the product must have. A programme of demands and specifications follows out of the research. The integration of the alcohol detection method in a small product is emphasized. In the end, the elaboration of the product results in a visual prototype.

For this assignment a plan of approach is drafted as a guideline in the design process. The plan of approach contains the following questions that are derived out of the objectives:

**1. Which applicable methods to detect alcohol exist?**
1.1 By which principle(s) can alcohol be detected?
1.2 Which methods are applied by which principles if alcohol needs to be detected?
1.3 In which way are the reactions in the methods effectuated?
1.4 What are the advantages and disadvantages of each method?

**2. Which target group is the product going to be designed for?**
2.1 Which groups come, in proportion, more into contact with alcohol?
2.2 Which markets can be distinguished in these groups?
2.3 At which events is alcohol accessible concerning the groups from question 2.1 & 2.2?
2.4 Which existing alcohol test devices are utilised on those events?

**3. What is the programme of demands and specifications for an alcohol testing device?**
3.1 Which demands derive from the principal?
3.2 Which demands derive from the user concerning alcohol testing?
3.3 Which demands derive from the user concerning an additional function?

**4. What are possible additional functions for the product?**

4.1 What must be achieved with each function?
4.2 How can these functions be achieved?
4.3 What are applicable durable articles which execute a function?
4.4 What are applicable durable articles in which an alcohol testing system can be integrated?

**5. Which design stands out based on the programme of demands and specifications?**

5.1 Which concepts stand out in regard to what extent the user is indirectly confronted with their alcohol consumption and to what extent the concept is a gadget?

5.2 Which concept satisfies the programme of demands best?

5.3 How does that concept look in detail?
5.4 What is the additional function, hoe does the product work and what is its appearance, presented by a model?

**6. To what extent does the designed product connect to the target group?**

6.1 Does the product satisfy the program of demands derived from the target Group?
6.2 To what extent does the additional function appeal to the target group?
6.3 Are the users becoming conscious of their alcohol consumption?

The complete plan of approach can be found in annex A.

# INDEX

# DUTCH SUMMARY

Dit verslag is geschreven naar aanleiding van de bachelor opdracht ‘ontwerpen van een alcohol tester’ bij Escobar Advertising in Amsterdam. Er is een alcohol tester ontworpen in de vorm van een gadget die goedkoop is, maar wel enige kwaliteit biedt. Een wens was om de tester te relateren aan het verkeer en alcoholgebruik daarbij.

Als eerste is er een onderzoek uitgevoerd naar hoe alcohol ontstaat en hoe het werkt. Het hangt af van de hoeveelheid alcohol in iemands bloed hoe de persoon reageert onder invloed van alcohol.

Hierna is gekeken welke manieren er allemaal bestaan om alcohol gebruik bij een persoon te testen. Er zijn veel verschillende manieren, de meest gebruikte manieren zijn via bloed, adem, urine, speeksel en transpiratie. Deze vijf testprincipes zijn verder uitgediept en er is gekeken naar apparaten die alcohol gebruik meten met behulp van één van die vijf principes. De vijf manieren om te testen zij tegen elkaar uitgezet in een tabel om alle voor en nadelen te kunnen overzien. Uiteindelijke wordt testen met behulp van het bloed en twee principes die bij het testen van de adem worden gebruikt verworpen omdat ze te complex, te groot (de apparaten) en/of te duur zijn om geïntegreerd te kunnen worden in het te ontwerpen product.

Om een nuttig product te ontwerpen was het nodig om een onderzoek te doen naar de relatie tussen verschillende groepen personen en alcoholgebruik. Er is eerst gekeken naar wereldwijd gebruik en daarna focussend op Europa en uiteindelijke Nederland. Het resultaat van dit onderzoek was dat vooral jongeren (met name mannen) tussen de 18 en 24 jaar het meeste alcohol consumeren en ook vaak in aanraking komen met alcoholgebruik in het verkeer. Deze groep werd daarom als doelgroep gekozen. Vervolgens werd een enquête afgenomen onder een deel van deze jongeren om te weten te komen wat voor soort gadget hen aanspreekt. Het bleek dat gadgets wel gebruikt worden als ze leuk zijn om te gebruiken ook een geruime tijd nadat de gadget verkregen is.

Met de eisen van de doelgroep en de opdrachtgever is er een programma van eisen opgesteld t.a.v. productie, gebruik, distributie en verwijdering.

Met de eisen bekend zijn er schetsen gemaakt en is er gebrainstormd om tot mogelijk ideeën te komen. Er zijn drie principes van testen uitgewerkt: adem, speeksel en transpiratie. De ideeën zijn vooral leuk en er is een spelelement ingemaakt om dit te stimuleren. De confrontatie met alcohol is dan niet direct maar zo wordt de gebruiker er wel mee geconfronteerd.

Uit de ideegeneratie zijn drie concepten gekomen, de ‘AlcoWatch’ (een horloge die test door middel van transpiratie), de ‘AlcoPop’ (een lolly die speeksel analyseert en van kleur veranderd afhankelijk van de hoeveelheid alcohol) en de‘Wheel of fortune’ tester die de adem analyseert.

De drie concepten zijn tegen elkaar uitgezet in een tabel en beoordeeld op basis van punten uit het programma van eisen en o.a. originaliteit, fun- factor en haalbaarheid.

Het ‘wheel of fortune’ concept werd gekozen en is uitgewerkt tot een productconcept. Er is o.a. nagedacht over een sensor, energievoorziening en natuurlijk de vormgeving. Van het uiteindelijke ontwerp zijn twee modellen gemaakt. Om het gebruik te illustreren is er een scenario gemaakt met behulp van plaatjes.

# ENGLISH SUMMARY

This report is written within the framework of the Bachelor assignment ‘design of an alcohol tester’ executed by Escobar Advertising in Amsterdam. An alcohol tester is designed shaped like a gadget that is cheap, but has some quality. It was desired to link the tester to alcohol use and traffic.

First, a investigation was executed to gain insight in alcohol origination and how alcohol works in a body and how a body responds to alcohol use.

After this, there was researched in which ways alcohol in a body can be detected. There are many ways in which this is possible, but the most common used methods are detecting via the blood, breath, saliva, urine and perspiration. These five testing principles are studied and devices that detect alcohol use using one of those principles. The five principles are inserted in a table to overlook the advantages and disadvantages of each principle. Finally, testing using blood and two methods to detect alcohol via breath are rejected because they are too big (the devices), too expensive or too complex to be integrated in the product that is going to be designed.

To design a useful product it was necessary to investigate the relationship between alcohol use and different groups of persons. First there was a focus on the world, then Europe and then the Netherlands. This resulted in the fact that mainly young people (notably males) aged between 18 and 24 years of age consume the most alcohol and come into contact with alcohol use and traffic. A good reason to choose this groups as the target group of this project. A survey was executed among this target group, to gain insight in their alcohol use and their use of gadgets and what they appeal to. It appeared that gadgets are only used if it is considered to be useful and it is fun to use.

With the demands of the target group and the principal a programme of requirements was set up concerning production, use, disposal and distribution.

With the known requirements and a brainstorm sketches were generated to gain possible ideas. Three testing principles were elaborated: breath, saliva and perspiration. The ideas were fun and gaming-element was included to stimulate the fun-factor of the possible gadget. The confrontation with alcohol use is then indirect, but with a serious message.

From the idea generation, three concepts were created: ‘alcowatch’, a watch that analyses the perspiration of the user, ‘ alcopop’ a lollipop that analyses the saliva when eating the lollipop and ‘wheel of fortune’ that analyses the breath.

The three concepts are compared to each other using a table to overlook the fulfilment of the stated criteria.

The ‘wheel of fortune’ concept was chosen and is elaborated to a product concept. There is thought about a sensor, power supply, form giving etc. Two models of the final design were made. To illustrate the use of the device a scenario using images was made.

# CHAPTER 1

ALCOHOL

To begin the design process, the substance alcohol will be examined to gain insight in this material which is to be detected.

## 1.1 ETHANOL

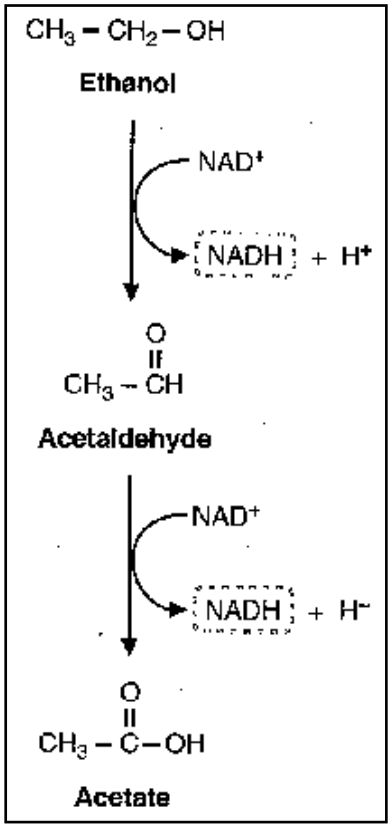
An alcoholic beverage is a drink containing ethanol, commonly known as alcohol. The chemical formula of alcohol (actually ethyl alcohol or ethanol) is $CH_3CH_2OH$. Ethyl alcohol is a colourless liquid. It boils at 78 degrees Celsius and freezes at -114 degrees Celsius. Ethanol can be mixed with water in all proportions. Ethanol is flammable and will burn in air when there is between 3 and 19% ethanol in the vapour (Boggan, 2003).

## 1.2 ORIGINATION

Alcohol is a product produced naturally by fermentation of barley (beer) or grapes (wine). This process of fermentation stops at approximately 15% of alcohol. Because of heating and cooling of these beverages (called 'distil') higher percentages of alcohol in these beverages arise (Alcoholinfo, 2007).

## 1.3 WORKING

Alcohol is absorbed by the blood, in the stomach and intestines. Trough blood vessels, the alcohol ends up in the whole body. Alcohol anaesthetizes. It affects the transmission of signals in the nerves and the brain in particular (Freudenrich, 2008).




Boggan explains*: "More than 90% of the ethanol that enters the body is oxidized to acetic acid. This process occurs primarily in the liver. The remainder of the alcohol is not metabolized and is emitted in the sweat, urine or given off in one's breath. There are several routes of metabolism of ethyl alcohol in the body. The major pathways involve the liver and in particular the oxidation of ethyl alcohol <catalyzed by the cytosolic enzyme> alcohol dehydrogenase (ADH) (...) It catalyzes the following reaction:*

*$CH_3CH_2OH + NAD^+ \rightarrow CH_3CHO + NADH + H^+$.*

*This reaction produces acetaldehyde, a highly toxic substance.*

*The second step of ethanol metabolism is catalyzed by acetaldehyde dehydrogenase. This enzyme converts acetaldehyde to acetic acid, which is a normal metabolite in humans.*

*Another system in the liver which oxidizes ethanol via the enzyme cytochrome P450IIE1 (CYP2E1) is called the MEOS system. The reaction catalyzed by MEOS is:*

*$CH_3CH_2OH + NADPH + O_2 \rightarrow CH_3CHO + NADP^+ + H_2O$.*

*Though of minor significance in comparison to ADH metabolism of ethanol, the MEOS system seems to play an increasingly important role at higher concentrations of ethanol. It is not surprising that there are variations in the P450E1 enzyme which lead to differences in the rate of ethanol metabolism. This may have implications for tissue damage from ethanol, particular in the liver."*

The concentration of alcohol in the blood is higher when a certain amount of alcohol is consumed in a short time. The higher the concentration of alcohol in the blood, the larger the effects alcohol has on a body. The faster alcohol is absorbed in the blood, the sooner those effects will appear.

If alcohol is consumed with a sober stomach, the alcohol is taken up in the blood faster than when the stomach contains food. The concentration of alcohol in the blood then rises more quickly. Hence, the effect is larger.

The effect of alcohol differs per person. This involves body weight and the amount of fluid in the body. The lower the fluid content, the more the effect of the alcohol: the concentration in the blood increases more quickly. A person having more body weight experiences the effect of he alcohol later than someone having less body weight. This is why women also experience the effect earlier than men. They also have less content of fluid than men.

When drinking regularly, the body becomes accustomed to the alcohol, so the body needs more alcohol to experience the same effect. The body does not become accustomed to all effects: the negative effect on the ability to react still remain undiminished (Trimbos instituut, 2008).

## 1.4 PROGRESSIVE EFFECTS

The effects that arise depend on the concentration alcohol in a body (table 1). The BAC means the Blood Alcohol Concentration.

| BAC | **Behaviour** | **Impairment** |
|---|---|---|
| .06–.10 | Relaxation<br>Sense of Well-being<br>Loss of Inhibition<br>Lowered Alertness<br>Joyous | Thought<br>Judgment<br>Coordination<br>Concentration |
| .11–.20 | Blunted Feelings<br>Disinhibition<br>Extroversion<br>Impaired Sexual Pleasure | Reflexes Impaired<br>Reasoning<br>Depth Perception<br>Distance Acuity<br>Peripheral Vision<br>Glare Recovery |
| .21–.29 | Over-Expression<br>Emotional Swings<br>Angry or Sad<br>Boisterous | Reaction Time<br>Gross Motor Control<br>Staggering<br>Slurred Speech |
| .30–.39 | Stupor<br>Lose Understanding<br>Impaired Sensations | Severe Motor Impairment<br>Loss of Consciousness<br>Memory Blackout |
| >.40 | Severe Depression<br>Unconsciousness<br>Death Possible<br>Unconsciousness<br>Death | Bladder Function<br>Breathing<br>Heart Rate<br><br>Breathing |

TABLE 1: EFFECTS OF USING ALCOHOL. *SOURCE: ANSWERS.COM*

# CHAPTER 2

(APPLICABLE) METHODS TO DETECT ALCOHOL

To design a gadget that can detect alcohol use, research has to be executed to investigate different existing methods that can do this. To structure this research it is divided in three paragraphs. At the end of this chapter there will be a conclusion that shows applicable methods to detect alcohol as a result of the investigation. To reach to this conclusion there will first be a study by which principles alcohol can be detected and which methods of detecting fit this principle. Second, each method is examined to find out how it works exactly. Third, after considering each method, the advantages and disadvantages will be studied. Gained insight in the different principles and methods, a competition analysis is made to chart other products in the same category of the future product.

## 2.1 ALCOHOL DETECTING PRINCIPLES

Alcohol can be measured in blood, serum, plasma, urine, saliva, breath, vitreous humour, cerebral spinal fluid and tissue. These substances are used for different applications: i.e. clinical (serum, plasma), law enforcement (breath, whole blood) and post-mortem (whole blood, urine, vitreous humour and tissue) applications. Approximately 10% of the alcohol ingested is eliminated unchanged through urine, breath, saliva and perspiration. Because breath, urine, saliva and perspiration are emitted by the body it is expected to be more easily measurable than the substances located within the body. Alcohol measurement using breath, urine, saliva and perspiration will be studied, together with alcohol measurement from blood because it is expected that most measurements follow from the BAC[1].

### BLOOD

The BAC is considered to be the standard for measuring the degree to which an individual is damaged by alcohol. For years, studies have shown that there is a direct correlation between the blood alcohol concentration and the degree to which reactions and judgments are impaired.

### BREATH

It is proven that there is a direct correlation between a person's blood alcohol concentration and his breath alcohol contents. Gas is exchanged from the lungs to the blood during inhalation, and vice versa during exhalation. During this exchange, alcohol in the blood vaporizes and is carried out of the lungs in the exhaled breath. The ratio of breath alcohol to blood alcohol is 2100:1. This means that 2100 millilitres (ml) of alveolar air will contain the same amount of alcohol as 1 ml of blood.

### URINE

Urine/alcohol testing will indicate the presence of alcohol in a body, it will not indicate an individual's current condition, though. Alcohol enters the blood through the stomach within

[1] Blood Alcohol Concentration

15 minutes. It is then metabolized by the body and after 1½ to 2 hours it will begin to show up in the urine. So, urine/alcohol testing does not measure a true condition of the person. The results indicate the person's condition several hours before.

The urine/ alcohol concentration can vary, depending on the person's metabolism and the amount of fluid in his/her system. When urine is analyzed for alcohol, the assumption is that there are 1.3 parts of alcohol in the urine for every 1 part in the blood, but this can vary.

### SALIVA

Although a correlation between blood alcohol concentration and saliva alcohol concentration is believed to exist, the technology and chemical reaction employed has not been proven to be accurate or reliable (ASD, 2008).

### PERSPIRATION

Ingested alcohol is partitioned into the body water and can be secreted through the human skin. Although the total amount of alcohol eliminated through perspiration is small (approximately 1% of the total alcohol eliminated), simultaneous measurements of alcohol in liquid and vapour phases for perspiration find approximately equal ethanol concentrations to blood and other body fluids. (SWIFT, 1993).

## 2.2 PRINCIPLES AND THEIR METHODS

In this section the various principles discussed above will be investigated further on which methods exist to test the BAC using a specific principle. Recent applications of the specific method will be given, if possible.

### BLOOD

#### GAS CHROMATOGRAPHY

Gas chromatography is a technique used to analyze mixtures. The device allows mixtures to be separated and the amount of each component to be determined.

Samples to be analyzed in a gas chromatograph must be volatile. Once vaporized, the sample is carried through a long tube (a 'column') containing a cellular material. A nonreactive gas is used to carry the components of the mixture through the column. Not all components of a mixture travel through the column at the same rate, so, some

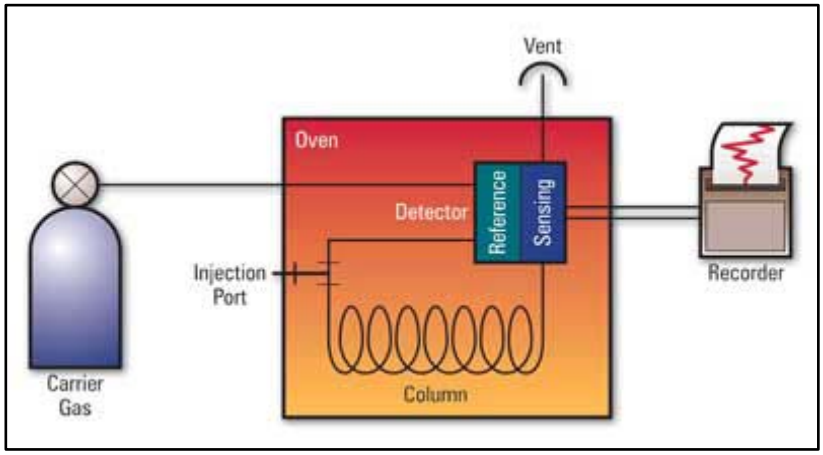



IMAGE 1: SCHEMATIC OVERVIEW OF THE WORKING PRINCIPLE OF GC. *SOURCE: PRACTICINGOILANALYSIS.COM*

components will arrive at the detector at the end of the column before others. As the components pass over the detector, the detector sends a signal to a recorder and a graph (chromatogram) is produced.

IMAGE 2: GAS CHROMATOPGRAPH

Using the chromatogram, the percent composition (amount) of each component in the mixture can be determined. The percent composition is directly related to the area of each peak in the chromatogram.

The blood sample is first mixed with one of two internal standards, either 1-propanol or t-butanol. Each sample is then tested separately by two different chromatograms, and the lab reports the lower of the two results. Once the sample is diluted, it is then heated to produce a vapour. The vapour is then passed through a glass column. The vapour is then timed and measured as it passes out of the other end of the column. The chromatograph produces a chromatogram. The peak measurement or curve on the chromatograph is then compared with a calibration curve, and the amount of blood alcohol is determined by reading where this sample peak passes over or meets the calibration curve (Barone & Crampton, 2003).

Gas chromatography is the most accurate forensic quality test in the industry today. However, drawing blood is an invasive and expensive procedure that most companies prefer to avoid (Bayley, 2006).

## BREATH

The common name for a device detecting alcohol is 'breathalyzer'. There are four types of breathalyzers though, that use different systems to detect the alcohol. First, there is the original breathalyzer. This device detects alcohol using the principle of colour change of a substance when a reaction with alcohol takes place. Second, a breathalyzer called an 'intoxilyzer' detects alcohol by IR (infrared) spectroscopy. Third, 'alcosensor' uses a fuel cell to detect a chemical reaction of alcohol. Last, a device that uses a semiconductor alcohol sensor that varies in resistance depending on the detected BrAC. The concentration of alcohol in breath is called BrAC (Breath Alcohol Concentration).

### COLORIMETRIC TEST

Approximately sixty years ago, the police used breathalyzers to determine if someone consumed alcohol. These early breathalyzers contained a chemical, orange substance: potassium dichromate. If a person blew into the breathalyzer, the ethanol in the breath converts to another substance. During this reaction, the potassium dichromate containing the orange dichromate ion converts into a green chrome(III)ion.

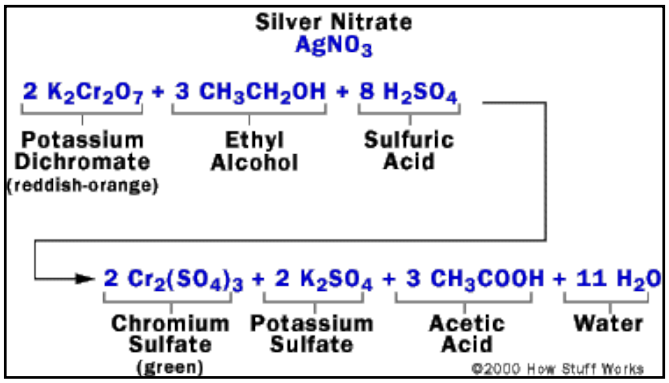



IMAGE 3 SCHEMATIC PROCESS OF REACTION. *SOURCE: HOWSTUFFWORKS.COM*

The greener the new substance, the more alcohol (ethanol) the blood contains. The colour reading was subjective, though.

This principle is developed into a digital device. The reaction is a bit different, though. The sample of the breath is blown through a mix of sulphuric acid, potassium dichromate, silver nitrate (a catalyst) and water. This too results in a green substance. The sulphuric acid removes the ethanol from breath blown into the device. The ethanol then reacts with the potassium dichromate and chromium sulphate (with potassium sulphate, acetic acid and water) follows from the reaction. The reacted mixture is compared to an unreacted mixture in a photocell system. This system produces an electric current that causes the needle of the meter to move. The operator must rotate a knob to get the needle back to the origin and then reads the level of alcohol from the knob. The more the knob has to be rotated, the more the amount of alcohol in the breath sample.

Because this is one of the first models used to test one's BAC recent applications could not be found. There are other methods nowadays that are more accurate and better manageable.

## INFRARED (IR) SPECTROSCOPY ('INTOXILYZER')

The breath can also be tested for alcohol by infrared spectroscopy. This method identifies molecules based on in what extent they absorb IR light. Devices that use this method are called 'intoxilyzers'.

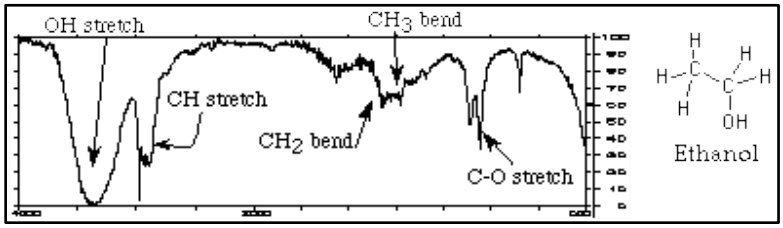



IMAGE 4: IR SPECTRUM OF ETHANOL. *SOURCE: CHEMCASES.COM*

Molecules vibrate. These vibrations change when the molecules absorb IR light, because the bonds between the molecules then absorb different wavelengths of the IR light (there are different types of bonds which each their own wavelength). The wavelengths that are absorbed can help to identify the substance as alcohol, thus the amount of absorption can tell how much ethanol there is (Freudenrich, 2008).

IMAGE 5: IR SPECTROSCOPY DEVICE. *SOURCE: OK-DUI.COM*

The IR spectrum of ethanol has a C-H stretch, an O-H stretch, a C-O stretch and some bending vibrations. The O-H stretch will always appear as a broad band at approximately 3300 – 3500 $cm^{-1}$ as shown in image 4. The image shows also the placement of the C-H and C-O stretch (Volland 1999).

The system is set up as can be seen in image 6. A quartz lamp (A) generates an IR beam. This beam passes through the sample chamber (D) and is focused by a lens (E) on to the spinning filter wheel (F). This wheel contains band filters for the wavelengths of the bonds in the ethanol. The light of the beam passes through each filter and is then detected by the photocell (G). The light is here converted to an electric pulse. The microprocessor interprets the pulses and calculates the BAC based on the absorption of IR light from the breath blown into the chamber (B and C).

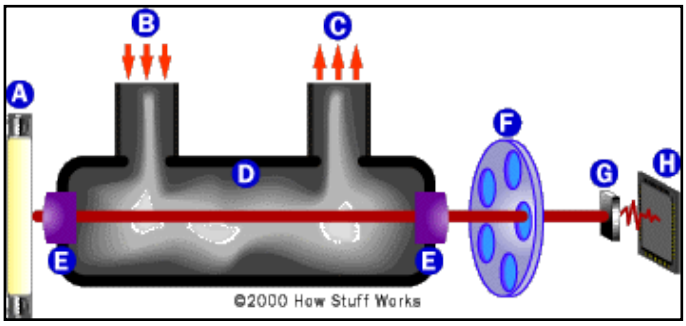



IMAGE 6: SCHEMATIC IMAGE OF THE IF SPECTROSCOPY DEVICE. *SOURCE: HOWSTUFFWORKS.COM*

## FUEL CELL ('ALCOSENSOR')

An alcohol testing device that uses a fuel cell to detect alcohol is also called an 'alcosensor'. A fuel cell has two platinum electrodes with a cellular acid electrolyte material between them. If the exhaled air flows past a side of the fuel cell, the platinum oxidizes the alcohol in the breath to product acetic acid, protons and electrons. The electrons flow through a wire from the platinum electrode to an electrical current meter and to the electrode on the other side.

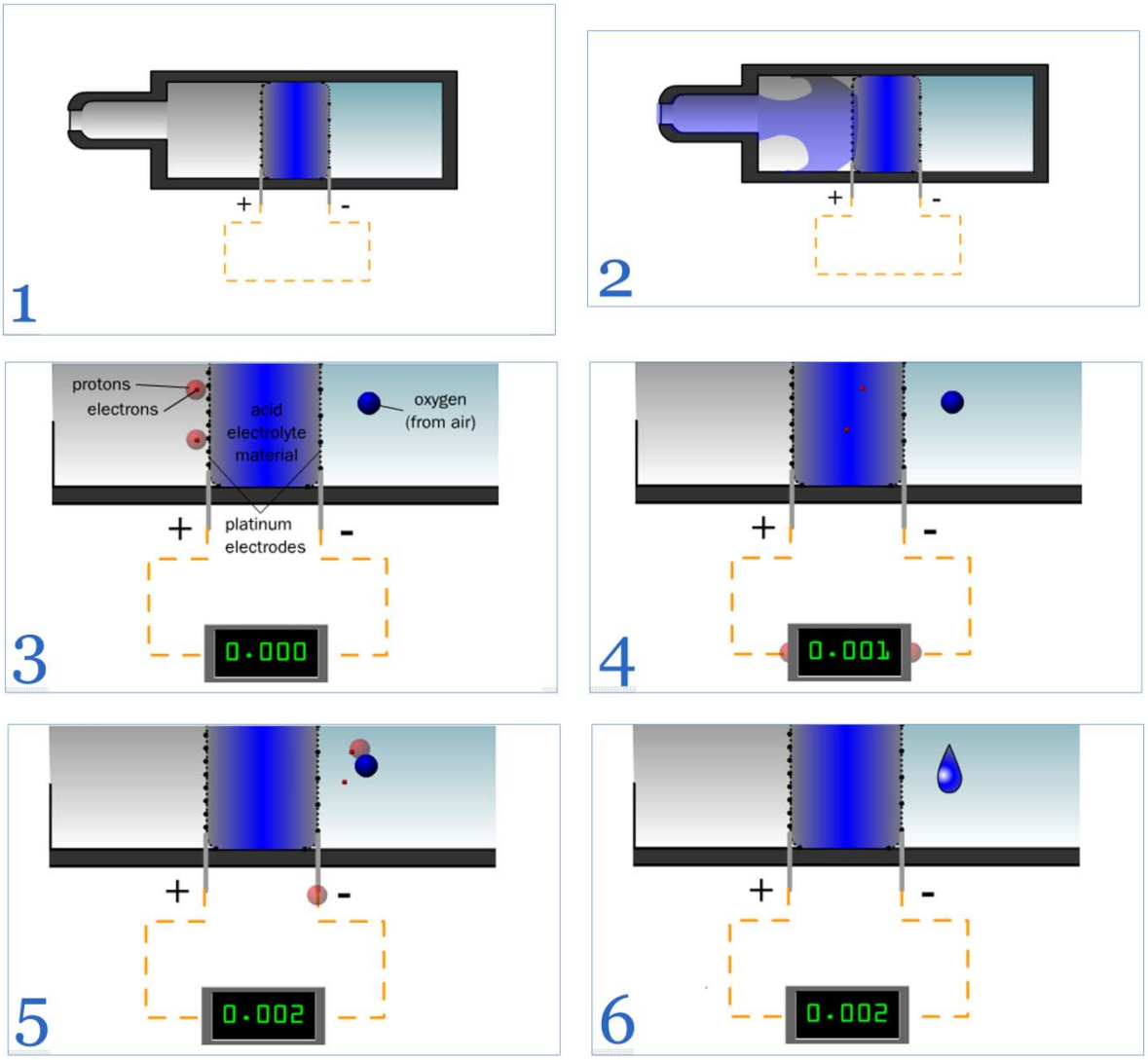



IMAGE 7: SCHEMATIC REPRESENTATION OF THE REACTIONI A FUEL CELL.

*SOURCE: HOWSTUFFWORKS.COM*

The protons move through the lower part of the fuel cell and unite with oxygen and the electrons on the other side. Water forms out of this reaction. The more alcohol that becomes oxidized, the higher the electrical current. A microprocessor measures the electrical current and calculates the BAC out of it (Freudenrich, 2008).

IMAGE 8: ALCO-SENSOR FST

A schematic representation of the process is illustrated using image 7. Alcohol testing devices using a fuel cell are more used by law enforcers, because they are too expensive for personal use.

### SEMICONDUCTOR

The most common used alcohol testing device uses a system with a semiconductor, more specific, a semiconductor alcohol sensor. A test device containing a semiconductor uses voltage differences between capacitors to determine the level of alcohol in a breath sample (AK solutions, 2008).

Semiconductor sensors use a small ceramic bead of a transition metal oxide, heated to a high temperature (approximately 300°C), across which a voltage is applied to produce a small standing current. The magnitude of this current is determined by the conductivity of the surface of the bead, which may be affected by the presence (and concentration) of alcohol. When alcohol is present, the electrical resistance of the sensor changes, and a circuit measures the change and converts it into a blood alcohol (BAC) reading.


IMAGE 9: BREATHALYZER WITH SEMI-CONDUCTOR FROM 'ALCOHAWK'.

## URINE

The number of consumptions containing alcohol can be deduced from the BAC. The concentration of alcohol in urine (UAC) is in proportion with the BAC. Jones (1992) compared the UAC and BAC of healthy men drinking alcoholic beverages and concluded that the proportion UAC/BAC can vary between 1.4 to 1.7 if the BAC exceeded 0.5 mg/ml. This variation does not depend on the age of the candidates.

### ETHYL GLUCURONIDE (ETG)

EtG is a (direct) metabolite of alcohol. This substance is still measurable if ethanol is not. The presence of EtG indicates a consumption of alcohol within the past 3 or 4 days. So, EtG is more a indicator of the consumption of alcohol than measuring the presence of alcohol itself at that moment.

Methods to detect EtG include immunoassay (a biochemical test that measures the concentration of a substance in a biological liquid usting a reaction of an antibody to its antigen), gas chromatography, mass spectrometry (an analytical technique that identifies the chemical composition of a compound or sample on the basis of the mass-to-charge ratio of charged particles) and/or liquid chromatography (expertdrugtesting.com, 2008).


IMAGE 10: ALCOHOL URINE TEST

## SALIVA

To test if there is any alcohol present in someone's saliva, a strip has to be put in the mouth and swept along the inside of the cheek. This strip is treated with an enzyme, called alcohol oxidize. This enzyme responds to alcohol in proportion to the concentration of alcohol in the saliva. When there is alcohol in someone's saliva, the cream colour of the reactive pad on the strip changes to a green colour. The more alcohol the saliva contains, the greener the pad. The colour of the pad must be compared to a supplied strip with colour standards for different percentages of BAC. An example of such a strip is shown in image 11 (Expomed Inc, 2007).


IMAGE 11: ALCOHOL SALIVA TEST STRIP WITH COLOUR STANDARDS

The proportion of BAC and SAC [2] is approximately 1:1. Schulz et al. studied the relationship between saliva and blood concentration. They proved that up to two hours after alcohol consumption there is a relationship between saliva and blood concentration. The largest difference between the two concentrations was 30 mg/g.

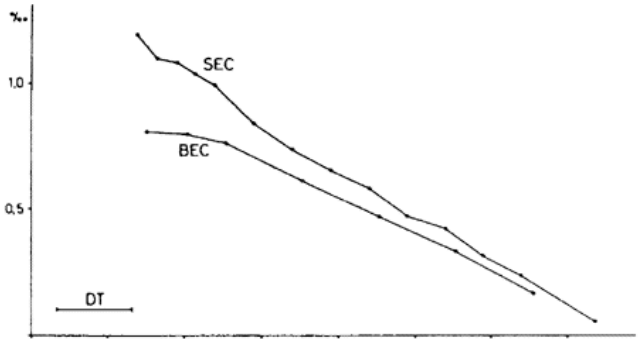



IMAGE 12: ETHANOL CONCENTRATION IN SALIVA (SEC) AND BLOOD (BEC). *SOURCE: SCHULZ ET AL. 1986*

## PERSPIRATION

Alcohol can also be detected by perspiration (sweat). This kind of measurement is called 'transdermal alcohol detecting'. The way in which alcohol passes through skin is very complex, because there are a great number of variables like, among other things, the level of alcohol itself, rate of diffusion through the skin, type of skin, location where the test takes place, and the blood flow within the skin. There is also a delay in peak of the BAC and the TAC[3]. This delay can vary from 30 up to 120 minutes. This delay depends on the factors mentioned above. For example, the longest delay occurs when a measurement is taken from the forearm. It is not know whether the measurement varies with location, type of skin or age. Because of these complexities, the measurement of TAC can not be as accurate as BrAC, but it can be helpful as a screening tool (Barone, 2005).

IMAGE 13: SCRAM DEVICE

A recent tool is the SCRAM (Secure Continuous Remote Alcohol Monitor). This unit provides continuous, 24-hour monitoring of alcohol concentration through the skin. SCRAM is the first technology to utilize the science of transdermal alcohol testing in order to determine a person's blood alcohol content (BAC). SCRAM measures the ethanol in Insensible Perspiration – a byproduct of alcohol consumption – in order to determine a person's BAC – or with SCRAM, a person's TAC.

[2] Saliva Alcohol Concentration

[3] Transdermal Alcohol Concentration

## 2.3 (DIS)ADVANTAGES

To deepen the research, each method is analysed and compared to the others to note the (dis)advantages per method. In this way, methods which are worth continuing with can be distinguished from those which are not feasible in the future product.

| Advantages | Disadvantages |
|---|---|
| **Blood** | |
| Most accurate | Expensive<br>Intrusive<br>Complicated |
| **Breath - colour change** | |
| Minimal arrangement of components<br>Quick analysis<br>Accurate<br>Small sample needed | Handling critical (sulphuric acid)<br>Operator dependent |
| **Breath - IR spectroscopy** | |
| Assurance sample of alveaolar nature<br>No limited life expectancy | Size not suitable for handheld operation<br>Expensive<br>Detects methyl group (part of alcohol) and<br>Not alcohol molecule itself |
| **Breath - Fuel cell** | |
| Highly specific sensor<br>Sensitive sensor (to 0.1 ppm)<br>5 yr life expectancy<br>Linear response to alcohol<br>Minimal power use<br>Rarely fals positives | EC sensor is cross sensitive (other alcohols)<br>Output is temperature dependent<br>Relatively high cost unit<br>Periodic calibration |
| **Breath - semiconductor** | |
| Inexpensive | Power use<br>Warm-up time |
| **Urine** | |
| Inexpensive<br>High assurance reliable results | Intrusive<br>Delayed indication<br>Only used qualitatively, not quantitatively<br>Alcohol can form also by fermentation (diabetics) |
| **Saliva** | |
| Time reducing<br>Cost reducing<br>Non-invasive | Complicated |
| **Perspiration** | |
| Passive participation<br>Non-invasive | Delayed indication<br>Variety in diffusion rate per part of the body |

TABLE 2: ADVANTAGES AND DISADVANTAGES OF DIFFERENT METHODS

There are three disadvantages that need some remarks:

*Only used qualitatively, not quantitatively:* The concentration of alcohol in urine does not correlate well with blood alcohol levels, because of the unpredictable amount of dilution in the urine from recent fluid consumption and because the urine in the bladder reflects blood alcohol levels over several hours

*Delayed indication*: Brown found the transdermal ethanol concentration approximately equal to that of the BAC, but delayed with respect to BAC, and with significant differences in terminal rate constants between the two measures (Brown 1985), Giles *et al* compared BAC to transdermal ethanol vapour from the palm using electrochemical detection and found high correlations. Transdermal ethanol detected at the forearm was found to be delayed with respect to BAC and attenuated by a factor of four

*Variety in diffusion rate per part of the body*: An additional complexity is that transdermal ethanol derives from two processes: passive diffusion through the skin and active secretion by, primarily, sweat glands. The skin permeability to small, relatively polar molecules such as ethanol, varies from area to area: plantar and palmar skin shows the highest ethanol diffusion, forehead, axilla and perineal skin somewhat less diffusion, and skin of the extremities the least diffusion (alcohol-test-info.com, 2008)

## 2.4 CONCLUSION

There are many ways in which alcohol can be detected. Alcohol can be detected with substances from within the body and substances that are excreted by the body. It is expected that the substances excreted by the body have a higher feasibility to be useful when designing a gadget that can detect the consumption of alcohol. These excreted substances are breath, urine, saliva and perspiration.

The most common method to test if someone has consumed alcohol is to test someone's breath. A device that can detect alcohol by blowing a sample of breath is called a 'breathalyzer'. A breathalyzer can use four different systems to detect alcohol, viz. the use of a colorimetric test, infrared spectroscopy, a fuel cell or a semiconductor alcohol sensor.

Someone's urine can also be tested. Most tests are based on testing not alcohol itself in the urine but a metabolite of alcohol, ethyl glucuronide, called 'EtG'. This method of testing is more an indicator of alcohol consumption in the past 3 to 4 days, not a method that measures alcohol concentration at the moment of measuring.

Two other methods to measure alcohol concentration are testing via saliva and perspiration. Alcohol concentration in saliva is 1:1 two hours after first consumption. The concentration can be tested by putting a strip, treated with the enzyme alcohol oxidize, in someone's mouth for a couple of seconds. The alcohol in the saliva reacts with the enzyme and the strip changes colour (if positive).

Testing using perspiration, also called transdermal testing, is very complex, because it is dependent of many factors. The place of measurement, for example, can cause differences that can not be neglected. A yet existing device measures someone's alcohol concentration by taking a sample of perspiration every 30 minutes and analyzes this sample using a fuel cell.

Every method has advantages and disadvantages. Comparing these (dis)advantages causes that measuring using gas chromatography (blood), infrared spectroscopy and a fuel cell (breath) to be abandoned from implementation in the future product, because they are relatively too big and too expensive.

## 2.5 MARKET

To visualize the market a collage is made to visualize all the products that can be found that detect alcohol using one of the four principles. The collage can also be used in a later stadium to design a product that is distinctive of other products. The rejected methods and/or applications are not included in the collage. A large version of the collage can be found in Annex B. Another market analysis of only breathalysers can be found in Annex C.


IMAGE 14: ANALYSIS OF DIFFERENT TYPES OF ALCOHOL TESTING

# CHAPTER 3

WITH WHICH TARGET GROUP IN MIND IS THE PRODUCT GOING TO BE DESIGNED?

To design a striking gadget that can incite the customer to consider one's alcohol use, an investigation has to be executed to examine with which target group in mind the product is going to be designed. This target group is a group which uses alcohol more frequently than other groups and which the gadget can exert influence on.

## 3.1 FREQUENT ALCOHOL CONSUMERS

Because there is initially the intention to launch the future product worldwide, a research will be done to register which groups of people consume alcohol more frequently internationally. There will be three grades of focus, viz. Worldwide, Europe and the Netherlands. The main focus is the Netherlands, because information, trends an detailed statistics can best be checked and of course of the fact that the project is executed here.

### WORLDWIDE

The regional data indicates that for the WHO [4] Regions other than EMR (Eastern Mediterranean Region, mostly countries with majority Muslim populations) there is a certain trend towards harmonization of the consumption levels.

The one consistency that appears to transcend cultures is the difference in abstention rates between males and females. A higher proportion of women abstain from alcohol than men. A second common finding is the role of religion in shaping drinking habits. For instance, countries with Islam as the official religion almost always have higher rates of abstinence. However, in each case, one must keep in mind that patterns of abstinence, like drinking patterns, may vary within specific subpopulations and across different regions of a particular country. This is especially true for multicultural and multiethnic societies, in which different groups may represent quite diverse traditions with respect to alcohol.

### EUROPE

Europe is the heaviest drinking region of the world (illustrated by the adjoining image of WHO. Explanation of the legend: The European Region (EUR), the African Region (AFR), the Region of the Americas (AMR), The Eastern Mediterranean Region (EMR), South-East Asian Region (SEAR), the Western Pacific Region (WPR).): 11 litres of pure alcohol drunk per adult annually. Most Europeans drink alcohol, but 55 million adults (15%) abstain; taking this and unrecorded consumption into account, the consumption per drinker reaches 15 litres per year.

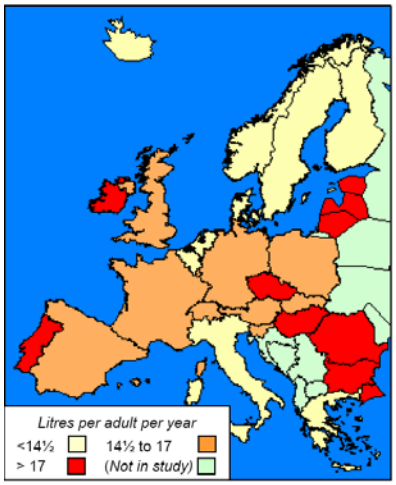



IMAGE 15: TOTAL ALCOHOL CONSUMPTION PER DRINKER IN EUROPE, 2002. *SOURCE: WHO*

[4] World Health Organization

The heaviest drinkers account for 10% of the population consuming one-third to one-half of all the alcohol consumed. While 266 million adults drink alcohol, over 58 million adults (15%) consume at harmful levels above this, with 20 million of these (6%) drinking very dangerous.

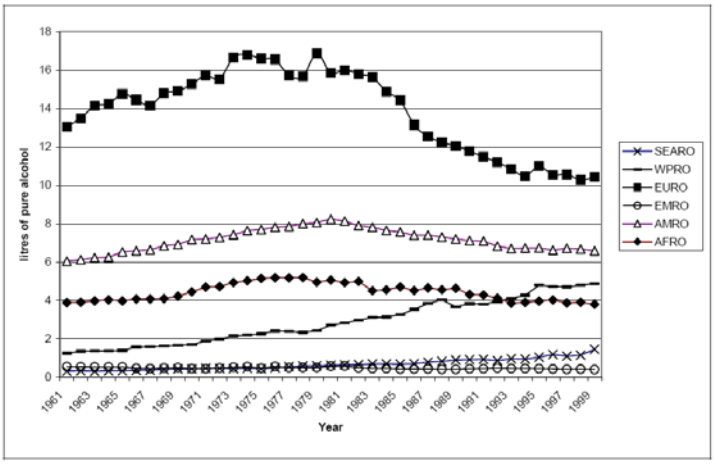



IMAGE 16: EUROPE AND THE WORLD'S DRINKING. *SOURCE: WHO*

In every culture ever studied, men are more likely than women to drink at all and to drink more when they do, with the gap greater for riskier behaviour.

Over 90% of all 15-16 year old students have used alcohol. The average age of beginning to drink is 12 years of age and getting drunk averagely at 14 years of age. Approximately 13% of young people aged 15 or 16 have been already drunk more than 20 times and more than 18% have experience with binge drinking (drinking until you get drunk) for an average of three or more times the last month (Institute of Alcohol Studies, 2006).

## THE NETHERLANDS

The annual alcohol consumption per capita in the Netherlands is approximately a hundred litres. Alcohol consumption varies with age, though. The group of young people contains the most heavy drinkers (people who drink at least six glasses of alcohol at least once a week). In the group of young people, aged between 15 and 24, 20% are heavy drinkers (image 17). The rest of the people in this group drink an average of 1.4 glasses a day. As can be seen in image 17, this is almost the same amount as the over-65s. People aged between 45 and 65 drink an average of 1.6 glasses a day. In this group, 12% are heavy drinkers and 14% drink at least three glasses a day (CBS, 2007)

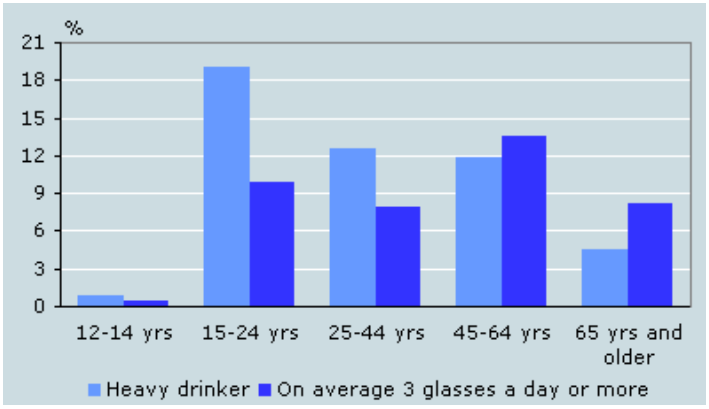



IMAGE 17: ALCOHOL SONSUMPTION PER AGE IN THE NETHERLANDS IN 2006. SOURCE: CBS

Because the group of young people drinking is striking, they are divided into male and female and a smaller interval of age in image 18. The image shows that women don't differ

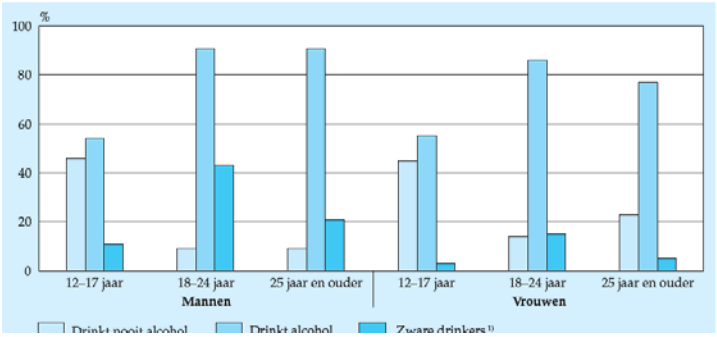



IMAGE 18: ALCOHOL CONSUPTION IN GROUPS OF AGE. *SOURCE: CBS*

much from men looking at their 'normal' behaviour of alcohol consumption. It is striking, though, that among men (especially aged between 18 and 24) there are far more heavy drinkers than among the women.

## 3.2 TARGET GROUP

Heavy drinkers are mostly present in western countries among young people aged between 15 and 24 years. In the Netherlands, 20% of these group of people are heavy drinkers. Mainly men represent this group. The annual alcohol consumption per capita in the Netherlands is approximately a hundred litres (young people included) against 15 litres in Europe, only adults reckoned in. Comparing this with the overview in image 16, there can be read that the consumption per adult per year is in the Netherlands less than 14,5 litres.

So, when young people are included in this sum, they include a large part of the consumption per capita. The average consumption per capita among young people in Europe is probably even higher than that of the Netherlands when estimating the average consumption, youngsters included.

Thus, young people come in proportion more into contact with alcohol than adults. A part of this young group of people get their licence for car driving when their 16 (America), 18 (Netherlands) or just some time later. It is therefore very important that they not only are confronted with alcohol consumption but also with the risks of drink and drive. For this reason these young people are chosen to be the target group.

## 3.3 ENQUIRY

To get to know the target group, an enquiry was held among a group of students from the Netherlands aged between 18 and 26. The list of asked questions can be found in annex D. The results showed below are extracted from the questions concerning alcohol testing and what the kind of additional function it should have.

### RESULTS

About alcohol testing:

People who were tested on alcohol consumption in public thought it was fun or didn't have a clear opinion. People who were not tested was asked what they would think íf they are tested. The half of this group didn't have a clear opinion. 4% thought it is annoying, while the remain of the group thought it is even fun (33%) or much fun (15%).

The respondents was asked what they think is the most enjoyable way to detect alcohol, after explaining that detecting is possible via breath, urine, saliva and perspiration. More than the half of the group think detection via breath is the most pleasant, because it is easy and not very radical. After detection via breath, detection via saliva is thought the most pleasant (22%), because it is a very effortless method. Urine is thought the most unpleasant, because it is a very awkward method and very radical.

During the enquiry it became obvious people think it is important to have at least a bit reliability concerning the testing method.

About additional function:

At the beginning of the enquiry the respondents was asked if they had ever been to a particular event and if they got any kind of gadget at that event. Well over the half of the group has been to a music festival (e.g. Lowlands, Parkpop, Pinkpop). Less visited were events like dance party's (e.g. mysteryland, trance energy), concerts and fairs (e.g. furniture, game).

The respondents called most of the gadgets received at an event 'rubbish', because the product are fun to have at the event, but at home it is useless. They called products like pencils, key cords and luminous objects. They say the more useful, fun and original objects, like bracelets with a second function, a radio and a can holder for beer, are products which are taken home and used. They said also that fun products, like eatable objects are not taken home, but yet remembered.

So, in short: An enquiry was spread among representatives of the chosen target group: students aged between 18 and 24 years. They were asked questions about alcohol use and if they ever had an experience with driving while alcohol was consumed. After that the questions turned to questions about gadgets and visited events. Most students think that testing using breath is most pleasant and testing itself is not experienced as annoying. Most students attach importance to reliability, but not too much. Testing using someone's urine is thought the most unpleasant and radical. Due to this result urine is rejected as future testing principle.

Most students did go to an event and got a gadget there. More than half of the students has ever been to a music festival and receives a gadget. Gadgets were defined as 'rubbish' when a one time use is fun at the event itself, but not at home or somewhere else after the event.

# CHAPTER 4

THE PROGRAMME OF REQUIREMENTS

To start designing an alcohol testing device, demands concerning the product have to be formulated. The requirements from the target group can be derived from the enquiry from the previous chapter. There are also demands from the principal and of course some production, distribution and disposal demands are set up.

## 4.1 PROGRAMME OF REQUIREMENTS

***Demands for production:***

The gadget is at first produced in one design

The gadget is produced by a suitable production method

The gadget consists of low-cost parts

The gadget uses an already existing testing method

The gadget is as qualitative as possible

The gadget has as few parts as possible

The gadget is easy to assemble

***Demands of use:***

The gadget can detect alcohol<br>The gadget can observe alcohol } within one minute

The gadget can indicate the detected permillage without using digits

The gadget can indicate the minimal permillage at which driving is not allowed any longer

The gadget can be used multiple times

The gadget is a handheld (small) product

The gadget has an interchangeable power supply

The gadget has to be intuitive in use and need very few instructions

The gadget has a simple interface

The gadget can test again within one minute

The gadget uses a pleasant testing principle

The gadget has a positive influence on the user and is experienced as a funny action

The gadget is experienced as useful at every occasion with alcohol involved

The gadget is distinctive from competing products

*Advisable demands*:

The gadget can detect & observe alcohol in 10 seconds

The gadget can test again after 10 seconds

The gadget can be used in  a campaign of a brand selling alcoholic beverages

***Demands for distribution***:

The gadget is packaged during distribution and sales

The gadget can be bought in a retail store (also online)

***Demands for disposal:***

The gadget is recyclable

The gadget is harmless to the environment

The gadget is easy to disassemble

The gadget can be treated as regular waste in a waste disposal

At the end of the design process the requirements are checked whether the designed product satisfies the programme of requirements and in to what extent.

# CHAPTER 5

POSSIBLE ADDITIONAL FUNCTIONS FOR THE PRODUCT

The first function of the additional function has to achieve that the user is confronted in an indirect way with his/her alcohol consumption level. The second function is to invite the consumer to use the product and third, cause the user to either blow, perspire or produce saliva to start the test. Because testing using urine is judged to be very radical, this method has been rejected (paragraph 3.3).

## 5.1 MINDMAP

To get inspiration for the additional function a brainstorm was executed to list possible ways to excite perspiration, saliva or breath. For this reason a mindmap was produced.

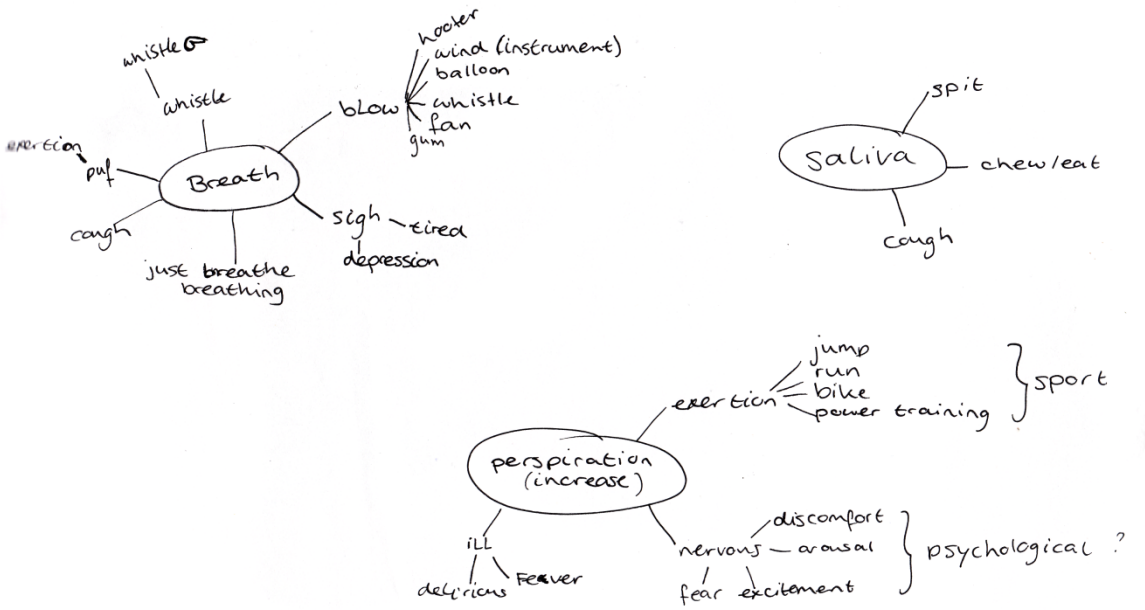



IMAGE 19: MINDMAP

The useful term that can be a possible application in the product is excite perspiration.

When a person does any kind of exertion, the blood in the body is going to stream faster and transdermal skin breathing increases. When the exertion continues and the body heats up it produces sweat. The transdermal skin breathing can be absorbed for alcohol analysis.

To receive a sample of breath enough for a sensor to analyse that sample there is expected that just one method produces a reliable sample:

Blowing. A substantially blow near the sensor in a testing device will give the best results.

To use someone's saliva the mouth is involved in every possibility: Spit, chew/eat, for example licking, sucking, tongue movements, drinking etc. and cough. It is expected that

saliva produced during chewing/eating has the highest reliability and it is more comfortable than the other two options.

## 5.2 APPLICATIONS

To generate possible applications for the three principles another brainstorm follows upon the previous mindmap. The terms ‘breath’, ‘perspiration’ and ‘saliva’ are placed centrally and associative terms that define an application that uses that principle are placed around it. For example, the terms defined around the breath:

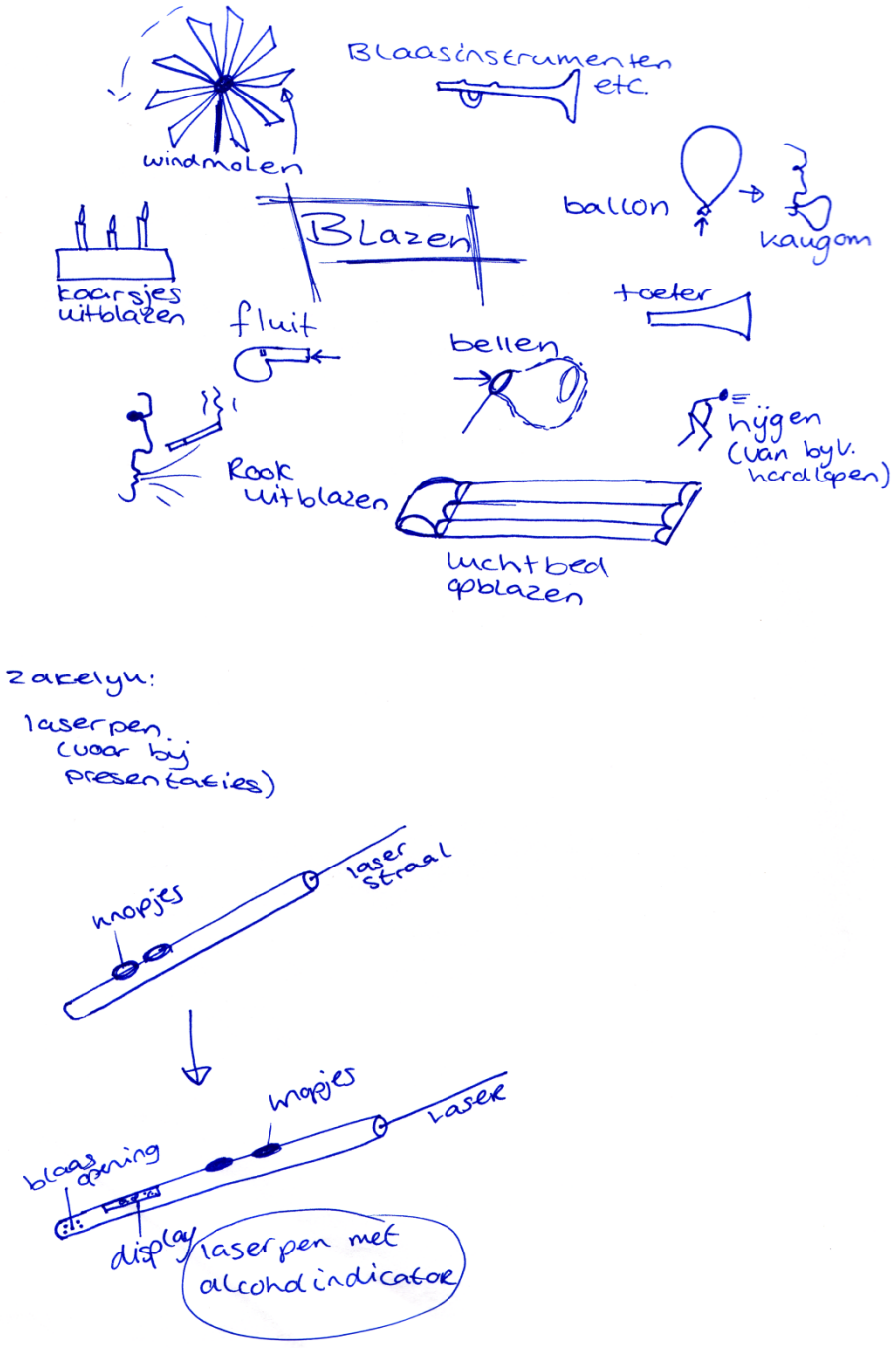



IMAGE 20: MINDMAP AND SKETCHES

## 5.3 IDEAS

For each of the three principles some ideas were thought up that could be possible concepts for the product.

### 5.3.1. BREATH

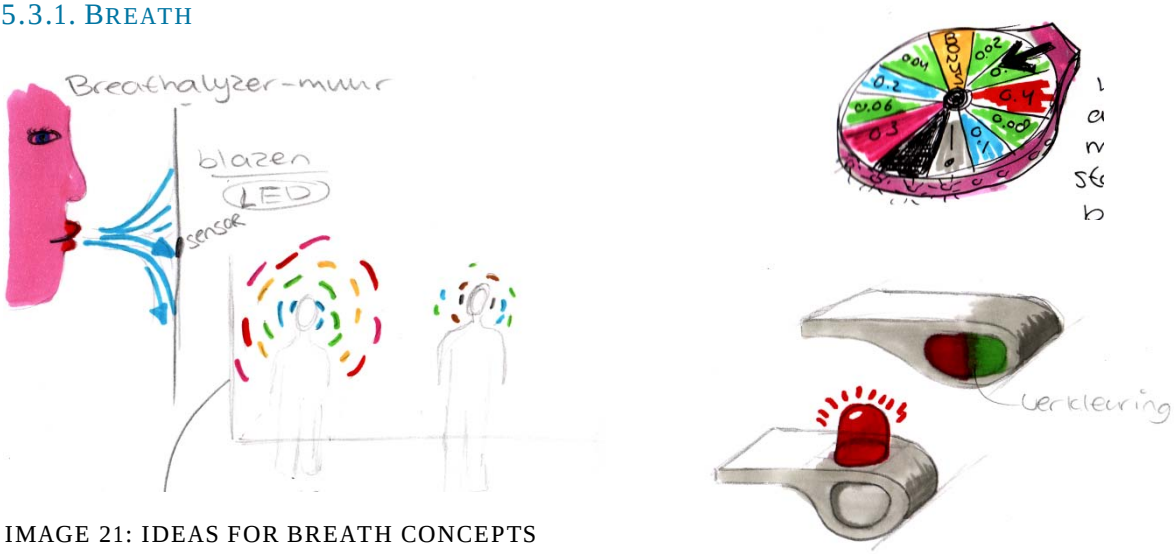



IMAGE 21: IDEAS FOR BREATH CONCEPTS

The first idea is very simple and is close related with blowing: a whistle. When blowing that whistle some unit changes colour, the sound changes etc. One of the other ideas was to create a wall with sensors where people in, for example, a disco can blow on. The drunker that person is the less colourful pattern will be produced. This is then psychologically seen as a 'punishment'. Although this idea does not really fit the demands it was a nice idea though. One of the ideas that made it to a concept was the 'wheel of fortune'. This device is like game. A person blows into the device and the arrow indicated the amount of alcohol the user has drunk.

### 5.3.2 PERSPIRATION

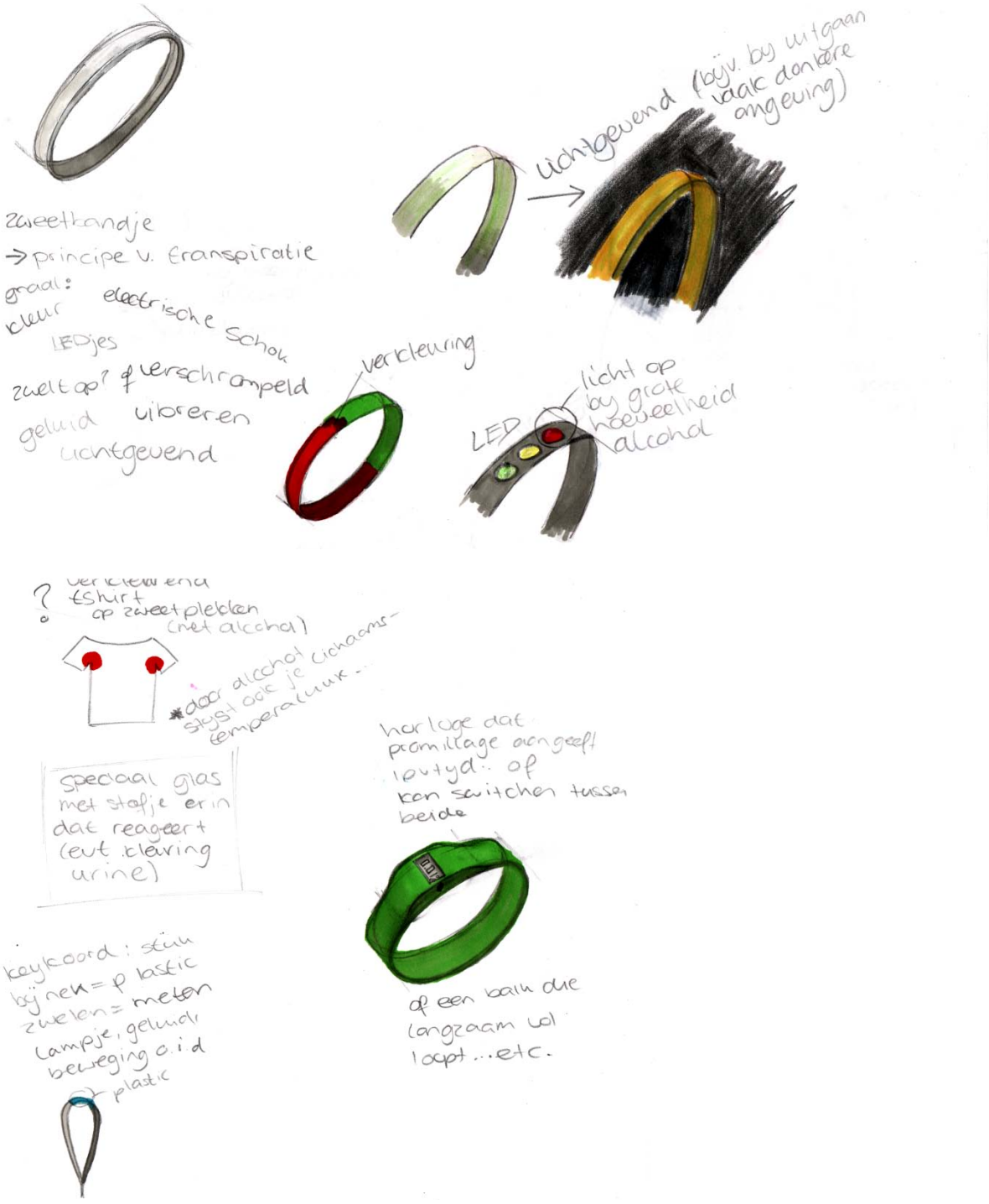



IMAGE 22: IDEAS FOR PERSPIRATION CONCEPTS

This first idea too is very simple: a bracelet that does a certain action when detecting alcohol, like glow in the dark (for in a disco perhaps), colour change, LEDs, etc.

After the bracelets some funny ideas came up, like colour changing clothes and accessories.

### 5.3.3 SALIVA

Ideas concerning detecting using saliva resulted in applications where some type of consumption is involved i.e. gum, lollipops, a glass etc. The idea with gum was to eat it and when the user has consumed alcohol, the gum colours the tongue a specific colour. This is like an already existing type of gum, yet it has an underlying meaning.

Another idea was to implement a sensor in the edge of a glass. This sensor measures every time the user drinks from the glass.

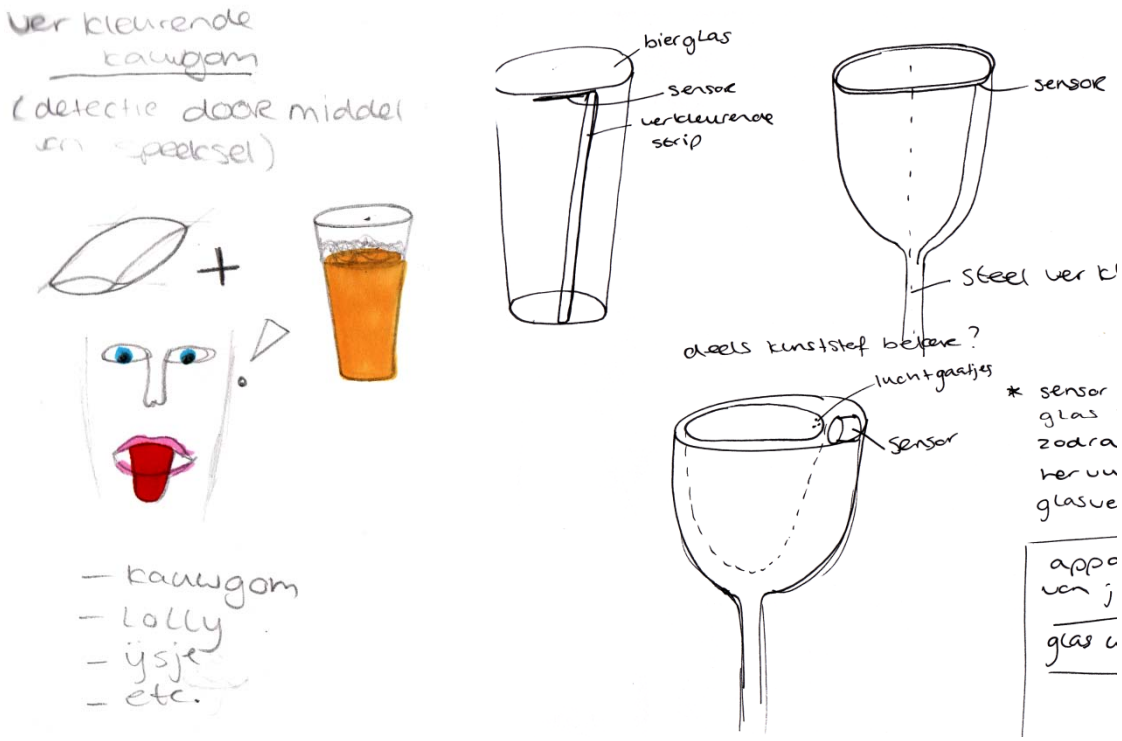



IMAGE 23: IDEAS FOR SALIVA CONCEPTS

# CHAPTER 6

CONCEPTS

From chapter 5, many ideas were elaborated to possible concepts. In a meeting with the staff of the company, three out of many concepts were chosen which could be a possible product and which were considered most fun and original.

## 6.1 CONCEPT 1 - 'ALCOWATCH'

This concept works by analysing assimilated perspiration. The device can be used as a normal watch, but when someone consumes alcohol, the sensors will signalise the alcohol consumption and the display shows the current signalised permillage. The concept name is chosen because it is ambiguous: Literally it is a combination of 'alcohol' and 'watch', but can also mean that the alcohol consumption is monitored, i.e. watched. The method used in this device is not invasive and can be used as a normal watch. The permillage indicator however confronts the user with alcohol consumption.

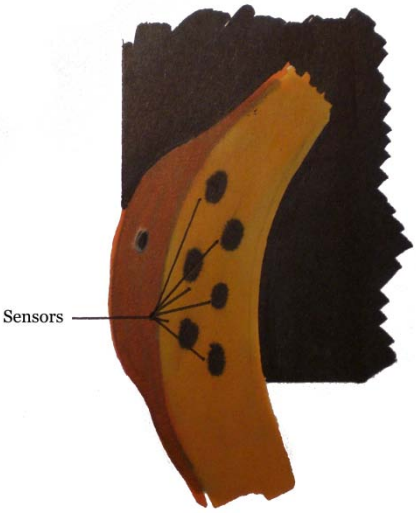




IMAGE 24: CONCEPT USING PERSPIRATION

## 6.2 CONCEPT2 – ‘ALCOPOP’

This concept works by a substance that reacts to alcohol present in someone’s saliva. The substance changes colour (which can be eaten with the rest of the lollipop) to indicate how much someone has drank. The name ‘alcopop’ is here too a combination of two words: ‘alcohol’ and ‘lollipop’. The term ‘alcopop’ already exists as a term for certain flavored alcoholic beverages, but is fine concept name for now. The alcopop has a high fun factor, but can be used only once.

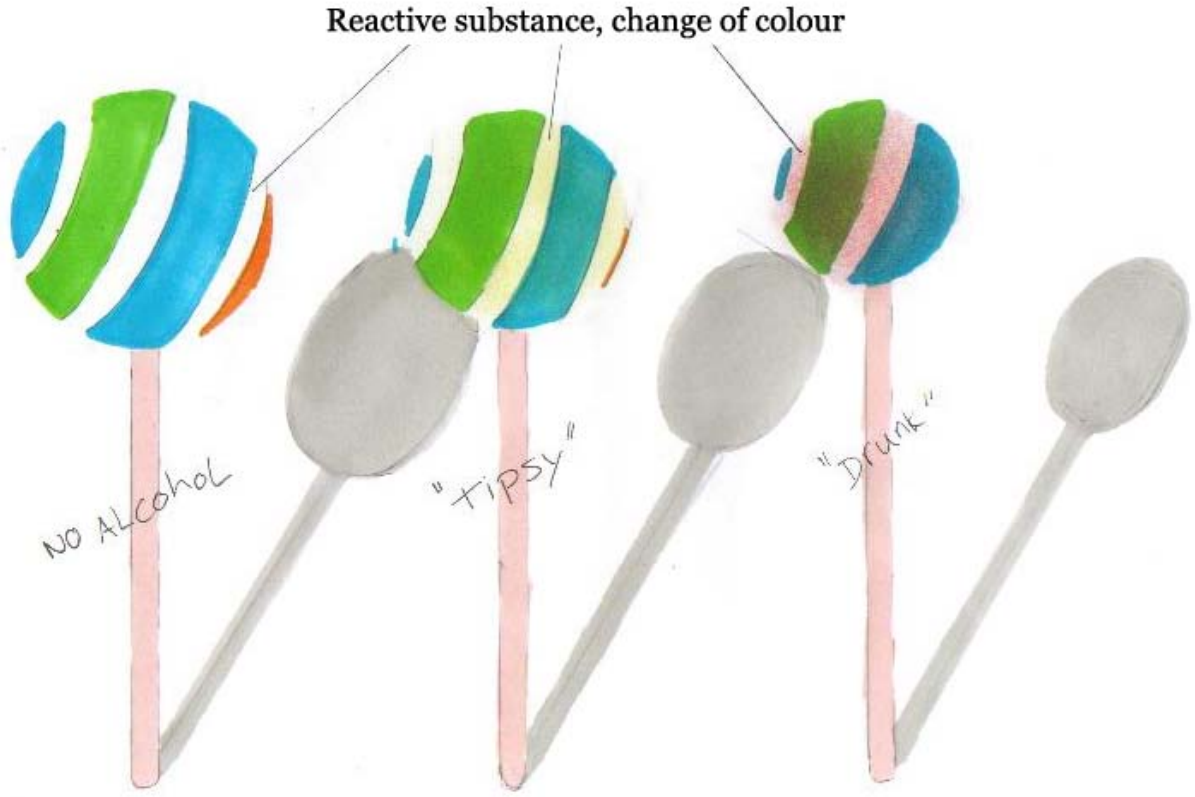



IMAGE 25: CONCEPT USING SALIVA

## 6.3 CONCEPT 3 - 'WHEEL OF FORTUNE'

This is actually a concept which came up a few hours before the concept-meeting. The concept arose from testing on alcohol and doing this in the form of a game, so people are actively gain conscience about alcohol consumption. Together with the analysis what can be activated with someone's breath (in this case the principle of a mill/ventilator was used) the idea of a game with a rotor came up, like the game 'wheel of fortune'.

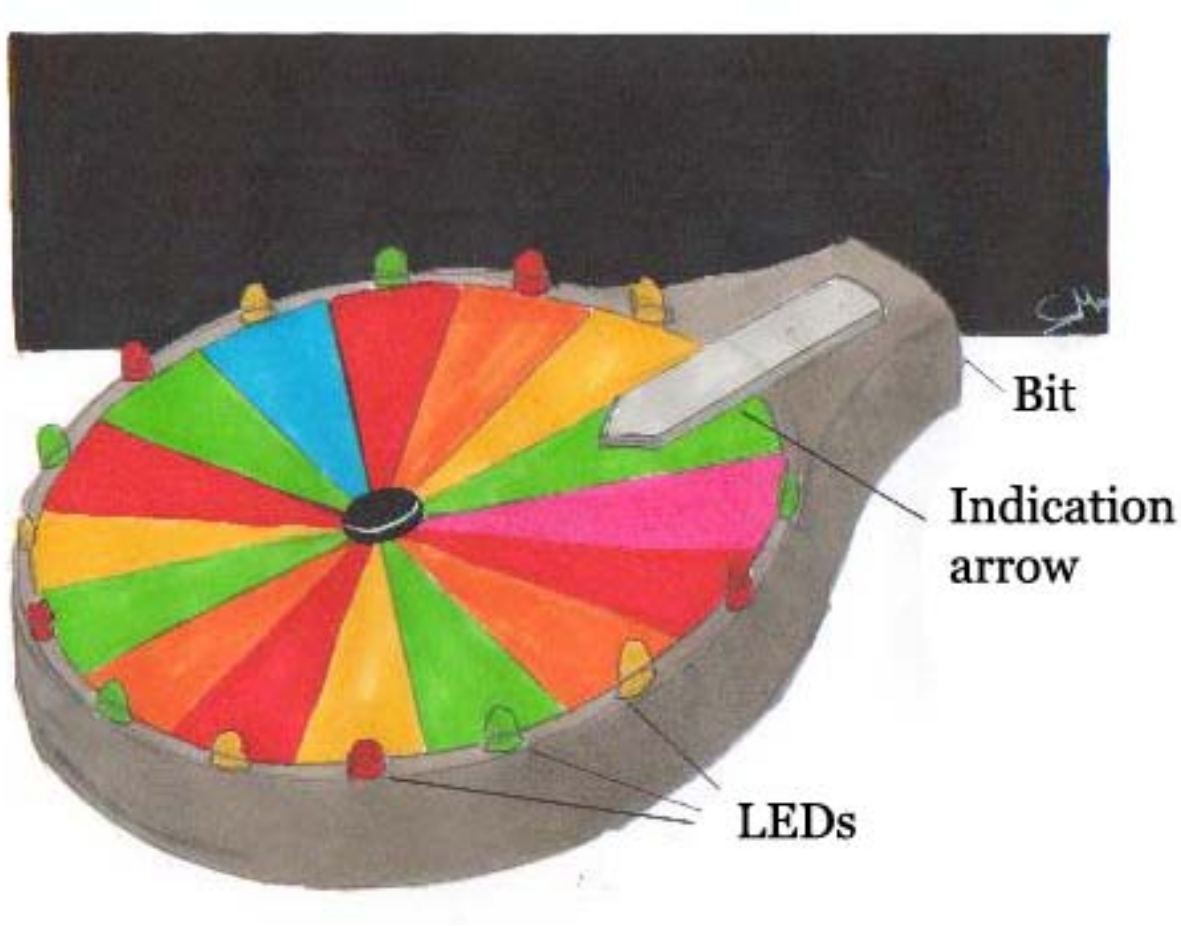



IMAGE 26: CONCEPT USING BREATH

If someone blows into the device using the bit the rotor will start to rotate and the LEDs will be flashing. At the same time the breath is analysed. A not yet specified system will cause the rotor to stop the colour indicating the permillage interval at the indication arrow. To help indicate the permillage a rating can be printed on the different parts. The device can be reused time after time. The concept does not really have a clear side-function, but is not confronting the user immediately.

# CHAPTER 7

WHICH DESIGN IS GOING TO BE ELABORATED?

## 7.1 CONCEPT CHOICE

In this chapter the concepts are reviewed on numerous aspects to choose the concept that will be elaborated to a feasible product. First the concept will be judged based on the programme of requirements. Some demands can not be taken into the judgement, because those requirements are not yet processed in de concepts.

The requirements where the decision concerning the programme of demands will be based on, are:

1. The gadget can indicate the permillage without using digit
2. The gadget can be used multiple times
3. The gadget is a handheld (small) product
4. The gadget is intuitive in use (less or no instructions)
5. The gadget has a simplistic interface
6. The gadget uses a pleasant method as a testing principle
7. The gadget is distinctive from competing products

Other aspects that are taken into account:

1. Expected Fun factor
2. Originality
3. Feasibility
4. Cost expectation

The last four aspects are issues the company think is important, so demands claimed from the principal. The ratings for these aspects are discussed in a meeting concerning the concepts. Table 4 shows all different ratings ascribed to the different demands and aspects. The ratings for satisfying the demands and are as follows: 0=not at all, 1 = a bit, 2 = reasonably, 3 = yes.

Why some concepts are less strong in certain aspects (and thus rated under 3 points) is explained:

### 'ALCOWATCH'

The watch uses digits whereas the demand is to use no digits. The product has to be low-cost so can not be as precise (yet reliable though) so that the permillage is showed with numerous digits. A watch is not very distinctive, because there are also other watches which contain a variety of additional functions too. This is also the reason why it also is not very original. The system must be installed in a small accommodation which causes that the concept is going to be expensive.

### 'ALCOPOP'

This concept is less strong in the following aspects: The demand that can not be satisfied at all is the demands that the product can be used multiple times. When the lollipop is eaten, the product is gone. A lollipop is not very distinctive, it is a type of candy which has hundreds of varieties of its kind. A lot of lollipops are changing colour too. In that way it is not very original, but yet more than the 'alcowatch' because the combination of the lollipop and the reaction with alcohol is not common. The reaction that takes place is used to indicate alcohol. This substance which causes the reaction is normally used on a strip. It is not known if this substance can be dangerous when absorbed in the human body.

### 'WHEEL OF FORTUNE'

This concept is less strong in the following aspects: A watch and a lollipop are products every human is known with. So, it can be difficult to get the working principle immediately when having the product in one's hand. For this reason the concept is rated as a little less intuitive than the other two concepts. Because the system for detecting and signalising alcohol must fit in a certain accommodation the feasibility and cost expectation are rated at two.

Based on the table, the third concept, 'Wheel of fortune' will be elaborated to a product concept. The staff of the company was very enthusiastic about this concept too.

| | 'Alcowatch' | 'Alcopop' | 'Wheel of Fortune' |
|---|---|---|---|
| **No use of digits** | 0 | 3 | 3 |
| **Used multiple times** | 3 | 0 | 3 |
| **Small Product** | 3 | 3 | 3 |
| **Intuitive** | 3 | 3 | 2 |
| **Simplistic interface** | 3 | 3 | 3 |
| **Pleasant method** | 3 | 3 | 3 |
| **Distinctive** | 1 | 2 | 3 |
| **Fun factor** | 1 | 3 | 3 |
| **Originality** | 1 | 2 | 3 |
| **Feasibility** | 2 | 1 | 2 |
| **Cost expectation** | 1 | 3 | 2 |
| | | | |
| **Total** | **21** | **26** | **30** |

TABLE 3: RATING DIFFERENT ASPECTS TO HELP THE DECISION MAKING PROCESS. 0=NOT AT ALL, 1 = A BIT, 2 = REASONABLY, 3 = YES

# CHAPTER 8

DETAILED DESIGN

The concept 'Wheel of fortune' is elaborated to a product concept. The concept is first elaborated to a device which has the focus on the rotating wheel as dynamic part of the tester. After analysing this proposal, there was decided to elaborate the concept again, but now with no rotating wheel but LEDs as the dynamic aspect. After this, a final choice is made which elaboration is the final direction of the project. This concept is then further detailed in e.g. proposal for power supply, electric circuit, design etc. and more insight is gained in the use of different sensors.

## 8.1 PHYSICAL ROTATING INDICATOR

### DRIVING THE WHEEL

To keep the game-element, it was stated that the rotating wheel had to stay in the final design. So, first a solution must be found to let the wheel rotate when the consumer blows into the device. These two facts can be combined: due to the blow of the consumer into the device the wheel starts to rotate and simulates the rotating wheel of the game 'wheel of fortune'. In this case no motor is needed to urge the wheel. To start rotating, the wheel needs to be connected to a fan that uses the blown breath to start the rotation.

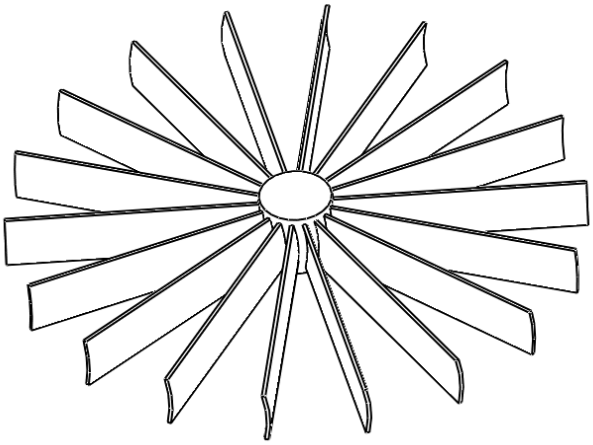


IMAGE 27:FAN

### STOPPING THE WHEEL

While the wheel is rotating, the sensor has time to analyse the breath that is blown in the device. But how can the result of the sensor be read from the wheel? The wheel has to stop at some point that indicates the alcohol concentration in the breath.

The idea came up to solve this problem with magnets.

Electromagnets to be precise. An electromagnet is a type of magnet in which the magnetic field is produced by the flow of electric current. The magnetic field disappears when the current ceases.

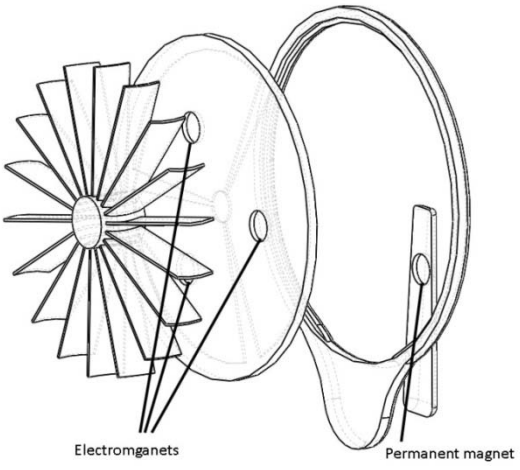



IMAGE 28: EXPLODED VIEW

The way in which this can be applied in the gadget is the use of placing a electromagnet per part that indicates the state of the user. Depending on which outcome the sensor gives a current is applied on the accompanying part. So, the dynamic part of this concept is that the fan is rotating together with the wheel with the indication parts. The arrow is fixed on the housing of the gadget.

### ROTATING ARROW

However, when the wheel is rotating the electromagnets rotate too, because the electromagnets are integrated in the wheel. The electromagnets need a current to become a magnet, so the electromagnet needs wiring. When the wheel rotates the wiring enlaces en keeps the wheel from turning. Because of this, this solution is revised to generate a similar, but better, solution. This is by upturning the dynamic aspect of the gadget. The rotating wheel becomes a static part en the arrow (that was a static part) becomes the dynamic part.

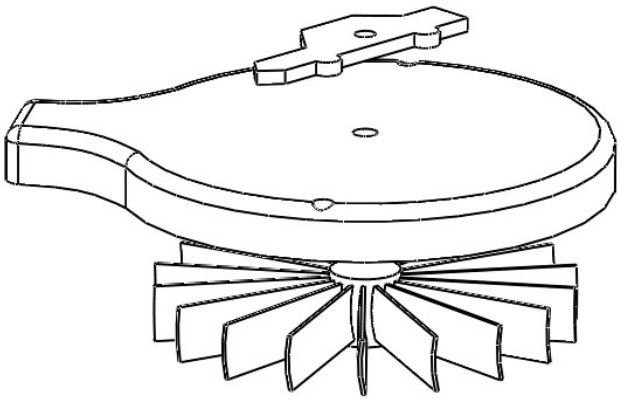


IMAGE 29: EXPLODED VIEW

In this way, a part is still rotating due to the blown breath in the device. The electromagnets can stay in place (integrated in the top housing). In the arrow (in the image indicated as a car, this is explained later), a permanent magnet is integrated still, but the weight of the magnet has to be compensated with another weight to achieve an equilibirum to permit an equivalent rotation.

Because this is considered as a promising elaboration, different design for the indication parts were made. Finally, the traffic-design was selected to have association with traffic use.

IMAGE 30: INDICATION PARTS DESIGN

The arrow is shaped as a car to support the design of the indication parts. The options to indicate the alcohol concentration is reduced to two options, because of the complexity of the electronics and take away the doubt of the user if the permillage of the user is at a higher or lower side of the limit permitted to drive or quite the contrary.

However, this solution raises some problems when a little study is done concerning electromagnets:

1) Electromagnets need high power supply
2) The needed dimensions of the electromagnets are hard to reach
3) Electromagnets are too expensive to be applicable in a gadget that has to be as cheap as possible.

An example of one of the smallest electromagnets found comes from the website of www.planetengineers.com:

Electromagnet, Tubular, Low Profile, 6.0 VDC Continuous Duty, 1.00" (25 mm) DIA X 0.66" (17 mm) L

Unit Price for 1-4 Pieces: $35.15 *(€11,23)*

IMAGE 31: EELCTROMAGNET

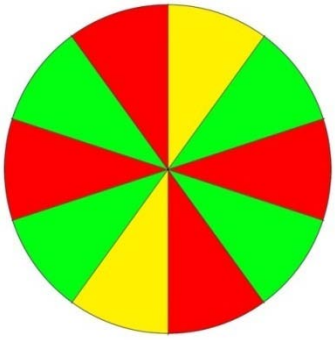
IMAGE 32: DRAWING OF DESIGN ONE

The questions raises if the consumer appriciates the fact that there are only two outcomes possible: do or do not drive a car. There are doubts if the breath can start the whole mechanism to rotate at a reasonable speed. Because of these doubts a second idea was elaborated to design two.

## 8.2 VIRTUALLY ROTATING WHEEL

This design goes back to the first idea of the concept as it was when it was chosen. That is, a turning wheel and flashing LEDs. Because the elaboration of the turning wheel and stopping it at the right spot turned out to be difficult and it uses a complex mechanism to do so, design two has a focus on flashing LEDs and use the LEDs to notify the outcome of the sensor. It is chosen to use 10 LEDs, because then there are a enough LEDs to make the test experience exiting enough (which colour is going to light up at the end) but not too many LEDs that the LEDs need a large power supply.

The sensor is warmed up when a button is pressed in the middle of the wheel (see hole in the middle of the top view at image 33). When the sensor is warmed up the user can start blowing. When it is detected that the user blows into the device (with an airflow sensor), the LEDs start to flash simultaneously until the sensor has detected the permillage of alcohol that is present in the breath. Then, the sensor shows the outcome by flashing LEDs that light up one by one in consecutive order (like a wheel). At first the LEDs flash at a fast speed and then slow down and stop at a LED which colour indicates the permillage in the breath. The sticker pertaining to support the LEDs and decorate the device can be something like this (left image):



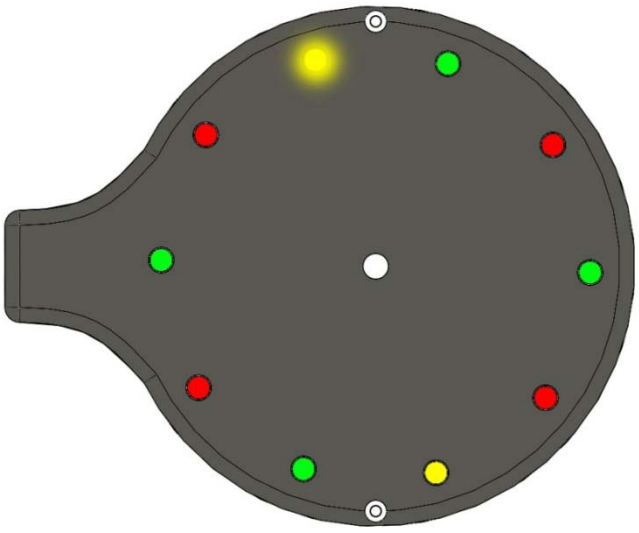


IMAGE 33: DESIGN OF RESULT TWO, TOP VIEW

### CONCLUSION

The second design has the advantage that the level of alcohol in the breath can be displayed more specific, for example for defining the range of permillage in each indication part. The mechanism is simpler than the mechanism of result one, so it is presumably cheaper to produce and therefore it is more suitable as a device that has to be a (cheap) gadget that can be, for example, passed around by a producer of beer.

It is important though that the element of playing a game, but also propagate an indirect message, is preserved.

Comparing the two designs, the second result satisfies a few demands better than the first result. For example, the gadget has as few parts as possible and because there are no electromagnets and no fan the device is easier to assemble and the LEDs cost less than the electromagnets and the fan (demand: The gadget consist of low-cost parts and the gadget is easy to assemble).

## 8.3 FINAL DESIGN

### SHAPE DESIGN

The base shape of the tester (as proposed in the concept) stays, so a circle with a bit in which the user has to blow its breath. A small study was executed to gain insight in the different shapes of bits applied on other alcohol testers:

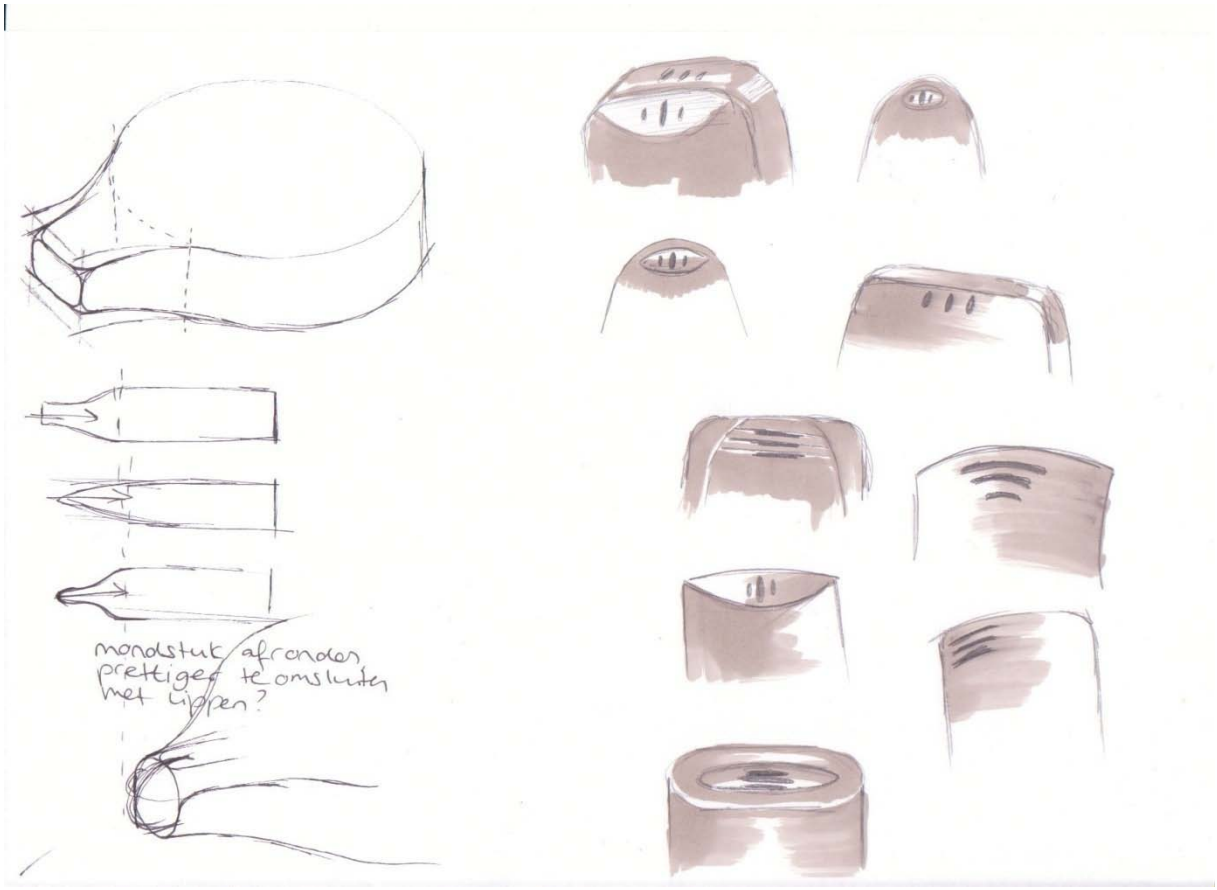



IMAGE 34: SKETCHES FOR THE BIT

The bit in the concept is an almost square shape. The study shows that most of the bits used are of a rectangular shape (app. 3 centimetres in length) with rounded corners and multiple holes (mostly three) to let in the breath into the device. The final chosen shape of the bit is shown below. It is a mixture of the different designs shown in image 34.

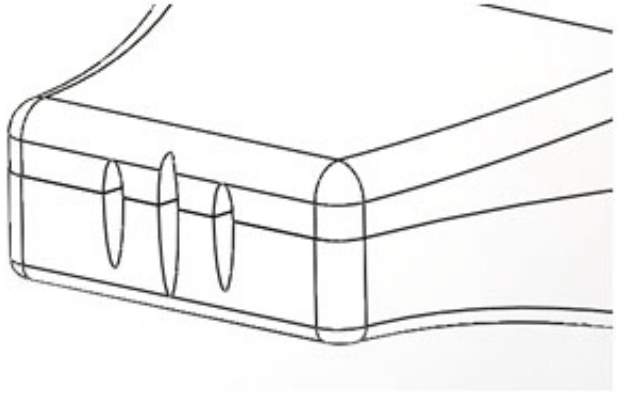


IMAGE 35: FINAL SHAPE OF THE BIT

## SOLIDWORKS

The final concept is elaborated in SolidWorks. This gives a clear  view of the number , shape and orientation of the parts. The production method (injection moulding) is also taken into account when designing the parts. Injection moulding is cheap and is used for high editions. All parts are discussed on the following pages.

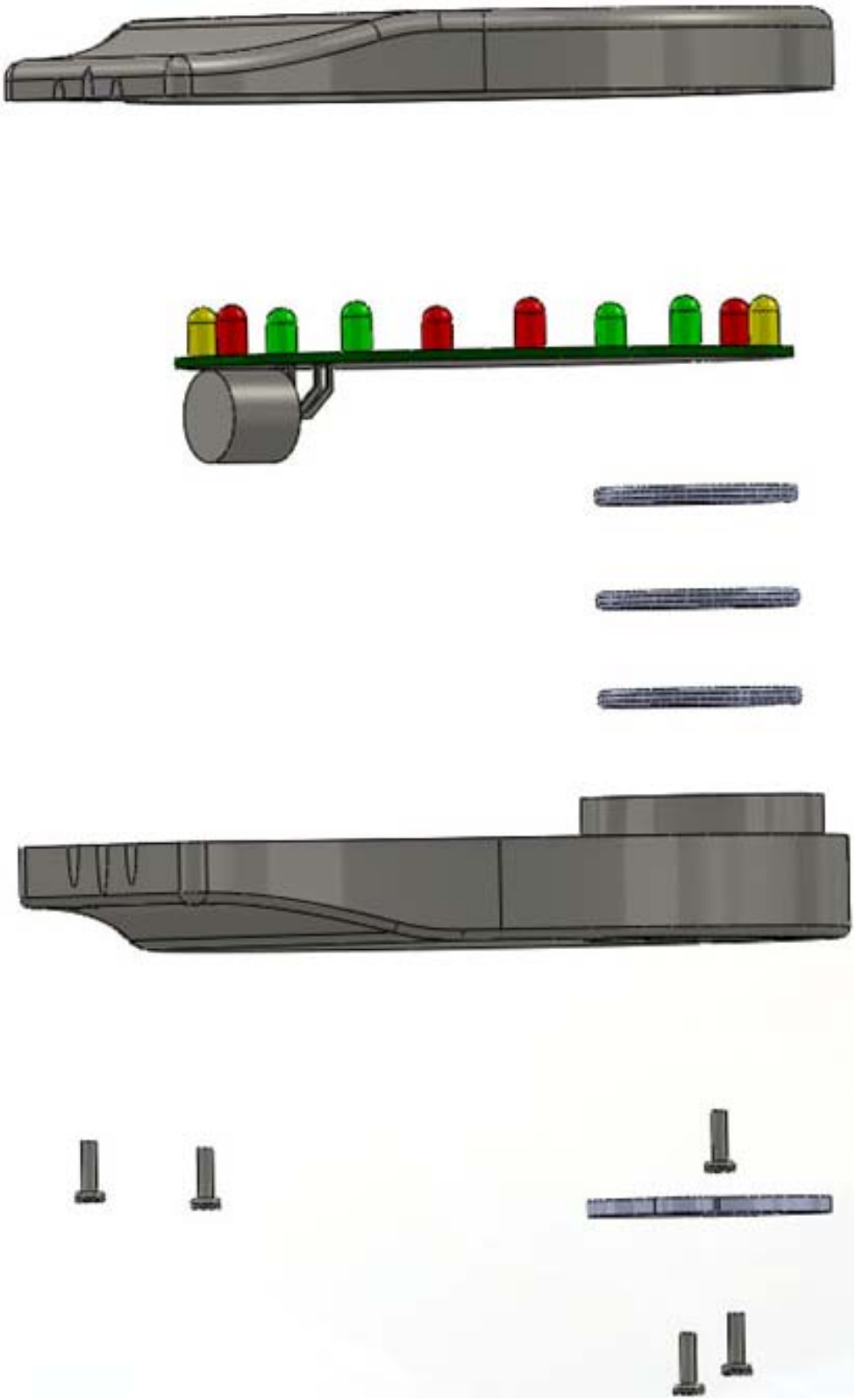


IMAGE 36: EXPLODED VIEW OF THE ALCOHOL TESTER

### TOP HOUSING

Both top and bottom housings circle element has a diameter of 70 mm. The bit extends 20 mm. The height of the part is 8 mm and the wall thickness is 2mm. The dimensions of the bit derives from the other bits analysed at 'shape design'. The diameter of the circle is derived from the the requirement that the gadget must be a handheld device. The chosen dimension allows enough space for placement of a PCB, LEDs and power supply. There are 10 holes for the LEDs, these holes are supported at the backside with 10 circular ribs. The backside supports also the three screws that connect the bottom housing with the top housing. At the front of the bit there are three oval holes that leads the breath to the sensor that is almost directly behind the holes. The inlet at the top (backside view) is for leading the bottom housing to the right position in relation to the top housing. The top housing is connected to the bottom housing by three screws. The holes for the screws are supported by bosses.

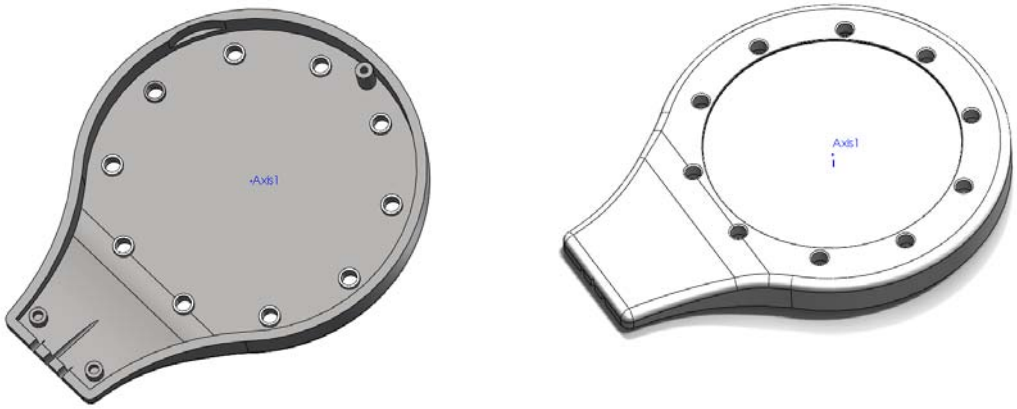


IMAGE 37: TOP HOUSING, INSIDE VIEW AND OUTSIDE VIEW

### PCB WITH LEDS AND SENSOR

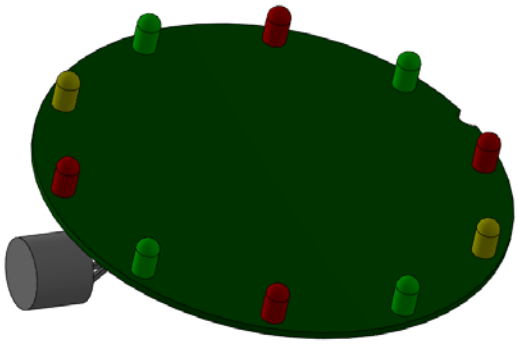


IMAGE 38: PCB WITH LEDS AND SENSOR

The LEDs are placed equally spaced on a PCB. There are no other components on the PCB because there are many ways in which the circuit can work and developing a circuit is no part of this assignment. It is presumable that the sensor is connected to the same circuit as the LEDs, so the sensor is placed near the PCB. The sensor has the same dimensions as showed in the datasheet. The inlet at the right side of the PCB supports the orientation of the PCB in proportion to the top housing. The PCB can be glued to the top housing using the edges

supporting the holes and the boss for the screw. A proposal for the sensor is discussed further in this section. The airflow sensor is positioned near the alcohol sensor and the warm up button in the middle of the PCB (not visible at image).

### BOTTOM HOUSING

The bottom housing is pretty much the reflection of the top housing, but the height of this part is 10 mm instead of 8 mm. The circular hole allows three buttons cells in the device. The space for the button cells is closed by the PCD that closes up to the edge. The buttons cells can be exchanged when they are empty by removing the cover that is connected to the bottom housing by two screws. The bottom housing is connected to the top housing by three screws. The screws sink 2 mm into the housing.

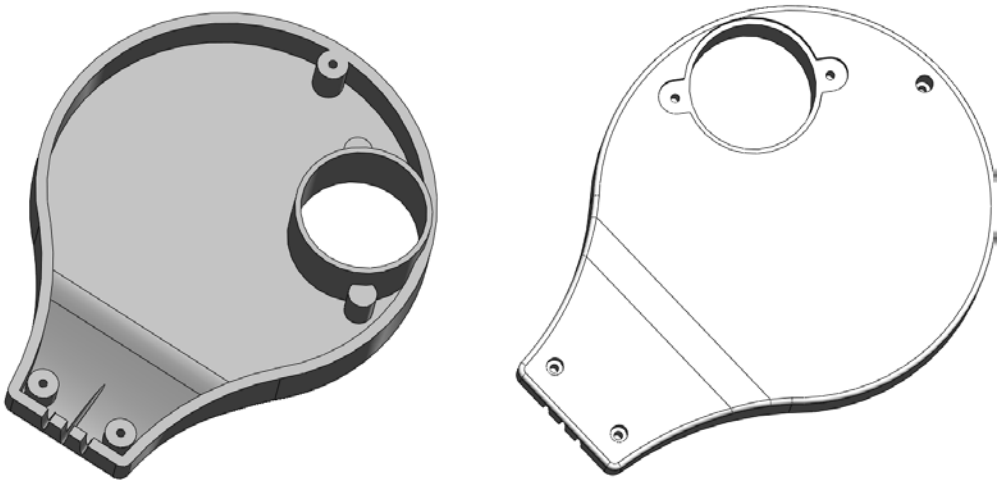


IMAGE 39: BOTTOM HOUSING, INSIDE VIEW AND OUTSIDE VIEW

### COVER

The cover closes the space for the button cells. The diameter o the circle is 24 mm. The screws sink 1 mm into the cover.

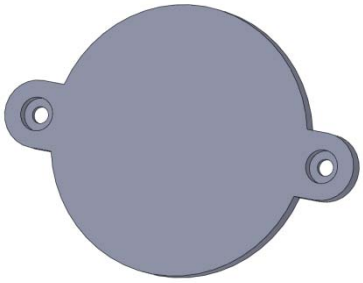


IMAGE 40: COVER

### SCREWS

Just one type of screw is used to minimize the number of different parts needed. This type of screw is also used in the bought alcohol tester in paragraph 8.2. It is a M1.5 screw with a button head. The length of the thread is 5 mm.

## STICKER DESIGN

The parts on the sticker have to fit the outcome of the sensor showed by the last LED that is lighten up (en stays lighten). The chosen sticker design is based on the allowed permillage in traffic. For every driver who obtained a license after 30th of march 2002 in the Netherlands, a maximum of 0.2 ‰ is applied. This maximum is used for the sticker design. Because the boundary of driving lies at 0.2‰, first four green parts indicate permillages smaller than 0.04‰, 0.08‰, 0.12‰ and 0.16‰, indicated too with a check mark on the background. After this value the user enters the 'danger zone', indicated with a lightning bolt and the values of greater than 0.16‰ and 0.18‰. (if the sensor measures an exact value of 0.16 ‰ it shall indicate 'more than 0.16‰ because alcohol is a serious topic). When the user has too much alcohol the permillage is indicated in values of 0.1‰. This is because experienced drivers (with a license before 2002) are allowed to have 0.5‰. This permillage can be achieved when only having 2 glasses of alcoholic beverage within an hour.

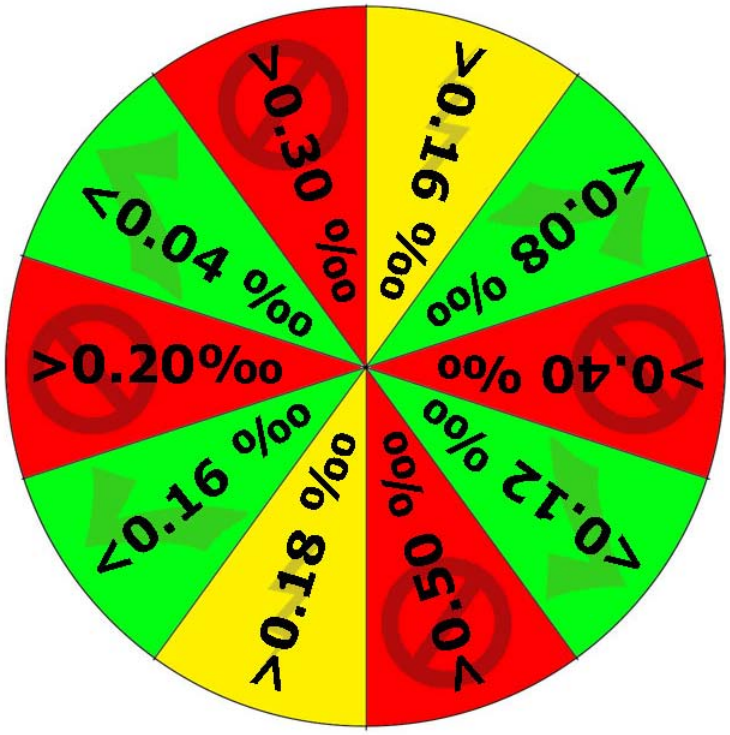



IMAGE 41: STICKER DESIGN

## DIGITAL MODEL

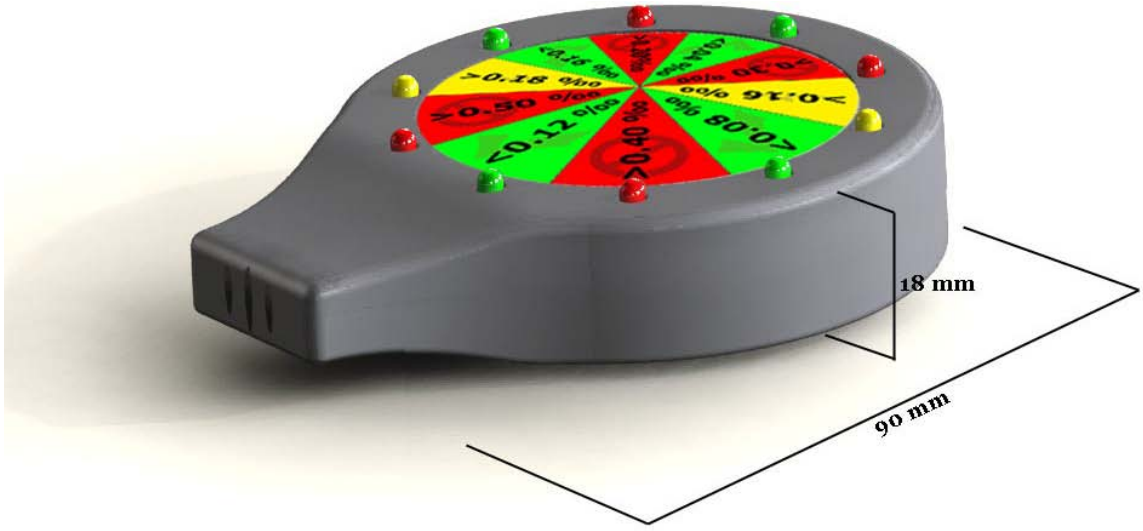



IMAGE 42: RENDER OF FINAL DESIGN WITH DIMENSIONS

## SENSOR PROPOSAL

As explained in paragraph 2.2, the early breathalyzers contained a chemical, orange substance: potassium dichromate. During the reaction with ethanol, the potassium dichromate containing the orange dichromate ion converts into a green chrome(III)ion. The greener the new substance, the more alcohol (ethanol) the blood contains.

Nowadays, an officer can use a digital device. The reaction is a bit different: The sample of the breath is blown through a mix of sulphuric acid, potassium dichromate, silver nitrate (a catalyst) and water. This too results in a green substance. The reacted mixture is compared to an unreacted mixture in a photocell system. This system produces an electric current that causes the needle of the meter to move.

The colour reading was subjective, though. Other, less subjective, methods were found to detect alcohol, i.e. digital devices. The 'digital' version of colour reading is still subjective: an operator must rotate a knob to get the needle back to the origin and then reads the level of alcohol from the knob. The more the knob has to be rotated, the higher the amount of alcohol in the breath sample.

The most recent used method to detect alcohol is the use of a semiconductor alcohol sensor. The sensing element is mostly comprised of a metal oxide semiconductor layer formed on an alumina substrate of a sensing chip together with an integrated heater. In the presence of a detectable gas, the sensor's conductivity increases depending on the gas concentration in the air. A simple electrical circuit can convert the change in conductivity to an output signal which corresponds to the gas concentration.

When comparing the two methods it becomes obvious that the first method is one of the first methods ever used and subsequently refined. The method stays a subjective one, though. With the use of the colorimetric change method, several substances are used like potassium dichromate, sulphuric acid and silver nitrate. Sulphuric acid is a corrosive chemical and can severely burn the skin and eyes. It may cause third degree burns and blindness on contact (NPI, 2008). As with all silver salts, silver nitrate is toxic and corrosive. Brief exposure to the chemical will not produce immediate or even any side effects other than the purple skin stains (Oxford University Chemistry department, 2008). The application of these materials cause that when they are run out it is for a unpractised consumer dangerous to refill the substances and make the device operational again (assumed that there are still little remains of each substance present in the device). Each of the materials is harmful to the environment, too.

As said above, the sensing element is mostly comprised of a metal oxide semiconductor. A small study on the internet resulted in the conclusion that mostly tin dioxide is used as metal oxide. This mineral has its appearance as a white odourless powder. When ingested, it may cause nausea, vomiting and diarrhoea. Because the oxide is formed as a layer it can only do harm when the whole sensor is ingested. The little bit of the tin processed is not harmful for the environment.

IMAGE 43: ALCOHOL SENSOR

For example, the TGS 2620 has high sensitivity to the vapors of organic solvents as well as other volatile vapors. It also has sensitivity to a variety of combustible gases such as carbon monoxide, making it a good general purpose sensor.

Due to miniaturization of the sensing chip, TGS 2620 requires a heater current of only 42mA. The data sheet for this sensor can be found in annex E.

## POWER SUPPLY PROPOSAL

Components that need power supply:
LEDs (10)
Sensor (1)
components on the PCB (converts the output of the sensor to useful data for the alcohol level indication by the LEDs)

**LEDs (3mm)**

| | |
|---|---|
| DC current duty 100% | 20mA |
| Voltage | 2,1V |
| Inverse voltage | 5V |
| Inverse current (5V) | 10µA |

(Source: http://www.leds-buy.nl)

**Sensor**

| | |
|---|---|
| Heater Voltage | 5.0±0.2V DC/AC |
| Circuit voltage | 5.0±0.2V DC/AC |

This means at least four (!) AAA of AA batteries are needed to reach the 5 Volts. To maintain a device that is very compact, another option for power supply is searched for. This resulted in the form of a 3 V (CR2016) button cell that can be serial connected. For example:

Height: 1,6 mm

Weight: 1,6 g

Diameter: 20 mm

Voltage: 3 V

Capacity: 90 mAh


IMAGE 44: BUTTON CELL CR2016

To ensure that the power supply is enough, three buttons cells are needed. Even when three buttons cells are serially connected, it is in proportion to the AA or AAA batteries and their power supply a compact alternative. It is important that the circuit voltage of 5 Volts is reached to allow the device to operate correctly. The capacity is less important, because the device is considered to be used once in a while and the test cycle cost not much time.

## MODEL

The model has two editions: the electric model and the shape model. The electric model shows what the device does when it is testing someone's breath. The other model shows the size and look and feel of the device. When pressing the button in the middle of the LED circle (electric model), the LEDs start to flash in a consecutive order. When releasing the button, the LEDs still flash in a consecutive order but stop gradually. In the end one LED stays lighten. This LED indicates (supposedly) the alcohol level.

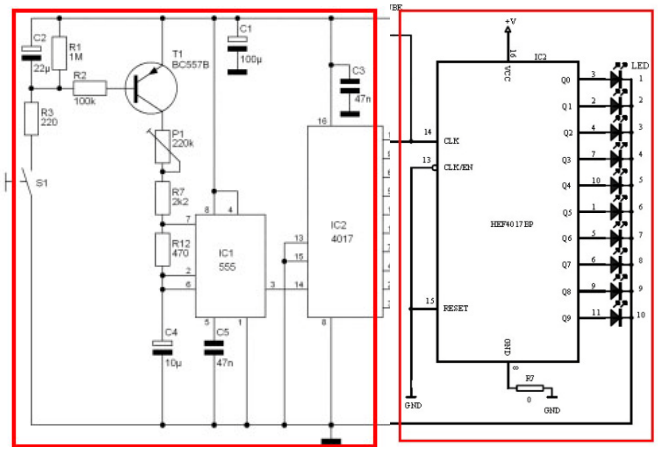



IMAGE 45: ELECTRIC SCHEMEOF COMPONENTS

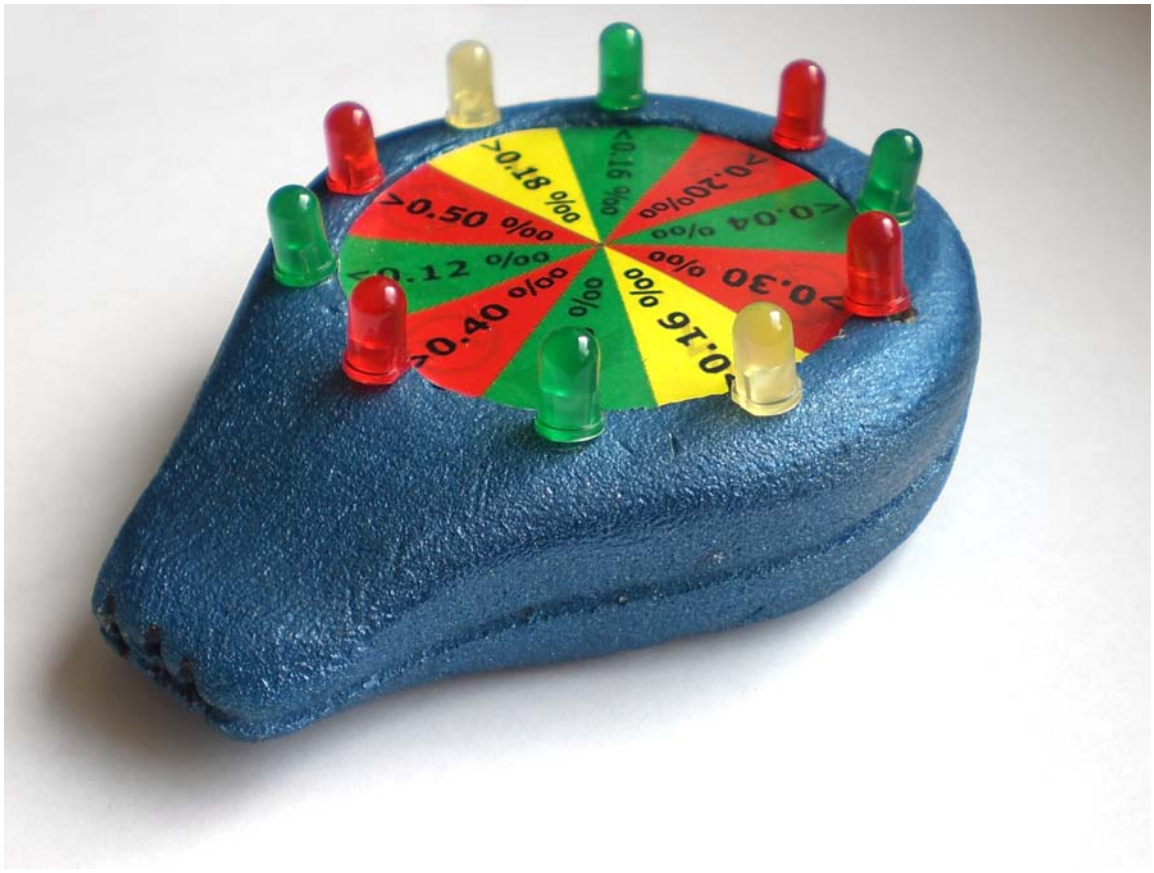



IMAGE 46: FOAM MODEL

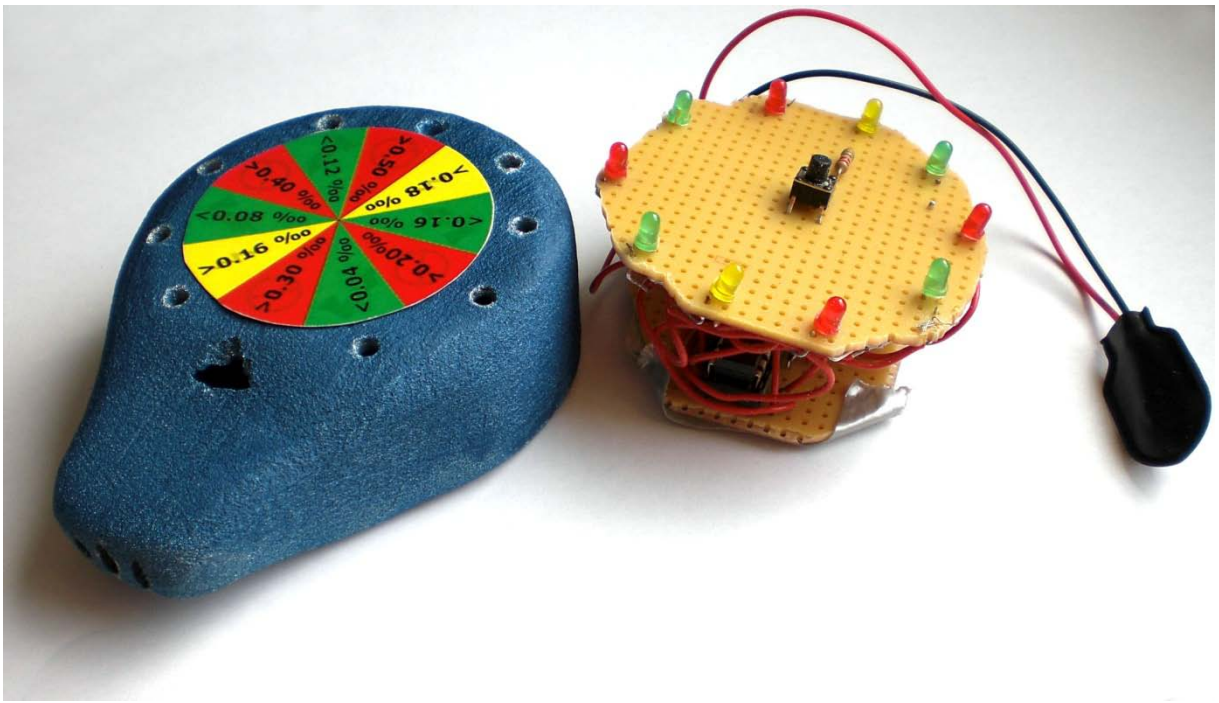



IMAGE 47: FOAM MODEL AND PCB WITH COMPONENTS AND LEDS

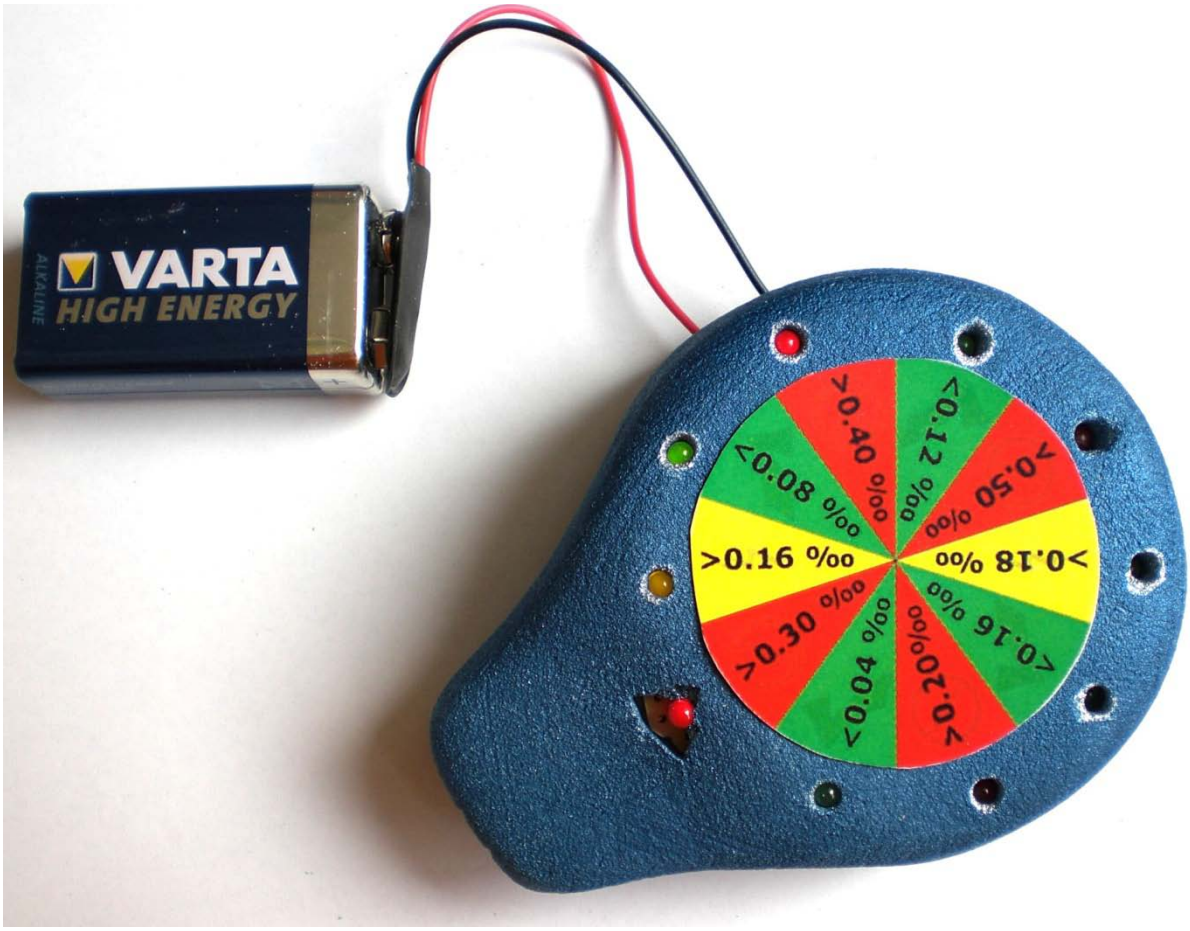
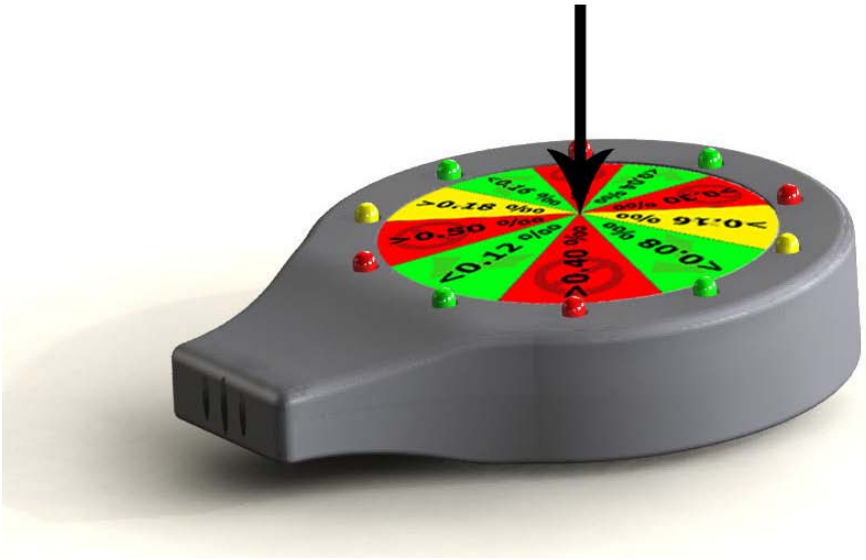



IMAGE 48: FOAM MODEL,WITH  FLASHING LEDS INTEGRATED

## 8.4 USER SCENARIO

A user scenario is made to illustrate the use of the alcohol tester.



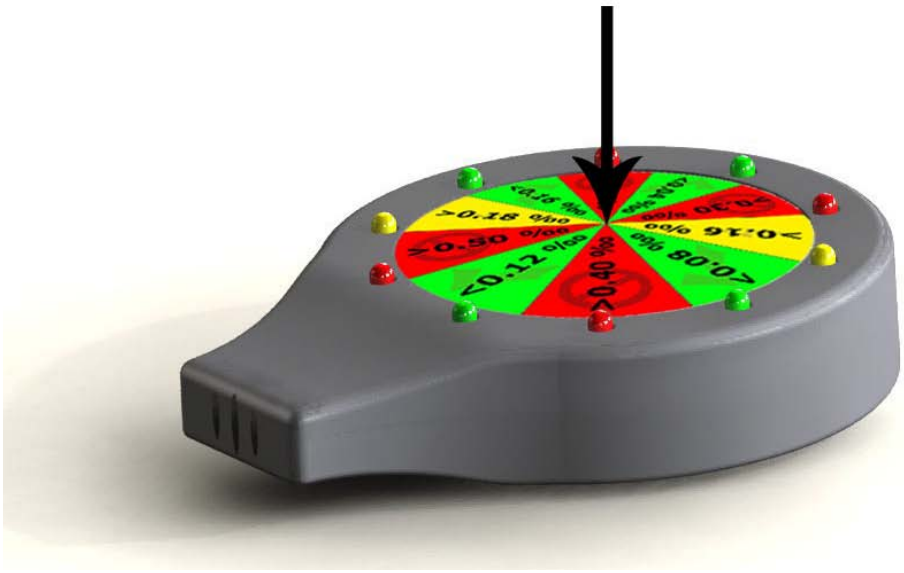
FIGUUR 49: THE DEVICE IS TURNER ON WITH A BUTTON IN THE MIDDLE

FIGUUR 50: THE RED LEDS LIGHT UP, INDICATIND THAT THE SENSOR IS NOT READY YET

FIGUUR 51: THE GREEN LEDS LIGHT UP WHEN THE SENSOR IS READY FOR USE

FIGUUR 52: THE USER BLOWS, LEDS ARE FLASHING WHEN THE SENSOR IS ANALYSING

FIGUUR 53: THE SENSOR HAS ANALYSED THE BREATH AND THE OUTCOME IS SHOWED



FIGUUR 54: THE DEVICE CAN BE TURNED OF BY PUSHING THE BUTTON IN THE MIDDLE AGAIN.

# CHAPTER 9

CONCLUSION & RECOMMENDATIONS

Now the concept is elaborated to a final design and a model, it is time to check is al requirements are met and if the device is a feasible and satisfying product idea. The requirements that are met are coloured green. The requirements of which it is presumable that this can be met when the product is taken into production are coloured orange. The requirements that are not met are coloured red. Each requirement has an explanation of the colour.

## 9.1 TESTING THE REQUIREMENTS

***Requirements for production:***

The gadget is at first produced in one design

There is one sticker designed as a proposal. More variable sticker can be designed when the gadget is used for a certain advertising campaign (which can be a possible option since the principal has a advertising company) for a beer brand.

The gadget is produced by a suitable production method

When the device is designed in SolidWorks the production method of the housing, injection molding, is taken into account (wall thickness, ribs/bosses etc.). This production method is relatively cheap when producing a great number of parts. When the right circuitry is established, the PCB can be machine-made and assembled, etc.

The gadget consists of low-cost parts

In the design process there is always been a focus on low-cost parts. It is presumable that all the parts are low-cost.

The gadget uses an already existing testing method

The existing testing method is the method of a breathalyser using a semiconductor sensor to analyse the users breath.

The gadget is as qualitative as possible

The sensor is the part that has to have the most quality. The choice of the sensor is done with great care. Tests have to be executed, though, to test the quality in practice.

The gadget has as few parts as possible

The gadget has as few parts as possible: there are no parts that have a redundant function. All parts are needed.

The gadget is easy to assemble

There is attempted to keep as few parts as possible so the assembling would be easy. There are just 4 actions needed.

1. Connect PCB to button cell holder
2. Connect PCB to top housing
3. Connect top and bottom housing with three screws
4. Connect cover to bottom housing

***requirements for use:***

The gadget can detect alcohol
The gadget can observe alcohol } within one minute

The intention of the product is to detect and observe alcohol in someone's breath. In theory the device does, but if the theory works in practice and if the device can do this in one minute should be tested.

The gadget can indicate the detected permillage without using digits

There are no digits used in the device. A sticker can be glued on the inlet at the top housing. The sticker indicates different intervals of permillage.

The gadget can indicate the minimal permillage at which driving is not allowed any longer

The minimal permillage at which driving is not allowed is 0.2 ‰. There are two parts (yellow) that indicate a warning when approaching that permillage.

The gadget can be used multiple times

The intention is that the gadget can be used multiple times.

The gadget is a handheld (small) product

The gadgets outer boundary dimensions are 90 by 70 mm. So, the device can be easily held in one hand.

The gadget has an interchangeable power supply

The power supply consists of three button cells. Button cells are freely available in a consumer shop and are not expensive. The cover can be taken off from the bottom housing to replace one or all button cells.

The gadget has to be intuitive in use and need very few instructions

The user only has to blow into the device.

The gadget has a simple interface

The gadget has actually no interface.

The gadget can test again within one minute

This should be tested when a working prototype is made.

The gadget uses a pleasant testing principle

Giving a breath sample appeared to be the most pleaseant testing method. This resulted out of the questionnaire.

The gadget has a positive influence on the user and is experienced as a funny action

This should be tested when a working prototype is made.

The gadget is experienced as useful at every occasion with alcohol involved

This should be tested when a working prototype is made.

The gadget is distinctive from competing products

The market analysis in annex C shows differ types of breathalysers. The wheel of fortune tester is very distinctive from the products showed in the market analysis.

*Advisable demands*:

The gadget can detect & observe alcohol in 10 seconds

This should be tested when a working prototype is made.

The gadget can test again after 10 seconds

This should be tested when a working prototype is made.

The gadget can be used in a campaign of a brand selling alcoholic beverages

As said before by 'sticker design' the device is suitable to be used in a campaign. The housing can be coloured in the colour of, for example, the beer brand.

***Requirements for distribution***:

The gadget is packaged during distribution and sales

This requirement can be met in a later stage of development

The gadget can be bought in a retail store (also online)

This requirement can be met in a later stage of development

***Requirements for disposal:***

The gadget is recyclable

This requirement can be met in a later stage of development

The gadget is harmless to the environment

The amount of unnatural materials (like in the sensor, PCB) are not harmfull for the environment.

The gadget is easy to disassemble

See the requirement 'The gadget is easy to assemble'. The actions are then done in opposite direction.

The gadget can be treated as regular waste in a waste disposal

This requirement can be met in a later stage of development

## 9.2 CONCLUSION

The requirements for production are partly met. The gadget needs to as cheap as possible but also as good as possible. Some factors have been taken into account that support these requirements (like as few parts as possible and easy assembling) but some factors are not sure yet, because the phase of testing and producing has yet to come.

The requirements of use are almost met. Some requirements have not been evaluated because they need testing (like how the users experience a such like alcohol test device).

The requirements for distribution are not fully met. These requirements can be met, but are not executed in practice (yet).

The requirements for disposal are partly met. During the design process a study was done concerning the use of materials in the sensor (paragraph 8.1) and it was shown that the sensor was not harmful for nature. If the whole device can be treated as waste disposal is not known, nor to what extent it is recyclable.

## 9.3 RECOMMENDATIONS

As said before, some testing needs to been done to test the suitability of some parts.

1. The sensor need to be tested on accuracy (qualitaty) and the rate of testing. Is this sensor really suitable for this kind of application? One requirement is that the sensor can detect and observe alcohol within one minute.
2. The experience of the user. The device has the strategy to look like a game but confront the user indirectly with alcohol consumption. Does this strategy really work like expected, or is it just experienced as a game and is it used in an opposite way (like it is cool to achieve the highest ‘score’)? Is it clear that the user has to blow into the bit? Is the feedback of the permillage indication enough or does the user expect another kind of feedback?
3. The power supply. Because the electric circuit needs 5 Volt and the sensor too, are three button cells that generate 9 Volts enough? And if so, what is the lifetime of this power supply? What is the lifetime of the LEDs in a circuit like this?
4. Disposal. Is there in any kind a threat to the environment. What kind of materials are used exactly and how can it be processed after disposal?

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# ANNEXES

# Plan van Aanpak

***Het ontwerpen van een alcoholdetecterend apparaat***

# 1.Opdrachtomschrijving

De opdracht is een apparaat te ontwerpen om te testen of iemand onder invloed is van alcohol. Er moet door middel van een product ingespeeld kunnen worden op de internationale maatschappelijke trend van het bewust worden van de gevaren van drinken in het algemeen, maar in het bijzonder drinken in combinatie met verkeer. De aandacht gaat vooral uit naar het ontwerpen van een kleiner apparaat: het wordt eigenlijk meer een gadget. Het apparaat zal niet alleen iemand op alcohol testen maar tevens een nevenfunctie hebben, bijvoorbeeld een zweetbandje dat mee kleurt in de mate waarin iemand alcohol heeft genuttigd. Er zal onderzocht moeten worden op welke manieren alcohol gedetecteerd kan worden en in welke markt een dergelijke device potentieel heeft. Een doelgroep passend bij de gekozen markt zal worden geanalyseerd, waarna er dan het product ontworpen gaat worden. De nadruk zal vooral liggen op de integratie van de manier waarop alcohol gedetecteerd wordt in een (klein) product passend bij de doelgroep. Hierbij komen onderzoek, techniek en vormgeving aan bod. De opdracht wordt zelfstandig uitgevoerd (er is echter al wel een student van de TuE bezig met een deelproject over dit onderwerp) en zal drie maanden beslaan. De TuE student kan informatie verschaffen over het project en de door hem gevonden informatie omtrent het project mag worden ingelezen. Er wordt gestart in juni 2008.

# 2. Conceptueel ontwerp

**Actoranalyse**

De actor is genaamd ‘Escobar Group’ en bestaat uit ‘Escobar advertising’ en Weesperzijde Beheer B.V.’ en is gevestigd in hartje Amsterdam. Deze twee bedrijven hebben zich samen gericht op het ontwerpen van producten, waarbij dit het eerste project is. Escobar advertising is van huis uit een creatief gericht bedrijf en richt zich op commerciële communicatie zoals huisstijlen, campagnes etc. Weesperzijde Beheer B.V. is een investeringsbedrijf. De doelstelling van de actor is commerciële producten te ontwikkelen die in de internationale markt gezet kunnen worden. Doordat er al een student bezig is met hetzelfde project is er een documentatie aanwezig over het betreffende project.

**Projectkader**

Overmatig alcoholgebruik is schadelijk voor de gezondheid. Vooral mannen (meer dan 40%) tussen de 18 en 24 jaar drinken op één dag meer dan 6 glazen alcohol. Alcohol kan een mens veranderen: sommigen worden vrolijk, anderen agressief. Dit in combinatie met verkeer is al een aantal jaren een algemene maatschappelijke zorg.

Om mensen op een indirecte manier bewust te laten worden van hun alcoholgebruik zal er een product ontworpen worden waarvan de hoofdfunctie de doelgroep aanspreekt. Een systeem die alcohol gebruik detecteert en signaleert zal in dit product geïntegreerd moeten worden. Als het product wordt gebruikt zal het de gebruiker duidelijk worden gemaakt of deze alcohol heeft genuttigd of niet en in welke mate als dit haalbaar is.

**Doelstelling**
Het onderzoek is praktijkgericht. Het betreft een ontwerpgericht onderzoek: de consument moet op een indirecte manier bewust gemaakt worden van alcoholgebruik met behulp van een klein, gadgetachtig product. Het ontwerpen wordt voorafgegaan door ten eerste een onderzoek te doen naar mogelijkheden waarop alcohol gedetecteerd kan worden. Op welk principe berust dit en welk systeem is hiervoor nodig? Vervolgens moet er gekeken worden naar verschillende markten waarin het product geplaatst kan gaan worden. De markt waarvan wordt verwacht dat deze goed op het product gaat reageren en natuurlijk waarvan is geconstateerd dat deze regelmatig in aanraking komen met alcohol, wordt gekozen. Deze markt wordt verder uitgediept waardoor er een doelgroep volgt. Hieruit volgend wordt een Programma van Eisen worden opgesteld. Hierna zal er een product ontworpen worden waarbij een systeem waarmee alcohol getest kan worden is geïntegreerd in een product die naast testen op alcohol nog een andere functie heeft. Doel hiervan is om het gebruik van de gadget laagdrempeliger te maken. Mensen gebruiken waarschijnlijk eerder een product als het een functie heeft die hen vertrouwd is (zoals het eerder genoemde zweetbandje) en accepteren de alcoholtestende functie erbij.
Het doel is om dit product te realiseren, welke tot in detail uitgewerkt is en deze op een duidelijke manier te presenteren met behulp van een model. Later kan gekeken worden wat voor type model hiervoor beter geschikt is.

Het doel van de opdracht kan gerealiseerd worden door onderzoek te doen naar verschillende systemen die alcohol kunnen waarnemen en een marktonderzoek uit te voeren waardoor een potentiële markt zichtbaar wordt, dit uit te werken en vervolgens het product, die naast alcohol detecteren nog een nevenfunctie heeft, te presenteren met een model. Het marktonderzoek zal bestaan uit een onderzoek naar groepen die regelmatig in aanraking komen en/of regelmatig onder invloed zijn van alcohol. Binnen deze groepen wordt dan gekeken waar het te ontwerpen product nuttig zou kunnen zijn. Ook zal er onderzocht moeten worden welke eisen de gekozen groep stelt aan een dergelijk product.

De doelstelling is nuttig, want met gadget passend bij een bepaalde markt kan het bedrijf inspelen op alcoholgebruikers in die markt. De doelstelling is uitvoerbaar binnen een tijdsbestek van 3 maanden, omdat de productrichting en achterliggende gedachte al vastliggen. De doelstelling is eenduidig, omdat duidelijk is wat het uiteindelijke ontwerp moet worden. De doelstelling is informatierijk, omdat eruit te halen is welke kennis gegenereerd wordt, namelijk kennis over methoden om alcohol te detecteren en welke markt potentieel heeft, resulterend in programma van eisen en wensen resulterend in ontwerp en model.

**Vraagstelling**
**1. Welke toepasbare manieren om alcohol te detecteren, zijn er?**
*1.1 Via welk(e) principe(s) kan alcohol gedetecteerd worden?*
*1.2 Welke methoden worden gebruikt bij de verschillende principes zodat alcohol gedetecteerd kan worden?*
*1.3 Hoe komen de reacties in deze methoden tot stand?*
*1.4 Wat zijn de voor- en nadelen van de verschillende methoden?*

**2. Voor welke doelgroep gaat het product ontworpen worden?**
*2.1 Welke groepen komen in verhouding meer in aanraking met alcohol?*

*2.2 Welke markten zijn in deze groepen te onderscheiden?*
*2.3 Bij welke evenementen, waarbij mensen komen uit vraag 2.1, is er alcohol toegankelijk?*
*2.4 Welke bestaande alcoholdetecterende apparaten worden toegepast op die evenementen?*

**3. Wat is het programma van eisen voor een op alcoholtestend apparaat?**
*3.1Welke eisen stelt de vanuit de achtergrond van de opdrachtgever gesteld?*
*3.2 Welke eisen stelt de doelgroep aan het op alcoholtestende systeem?*
*3.3 Welke eisen stelt de doelgroep aan de nevenfunctie van het product?*

**4. Wat is een goede nevenfunctie voor het te ontwerpen product**
4.1 Wat moet er bereikt worden met deze functie?
4.2 Hoe kan deze functie worden bereikt?
4.3 Wat zijn toepasbare gebruiksvoorwerpen die deze functie uitvoeren?
4.4 Wat zijn toepasbare gebruiksvoorwerpen waarin een alcohol detecterend systeem geïntegreerd kan worden?

**5. Tot welk ontwerp van een alcoholdetecterend apparaat wordt gekomen aan de hand van het programma van eisen?**
*5.1 Welke concepten komen naar voren bij het ontwerp van het op alcoholtestende apparaat door te kijken naar de mate waarop de gebruiker indirect geconfronteerd wordt met zijn/haar alcoholgebruik en gadgetgehalte?*
*5.2 Welk concept voldoet het beste aan het programma van eisen?*
*5.3 Hoe ziet dat concept er in detail uit?*
*5.4 Wat is de nevenfunctie, hoe is de werking en uiterlijk van het ontwerp, gepresenteerd door middel van een model?*

**6. In hoeverre sluit het voorgestelde product aan bij de doelgroep?**
*6.1 Voldoet het product aan het programma van eisen gesteld vanuit die doelgroep?*
*6.2 In hoeverre sluit de nevenfunctie aan bij de doelgroep?*
*6.3 Worden de gebruikers bewuster van hun alcoholgebruik?*

# 3. Technisch ontwerp

**Strategie**

Dit onderzoek zal vooral een diepteonderzoek zijn, omdat een ontwerp tot stand komt voor een specifiek marktgebied. Eerst is er een analyserende fase, met daarna een ontwerpfase. Het gaat bij het onderzoek om een overwegend kwalificerende benadering. Het is zowel een bureauonderzoek als een empirisch onderzoek, gezien het feit dat manieren om alcohol te detecteren onderzocht moet worden in de literatuur evenals bestaande producten. Het is echter ook een empirisch onderzoek omdat de nader te bepalen markt onderzocht moet worden om passende productvormen te vinden. De marktgroep zal dus ondervraagd moeten worden om een beeld te krijgen van wat deze groep aanspreekt. Daarna zullen meerdere concepten ontwikkeld worden, waarna aan de hand van het programma van eisen en wensen de beste gekozen en uitgewerkt wordt.

**Materiaal**

**1. Welke toepasbare manieren om alcohol te detecteren, zijn er?**

*1.1 Via welk(e) principe(s) kan alcohol gedetecteerd worden?*

opdrachtgever → documentatie
media → zoeksysteem
literatuur → zoeksysteem
personen → ondervraging deskundigen

*1.2 Welke reacties vinden plaats bij de bijbehorende principes zodat alcohol gedetecteerd kan worden?*

*media → zoeksysteem*
*literatuur → zoeksysteem*
*personen → ondervraging deskundigen*

*1.3 Hoe komen deze reacties tot stand?*

*media → zoeksysteem*
*literatuur → zoeksysteem*
*personen → ondervraging deskundigen*

*1.4 Welke principes en reacties worden gebruikt in welke reeds gebruikte producten?*

*media → zoeksysteem*

*1.5 Wat voor toepassingen hebben de reeds gebruikte producten?*

*media → zoeksysteem*

*1.6 Wat zijn de voor- en nadelen van de verschillende toepassingen?*

*media → zoeksysteem*
*personen → ondervraging*

**2. Voor welke doelgroep gaat het product ontworpen worden?**

*2.1 Welke potentiële markten zijn er voor het product?*

*werkelijkheid → inhoudsanalyse*
*media → zoeksysteem*

*2.2 Welke groepen kunnen worden onderscheiden in die markten?*

*werkelijkheid → inhoudsanalyse*
*media → zoeksysteem*

*2.3 Welke groepen komen in verhouding meer in aanraking met alcohol?*

*media → zoeksysteem*
*documenten → zoeksysteem*

*2.4 Welke bestaande op alcoholtestende apparaten worden toegepast in die groepen?*
*media → zoeksysteem*
*2.5 Zijn er evenementen voor een bepaalde groepen waarbij alcohol beschikbaar is?*
*media → zoeksysteem*
*documenten → zoeksysteem*

**3. Wat is het programma van eisen voor een op alcoholtestend apparaat met een nevenfunctie?**

*3.1Welke eisen stelt de vanuit de achtergrond van de opdrachtgever gesteld?*
*personen → ondervraging*
*3.2 Welke eisen stelt de doelgroep aan het op alcoholtestende systeem?*
*personen → ondervraging*
*media → zoeksysteem*
*3.3 Welke eisen stelt de doelgroep aan de nevenfunctie van het product?*
*personen → ondervraging*

**4. Tot welk ontwerp van een op alcoholtestend apparaat wordt gekomen aan de hand van het programma van eisen?**

*4.1 Welke concepten komen naar voren bij het ontwerp van het op alcoholtestende apparaat door te kijken naar de mate waarop de gebruiker indirect geconfronteerd wordt met zijn/haar alcoholgebruik en gadgetgehalte?*
*programma van eisen → ontwerpen van concepten*
*4.2 Welk concept voldoet het beste aan het programma van eisen?*
*concepten → vergelijken → programma van eisen als beoordelingscriterium*
*4.3 Hoe ziet dat concept er in detail uit?*
*uitwerking*
*4.4 Wat is de nevenfunctie, hoe is de werking en uiterlijk van het ontwerp, gepresenteerd door middel van een model?*
*uitwerking*

**Planning**

a) PvA
werktijd: 4 dagen doorlooptijd: 1 week

b) verzamelen onderzoeksmateriaal alcohol
werktijd: 6 dagen doorlooptijd: 2 weken

c) marktonderzoek
werktijd: 9 dagen doorlooptijd: 2 weken

d) verwerking en documentatie
werktijd: 5 dagen doorlooptijd: 1 week

e) programma van eisen
werktijd: 2 dagen doorlooptijd: 1 week

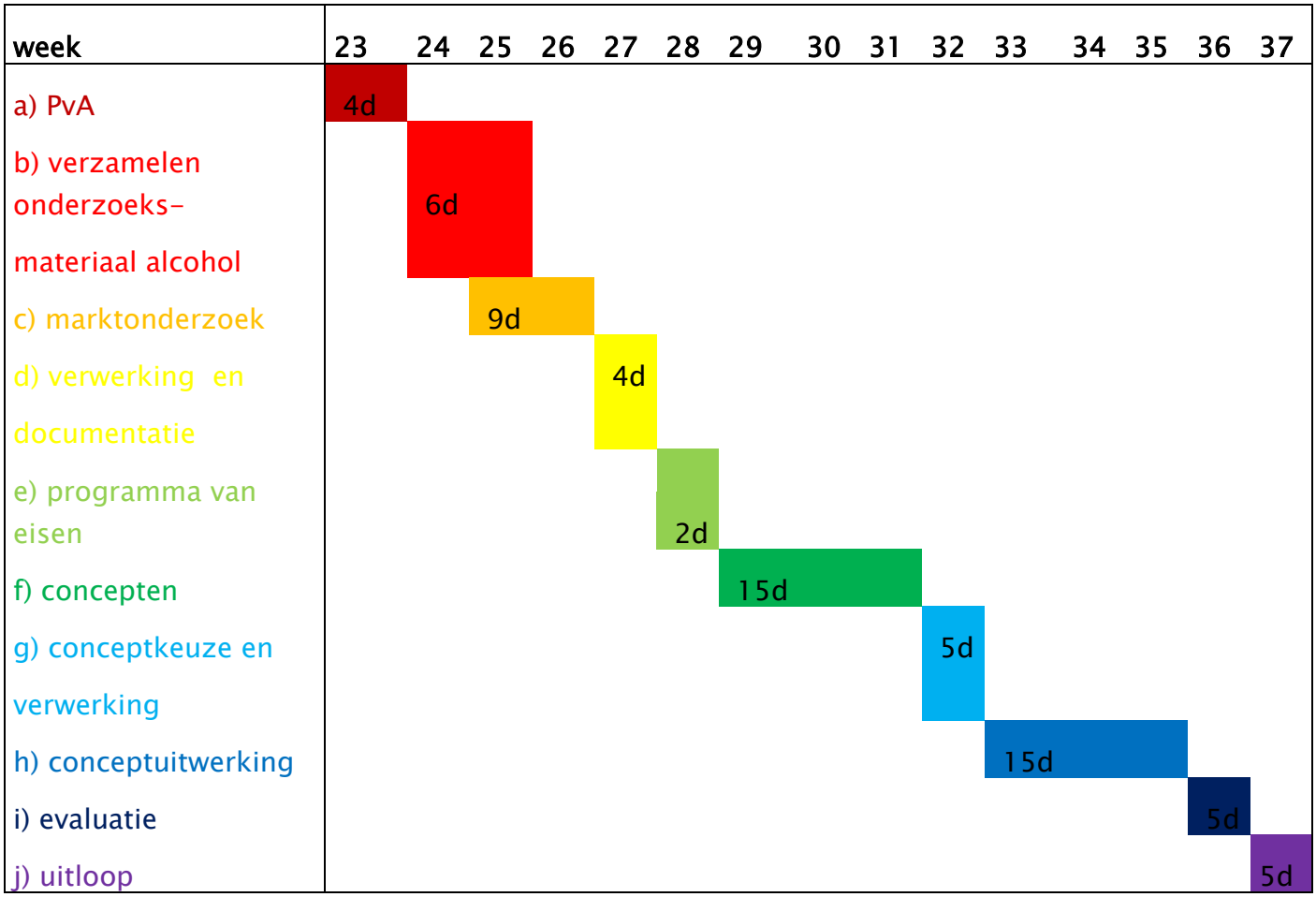
f) concepten
werktijd: 15 dagen doorlooptijd: 3 weken

g) conceptkeuze en verwerking
werktijd: 5 dagen doorlooptijd: 1 week

h) conceptuitwerking
werktijd: 15 dagen doorlooptijd: 3 weken

i) evaluatie
werktijd: 5 dagen doorlooptijd: 1 week

j) uitloop
werktijd: 5 dagen doorlooptijd: 1 week




Breath
Saliva
Urine
Perspiration
Q.E.D.
A150
READY
OK
Alcohol Test
D.O.T. Approved
CLIA-10
For in Vitro Diagnostic Use
SCREEN 02®
A Simple 4-Minute Saliva Screening Test
D.O.T. Approved
DRUGCHECK®
NxStep OnSite


As can be seen, the existing products are not very distinctive. The pen in the right lower corner, though, is. The remaining products are very basic, a rectangular shape and white, grey or black coloured. They have a minimal number of buttons and one display or none.

# ANNEX D

1.Geslacht
Man
Vrouw

2.Wat is je leeftijd?

3.Welke niveau is je opleiding?
mbo
hbo
wo
anders

4.Op welke evenementen/festivals/feesten etc. ben je wel eens geweest?

5.Op evenemten kun je vaak gadgets krijgen, heb je er wel eens 1 gehad en welke is je vooral bijgebleven? Zeg er ook even bij waar je deze hebt
gekregen, of er een sponsor aan verbonden was en wat de gadget precies is

6.Drink je alcohol?
Ja
Nee

7.Hoe regelmatig drink je alcohol?
elke dag
meerdere keren per week
1 keer per week
minder dan 1 keer per week
minder dan 1 keer per maand

8.Hoeveel drink je gemiddeld per keer

9.Ben je het afgelopen jaar dronken geweest? Zo ja hoe vaak?
Nee
Ja

10.Met wie drink je het vaakst alcohol

11.En waar doe je dit dan?

12.Ben je wel eens op alcoholgebruik getest (bijv. door de politie)
Ja
Nee

13.Alcoholtest
erg vervelend best leuk
Wat vond je van de test?

14.Met welke methode werd dit gedaan? (bijv blaastest)

15.Waar vond de test plaats?

16.Alcoholtest
erg vervelend best leuk
Hoe zou je zo'n test vinden, denk je?

17.Welke methoden om alcohol te kunnen detecteren weet je nog meer naast bijv. blaastest?

18.Waar stel je je voor dat zo'n test plaatsvindt?
19.Alcohol in je lichaam kan o.a. gedetecteert worden via de urine, speeksel, adem en door de huid heen. Welke methode lijkt je het prettigst, enwaarom?

20.Heb je een rijbewijs?
Ja
Nee

21.Heb je wel eens auto gereden terwijl je alcohol op had?
Ja
Nee

22.Zaten er toen ook andere mensen bij je in de auto?
Ja
Nee

23.Hebben zij toen gevraagd / er iets van gezegd dat je alcohol op had?
Ja
Nee

24.Hadden zij zelf ook alcohol gehad?
Ja
Nee

25.Heb je wel eens bij iemand in de auto gezeten die reed terwijl hij of zij alcohol op had?
Ja
Nee

26.Wat vond je daarvan? Heb je er iets van gezegd?

27.Zou je willen weten of jouw 'Bob' (toch) alcohol gehad heeft of niet?
Ja
Nee

FIGARO

PRODUCT INFORMATION

# TGS 2620 - for the detection of Solvent Vapors

## Features:

* Low power consumption
* High sensitivity to alcohol and organic solvent vapors
* Long life and low cost
* Uses simple electrical circuit

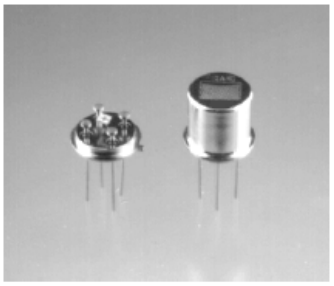
## Applications:

* Alcohol testers
* Organic vapor detectors/alarms
* Solvent detectors for factories, dry cleaners, and semiconductor industries

The sensing element is comprised of a metal oxide semiconductor layer formed on an alumina substrate of a sensing chip together with an integrated heater. In the presence of a detectable gas, the sensor's conductivity increases depending on the gas concentration in the air. A simple electrical circuit can convert the change in conductivity to an output signal which corresponds to the gas concentration.

The **TGS 2620** has high sensitivity to the vapors of organic solvents as well as other volatile vapors. It also has sensitivity to a variety of combustible gases such as carbon monoxide, making it a good general purpose sensor.

Due to miniaturization of the sensing chip, TGS 2620 requires a heater current of only 42mA and the device is housed in a standard TO-5 package.



The figure below represents typical sensitivity characteristics, all data having been gathered at standard test conditions (see reverse side of this sheet). The Y-axis is indicated as *sensor resistance ratio* (Rs/Ro) which is defined as follows:

Rs = Sensor resistance in displayed gases at various concentrations

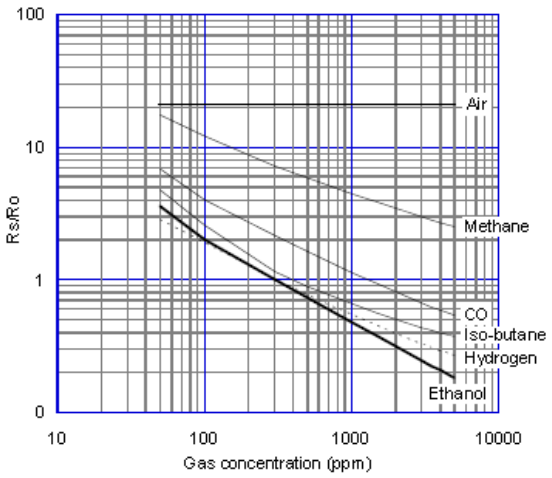
Ro = Sensor resistance in 300ppm of ethanol

The figure below represents typical temperature and humidity dependency characteristics. Again, the Y-axis is indicated as *sensor resistance ratio* (Rs/Ro), defined as follows:

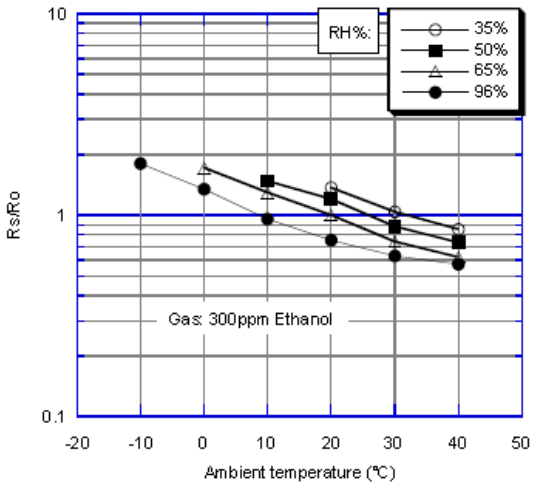
Rs = Sensor resistance in 300ppm of ethanol at various temperatures/humidities

Ro = Sensor resistance in 300ppm of ethanol at 20°C and 65% R.H.

**Sensitivity Characteristics:**




**Temperature/Humidity Dependency:**

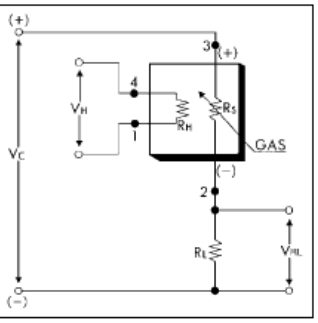



IMPORTANT NOTE: OPERATING CONDITIONS IN WHICH FIGARO SENSORS ARE USED WILL VARY WITH EACH CUSTOMERS SPECIFIC APPLICATIONS. FIGARO STRONGLY RECOMMENDS CONSULTING OUR TECHNICAL STAFF BEFORE DEPLOYING FIGARO SENSORS IN YOUR APPLICATION AND, IN PARTICULAR, WHEN CUSTOMERS TARGET GASES ARE NOT LISTED HEREIN. FIGARO CANNOT ASSUME ANY RESPONSIBILITY FOR ANY USE OF ITS SENSORS IN A PRODUCT OR APPLICATION FOR WHICH SENSOR HAS NOT BEEN SPECIFICALLY TESTED BY FIGARO.

**Basic Measuring Circuit:**

The sensor requires two voltage inputs: heater voltage ($V_H$) and circuit voltage ($V_C$). The heater voltage ($V_H$) is applied to the integrated heater in order to maintain the sensing element at a specific temperature which is optimal for sensing. Circuit voltage ($V_C$) is applied to allow measurement of voltage ($V_{RL}$) across a load resistor ($R_L$) which is connected in series with the sensor.

A common power supply circuit can be used for both $V_C$ and $V_H$ to fulfill the sensor's electrical requirements. The value of the load resistor ($R_L$) should be chosen to optimize the alarm threshold value, keeping power consumption (Ps) of the semiconductor below a limit of 15mW. Power consumption (Ps) will be highest when the value of Rs is equal to $R_L$ on exposure to gas.




## Specifications:

| | | | | |
|---|---|---|---|---|
| Model number | | | TGS 2620 | |
| Sensing element type | | | D1 | |
| Standard package | | | TO-5 metal can | |
| Target gases | | | Alcohol, Solvent vapors | |
| Typical detection range | | | 50 ~ 5,000 ppm | |
| Standard circuit conditions | Heater Voltage | $V_H$ | 5.0±0.2V DC/AC | |
| | Circuit voltage | $V_C$ | 5.0±0.2V DC/AC | Ps ≤ 15mW |
| | Load resistance | $R_L$ | Variable | 0.45kΩ min. |
| Electrical characteristics under standard test conditions | Heater resistance | $R_H$ | 83Ω at room temp. (typical) | |
| | Heater current | $I_H$ | 42 ± 4mA | |
| | Heater power consumption | $P_H$ | approx. 210mW | |
| | Sensor resistance | Rs | 1 ~ 5 kΩ in 300ppm ethanol | |
| | Sensitivity (change ratio of Rs) | | 0.3 ~ 0.5 | Rs (300ppm) / Rs (50ppm) |
| Standard test conditions | Test gas conditions | | Ethanol vapor in air at 20±2°C, 65±5%RH | |
| | Circuit conditions | | $V_C$ = 5.0±0.01V DC<br>$V_H$ = 5.0±0.05V DC | |
| | Conditioning period before test | | 7 days | |

The value of power dissipation (Ps) can be calculated by utilizing the following formula:

$$Ps = \frac{(Vc - V_{RL})^2}{Rs}$$

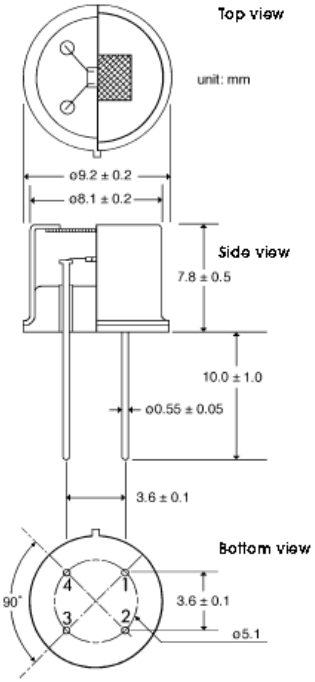
Sensor resistance (Rs) is calculated with a measured value of $V_{RL}$ by using the following formula:

$$Rs = \frac{Vc - V_{RL}}{V_{RL}} \times R_L$$

**For information on warranty, please refer to Standard Terms and Conditions of Sale of Figaro USA Inc.**

REV: 10/00

## Structure and Dimensions:




**Pin connection:**
1 : Heater
2 : Sensor electrode (-)
3 : Sensor electrode (+)
4 : Heater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