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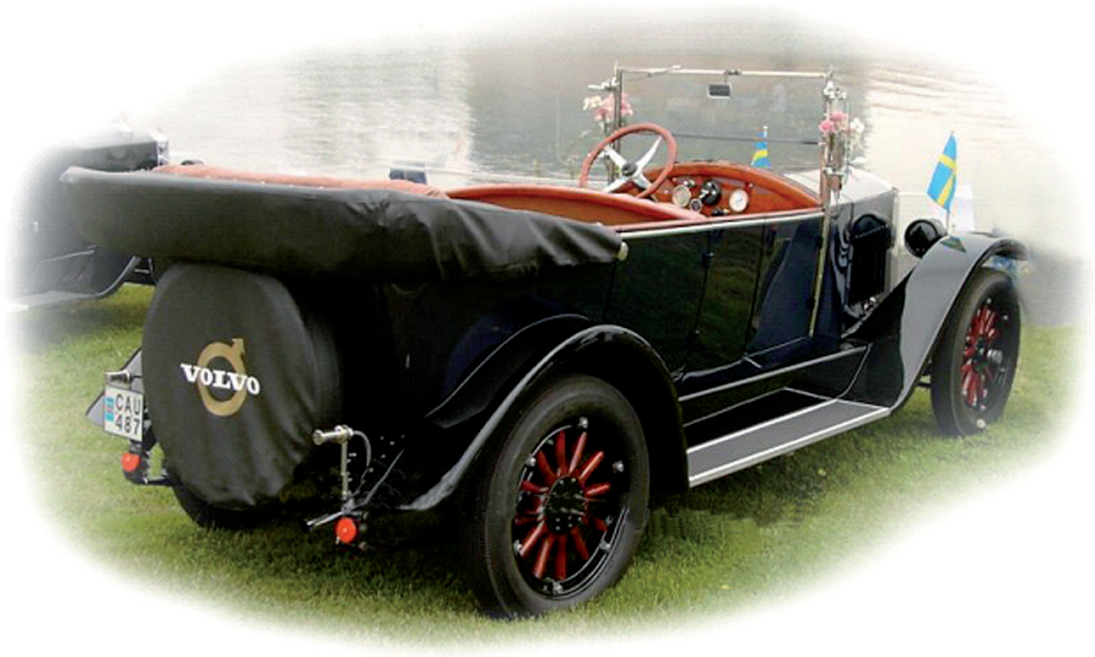
MASTER'S THESIS

Design of instrument cluster for automobiles



Malin Rundqvist
Louise Persson

MASTER OF SCIENCE PROGRAMME
Ergonomic Design & Production Engineering

Luleå University of Technology
Department of Human Work Sciences
Division of Industrial Design

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DESIGN OF INSTRUMENT CLUSTER FOR AUTOMOBILES

-CUSTOMIZED AFTER DRIVER'S REQUIREMENTS

Louise Persson
Malin Rundqvist

Luleå University of Technology
Department of Human Work Science
Division of Industrial design
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PREFACE

We would like to thank a number of people for making this project and result possible.

Firstly, our mentor Jan Lundberg, Professor at Luleå University of Technology, for guiding us through the project and also Phillip Tretten, doctoral candidate at the University, for further directions. Secondly, our mentor at Volvo Car Corporation Thomas Lindgren. Thirdly, Jörgen Normark, doctoral candidate at Luleå University of Technology, for helping us with the Eye tracking tests. Last but not least, all the subjects who have answered our questionnaires.

Hopefully Volvo Car Corporation and Luleå University of Technology will be able to use the result of this project in future development.

(Picture on front page is available at Wikipedia http://sv.wikipedia.org/wiki/Volvo_ %C3%96V_4 [2007-02-20])

Malin Rundqvist

Louise Persson

ABSTRACT

This master thesis commenced in the beginning of September 2006. It was performed as a part of the project OPTIVe (Optimized System Integration for Safe Interaction in Vehicles). OPTIVe's purpose is to investigate, evaluate and demonstrate methods and technical solutions for safe, efficient and cost effective integration of HMI systems in cars. It is a cooperative project between Volvo Car Corporation and Luleå University of Technology among others, which were also the assigners for this thesis.

OPTIVe has executed surveys in USA and Sweden about which information instruments the driver desires to have displayed in the automobile and on which display. The purpose with this master thesis was to compile the answers regarding the instrument cluster and analyze which information instruments should be placed in that display. The results would be different design concepts suitable for Sweden and USA and if possible a concept suited for both countries.

The result of the survey, when both countries were taken under consideration, was that the users desired to have the warning symbols *Low oil pressure, Low fuel level, Parking brake engaged, High motor temperature, Charging system failure, and ABS failure* displayed in the instrument cluster. The driver instruments desired were *Speedometer*, *Fuel level* and *Motor temperature level indicator* and no In-vehicle technology instruments. This lead to that four different concepts were designed which were suited for both countries. The first two concepts had a simple and clean design which was further developed into two new concepts with more decorations. When comparing the countries and the genders, instruments and warning symbols that will differ is the *Tachometer, Low tire pressure* and *Engine in need of service*.

Testing the four concepts in the eye-track lead to discussions about changes and improvements that could be made and also, to a questionnaire handling the speedometer. The new questionnaire was conducted since it was discovered that the pointer of the speedometer in all four concepts was a new idea in this context and the question was if it attracted the drivers or not, if the standard speedometer was more popular, or if a combination of the two was more likely to please. The speedometer questionnaire showed that the idea itself was good but that a combination between the standard speedometer and the modern speedometer was more popular. The combination speedometer will therefore be used in all the concepts.

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1 INTRODUCTION

This master thesis, of 20 university points, was performed by Louise Persson and Malin Rundqvist, two students at Luleå University of Technology. The thesis was the final task within the programme of Ergonomic design and production with concentration towards industrial design, 180 university points. The project covered both HMI (Human Machine Interaction) and design. It was performed through Luleå University of Technology and was a part of the OPTIVe (Optimized System Integration for Safe Interaction in Vehicles) project, which the Department of Human Work Sciences at the University was participating in. The academic mentor for this project was Jan Lundberg at the University and at Volvo Car Corporation the mentor assigned was Thomas Lindgren.

1.1 OPTIVE

OPTIVe is a project that is accepted by IVSS (Intelligent Vehicle Safety System), which began in October 2005 and continues until 2009. The purpose of the project is to investigate, evaluate and demonstrate methods and technical solutions for safe, efficient and cost effective integration of HMI systems in cars. This is in cooperation between Volvo Car Corporation (applicant and lead), Luleå University of Technology, Chalmers University of Technology, and IT University of Gothenburg.

1.2 PROJECT

The project would result in a number of design concepts of the instrument cluster for an automobile. The concepts would represent the drivers' requirements of instruments and suitable theories were to be used for the design. At least one concept would be suited for the Swedish market, and one for the American. If possible, a combined solution would also be developed. In the end, an evaluation of the concepts was to be performed in an eye tracking test.

The selection of information instruments for the instrument cluster was based on information gathered through a questionnaire. The questionnaire was used in a survey within OPTIVe and was executed in Sweden and the USA. The answers were evaluated in SPSS (the Statistical Package for the Social Sciences), a statistical analysis software, to be able to make structured decisions. The design, including shape, color, placement etc., was to be based on relevant theories.

1.3 PROJECT OUTLINE

"The task was to investigate and improve the instrument cluster interface based on customer requirements."

1.4 OBJECTIVE

The objective of this project was to develop a design with focus on the drivers' requirements. The design should be easy to comprehend and only necessary information displayed. If possible, to create a design suitable for a bigger target group and more international. The objective was also to find out if there were any prominent differences

between any subject groups, for example country, gender or age, and to find design solutions to cover for the differences. The result was to be used in future studies within OPTIVe and hopefully be useful for Volvo Car Corporation in future development.

1.5 SCOPE

The information from the questionnaire concerning other displays than the instrument cluster will not be taken under consideration. A prerequisite for the project was that the automobile had all four displays; HUD (Heads-Up Display), instrument cluster, infotainment, and center stack. The icons of the warning symbols would not be further developed in this project.

2 METHODOLOGY

This part summarizes the methodologies which were used to make a structured product development.

2.1 STATISTICAL METHODOLOGY

These methods were used to evaluate the reliability of the survey about Warning symbols, Driver information and In-vehicle technologies.

2.1.1 NORMAL DISTRIBUTION

The normal distribution, also called Gaussian distribution, is a probability distribution. If the stochastic variable X has a probability function

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}, -\infty < x < \infty, \quad (1)$$

then X is *normal distributed with the parameters* μ *and* σ, *see Figure 1* for a curve with a mean of zero. The parameters μ *and* σ is given constants with -:<μ<: and σ>0. It is written X ε *N*(μ,σ).

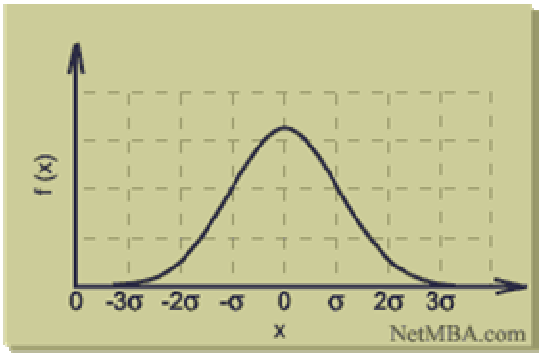

Figure 1 Normal distribution curve with a mean of zero. (http://www.netmba.com/Statistics/distribution/normal/)

Standard deviation is a statistic value of the dispersion of data, a value of how far in average the observations are from the mean value. If the values are well composed around the mean value, the standard deviation is small and vice versa. A sample standard deviation (*s*) is used to estimate population standard deviation (σ), because finding the standard deviation of an entire population is unrealistic except in certain cases. Sample standard deviation is defined by

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad (2)$$

where *n* is the number of samples taken and x_i is the value of the sample, i=1,2,…,*n* and $\bar{x}$ is the average value.

The standard error is the average error of the mean value

$$S_E = \frac{s}{\sqrt{n}} \quad (3)$$

where *s* is the sample standard deviation and *n* the number of samples.

2.1.2 CHRONBACH'S ALPHA

Chronbach's alpha is used to measure reliability to know if a result, of for example a survey, is valid and reliable. High reliability is when the same value is reached every time the test is conducted with the same instruments and with the same method. The test result is divided into two groups and compared to each other by computing a measure that describes how much that item can be associated to another item.

2.1.3 ONEWAY ANOVA

The abbreviation ANOVA stands for ANalysis Of VAriance between groups. The ANOVA is based on the fact that two independent estimates of the population variance can be obtained from the sample data. A ratio is formed for the two estimates, where:

$$\text{One is sensitive to} \rightarrow \frac{\text{treatment effect and error}}{\text{error}} \qquad \text{And the other to} \rightarrow \frac{\text{between group estimate}}{\text{within group estimate}}$$

If the between group estimate is much larger than the within group estimate then there are real differences between the means. The statistical question is whether the first estimate is larger enough than the second estimate to reject the idea that the means are the same with at least 95% confidence. A formal hypothesis test can be formulated of the form:

$$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 \qquad (4)$$

H_A: not all means equal

The statistic used to test these hypotheses is the F-ratio given by

$$F = \text{between group mean square / within group mean square} = \frac{MS_{between}}{MS_{within}} \qquad (5)$$

If F is sufficiently large, we reject the null hypothesis that all the means are equal. If the P-value is for example 0.0003 which is well below 0.01, we can reject the null hypothesis and state that there are significant differences between the group means at the 1% significance level. This means that with a probability of 99% the same result will be obtained if the test is performed again. This does not imply that all the means are different from all the others. It simply implies that they are not all the same.

2.2 PRODUCT SPECIFICATION

In this phase the task is to get familiarized with the design mission and to gather additional information which is not found in the mission statement. The product specification specifies what result is to be accomplished through the product development process. The information is to be used as a base in the search of solutions of construction, as well as a reference in the evaluation of those solutions and the solution of the final product.

There are four important demands when stating a product specification; *completeness* – regard all interested parties, life cycle phases and aspects; formulate the criteria *independent of solutions* and to be *unambiguous*; if possible the criteria should be *measurable/controllable*; *irredundant* - each criterion should be unique. The criteria stated should be relevant for the

product that will be developed, i.e. the ones stated in the mission and given in the prerequisites and those that has come to hand during analyzes and elucidations of the task.

The criteria are divided into two main categories; demands and wishes. Demands are criteria that always must be completely fulfilled, whereas wishes can be fulfilled more or less complete. All product concepts must include all the demands while the wishes provide the possibility to diversify the solutions. The wishes are of different importance hence they are assigned a factor of importance on a suitable scale. (Johansson, Persson, Pettersson, 2004)

2.2.1 CRITERIA WEIGHING

To be able to compare different product concepts with each other, a weight coefficient must be calculated. This can be performed in a number of ways, one method is criteria weighing where a weight factor is calculated for each criteria/group and multiplied with each criteria's factor of importance where the products is the weight coefficient. (Johansson, Persson, Pettersson, 2004)

The method of criteria weighing is performed by the following steps by means of a table for criteria weighing, *see Figure 2*, according to Johansson, Persson, and Pettersson (2004):

1. Each main group is assigned a letter notation
2. The groups are compared in pairs according to:
   - If A is more important than B, two points is placed in the A-B box
   - If A and B are equally important, one point is placed in the A-B box
   - If B is more important than A, a zero is placed in the A-B box
3. All the groups are compared in the same way
4. Add the points together vertically and put a minus in front of each sum
5. Add each row horizontally; take into consideration the sign of the numbers and the correction factor. The correction factor consists of a sequence of odd numbers (1, 3, 5 etc.) placed from the top downwards
6. n = number of groups and control that $\sum p_i = n^2$.
7. Calculate respective weight factor $k_i = p_i / \sum p_i$ and control that $\sum k_i = 1.00$

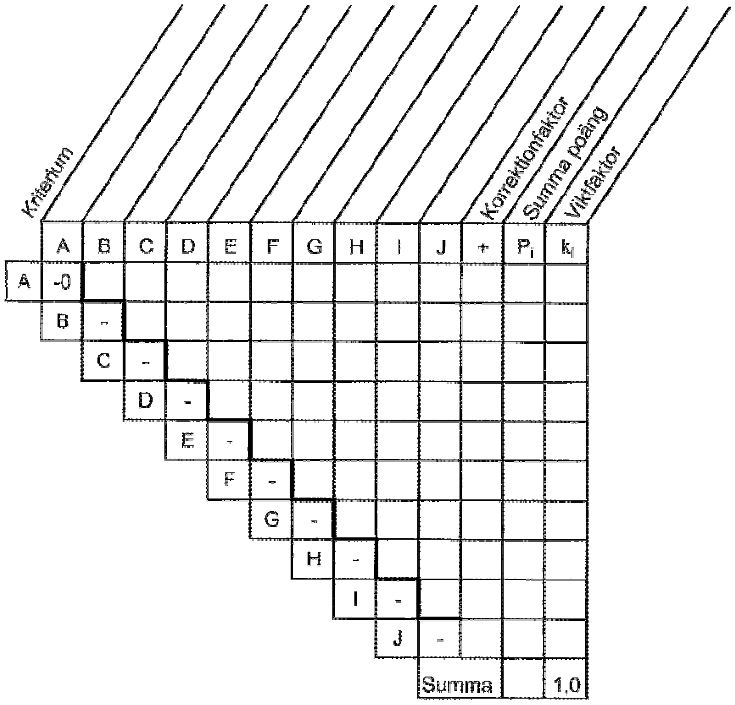

Figure 2 Table for criteria weighing (Johannesson, Persson, Pettersson, 2004).

2.3 CONCEPT GENERATION

The methods used to explore the area of product concepts which might fit the customer needs.

2.3.1 BRAINSTORMING

Normally, this method is performed in a group of five to fifteen persons. The group should generate as many ideas as possible without judging them. The members should motivate each other to develop new ideas from one another's ideas; hence the quantity is aimed at instead of quality. There are four fundamental rules which are important to follow throughout the whole process, these are:

- *No critic is allowed* – Do not comment, positively or negatively, the ideas.
- *Strive after quantity* – It is important that as many ideas as possible are generated, this increase the chances that some of them are really good.
- *Ideas out of the box* – Unusual ideas are more than welcome. Wild and crazy ideas can lead to really good ideas by some modifications.
- *Combined and complement* – By combining and complementing ideas, new ideas can be developed. (Johannesson, Persson, Pettersson, 2004)

2.3.2 CATALOG METHOD

Catalog or literature method is the simplest idea generation method. It is suitable to perform in a group or individually. The idea of the method is to collect information from literature or "catalogs". It can be performed systematically or unstructured; either

investigating how others have solved the problem or similar problems, or searching inspiration and ideas. The sources which can be used to find information might be: internet, product catalogs, internal company information, specialist literature, or fashion and design magazines. (Johannesson, Persson, Pettersson, 2004)

2.3.3 OSBORN'S CHECKLIST

When the brainstorming does not seem to provide with any further ideas, the Osborn's checklist is a good method to continue with. Alex F Osborn has formulated a large number of questions to use on the ideas gained from, for example, the brainstorming phase. Questions to use can be:

- *Enlarge*? Can something be added to the idea or can it be made larger in size?
- *Reduce*? Can something be taken away or maybe do it lighter or smaller?
- *Substitute*? Can something else be used instead?
- *Combine*? Are there ideas that can be combined or different mixes?

The list can be made long, this was only a few examples. Important to remember is to ask only one question at a time and to follow each direction the question might take you although it may seem unrealistic at the moment. (Johannesson, Persson, Pettersson, 2004)

2.3.4 CONTROL METHOD

In this method ideas for solutions are searched for by following a checklist made in advance. This will force the user of the method to take simple and closely related questions that otherwise risk to be forgotten or taken for granted. However, a checklist will never be complete and it might mislead the user into thinking that everything has been taken under consideration when the whole list has been run through. It is therefore important to make sure to use the control method in the right way. (Johannesson, Persson, Pettersson, 2004)

2.4 CONCEPT SELECTION

Every solution alternative must be analyzed with the intention to decide its "value/quality" in proportion to the demands and desires formulated in the product specification. The alternatives with the highest "value/quality" are then chosen for further development. The quality analysis can be performed by both theoretical and experimental methods. Quantitative measures are preferable, but in some cases it is not possible and qualitative measures have to be trusted instead.

The first step in the process is to "eliminate bad solutions". The second step is to further reduce the solution alternatives with relative decision matrixes. Meanwhile, combinations of old alternatives can lead to new good alternatives. The evaluation can be performed in different ways; simple calculations, physical prototypes or computer modeling and simulation. Another method is to use decision rules to make a structured and systematic selection. (Johannesson, Persson, Pettersson, 2004)

3 THEORY

This part contains the theories which were used as a base throughout the project and making decisions.

3.1 INTERFACE

Along with the development, the user's role has landed in the centre for the technical development. It has become more important to design suitable and functional user interfaces and usefulness has increased as the keyword. To increase usefulness, it must be among other things feasible for the user to in the simplest way determine how to act in a certain situation. (Westerholm, Åström, 2002) A user interface is the part of a product or a technical system which communicates with the user. In other words it is the part which gives the clues to how the product shall be used for example, buttons or instructions on the screen. (Danielsson, 2001) To construct functioning user interfaces you have to know the user's physical and psychic requirements, and also understand how the human thinks and creates meaning out of and conceives the world around. (Westerholm, Åström, 2002)

3.1.1 PROBLEMATICAL INTERFACES

Avoid providing the user with *false clues*, for example if it says on the door pull and you have to push, *see Figure 3* for another example. This can be a stress factor and false clues can also cause serious accidents.

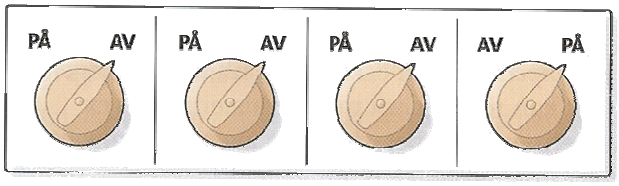

Figure 3 The marks besides the controls are inconsistent which provides the user with *false clues* (Danielsson, 2001).

Avoid making *the user doubtful*. Two factors which can do that are: the information is ambiguous (can have different meanings due to the situation) and same information can have varying meaning to different persons. Standards, which are binding rules for solutions of interfaces, may be used to avoid those factors. Because of the continuous development and that all systems have different requirements it is impossible to create standards for all systems.

A lack of feedback or a delay is another uncertainty factor. (Danielsson, 2001) When you make a phone call and are put on hold and there is no sound while you wait, you start asking yourself if you are still in the line or if the connection has been cut off.

3.1.2 A GOOD INTERFACE

A good interface gives clear feedback which means fast and comprehensible feedback. This implies that the user can directly detect in which state the system are and what actions need do be performed. Secure systems are easy to understand and use, the probability to take wrong actions and make mistakes becomes smaller (Danielsson, 2001).

3.2 ATTENTION

Attention can be defined as our gathered conscious mentally resources. If we try mentally to get a grip of more than our consciousness is able to at once, we generally loose control

of the situation (Westerholm, Åström, 2002). The demands for our attention vary with the situations and three different sorts of attentions can be distinguished.

- *Selective attention* occurs when there is an abundance of information and we have to choose what we shall pay attention to (Danielsson, 2001). The demands on the attention when performing a task are an important consideration in terms of designing systems. The design of the interface must prevent distraction from the closest surrounding if undivided attention is required (Noyes, 2001).
- *Focused attention* occurs when we have to with a conscious effort ignore distracting activities in the immediate surrounding and concentrate on a specific source of information. One example is trying to find a piece of information on a full display (Noyes, 2001).
- *Divided attention* occurs when we must attend to two or more sources of information simultaneously, without any task suffering. A driver must divide his attention between the instruments and the traffic (Danielsson, 2001). A total deterioration of both tasks might be the result if divided attention is not successful (Noyes, 2001).

Other external factors which control our attention have to do with how conspicuous the information is. Three of the factors are: color, movement and placement (Danielsson, 2001).

3.3 INTERPRETATION

Things which are experienced have to be interpreted to be meaningful. The eye sends for example light impressions to visual centre of the brain. The "picture's" abstract mixture of colors has there to be interpreted by discerning a pattern, a figure, then understood and compared to a correspondence among different conceptions. The brain chooses the figure which is easiest to distinguish and which regulates the experience in the best way. By organizing the visual impressions into groups, it is possible to simultaneously keep the attention on twice the number of things. The signification which gives the discern pattern a meaning, which allows the brain to "put a name" on it, becomes the *interpretation*. The brain searches within its *frame of reference*; the references which the user has to its world around consisting of culture, norms, values, attitudes and experiences. The interpretation which feels most natural is unconsciously chosen (Österlin, 2003). Humans detect at a glance if a pattern has been broken. When designing objects in our environment which we need to respond quickly to in an abnormal situation, this aspect is particularly important (Noyes, 2001).

3.3.1 GESTALT

A gestalt is an arrangement of parts which appears and functions as a whole which is more than the sum of its parts. Everything that can be discerned as a whole constitutes a gestalt for example a certain arrangement of colors. There are certain factors which can help us discern a gestalt (Monö, 1997). When the user has to manage a large amount of information, the gestalt factors make it easier *see Figure 4* (Danielsson, 2001). The most important ones are;

- *The proximity factor*, the clearer gestalt the closer it is;
- *The similarity factor*, figures with the same properties form gestalt;
- *The area factor*, the smaller the enclosed area is the clearer the gestalt;
- *The symmetry factor*, areas which are demarcated by symmetric lines are perceived as a gestalt;
- *The inclusion factor,* lines which enclose an area are more easily seen as a gestalt;
- *The good curve*, the arrangement that causes the minimum change or break in straight or uniformly curved lines creates a gestalt;
- *The common movement*, of different elements makes them stand out as a gestalt. Groups of cars moving on a road in each direction create two gestalts;
- *The experience factor*, in order to be able to recognize a specific gestalt it is required that we observe the conditions in the way we have learned from experience (Monö, 1997)(Danielsson, 2001).

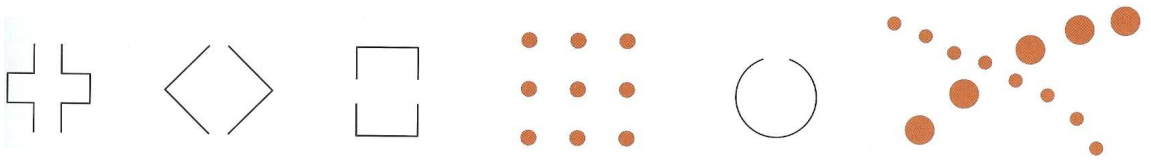

Figure 4 The symmetry factor, The proximity and the similarity factor, The inclusion factor, The good curve (Danielsson, 2001).

Contrasts are needed for the experience not to be too simple and to be perceived as uninteresting. It becomes fatiguing and elusive if it is too complicated. The experience gives stimulation if it diverges moderately from what the user is accustomed to. This is used when designing a product to give it a strong, distinct and comprehensible shape (Österlin, 2003).

3.3.2 FIELD OF APPLICATION FOR THE FACTORS OF GESTALTS

Instruments which functionally are connected should be placed close to each other and the placement ought to follow good principles of gestalt, *see Figure 5* for an example. For those instruments the consequences must be of a similar kind, for example the tachometer and the speedometer in a car. By *integrating several variables in one object* the factors of gestalts can be utilized in another way (Danielsson, 2001).

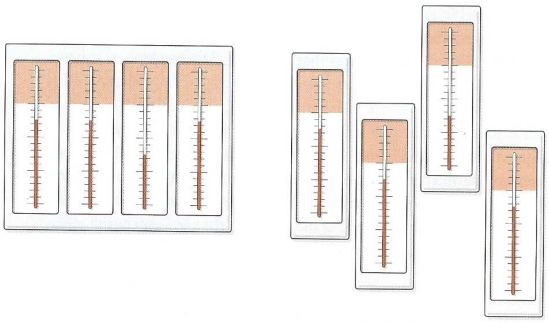

Figure 5 In the first picture it is easier to divide the attention between the different instruments, because of *parallel perception*. The user spontaneously arranges the parts to a whole, a gestalt (Danielsson, 2001).

If there are two variables in a system which covariances they can be integrated into one instrument, for example pressure and

temperature, *parallel processes*, *see Figure 6*. One of the advantages is that disruptions can easily be detected, because a new gestalt appears. On the other hand it becomes harder to solely focus on one of the variables (Danielsson, 2001).

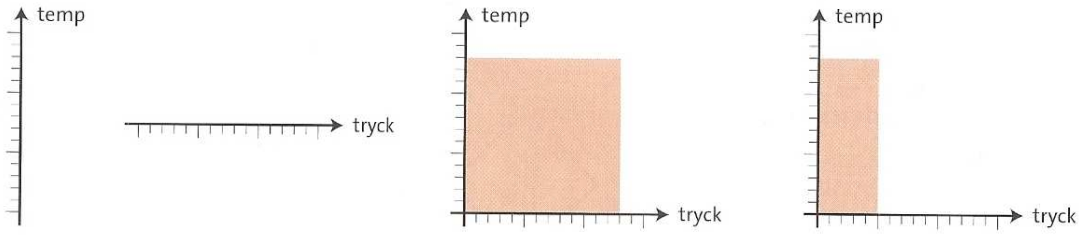

Figure 6 Parallel process temperature and pressure (Danielsson, 2001).

3.3.2.1 CONFLICTS OF RESPONCES

When you parallel perceive two different aspects of stimuli and these have different consequences for the actions which are similar but incompatible, a conflict of response appears. In an interface this conflict must be avoided because it appears distracting. One example where we parallel observe the meaning of the words and color of the words is;

STOP! GO!

Most people code red and green automatically; green is interpret as ”okay” and red generally as ”stop” or ”warning” (Danielsson, 2001).

3.3.2.2 REDUNDANCY – ABUNDANCE OF INFORMATION

Focused attention can however be facilitated by parallel processes. *Redundancy* means abundance of information and in terms of designing interfaces it should be used in an intelligible way. This is an example of two aspects of stimuli which have the same consequences for the action;

22
333
4444

The transmission of information becomes safer by redundancy presentation or coding; if you miss one aspect there is still another one obtainable (Danielsson, 2001).

3.6 DESIGN FACTORS

“Things which are designed to be useful must be understood to be usable.” (Monö, 1997)

3.6.1 SEMIOTICS

Semiotics is the study of signs and sign systems and their structure, properties and application. When designing useful products aimed to be adapted by man and his environment, they should be adapted to the whole person and the way all his senses perceive the surroundings. What the eyes see sets the expectations of what the other senses will perceive, for example a graceful form as light to carry. Usefulness should be increased

by the design. Usefulness is not only about technical and practical functions, the user has to physically and psychologically accept the product (Monö, 1997).

3.6.2 SEMANTICS

Semantics is the study of the signs message and signification. Communication with the user is one part of the product's function, in general and most importantly through the shape, surface and appearance. The product can express character, identity and function, which the designer designs it to communicate. For the product's message to be clear, the product design should consist of a strong gestalt, be moderately complex and correspond with the man's needs and frame of reference. It is advisable that the user knows his way about when a new version of an existing product is designed (Österlin, 2003).

It is impossible to ask a user why he thinks that a product is *attractive*, the motives are often hidden. The concept a*ttractiveness* is composed by feelings, thoughts, notions, and associations, *see Figure 7*. Enjoying the product as an implement is not the most important thing to be able to use it, it is instead understanding that it is an implement. What is to be understood, what the product must "say" to the market and the user, is important in terms of product development (Monö, 1997).

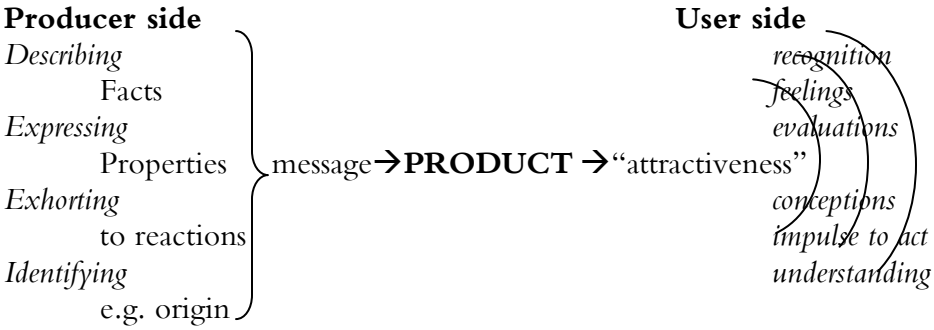

Figure 7 Attractiveness (Monö, 1997)

3.6.3 ANALYSIS OF THE SHAPE

The shape of a product has to convey an important part of its message. Lines and surfaces create more or less dynamic shapes; sharp shapes indicate tensions, streamlined shapes and diagonals convey the impression of movement, and an increase conveys a systematic and rhythmic organization of the parts. The different shapes are assembled to a main shape according to a principal of structure. The product's expression is built up of both the parts and the whole. The *product style* is in many cases important to not differ too much from, in order that the user recognizes the product's use (Österlin, 2003).

3.6.4 INFORMATION TRANSFER

Transfer of information in a system is one source of error and hence failure. To minimize this failure a common understanding between the sender and the receiver of the information must exist. Important is to identify where errors may occur and then utilize human factors principles to prevent them from happening. Common errors include:

- Not complying with warnings

- Misinterpretation of instructions
- Information overload from too many codes
- Entering information in the wrong location on a form
- Misinterpreting a survey question, thus providing inaccurate data

The novice or infrequent user should be the target group when designing for the general population. In time the user becomes familiar with the task and its environment which reduces the reliance and at the same time increases the comprehension of the information. However, in emergency situations the user acts on reflexes, so well-designed written information is needed for the experienced user as well (Chengalur, Rodgers, Bernard, 2004).

3.6.5 EXPRESSION: COMMUNICATE

Everything that exists and is visible has an expression; an instrument panel has an expression and should communicate with the user. The expression is one of the functions and how distinct it is varies and depends inter alia on the formation of gestalts. C*haracter*, *identity*, and *function* are the three types of expressions.

The product must have a *character*, an attractive expression, and it must correspond with the user's frame of reference and expectations from the product. The expression could be inter alia exclusive, trendy, homely, technical complex or simple. The character is used as competitive means in a buying situation and provides surplus value when in use. Décor an idiom are used as means to create a character.

Identity describes the products origin. The design of a product can reduce its anonymity, visualize competence, and inspire confidence by expressing the company identity. By marking a product with either manufacturer, product name or technical product data the identity will be consolidated. Sometimes the user also has the opportunity to adjust the appearance of the product to make it "one's own".

The expression might also explain the products function; product type, technology, and handling. The optimal product is self-instructional; the design speaks for itself about the products functions. The design has to be logic, easy to understand, obvious, and self-evident. If necessary, the functions can be elucidated by instruction plates and signs and in certain cases also with a special manual, or even need of practice (Österlin, 2003).

3.6.6 COLORS

Humans have the ability to tell the difference between millions of colors, but yet colors should be used with caution. Too many colors may distract and confuse the user of a system and colors also have different meaning and gives different associations to different people(Kroemer, Kroemer, Kroemer, 2001).

3.6.6.1 VISUAL WEAKNESS

Defective color vision is rather common in men, where about eight percent are unable to distinguish some colors in the right way or are unable to see colors at all. In some cases a

person can see all colors but confuses them, for example red, green, and gray, and very few persons are able to see one color or none (Kroemer, Kroemer, Kroemer, 2001).

The degree of difficulty in distinguishing colors also increases with less sufficient luminance. Dark hues are difficult to distinguish in an insufficient surrounding. When using color coding it is possible to vary the colors by using different brightness and saturation, but this should also be done with caution. The maximum number of levels of luminance or brightness that can be distinguished by a person is about two. If more levels are used, the less certain it is to get an error-free performance. In case of lights, colored lights are preferred over painted coloration (Chengalur, Rodgers, Bernard, 2004).

Although a person is able to see all colors he/she have areas on the retina that are less sensitive to colors. The distribution of cones and rods on the retina leads to seeing all colors when looking straight ahead but none at the very periphery of the person's visual field. In between, green, red, and yellow can be distinguished until about an angle of 50 degrees and blue can be distinguished until about 65 degrees. Most people are able to distinguish white at 90 degrees to the side from straight ahead (Kroemer, Kroemer, Kroemer, 2001).

3.6.6.2 EFFECTS OF COLORS

As mentioned above, colors may have different meaning to different people. There are psychological, physiological and cultural effects of colors which should not be ignored. For example, using the color yellow increases the visibility since yellow is the most visible color and a contrast to black, but in the nature the combination of yellow and black is used as a warning sign for danger and should therefore be used with caution (Russel, 1991).

3.6.6.3 THE USE OF COLORS

Color is often used in displays, but it could be done in good or less good ways (adapted from Cushman and Rosenberg 1991). There should be a maximum number of seven colors used, and if the user may not be experienced with that certain system or if that display not is used very often, no more than four colors should be used. The discrimination plays a big role in well-designed systems. The colors must be separated widely in wavelength and not only differ in the amount of one primary color to get different shades of the same color. There are, according to Kroemer, Kroemer and Kroemer, in *Ergonomics How to design for ease and efficiency*, a few combinations that could be used:

1. green, yellow, orange, red, and white;
2. blue, cyan, green, yellow, and white; and
3. cyan, green, yellow, orange, and white.

And also a few suggestions of combinations that should be avoided:

1. reds with blue;
2. reds with cyan; and
3. magentas with blues.

The color blue should not be used for thin lines like text, but works good like background and larger figures. The text and numbers must be of a color that stands in contrast to the background to make it distinguishable. Since red and green is difficult to detect in the peripheral area of the visual field, these colors should not be used for small figures in large displays that might enter this area. The use of opponent colors may in some cases enhance the display, but in other cases work as damaging. Shape and color together could work as redundant cues and aid the users who have visual weaknesses. The size of the objects coded with colors should be increased, if the number of colors increases (Kroemer, Kroemer, Kroemer, 2001).

3.6.7 PLACEMENT

Placement is a factor that is very important to make the user detect and identify information. The user should be able to find faults as quick as possible and connect a display with the right control and also understand the relations between the display and the control. Color marking could here enhance the effect. This helps the user to understand functions and operations needed (Monö, 1997).

Articles placed highest or at the left on a screen or on an instrument panel tends to draw the attention from the user, maybe because of the order in which we read. Articles in the middle also tend to draw attention, since it is placed in the user's direct field of vision (Danielsson, 2001).

3.7 DISPLAYS

The purpose with a display is to inform the operator about the status of the equipment. Since this is very important the information has to be easily detectable and any required action has to be indicated clearly. Information provided by the display can be categorized into three groups; Need to know, Nice to know, and Historical (Chengalur, Rodgers, Bernard, 2004). According to *Ergonomics How to design for ease and efficiency* the "four cardinal rules" for displays are:

1. *Display only that information which is essential for performing the job adequately.*
2. *Display information only as accurately as is required for the operator's decisions and control actions.*
3. *Present information in the most direct, simple, understandable, and usable form possible.*
4. *Present information in such a way that failure or malfunction of the display itself will be immediately obvious.*

3.7.1 VISUAL DISPLAYS

The display that is used the most is the visual display. Visual displays can be divided into three types; quantitative, qualitative, and check displays (Noyes, 2001).

Quantitative displays provide the user with exact information, like the precise numerical value in a digital clock or degrees (Kroemer, Kroemer, Kroemer, 2001). When the user needs only a quantitative value from the readout a digital is preferred over a dial. The risk of error is decreasing with a digital since the user does not have to consider scale markings

and calculate the desired value. However, this only applies to a slow rate of change and when the user is only in need of an exact value. (Chengalur, Rodgers, Bernard, 2004) Another disadvantage with digital displays is the risk of misinterpret the numbers, like confuse a 3 as an 8, or 1 as 7 (Noyes, 2001).

Moreover individuals trained to use one type of mechanical device may have difficulty adjusting to the digital output. For example, drivers used to semicircular analogue speedometers may have problems adapting to devices that display speed digitally." (Noyes, 2001)

Qualitative displays indicate the status of the equipment, an approximate value, or rate of change, for example cold- normal- hot. (Kroemer, Kroemer, Kroemer, 2001) When the rate of change is of higher velocity, a qualitative display gives more information to the user. A digital display may be easier to read but an analog display also provides the user with information about deviations from reference values. The user not only detects what speed the vehicle has but also how far above or below the posted speed limit he/she is driving. *(Cushman and Rosenberg 1991, pp. 92-93)* (Kroemer, Kroemer, Kroemer, 2001).

Check displays provide the user with information about if certain conditions exist. For example, a green light could indicate that the system is functioning alright (Kroemer, Kroemer, Kroemer, 2001).

3.7.2 DESIGN AND INSTALLATION OF VISUAL DISPLAYS

The operator's performance of the equipment or production system is affected by the design and installation of the visual display. There are different factors which should be considered when choosing and installing a display for example the distance between the operator and the display, number of displays on a single console and the readability of the dials. For further information see tables in *Kodak's Ergonomic Design for People at Work* page 285 (Chengalur, Rodgers, Bernard, 2004).

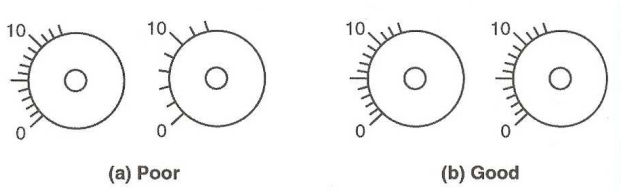

Figure 8 (a) poor layout and (b) good layout of marks (Chengalur, Rodgers, Bernard, 2004).

A group of dials should be aligned uniformly so the user is able to quickly detect if something is out of the usual. For example a group of dials the pointer in each one ought to be in the same position in normal conditions. Dials which are placed close together ought to have the same layout of marks and numbers, *see Figure 8*, and grouped after function. The display should be labeled clearly to avoid misinterpretation. Displays that are not used should be removed or covered up to draw the user's attention to the more important ones (Chengalur, Rodgers, Bernard, 2004).

3.7.2.1 QUALITATIVE AND QUANTITATIVE DISPLAYS

Looking at qualitative and quantitative displays there are four different displays to consider; a moving pointer and fixed scale, a moving scale and fixed pointer, counters, and pictorial. When a quantitative display is used, often it is preferred to use a moving pointer with a

fixed scale. A reduction of the information content of a display may be advisable to make it easier for the operator's mind. One example is to change the exact degrees of temperature into "too cold", "acceptable", or "too hot" (Kroemer, Kroemer, Kroemer, 2001).

Dials and gauges

When designing a visual instrument with displays, there are certain unwritten laws to follow to make the user able to make a quick and accurate reading. A gauge with a moving pointer and fixed scale should be used, but if the range is very large a moving scale behind a fixed pointer might be the right way to go (Chengalur, Rodgers, Bernard, 2004).

When it comes to the shape of the dials and gauges a rectangular probably takes up less room, but for easier reading, circular or semicircular ones are to prefer. (Chengalur, Rodgers, Bernard, 2004) The user has certain ways of reading things, if the designer does the opposite from what the user is used to it will increase the reading time and the risk of errors. A dial should therefore have the values increasing clockwise, a horizontal from left to right, and a vertical from the bottom to the top (Chengalur, Rodgers, Bernard, 2004).

Scale

A general rule when it comes to the scale is that it should be simple, uncluttered, and easy to read correctly and quick. The major marks on the scale should be numbered and it should be designed to prevent the user from having to "guess" the value between two numbers. The maximum of minor markings between two major marks are nine, where only the middle one has pronounced graduation. More suitable is to use progressions in units of one, two, five, or ten. It is important that the divisions showed is those which are most important to the user. Numerical values should be placed upright and outside the dial to avoid them being overlapped by the pointer (Kroemer, Kroemer, Kroemer, 2001).

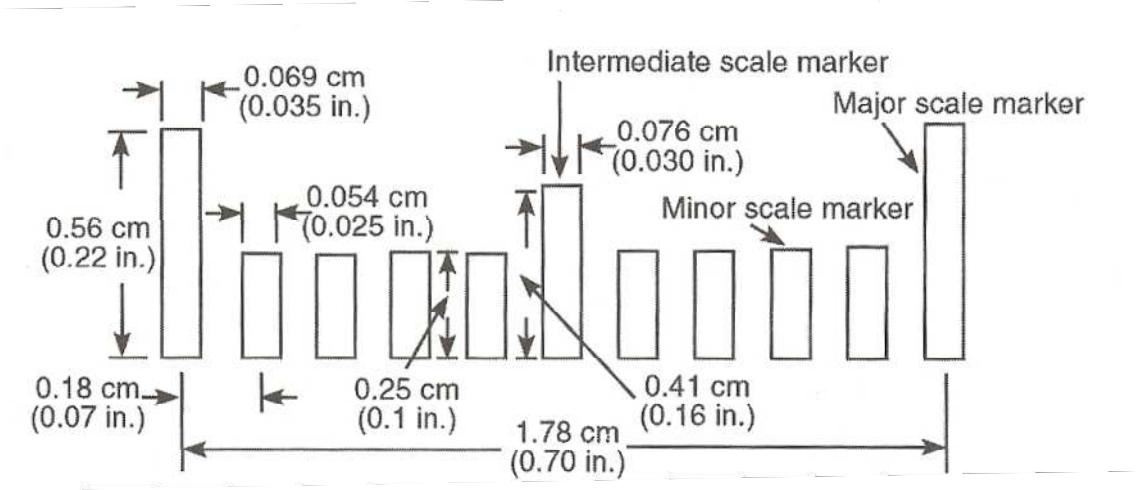

Figure 9 Recommended scale mark dimensions for 71 cm viewing distance (Chengalur, Rodgers, Bernard, 2004).

On a circular dial the zero should be placed at nine o'clock or twelve o'clock, but if the scale does not go all around place the zero at six or twelve o'clock. Depending on the distance between the display and the user, the markings should be of proper thickness to be able to be distinguished by the user. *See Figure 9* for recommended dimensions for a distance of 71 cm (Chengalur, Rodgers, Bernard, 2004).

The diameter of the dial should depend on the number of markings necessary and the viewing distance of the user. If the number of markings is very large it might be appropriate to use a digital readout instead (Chengalur, Rodgers, Bernard, 2004).

To use target zone markings or to color code certain areas of the dial is an excellent way to get a faster reading, *see Figure 10*. However, for the display to be distinguished correctly, especially in reduced ambient illumination, the markings, pointers, and numbers should be white against a black background. The printing should be as simple and legible as possible, to make it easier for the user to read it (Chengalur, Rodgers, Bernard, 2004).

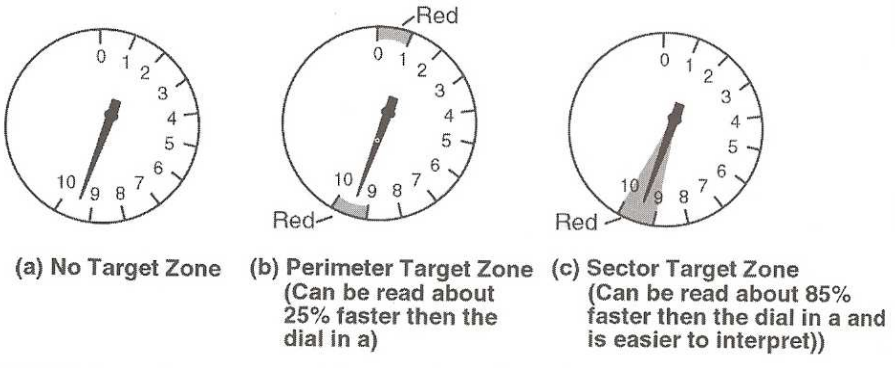

Figure 10 Target zone markings on dials (Chengalur, Rodgers, Bernard, 2004).

Pointer

The pointer itself should not overlap the smaller markers and make them difficult to detect, but it should reach the major scale marker with its tip so there is no differed opinions in where the pointer is pointing. To avoid misinterpretation when reading the dial from the side, the pointer should lay as close to the surface of the dial as possible. The end of the pointer should be sharpened with an angle about 20 degrees and have the same color in the end as at the start of the pointer (Adapted from Sanders and McCormick 1987; Ivergard 1999) (Chengalur, Rodgers, Bernard, 2004).

3.7.2.2 CHECK DISPLAYS

When designing check displays it is important to use a color that suits the information given by the display. White is a rather neutral color which usually does not provide the user with information about correct or incorrect implications. However, white check displays is perfect to indicate that a function are turned on. The choice of the color green for a check display provides the user with a "go ahead"-information. Green usually gives a positive feeling that everything is functioning alright. Yellow light you could say lies between "functioning" and "not functioning". When a yellow light comes up it tells the user to be alert and maybe checking is required, or that there is a delay. A red light is

known as a warning about malfunctioning or failures. An action has to be taken before the system will function alright again. If the red light is flashing it usually stands for an emergency in the action that must be taken. The consequences of delay in the action are severe like possibly personal injury or damage to the equipment. Blue is like white rather neutral, but together with a flashing red light it is used on emergency vehicles like police cars (Kroemer, Kroemer, Kroemer, 2001).

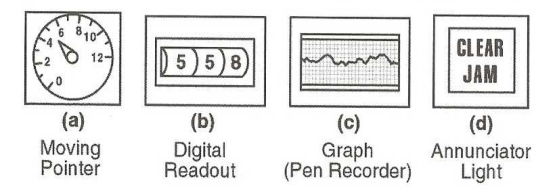

Figure 11 Visual displays (Chengalur, Rodgers, Bernard, 2004).

A lamp display is also very often size coded to, for example indicate the level of urgency. A small red light might mean only malfunction of the system, but a large one might be an emergency condition. There are also annunciator lights with a written instruction on, these are often pushbutton controls, *see Figure 11* for examples of visual displays (Chengalur, Rodgers, Bernard, 2004).

3.7.3 ELETRONIC DISPLAYS

In general electronic displays are emissive, i.e. gives off light, and reflective displays reflect light from its surrounding and is therefore seen by the user.

When presenting information on an electronic display, the keywords are; clarity, discrimination, conciseness, consistency, detection, legibility, and comprehensibility. Clarity is very important since the information has to be conveyed quickly and, of course, accurately. Discrimination also makes the user able to distinguish the information accurately, and conciseness results in providing the user only with the information needed, avoiding extraneous information as much as possible. It is also important to be consistent when presenting information, it should be presented in the same way throughout the system so the user knows what to expect. When talking about detection, the designer's mission is to draw the user's attention the right way, and when this is done the information must be easy to read, hence the legibility. However, there is no meaning in having the information easy to read if it's not comprehensible. Comprehensibility means the information is clearly understandable, unambiguous, interpretable, and recognizable (Chengalur, Rodgers, Bernard, 2004).

3.8 LABELS AND WARNINGS

"There are three factors in message design for labels and signs that enhance communication: comprehensibility, legibility, and readability." (Chengalur, Rodgers, Bernard, 2004)

3.8.1 COMPREHENSIBILITY

"*Comprehensibility* is a measure of how reliably the receiver interprets a message." It implies that the message should be clearly understandable, unambiguous, interpretable, and recognizable. The interpretation depends partly on the user's prior knowledge and language skills (Chengalur, Rodgers, Bernard, 2004).

3.8.2 LEGIBILITY

Legibility means that the label should be easy to interpret; the user shall be able to read the label easily and accurately under existing circumstances (reading distance, illumination level, vibration and motion in the environment). The legibility is affected by the contrast between the character and its background, distance between letters, words and rows, the letters size, the typography (the style, font arrangement, and appearance of the written word), color, and the specular reflections of the background, cover, or other components. The font (typeface) should be simple, bold, and vertical, good examples are Futura, Helvetica, Namel, Tempo, and Vega (Danielsson, Mats, 2001) (Kroemer, Kroemer, Kroemer, 2001) (Chengalur, Rodgers, Bernard, 2004).

Under normal lighting conditions:

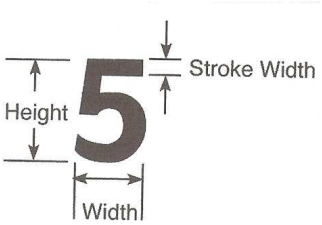

Figure 12 Definition of font characteristics (Chengalur, Rodgers, Bernard, 2004).

- *Stroke width* – Between 1/8 and 1/6 of the height of black letters on a white background, *see Figure 12* for definition of font characteristics. In darkrooms or other reduced-light locations, white letters on a black background tend to be more visible. In this case, the stroke width should be between 1/10 and 1/8 of the height.
- *Character width* - 3/5 of the character height, except for I; one stroke width, M and W; 4/5 of the height. In darkrooms or other reduced-light locations, the characters should be about 50% larger.
- *Number width* - 3/5 of the number height, except for 1; one stroke width
- *Letter and number height* - depend on viewing distances and the criticalness of the information;

  For a viewing distance of 35 cm, the suggested height is 22 mm.
  For a viewing distance of 70 cm, the suggested height is 50 mm.
  For a viewing distance of 1 m, the suggested height is 70 mm.
  For a viewing distance of 1.5 m, the suggested height is 1 cm.
- *Space between letters* – at least on stroke width
- *Space between words* – at least one character width
- *Characteristic openings/breaks in a letter/number* - readily apparent
- *Avoid the use of colored print.* However, if colored letters or numbers must be used in order to take advantage of color coding, note that legibility may be reduced. *Figure 13* illustrates different combinations of colors and their legibility in normal lighting conditions. Use of color in reduced-light areas is less satisfactory. If colored light is used, color combinations should be tested in that condition to assess their legibility
- *Adapt materials and methods* used for constructing labels and signs to the environmental conditions. For instance, engraved labels should not be used in an area where dirt is likely to fill in the indentations.
- Place labels and signs on the equipment in the workplace so that glare, reflections, and shading do not make them difficult to read. If a sign or a label is placed outdoors, pay attention to the changing direction of the sun when locating it in order to improve its visibility. Matte surface paints may also be used to reduce

reflections (Chengalur, Rodgers, Bernard, 2004)(Kroemer, Kroemer, Kroemer, 2001).

	Color Combination	
Legibility	Characters	Background
Very Good	Black	White
	Black	Yellow
Good	Yellow	Black
	White	Black
	Dark Blue	White
	Green	White
Fair	Red	White
	Red	Yellow
Poor	Green	Red
	Red	Green
	Orange	Black
	Orange	White
Very Poor	Black	Blue
	Yellow	White

Figure 13 Legibility of color combination in white light (Chengalur, Rodgers, Bernard, 2004).

Most electronically generated fonts (such as by an LED, an LCD, or a matrix) are inferior to printed fonts; thus, special attention must be paid to make them as legible as possible (Kroemer, Kroemer, Kroemer, 2001).

3.8.3 READABILITY

To be able to understand a text it is a necessary condition that it is readable. *Readability* concerns the ease of reading words and numbers, assuming that the individual characters are legible. A control panel needs a high degree of readability, which can be improved by careful categorization and arrangements. In terms of designing labels/messages there are a couple of principles which are important to follow:

- *Orientation* – The label/message should be oriented horizontally so it can be easily and quickly read
- *Location* – Place labels/messages consistently throughout the system/equipment and on or close to the item it signifies.
- Begin with a distinct heading or an illustration
- *Typography* - Take into account when selecting font: readability, purpose of the product and nature of the company profile
- *Letters* – For headings or messages of a few words use only capitals. For longer messages mix upper- and lowercases. Use italics only for emphasizing specific words or short phrases or use underlining
- *Abbreviations* – Avoid abbreviations as far as possible because the make reading more difficult and might leave the user in doubt about their meaning. If an abbreviation is needed, use standard ones. If a new one is necessary, its meaning

should be self-evident to the reader and it should be tested on inexperienced subjects before use. The abbreviation should be used consequently and for the singular and plural forms a word. Use capital letters and periods are normally omitted.

- *Brevity* – The message should be as concise as possible without out leaving the user in doubt, unambiguous and redundancy should be minimized.
- Avoid unnecessary *difficult words* and if possible use *words of familiarity* to the user.
- *Divide and number the phases* after the order they should be accomplished.
- Avoid *negations*; they make the comprehension of the message harder.
- The word order ought to follow order of actions. (Enter and close the door and not close the door after entering).
- *Borders* - Use borders between single blocks of numbers or letters, *see Figure 14*. Put distinctive borders around critical labels or messages if several are clustered in the same area. Keep the embellishments to a minimum, because each one reduces the effectiveness of display of the others.

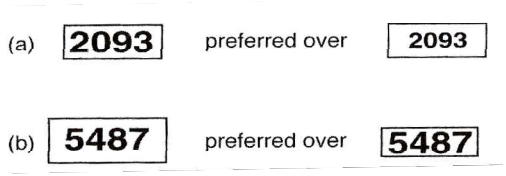

Figure 14 Spacing and boarders that improve readability (Chengalur, Rodgers, Bernard, 2004).

- *Figures* - Representative figures (icons), abstract symbols and diagrams, frames, and connecting lines should only be used when the layout, text content, and typography do not achieve clear identification.
- *Colors and patterns* – In cases where the readability the aesthetic harmony and balance cannot be combined, the readability is more important. But an optimal synthesis should always be strived for in the design (Monö, 1997) (Chengalur, Rodgers, Bernard, 2004) (Kroemer, Kroemer, Kroemer, 2001).

3.8.4 WARNINGS

Labels and sign for passive warnings must be carefully designed. The message or signal must be easy to detect, obviously identifiable and distinguishable from the background noise. Size, shape, contrast, and color are features which may aid in providing detection of visual warnings. The design should follow recent government laws and regulations, recognized national and international standards, and the best applicable human-engineering information. It is important that the user interpret and understand the message accurately. Additional factors to consider when developing warnings (Kroemer, Kroemer, Kroemer, 2001) (Chengalur, Rodgers, Bernard, 2004):

- Avoid vague or ambiguous words/icons, highly technical terms, double negatives, complex grammar, and long sentences (more than twelve words).
- Consider the target population and the possibility of visitors presented. Design for the novice or the infrequent user. Test the result on the general population.
- Consider the environment of usage (e.g. light, noise) that may have impact on the warning.
- The warning's appearance should match the severity of the warning.

- Test and experimentally validate the warning system under realistic conditions with the appropriate user population (Chengalur, Rodgers, Bernard, 2004).

3.8.4.1 VISUAL WARNINGS

Visual warnings may contain text, graphics, and pictures and often presented redundantly. The perceptions of dangers and warnings may differ due to the users' ages, experience, nationality, and educational background. However, it is preferable to design a "safe" product instead of applying warnings to an inferior product (Kroemer, Kroemer, Kroemer, 2001). A properly designed warning should include an indication of risk severity (danger/warning/caution), an indication of the hazard, consequences of not acting on the warning and instructions that will reduce or eliminate the hazard. In terms of designing a visual waning, consider following factors:

- *Size* – Consider the size of the warning relative to the surrounding information.
- *Shape* – has the ability to draw an individual's attention to a warning message. From the shape alone of some signs an approximate meaning can be derived (octagonal stop sign).
- *Graphics* – pictograms and icons – Have the ability to attract an individual's attention to a warning by representing the consequences which could occur. If the depictions are selected carefully they can be used for users from different cultures and with different languages.
- *Color and contrast* – The warning will be easily detected if it is high contrast between text and background on the sign itself. The same thing applies to the background and the warning sign itself (e.g. a colorized warning on an otherwise black and white printed page). Recommended colors for warning labels and signs are in general black, white, orange, red, and yellow.
- *Location* – Western countries read from left to right and from the top downwards, hence the warning should be placed toward the left or the top, depending on the design of the display and surroundings. The detection of the warning will be easier if it is separated from other information (labels and signs) (Chengalur, Rodgers, Bernard, 2004).

3.9 INFORMATION INSTRUMENT

Explained below are the information instruments which are considered in the questionnaire and through out this project.

3.9.1 WARNING SYMBOLS

Warning symbol for low window washer fluid – Warning symbol that alerts the driver when the window washer fluid is low.

Warning symbol for improper oil pressure – Warning symbol that alerts the driver when the oil pressure is too high or too low. An engine that runs with incorrect oil pressure, even for a short period of time, can easily be damaged.

Warning symbol for low tire pressure – Warning symbol that alerts the driver when the air pressure in the tires are low.

Warning symbol for low fuel level – Warning symbol that alerts the driver when the fuel level is low.

Warning symbol for parking brake engaged – Warning symbol that alerts the driver when the parking brake is engaged.

Warning symbol for improper engine temperature – Warning symbol that alerts the driver when the engine temperature is too high. High engine temperature may cause damage to the engine.

Warning symbol for electrical charging system failure – Warning symbol that alerts the driver when the battery is not being correctly charged.

Warning symbol for airbag not in function – Warning symbol that alerts the driver when something is wrong in the airbag system.

Warning symbol for Anti-lock braking system (ABS) – Warning symbol that alerts the driver when there is something wrong with the ABS brake system.

Warning symbol for poor road conditions – Warning symbol that alerts the driver when poor road conditions like slippery road, icy, rainy, poor visibility, etc occur.

Warning symbol for engine stall – Warning symbol that alerts the driver when the engine has stalled.

Warning symbol for malfunctioning light bulb – Warning symbol that alerts the driver of a malfunctioning light bulb.

Warning symbol for door is ajar – Warning symbol that alerts the driver when a door is ajar.

Warning symbol for electrical malfunction – Warning symbol that alerts the driver when there is a malfunction in the electrical system.

Warning symbol for engine in need of service – Warning symbol that alerts the driver when the automobile is in need of service.

3.9.2 DRIVER INFORMATION

Figure 15 An example of driver information displayed in an automobile (Tretten, Ärling, Lundberg, 2007).

Speedometer – An instrument that presents information about the velocity of the vehicle in kilometres per hour or miles per hour.

Tachometer – An instrument that presents information about the velocity of the engine in revolutions per minute.

Fuel level information – An instrument that presents information concerning the amount of fuel available.

Motor temperature information – An instrument that presents information of the temperature of the engine.

Oil pressure information – An instrument that presents information of the oil pressure level.

Clock – An instrument that presents the time of day.

Outside temperature indicator – An instrument that presents the temperature, outside of the vehicle.

Seatbelt reminder – An indicator which is to remind the driver to fasten their seatbelt.

Which door is ajar – An indicator that provides the driver with information of which door/hatch is ajar.

Which light is malfunctioning – An indicator that provides the driver with information of which light bulb is malfunctioning.

Cruise control indicator - An indicator that presents information concerning cruise control status.

Climate control information – Information concerning temperature controls, climate control functions and temperature controls for the interior climate.

Entertainment information – Information about the vehicle entertainment system function and status.

Mobile telephone information –Information from the mobile telephone connected to the vehicle.

Trip computer – An onboard computer that provides the driver with information about average speed, average economy, fuel consumption, instant economy, miles remaining before empty, etc. Information that may be important to know on a longer trip.

Scrollable menu of options – An menu that provides the driver with information about the status of the vehicle, such as service interval, mileage, temperature, vehicle malfunctions, fluid levels, etc.

3.9.3 IN-VEHICLE TECHNOLOGIES

Figure 16 An example of In-vehicle technology displayed in an automobile (Tretten, Ärling, Lundberg, 2007).

Image of road obstacles and other vehicles – An image that provides the driver with information of road/roadside obstacles.

Image of road – An image that provides the driver with road information in case of poor visibility such as bad weather, *see Figure 16*.

Navigator – An image of a map that provides directional helps. Shows the driver where to drive in order to reach a chosen location.

Adaptive cruise control – Information of the cruise control that steers the vehicle speed after a pre-set speed and also adapts the vehicle speed to the vehicle in front to prevent collision.

Parking aids – Provides information about the vehicles position in relation to other vehicles when parking.

Electronic brake assist – Assists the vehicle in braking for obstacles that the driver did not respond to.

Excessive speed indicator – Alerts the driver when the allowable speed limit is surpassed.

External vehicle speed control – Assists the driver in keeping the government-defined speed limits.

Video image of the back seat – Shows an image of the back seat so that the driver is not forced to turn their head away from the road ahead to look in the back seat.

Lane change help – Provides information of whether or not there are obstacles in the "dead-angle" when changing lanes.

Shift light for sport driving – Provides information about when to shift for optimal acceleration.

Shift light for economical driving – Provides information about when to shift for optimal economical driving.

Econo-meter – Provides information about how much energy that is saved in economical driving.

Advanced driver menu – Provides the opportunity to choose what language, functions and other options that are to be available when driving.

Advanced driver options – Provides an opportunity to choose where information is to be shown.

Adaptable display – Provides information which is adapted to the vehicle situation like; cold start, cruising or rush-hour traffic. Only relevant information is presented.

3.10 DISPLAYS

Heads-up display (HUD) is a type of display which presents data to the driver without blocking his view. In automobiles it is usually a secondary display for the most important information from the gauges (Wikipedia). *See Figure 17 and 18* for example.

The *instrument cluster* is placed right in front of the driver on the dashboard, *see Figure 17*.

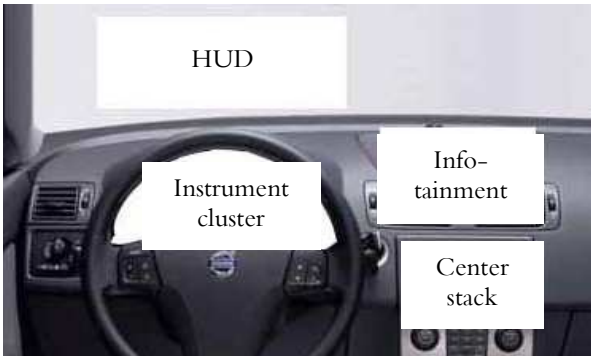

Figure 17 The dashboard in an automobile with the displays. (Tretten, Ärling, Lundberg, 2007).

Infotainment is a combination of the words information and entertainment, and this is also what it displays. The

display is placed in the middle of the dashboard, s*ee Figure 17*.

The *center stack* is the area below the infotainment and above the gearshift, s*ee Figure 17*.

Figure 18 Heads-up display
(http://www.pontiac.com/images/gallery_v2/grandprix/int_hud_lg.jpg).

3.11 COMPUTER PROGRAMS

Different computer programs were used as aids through out the projects element.

3.11.1 SPSS

SPSS, the Statistical Package for the Social Sciences, is a complete statistical computer program. It allows the user to "score and to analyze quantitative data very quickly and in many different ways". For more information visit the website http://www.spss.com.

3.11.2 MICROSOFT OFFICE EXCEL

The information analyze programme Microsoft Excel is used as a tool which helps the user to analyze, handle, and share the information in question. For more information visit the website http://www.office.microsoft.com.

3.11.3 AUTODESK ALIASSTUDIO

Autodesk® AliasStudio is a CAID (Computer Aided Industrial Design) software for the complete design process, used for automotive design and styling, 3D-modeling, rendering and engineering integration. For more information visit the website http://www.autodesk.com/aliasstudio.

3.11.4 ADOBE PHOTOSHOP CS2

Adobe Photoshop CS2 is a professional image-editing standard software. It is used by professionals as well as amateurs to edit images, for example a digital photo. The image can be examined up close and a number of imaging tools for different purposes can be used to enhance the quality of the image. For more information visit the website of Adobe; http://www.adobe.com.

4 MARKET ANALYSIS

This part contains the methods for the market analysis and its results.

4.1 OPTIVE SURVEY

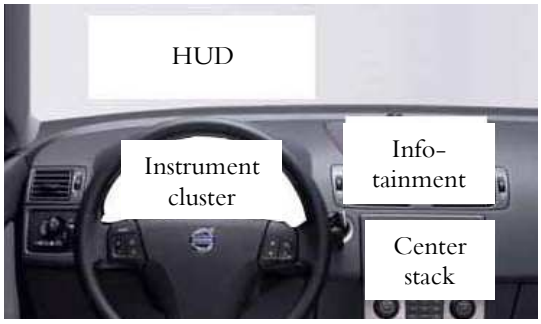

Figure 19 The dashboard in an automobile with the displays. (Tretten, Ärling, Lundberg, 2007).

OPTIVe has performed surveys in the USA and Sweden concerning information in automobiles, this by handing out a questionnaire at LTU and PBA. The questionnaire consisted of four subsections; warning symbols, driver information, In-vehicle technologies and sociodemographical questions. In the first three sections the subject ranked the degree of importance (on a scale from one to seven) of each information instrument and was able to choose the placement of it in the dashboard. The dashboard consisted of four different displays; the windshield (HUD), the instrument cluster, the infotainment and the center stack, *see Figure 19*. The sociodemographical questions dealt with sex, race, age, personal status, level of education, income and the relation to automobiles and aesthetic areas. When the survey was conducted in the USA, two new questions were added to the questionnaire. These questions had to be regarded with some caution. *See Appendix 1* OPTIVe questionnaire.

4.2 COMPILATION OF OPTIVE QUESTIONNAIRE

Both countries' answers to the questionnaire were entered into the statistic program SPSS. The data was compared in different combinations to identify distinct differences between subjects. Mean values were calculated for each information instrument to distinguish the most important instruments according to the subjects. Four was a neutral answer, therefore only values from five to seven were taken under consideration. For those instruments within that range, the selected placement was examined. The display of interest for the project was the instrument cluster and it was noted if it was the primary choice of placement for the instrument in question. A distinction was also made if the cluster was primary favored by more than 50 percent (red marked) or less (green marked) of the subjects. *See Appendix 2* Desired information instrument for the compilations of each compared combinations.

The first compilation to be conducted was with all subjects' answers included and to be able to detect possible differences between the countries, the answers from USA and Sweden were separated and compared to each other. Secondly, a separation between the genders was performed and then another one including country of origin. Thirdly, age might have affected the choice of instruments and placements. To make it easier to detect differences between them, the subjects were divided into five suitable age groups; 0-20 years, 21-30, 31-40, 41-50, and 50 years and older.

A comparison that could be of interest was whether the subject had a driver's license or not. No license could possibly amount to a lack of knowledge about the importance of some information instruments. A further division was the years of driving experience they had. Five suitable groups were created in order of years of experience; 0 years, 1, 2-4, 5-10, and 11+.

Could personal status of the subjects influence their responses? In the questionnaire the subjects could choose one of the following four statuses; single, single with children, married/partner, and married/partner with children. These groups were compared to each other, and then difference was made between country of origin, and after that also between genders.

The last comparison made was between levels of education; practical, high school, college, or other. A higher level of education could possibly mean a deeper comprehension in the area of information instruments.

The subject's ranking of criteria when buying an automobile might be of interest to focus on the right areas within the design phase. There were five areas to choose between; "exterior design", "interior design", "feel of quality", "practical", and "feels safe". The subjects ranked the areas from one to five, where one was the most important.

To determine which target group the subjects belonged to, the median and mean value of their age was calculated. Three subjects had not stated their age and the median and mean value were calculated without them in consideration. Two subjects had not stated their gender and one woman respectively one man had not stated their age.

Subject group, n numbers	**Median**	**Mean value**	**Min**	**Max**
Sweden and USA, 209 (212) subjects	21 years	22 years	14 years	69 years
Sweden, 142 (144) subjects	21 years	22 years	14 years	65 years
USA, 67 (68) subjects	21 years	23 years	16 years	69 years
Women, 89 (90) subjects	21 years	22 years	16 years	69 years
Men, 120 (120) subjects	21 years	23 years	14 years	69 years

4.3 EVALUATION AND CONCLUSIONS INFORMATION INSTRUMENTS

4.3.1 ELIMINATION DEPENDING ON MEAN VALUE

The different compilations were compiled in a table in Microsoft Excel to be able to easily compare them to each other. The red and the green marks were transferred from the compilations to the table. The instruments which received a mean value over five but where the primary choice of placement was not in the instrument cluster were marked with light yellow. The two instruments *Motor temperature level indicator* and *External brake assistant* were not included in the questionnaire in Sweden. Therefore were those cases where the Swedish subjects' responses could have affected the mean value marked with question marks. Within some of the analyzed groups the number of subjects was too few or too few had responded about the placement, so the result was in some cases considered unreliable. *See page 8 and 9 in Appendix 2* Desired information instruments.

When all the subjects' answers were analyzed together the warnings symbols desired were (mean value over five and more than 50% of the subjects wish to have it displayed in the instrument cluster): *Low oil pressure, Low fuel level, Parking brake engaged, High motor temperature, Charging system failure, ABS failure*. *Speedometer, Fuel level* and *Motor temperature level indicator* were the only driver information instruments desired by the subjects and neither any In-vehicle technology instruments. *Electrical failure* received a mean value over five but less than 50% of the subjects wished to have it displayed in the instrument cluster. According to the projects objective, only necessary information ought to be displayed there, hence it was decided that the warning symbol, *Electrical failure*, could be placed in another display and was therefore not taken under consideration.

4.3.2 SIGNIFICANCE TEST

If the mean value for the two currently analyzed subject groups were, respectively, over five and under five, a statistical significance test was conducted. The test was performed to establish if evident differences existed between the two groups. A confidence interval of 95% was used in an Oneway ANOVA test when calculating the significance and F-ratio.

4.3.3 EVIDENT DIFFERENCES BETWEEN SWEDEN AND USA

Displayed in the instrument cluster, USA also desired to have the warning symbols *Low tire pressure (F(211) = 17,00 p< 0,01 S_E=0,109,* where 211 is equal to degrees of freedom (*n*-1), p equal to significance, and S_E standard error*)* and *Engine in need of service (F(210) = 10,59 p<0,01 S_E=0,114)* displayed in the instrument cluster. On the contrary, Sweden desired to have the *Tachometer (F(211) = 14,33 p<0,01 S_E=0,113)* displayed in the instrument cluster. Since the significance levels were less than 1%, the probabilities were more than 99% which meant that they could be asserted as evident differences. According to the mean values, both countries desired to have *Electrical failure* displayed (F(210) = 0,23 p<0,630 S_E=*0,099*), but more than 50% of the Americans in the cluster and less than 50% of the Swedes within that display. In this case the significance level was that high that an evident difference could not be established and was therefore excluded in the concepts.

4.3.4 EVIDENT DIFFERENCES BETWEEN WOMEN AND MEN

Women in general wished to have displayed *Oil pressure (F(208) = 1,38 p<0,242 S_E=0,108)* in the instrument cluster in comparison with the men, who wished to have a *Tachometer (F(209) = 15,47 p<0,01 S_E=0,113)* and a *Motor temperature level indicator* (F(67) = 1,25 p<0,267 S_E=*0,179*) (not available in Swedish questionnaire*)*. The significance level for *Oil pressure* and *Motor temperature* was considered very high, so a new test with different confidence intervals was conducted. This showed that at a 70% interval, *Oil pressure's* reliability increased but not over 90%, while for *Motor temperature* no changes in probability could be indicated at any interval. Another difference was that the women also wished to have a warning symbol for *Engine in need of service* (F(209) = 8,13 p<0,01 S_E=*0,115*), but less than 50% had chosen the instrument cluster as primary placement and therefore it was not taken under consideration.

When separating the Swedish women from the American women, bigger differences were detected. The Americans wished to be warned about *Low tire pressure (F(89) = 5,84*

p<0,05 S_E=0,167) and if *Engine is in need of service (F(89) = 2,55 p<0,114 S_E=0,181)* in the instrument cluster, while the Swedes possibly wanted to be warned about *Airbag not in function (F(89) = 1,05 p<0,309 S_E=0,192)*. They both wanted a *Speedometer*, but the Swedes desired also a *Tachometer (F(89) = 5,77 p<0,05 S_E=0,177)* and an *Indicator of oil pressure (F(89) = 0,99 p<0,32 S_E=0,159)*, while the Americans instead desired only the *Fuel level (F(88) = 2,81 p<0,097 S_E=0,114)* also displayed in the instrument cluster. This implied that with probabilities over 90% *Low tire pressure, Tachometer* and *Fuel level* could be stated as evident differences between the women. The American men wanted to have displayed the warnings *Low tire pressure* (F(119) = 4,26 p<0,05 S_E=0,141) and *Engine in need of service (F(118) = 2,09 p<0,15 S_E=0,143)*, but not *Electrical malfunction (F(118) = 0,61 p<0,44 S_E=0,132)*. When comparing the driver information, the American men also wanted an indicator of *Motor temperature level*, but the question was not available in Sweden so nothing can be said about any difference, and *Oil pressure (F(118) = 0,15 p<0,70 S_E=0,147)* in the instrument cluster and possibly a *Trip computer (F(119) = 0,21 p<0,64 S_E=0,153)*. Therefore the significance test showed that the only evident difference between the men was *Low tire pressure* with a probability over 95%. All the instruments which received a probability under 90% were tested again but with a 70% confidence interval, but no probability changed discernibly.

4.3.5 WEIGHING OF BUYING CRITERIA

All the subjects' ranking-lists were compiled in SPSS and a valid percent was calculated for each criterion's ranking level. A valid percentage was needed because not every subject had ranked each criterion. The order of importance (1-5), where least important was 1, less important was 2 and so on, was multiplied with the percentage. Each area's points were then summarized to be able to compare the areas with each other. *See Appendix 3* Buying criteria.

When the Swedes and the Americans buys an automobile the most important criterion was "the feeling of quality". The second most important was that the automobile "feels safe", followed by the sense of "practical", "exterior design" and last on the list came "interior design". This order of criteria would be kept in mind through the concept generation phase.

5 PRODUCT SPECIFICATION

The product specification consisted of two types of specification; *instrument specification* and *function specification*.

There were three different instrument specifications made;

- a specification where all the subject's answers were compared together and separated by country, Sweden and USA
- a specification where women's and men's answers were compared and
- a specification where the answers of the women from Sweden, women from USA, men from Sweden, and men from USA were compared

As a first step the desired instruments were collected in a table to specify how important the different instruments were. The instruments were divided into the same three groups as in the questionnaire; warning symbols, driver information instruments, and in-vehicle technology instruments. By looking at the result in the chapter *Evaluation and conclusion*, the instruments could be graded according to the subjects' opinions. The instruments which had perceived a mean value between six and seven in the compilations in SPSS and more than 50 percent of the subjects placed in the instrument cluster as a primary choice were graded with five points. The instruments with a mean value between five and six and primary favored in the instrument cluster by more than 50 percent of the subjects were graded with four points. Three points were given to the instruments that perceived a mean value between six and seven and where the instrument cluster was a primary choice but by less than 50 percent of the subjects. If the instruments were favored in the instrument cluster by less than 50 percent of the subjects and still perceived a mean value between five and six, they were graded with two points, and the instruments that perceived a mean value over five but not favored in the instrument cluster were graded with one point. *See Appendix 4* Instrument specifications.

There also had to be a specification for the functions of the entire instrument cluster and of each instruments. This specification was named function specification and the criteria were sorted into suitable main and sub groups and each group was assigned a suitable name. The main groups explained the subgroups and the criteria beneath, and had the mission to simplify the steps in the following concept generation. Each criterion was assigned a factor of importance according to the following scale:

5 Feature is critical. I would not consider an instrument cluster without this feature.
4 Feature is highly desirable, but I would consider an instrument cluster without it.
3 Feature would be nice to have, but is not necessary.
2 Feature is not important, but I would not mind having it.
1 Feature is undesirable. I would not consider an instrument cluster with this feature.

Since all the statements were desired criteria there were no need to divide into demands and wishes. *See Appendix 5* Function specification.

5.1 CRITERIA WEIGHING

The main/subgroups of criteria from the function specification were weighted against each other. The most important criteria were: easy to detect instruments, controls, labels, and warnings and to comprehend the information instruments. The weight factor which was calculated for each group was entered in the function specification. Each criterion's importance factor was multiplied with its group's weight factor and a weight coefficient for each criterion was received. *See Appendix 5* Function specification and *Appendix* 6 Criteria weighing.

6 CONCEPT GENERATION

This section explains how the methods for generating ideas were applied in this project and its results.

6.1 BRAINSTORMING

The brainstorming method was adjusted to the project and it was performed by only two members. The instrument specifications were used as a foundation for the brainstorming, *see Appendix 4* Instrument specifications. Only the instruments which had gained a mark of 5, 4 or 3, equal to a mean value over 5 and preferred primary in the Instrument cluster by more than 50 % of the subjects and mean value over 6 preferred by less than 50 % but still primary placement in the cluster, were take under consideration during the brainstorming. According to the scope of the project, the icons of the warning symbols would not be further developed in this project. Hence the focus of the warning symbols in the brainstorming was on their shape, placement, color and arrangement. The instruments were studied each one individually and the brainstorming concerned their design and placement. *See Appendix 9* Sketches.

6.2 CATALOG METHOD

Pictures of clusters from the most common car brands in Sweden and USA were collected and it turned out to be about 80 different brands, *see Appendix 7* List of car brands. The information was gained through the Internet, mostly the different car brands' homepages. Special features for the clusters which were noted during the collecting phase for example bad or good design, what made it attractive or not, were gathered to be used when selecting the concepts.

6.3 QUALITY SURVEY

To gain a better idea of how people perceive different instrument clusters, i.e. their qualities, an unofficial survey was performed. Pictures of instrument clusters from different brands of cars which were collected during the *Catalog method* were used. The range of pictures were narrowed down to thirteen, all of which were rather similar in technology but different in appearance. *See Appendix 8* Quality survey. They were compiled and divided on two sheets and each was given a letter notification. Thirteen suitable qualities were gathered in a table, these were:

- Most handsome
- Ugliest
- Most modern
- Most unfashionable
- Most exclusive
- Cheapest
- Most sporty
- Most messy
- Most masculine
- Most feminine
- Most safe
- Easiest to comprehend
- Most attractive

The subjects' gender, age, and driving experience were also inquired. Since the time was limited there were a very small number of respondents and they had to be analyzed in the best possible way. The answers were compiled in Microsoft Excel and their frequency for each quality was calculated. *See Appendix 8* Quality survey. In some cases the choice of instrument cluster was evident, while in other cases the answers were scattered. In the latter case, the appearances of those instrument clusters which received the highest and most equivalent value were compared. Their similarities and differences were distinguished and compiled to be used in the concept generation phase.

6.3.1 CONCLUSIONS OF QUALITY SURVEY

Figure 20 Jeep Wrangler 2006 (http://www.familycar.com/RoadTests/JeepWrangler/)

There was one instrument cluster, *see Figure 20*, which was, by almost all subjects, perceived as the ugliest, most unfashionable, and cheapest by its appearance. The conclusion was that it gave a very plastic and low technology impression.

Figure 21 Bentley Arnage R 2002 (http://www.familycar.com/RoadTests/BentleyArnageR/Photos.htm)

The instrument cluster which appeared most exclusive was the cluster in the Bentley, *see Figure 21*. It looked old-fashioned but still in good shape. Surrounding the instruments was a wooden panel which probably had an influence on the impression of the cluster's appearance. The steering wheel also differs from the usual dark ones as can be seen in the pictures. That might also have affected the subjects in thinking the surrounding looks exclusive.

Figure 22 Toyota RAV4 (http://www.automobilemag.com/new_car_previews/2007/0604_2007_toyota_rav4/)

The instrument cluster in the Toyota RAV4, *see Figure 22*, appeared to be considered as the most modern. The conclusion was that it gave the impression of being high technological and with a clean design. The colors are dark and the pointers red and distinct. The lightning of the display probably strengthened the impression of something new and modern. However, the value of the frequency for the Toyota was not completely convincing. The clusters in Mercedes CL, Mitsubishi Eclipse, and Volvo S80, see A*ppendix 8* Quality survey picture I, J and M, also had something that made them fit

in with the quality of most modern. The colors were rather similar to the Toyota together with the distinct demarcation of the instruments against the surrounding in the cluster.

The cluster in the Toyota RAV4 was also considered to be the most handsome one, followed by the clusters in the Mercedes CL and Mitsubishi Eclipse. They were simple, clean and consisted of colors which were almost the same in all three cases. One special color, blue, was detected in all three clusters.

Figure 23 Mitsubishi Eclipse (http://www.familycar.com/RoadTests/MitsubishiEclipse/Photos.htm)

The car with the cluster that gave the sportiest impression was the Mitsubishi Eclipse, *see Figure 23*. But the value of the frequency was not very convincing here either. Following close were the clusters in the Acura TSX, Dodge Caliber 2007, Mazda MX5, and Volvo s80. What they had in common in their appearance were some kind of metallic border around the instruments, and very simple scales in the instruments. Almost all of them also had borders that resembled exhaust pipes.

Figure 24 Infiniti QX56 2005 (http://www.familycar.com/RoadTests/InfinitiQX56/Photos.htm)

The cluster in the Infiniti QX56 2005, *see Figure 24*, was considered to be the messiest by the main part of the respondents. Close behind were the clusters in the Saab 9-7 X and the BMW335 Coupe 2007. The large amount of numbers, marks, and instruments affected this opinion with certainty. Also, the demarcation between the instruments and the background of the cluster was weak and the placement asymmetric.

The Toyota RAV4 was also considered to have the most masculine cluster. The colors were black background with dark blue, red, and white. The design of the cluster was very clean and simple with well marked lines and borders. The clusters that were closest in value of frequency were the ones in the Acura TSX, Mercedes CL, and Volvo s80. They had rather much in common with the Toyota, the same colors and layout.

The most feminine cluster was found in the Dodge Caliber 2007. It received the highest value o frequency but was followed closely by the clusters in the Mitsubishi Eclipse and the Toyota RAV4. The shapes of the instruments were round and soft, almost playful. The colors were light.

The clusters that appeared to be considered to be safe were found in the Cadillac Escalade 2007, the Dodge Caliber 2007, the Mazda MX5, and the Mercedes CL. They consisted of

rather simple technology and uniform and simple design. The colors were few, black and white and one additional color. The scales were easy to read and not muddled.

The clusters in the Dodge Caliber 2007 and the Mercedes CL were also considered to be the easiest to comprehend, together with the cluster in the Volvo s80. The instruments were few and with distinct scales; few marks and distinct numbers.

Five clusters perceived high values of frequency when considering the quality "most attractive"; the Bentley Arnage R 2002, the Dodge Caliber 2007, the Mercedes CL, the Toyota RAV4, and the Volvo s80. They all had a clean and simple, but still unusual, design. A factor almost all of them had in common were metallic borders around the instruments.

6.4 CONTROL METHOD

The first step was to individually study all the theories which were collected in the beginning of the project and to summarize it in a list of important points. In the second step the two lists, one created by each project member, were compared, discussed and summarized into one list which was to be used in the concept selection phase, *see chapter 7.1 Selection list*.

All the current relevant criteria in the function specification were listed to receive more details for the product. Many of the criteria in the specification could not be taken under consideration during the project; they would be of more importance closer to the manufacturing phase such as the condition of illumination. However, all the criteria listed were kept in mind during the design phase.

6.5 OSBORN'S CHECKLIST

Before using the *Osborn's checklist*, the ideas from the earlier steps in the concept generation were combined into different total solutions concepts and which were all sketched. The sketches were used as a base for *Osborn's checklist* and new sketches were drawn of the new concept ideas. *See Appendix 9* Sketches. Some of the points in the list which were used were:

- Enlarge / reduce
- Add / remove
- Dived / join
- Change relative position
- Change place
- Turn upside down
- Combined ideas
- Modify color
- Modify shape

7 CONCEPT SELECTION

This chapter explains how and why the concepts were selected and their design.

7.1 SELECTION LIST

The points which were listed in the control method and the conclusions made from the quality survey were structured in a list, see below. It was to be used as a foundation for decision-making in the selection of concepts.

Speedometer

The speedometer should be a qualitative display to provide the driver with more information around the value of velocity. Since the driver is used to reading information in a certain way, the speedometer gets the shape of a circle and with the values increasing clockwise. This is to increase the time it takes to read off the information and to decrease the risk of error.

The area between the exact velocity in which the car is driving and zero will be lit to give the driver redundant information. The driver will see what the present velocity is and in a quick glance also approximately how fast he/she is driving at the time. It is important that the pointer, or in this case the lit area, does not hide the numbers and markings of the scale but instead enhances them. It is also important that the pointer reaches the main markings and not ends to far away from them.

As could be read in the theory it is important that the scale is simple and uncluttered to make it easy to read correctly and quick. In the speedometer the progression used is in units of ten, with even units marked with numbers (20, 40, 60 and so on). The numerical values are placed upright to make them easy to read. If the speedometer were equipped with a real pointer, the numerical values should be placed outside the dial to avoid them being overlapped. In this case, with the lit area, the numbers will not be overlapped but instead intensified by the light from behind. Further, smaller markings will not be used, with the purpose to make the speedometer as uncluttered as possible. The scale of numerical values will be placed all around the dial as follows; zero kilometers per hour at 6 o'clock, 60 at 9 o'clock, 120 at 12 o'clock, 180 at 3 o'clock, and the scale will go up to 220 kilometers per hour.

The background color will be dark and the marks and numbers white. In the lit area of the speedometer the marks and numbers will be dark since the background will be lighter.

Fuel level indicator

The fuel level indicator will be qualitative shaped as a triangle with its base turned upwards, oval or circle. The pointer will as in the speedometer consist of a lit area, this time between empty and the current fuel level. The color will be neutral, cyan or green to give, if any, a positive message to the driver, and it will also turn red when the critical level is reached. The icon will work as a check display by changing color from neutral, cyan or green to yellow and eventually red to give redundant information to the driver and call for attention in an even distinct way.

Motor temperature level indicator

The motor temperature indicator will work as a check display and be placed, together with the warning symbols, inside an area that is of same shape and size as the fuel level indicator to achieve some symmetry in the whole. To be able to easily and quickly distinguish the motor temperature level indicator from the ordinary warning symbols the indicator will be larger and lit at all times. When the temperature level is in normal state the color will be neutral, cyan or green, turn yellow when the temperature is rising over a certain temperature and red when the temperature is critical. By changing the motor temperature level indicator from the usual gauge into a check display, the number of large items in the cluster is decreased and it will probably convey a more uncluttered feeling.

Flasher

The flashers will still be reminding of arrow heads but the design will differ some from the classical. The shape will also in some way follow other shapes in the cluster to increase the belongingness in the cluster. The color will convey a positive feeling to the driver and also help increasing the belongingness to the other instruments by color; neutral, cyan or green.

Tachometer

The tachometer will be a quantitative display and provide the driver with the exact number of revolution with one decimal like 1, 8. Since it is quite difficult to reach to high revolutions in a normal car, a tachometer as a gauge takes up unnecessary space and is therefore replaced with digital numbers.

Cluster

The cluster will have a background color that is dark; black, black-blue or black-brown. The purpose of this is to get high contrast between the instruments and symbols and the background for safer reading. The colors of the instruments will be the same through out the system to increase the already mentioned sense of belongingness, and to make it uncluttered and comfortable to the eyes.

As a result from the quality survey it could be seen that a metal edge surrounding the instruments was considered exclusive and attractive. These qualities were very much wanted in this context, together with a soften masculinity, safety and modern. Therefore a metal edge will be used to enhance the appearance of the instruments and to enhance the desired qualities.

As much as possible the gestalt factors will be used in the design and placement of the instruments and of the cluster in its whole, to make the cluster more comfortable to look at, easy to read off and quickly and correctly comprehend.

7.2 REDUCE NUMBER OF CONCEPTS

Since the brainstorming was based on the instrument specification, all concepts already fulfilled the drivers' requirements of information instrument. This led to that in the first phase all the ideas of total solution concepts were discussed and the best ideas were selected. The remaining ones were sorted and the ideas which fulfilled all the wishes and

demands the best were combined into new concepts. At the end there were seven concepts left. To gain a better general view of each concept, detail full scale sketches were drawn by hand. This made it easier to see if any changes of the details were needed and to easier eliminate and sort out potentially acceptable total solution concepts. *See Appendix 10* Full scale sketches.

7.3 CONSULTATION

To control that the project was still heading in the right direction, Phillip Tretten was consulted. The sketches of the remaining concepts were discussed and they were considered to be a good base but they could be further developed into more extreme designs. It was decided that a softer concept and a harder concept should be used as a base for further development and a new brainstorming was performed.

7.4 MODELING

Four different concepts, which all fulfilled the selection list, were selected to be modeled in Autodesk AliasStudio. In an Alias CAID-file, received from Volvo Cars, with an existing Volvo model, the instrument cluster was erased and the four new concepts were modeled instead. The details were finished in Adobe Photoshop CS. By seeing the concepts in its real environment it was easier to see how the details fitted. Changes of the design could easily be made, for example placement and colors. After discussion and consultation with Phillip Tretten the final concepts could be exactly decided. Those models were to be used in the eye-track for concept testing. *See Appendix 11* Renders.

7.5 FINAL CONCEPTS

In all the concepts the colors and the speedometer are the same. The colors are dark brown or black-brown in the background with edges around the instruments in a rather brownish metal. The speedometer is circular with the scale in increasing units of ten, and the even tens as numbers. No smaller marks are included. The pointer consists of a more vaguely lit area between zero and the present velocity and with a more pronounced pointer at the actual velocity. The numbers and marks in the lit area are black and in the unlit area white. The speedometer and the flashers have a comfortable and smooth light yellow color that does not sting the eyes.

The warning symbols in all the concepts are *Low oil pressure, Low fuel level, Parking brake engaged, High motor temperature, Charging system failure,* and *ABS failure*. The warning symbol for high motor temperature is combined with the motor temperature indicator check display and *Fuel level indicator* includes the warning for *Low fuel level.* When changing the concepts to agree with one specific country or gender the differences in warning symbols will be *Low tire pressure* and *Engine in need of service*. One extra instrument will also be included, that is the *Tachometer. See Figure 25* for areas in the instrument cluster to place eventual additional information instruments. The concept shown is the cleanest variant thought to appeal to the majority of subjects.

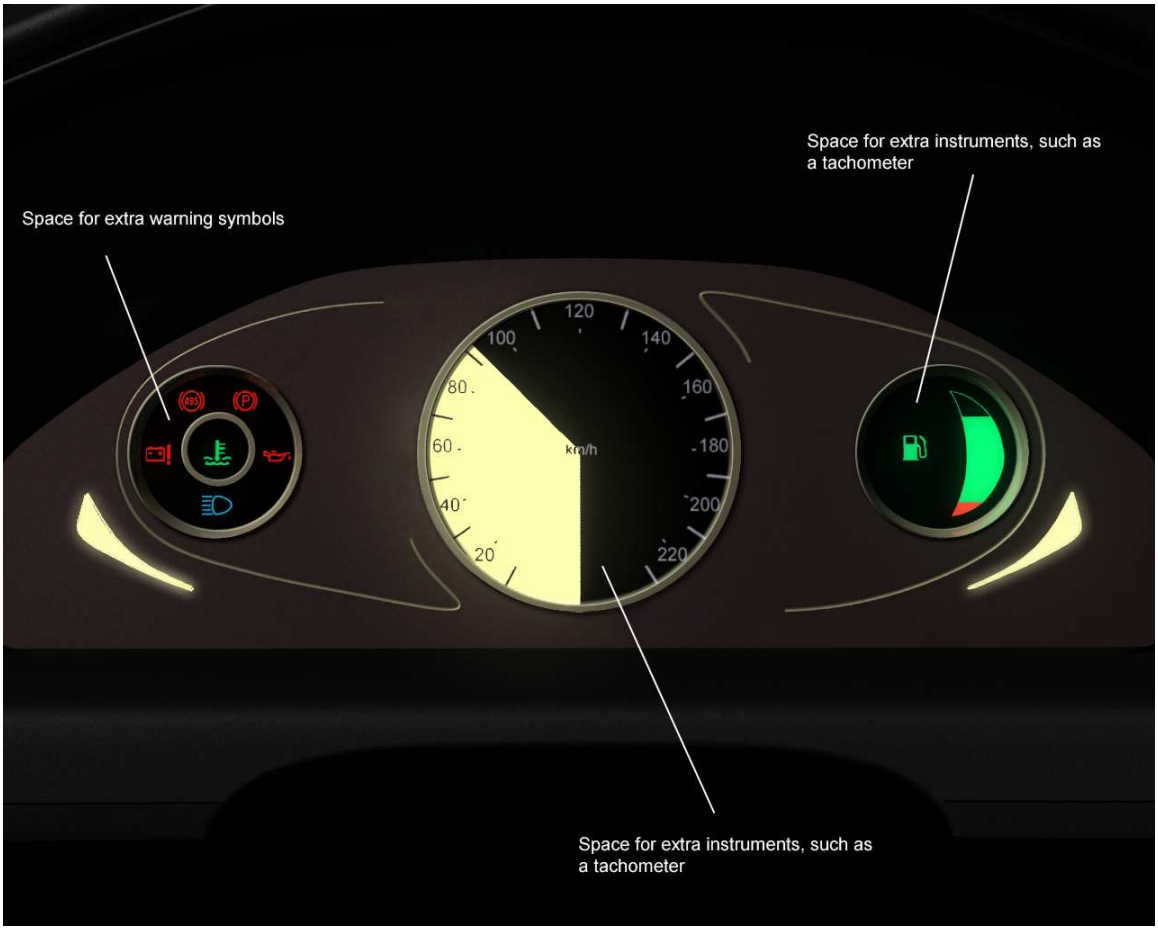

Figure 25 Areas for placement of additional instruments.

7.5.1 CONCEPT A

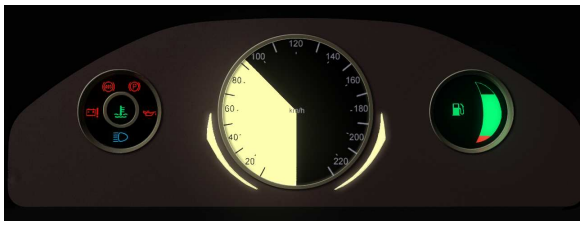

Figure 26 Concept A

Concept A consists of, apart from the speedometer, two more circles, *see Figure 26*. One circle contains the fuel level indicator shaped as a soft triangle with the point pointing down. This hopefully conveys a sense of the fuel running out when the level is decreasing. The side of the triangle is also shaped to follow the shape of the circle that encloses the fuel level indicator. The colors of the indicator are green and red; green in normal state and red bellow the critical level. Next to the triangle is a check display that is green in normal state, turns yellow when the level is starting to reach the critical value, and red when the critical value is reached.

The other circle contains the warning symbols together with the motor temperature indicator. The latter is larger than the others and the only icon that is lit all the time. It changes color depending on the level of the temperature, from green to yellow and when

critical red. The indicator icon of headlights turned on is blue and is also placed in this circle to gather them all together.

The flashers in concept A are rather abstract and placed near the speedometer and its shape follows the same.

7.5.2 CONCEPT B

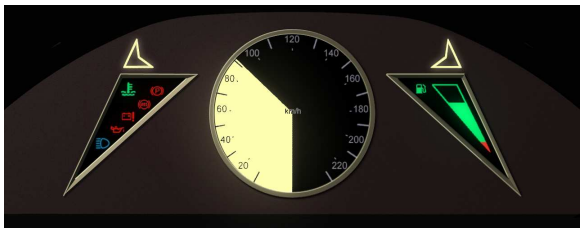

Figure 27 Concept B

Concept B consists of two triangles with the points down, *see Figure 27*. The triangles contains the same as the circles in concept A; one contains the fuel level indicator, this time shaped like a sharp triangle, and the second one contains the warning symbols, motor temperature indicator and indicator for headlights being switched on. The warning symbols are placed in a row to make it less uncluttered and the colors and sizes are the same as in concept A.

The flashers are in this concept more traditionally shaped like arrowheads, but still innovative with thin lines. They are placed above the triangles with the bottom edge following the edge of the triangle.

7.5.3 CONCEPT C

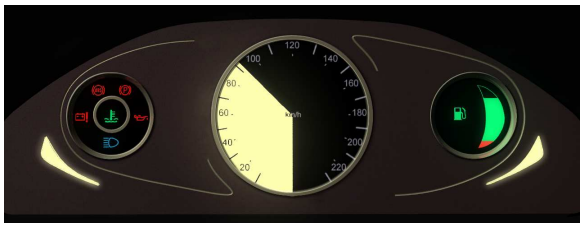

Figure 28 Concept C

Concept C is a further development of concept A. The circles and their content are the same, but a thin metal line is added enclosing the circles to enhance the designed feeling and connecting the individual parts with each other, *see Figure 28*.

The flashers resemble the ones in concept A but in this case the shape is following the shape of the metal lines.

7.5.4 CONCEPT D

Figure 29 Concept D

Concept D differ the most from the other concepts, *see Figure 29*. The content is the same but the instruments are not enclosed in the same way. The areas are open against the speedometer, the warning symbols is placed in a row that follows the shape of the speedometer and the shape of the fuel level indicator follows the same. On the outside the areas are partly enclosed by metal lines, which is asymmetric against each other.

The flashers resemble those in concept A and C and follow the shape of the metal lines.

8 CONCEPT TESTING

This part contains the methods for how the evaluations were performed and their results.

8.1 TEST PROCEDURE

To find out which concept that was considered most attractive by the users, an evaluation had to be performed. Another master thesis had been performed by Monica Kappfjell and Jörgen Normark within OPTIVe about evaluation of instrument clusters based on eye-tracking. Their project was used as a base for the concept testing.

The test consisted of three parts; a questionnaire with different qualities, the eye-tracking, and an interview. The first part answered what the subject thought about the instrument cluster. The eye-tracking made a registration of where in the instrument cluster the details were which attracted the eye. The last part answered the question why they had looked at and regarded the instrument cluster as they had done. These three parts would give an answer to what/which one was attractive.

The first step was to create renders of the four selected and modeled concepts, A-D, in Autodesk AliasStudio, *see Appendix 11* Renders. The rendered pictures were placed together on one picture. For the questionnaire, 14 different qualities were chosen based on the earlier performed Quality survey and Kappfjälls and Normarks master thesis. The chosen qualities were: *handsome, ugly, modern, unfashionable, masculine, feminine, exclusive, cheep, sporty, clean/simple, cluttered, easy to comprehend/read off information, pleasant to look at, and less pleasant to look at*. The subjects received papers with one quality per page and also a page with background questions, like gender, age, occupation, driving experience, if they had a car and what kind of car, and also what they regarded most important with an instrument cluster; function or attractiveness?

During the test the subject had to look at the picture on a computer screen and answer which concept that corresponded best to the quality in question. The eye-track registered at the same time the eyes movements and afterwards the result was used for the interview.

8.2 EYE-TRACKING

The eye-tracking technology which was used in this master thesis followed and recorded the eye movements and reactions as the subject looked at a stimulus. The equipment used was a Tobii x50, a black box containing a camera and a transmitter of infrared light. It was placed in front of the computer screen, a 17" TFT screen, which was displaying the stimulus, s*ee Figure 30*. The leader of the test controlled the test through another screen which was also connected to the equipment. The best result of measuring was to be

Figure 30 The eye-track in front of the computer screen and a camera to record picture and sound.

received in normal lighting conditions. The equipment could handle and continue the eye-tracking if the subject blinked or looked away from the screen. It could also make a correction if the subject had glasses or lenses (Kappfjell, Normark 2007).

8.3 COMPILATION OF INSTRUMENT CLUSTER EVALUATION

8.3.1 FUNCTION VS. ATTRACTIVENESS

The subjects were asked whether they thought function or attractiveness was most important in an instrument cluster. Generally the function was seemed to be the most important quality, for example the cluster should convey essential information, like velocity, in a distinct way. At the same time, half of the group of subjects did not want to fully exclude the property attractiveness; if the instrument cluster is not attractive to the user, the user might choose another model where the importance is evenly distributed between the two qualities.

8.3.2 CONCEPT A

Concept A was considered to be very clean and simple, *see Figure 31*. It is basic, balanced, and contains only necessary information and very few unnecessary design elements that conveys direction and movement. The lack of disturbing elements also made it easy to understand/ read off information and in some cases modern and a matter of current interest and might fulfill the function the best. On the other hand some of the subjects brought another side into view; the simplicity of the concept may be received as unfashionable, cheap, or gives a rather neutral impression and conveys no further feelings.

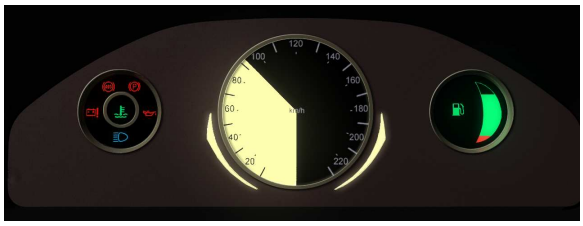

Figure 31 Concept A

The sharp edges made the subjects associate with masculinity, since it is the opposite from feminine curves, and the uncomplicated design in concept A intensified that association. The concept also reminded the subjects of the instruments in sports cars which, according to a few of the subjects, went hand in hand with masculine. The sense of sporty also arrived from the distinct circle shaped instruments, and one comment when discussing this quality was that sports cars do not have much designed details.

One detail that was considered to be quite handsome in concept A was the flashers which were placed close to the speedometer. This was also questioned; maybe they would attract too much attention. However, some of the subjects rated this concept as the ugliest simply because of the cleanness and simplicity, but then explained it to be boring rather than ugly.

The high ranking as unfashionable came from the concept being rather classical and reminded of the instruments in older cars and boats, also because of the simplicity. Other subjects thought it reminded of the instrument cluster in their own car which was ten to twenty years old; it was something everyone had seen before. Also, it did not convey the

same sense of unity as the other concepts, the instrument felt more placed apart and that made the concept more unfashionable.

A few of the subjects mentioned the concept to be exclusive with the reason that when producing something exclusive, less is more; no extra details has to be included to make the customer think the quality is high.

8.3.3 CONCEPT B

Concept B seemed to be a concept to either love or hate and nothing in between, *see Figure 32*.

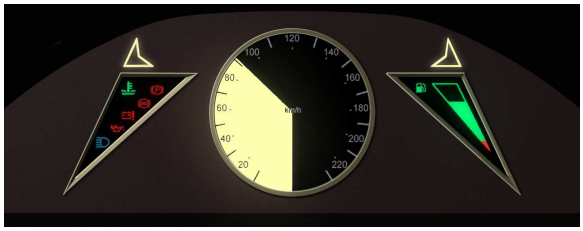

Figure 32 Concept B

Positive things to mention are the symmetry and the angles which were rather unusual in the context. It was simple, distinct, and easy to understand, and one of the subjects mentioned that B was clean and simple because there was no unnecessary design. The piles made the read off easy and quick, although the warning symbols gave a cluttered impression when they were lumped together in the triangle.

A few of the subjects thought concept B's sharp edges made it unpleasant to look at, unfashionable and cheap. The shapes were too simple to look exclusive and it felt like somebody had been trying too much but still the concept was not enough thought out. At the same time the sharpness made it more masculine and sporty with fast flashes of lightning.

This concept was received as the ugliest and one very frequent comment from the younger subjects was that the shapes reminded them of the eighties, while some of the older subjects thought the sharp edges might be the next modern thing. They even thought the triangles had got some Star Trek over them while the younger subjects thought they reminded of the shape of the devil. The triangles also gave the concept two directions towards the sides, the eyes was then drawn to the sides instead of the centre of the cluster, and the circle in the middle and the triangles on the sides did not seem to belong together. Also, the tips of the flashers were pointed downwards instead of to the sides.

8.3.4 CONCEPT C

The design of concept C was by most of the subjects considered to be the most handsome and pleasant to look at with the round shapes and softness, *see Figure 33*. It was simple but at the same time more interesting and felt more modern than concept A, and not quite as round as concept D. C was also considered more

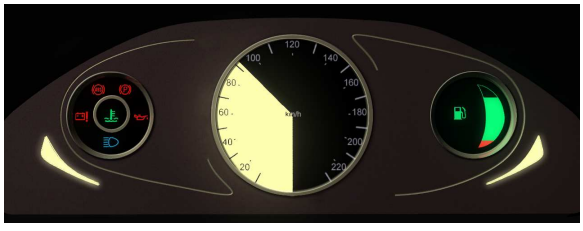

Figure 33 Concept C

balanced and contained more pleasant thinner lines than D. On the other hand one of the subjects mentioned that the lines made it a little cluttered and made you look one extra time.

The oval shape in the decoration intensified the sense of modernity, this together with the feeling of more time being spent on the design, also made the concept more feminine, while the wideness made it more masculine and muscular.

The quality exclusive also seemed to agree with concept C, some of the reasons were that the design felt stylish, more carefully planed, and with more discreet flashers. The basic shapes were considered classic and simple, but the decoration made the concept more lavish. It also conveyed a sense of being sporty, the lines around the instruments gave them life and movement. The fact that the instruments were placed away from each other also made it sporty since this might be more important in the context of a sports car. At the same time the lines made them a unity and the flashers were distinct when placed outside these lines.

8.3.5 CONCEPT D

Concept D was also received as modern, feminine and pleasant to look at because of the circular shapes, *see Figure 34*. The concept was considered to be rather exclusive because of the difference in shapes compared to the other concepts, and the extra details. At the same time the majority of the subjects considered this concept to be the most cluttered because of the asymmetric shapes, the lines coming into the field of vision and the placement of the warning symbols. The placement of the warning symbols was some times instead considered to be very distinct. The impression of the concept being cluttered also came from the fact of the instrument not being as well enclosed as in the other concepts. Another point of view was that the fuel level was so distinct that it was a little difficult to distinguish the warning symbols, and the flashers were rather small.

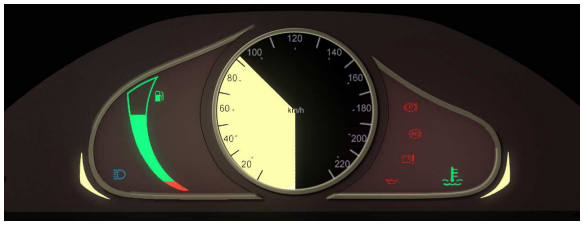

Figure 34 Concept D

The concept being feminine was explained to be associated as much "smaller car". Also circular shapes are the opposite from the masculine sharp edges. The open shapes included in concept D strengthen the femininity and the brown color in the background of the instruments made it softer although that might mean sacrificing the contrast.

Concept D was considered to be handsome by some of the subjects because of the distinct flashers and because it was a little more innovative than some of the other concepts. Things that made the concept ugly were the chaotic feeling the curves and the warning symbols conveyed, the asymmetry in the shapes, and the fuel level indicator.

The concept differed much from the other concepts and was more different than people were used to, which they received as either modern or ugly. The traditional ways to place the warning symbols were completely abandoned.

8.3.6 GENERAL OPINIONS

During the test and interview many of the subjects changed their mind later in the test especially considering the quality handsome.

The idea with a speedometer that lights up from the velocity zero km/h all the way to the current velocity was received as fun, although it conveyed a sense of luxury instead of sporty. However, there were subjects that received this feature as disturbing but agreed that it might be better if only the "pointer" shine as bright and the other area more vaguely.

Also the idea with the motor temperature indicator, that it would mainly work as a warning symbol, shine with the color green and then shift to orange and red when caution, was a good idea according to many of the subjects.

The flashers were popular when they were placed further to both sides, but also the opposite were sometimes mentioned.

One comment during the test was that it depends on the car how different and innovative the instrument cluster may be and still work. Is the car very odd itself the user might expect the instrument cluster to be the same.

The bended fuel level indicators in all the concepts except from concept B was received as unusual and a fun idea.

8.4 EVALUATION OF SPEEDOMETER

The speedometer was considered to be very modern when the whole area was lit up from zero and all the way to the current driving velocity, *see Figure 35*. After consultation with the projects mentor it was decide that an evaluation of the speedometer's "pointer" was of interest. The evaluation's purpose was to see if the new design was considered to be too modern or more attractive than a standard pointer, *see Figure 36* Standard pointer.

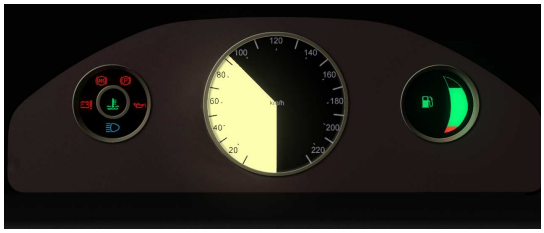

Figure 35 The new design

Figure 36 Standard pointer

Also created for the evaluation was a new model which was a combination between the new design and the standard pointer, a design which was thought to be more accepted and give more distinct information to the driver, *see Figure 37*. The combination was more discreet, but still clear. The model had a sharp pointer and faint lit up area between zero and the pointer.

Figure 37 Combination model

The three models were used in a survey where the subjects had to rate their attractiveness on a scale from one to seven, where one was least attractive and seven most attractive. They also had to motivate there ranking. *See Appendix 12* Questionnaire Speedometer.

8.5 COMPILATION OF SPEEDOMETER EVALUATION

The questionnaire was handed out to 50 students at Luleå University of Technology. Their answers were compiled in Microsoft Excel where the mean value and the median were calculated for each concept; *see Figures 38-40* for each design's result.

Mean value: 3,54
Median: 3,25

Figure 38 New design

Mean value: 4,08
Median: 4,0

Figure 39 Standard pointer

Mean value: 5,28
Median: 6,0

Figure 40 Combination model

Many subjects were doubtful to the *New design*; how it works in bright sunshine and when driving in the dark and thought that the up lit area shone to bright. The up lit area caught the eye and the velocity could be approximately determined with just a glance at the instrument cluster, but it was considered hard to clearly see the exact velocity.

The standard pointer concept was considered to be functional but old, traditional, boring, and harder to clearly see the velocity; a glance would not be enough. At the same time it felt clear, clean, and elegant.

The combination concept was as thought the most favored speedometer. It was considered to be clearest, easiest and quickest to read off the current velocity with double information; pointer and lit up area. The luminous intensity was more suitable than the *new design* and they were of the opinion that it was a good combination between the two other concepts. On the other hand some subjects were of the opinion that the lit up area was unnecessary and made the concept look cheap. Some subjects thought it was ugly while the majority found it handsome.

9 CONCLUSION

The result of this project was a clean cluster with an innovative design and new ideas of how the instruments might both appeal to the drivers and work in their advantage. Since the subjects in the essential questionnaire were both American, Swedish, and of both genders, the differences in desired instruments were kept in mind during the work with the project.

The concepts all contains the following instruments and warning symbols: *Speedometer, Fuel level indicator, Motor temperature indicator, Flashers,* warning symbols for *Low oil pressure, Low fuel level, Parking brake engaged, High motor temperature, Charging system failure and ABS failure*.

The extra instruments desired of Americans in general were *Low tire pressure* and *Engine in need of service*, while the Swedes' desire was about the *Tachometer*. In general the men wanted the *Tachometer*. Comparing the women and men in each country, the men in America was the ones wanting the *Low tire pressure* and the men in Sweden wanted the *Tachometer*. However, when comparing women to women and men to men, the American women wanted *Low tire pressure* and the Swedish women the *Tachometer* but not the *Fuel level indicator* in the cluster.

The quality survey conducted in the beginning of the project provided with the result that the winning cluster should have a clean and simple, but still unusual, design and metal edges around the instruments intensified the sense of the cluster being exclusive.

The evaluation of the concept test of the instrument clusters showed that the most desired concept was concept C, *see Appendix 11 page 3*. It was considered to be most handsome, exclusive and more feminine than the other concepts. The idea with the *motor temperature level indicator* that would work as a warning symbol and a check display was considered to be good by most of the subject asked. The flashers were popular when they were placed further to the sides, but also the opposite were sometimes mentioned.

The survey with the three different *speedometers* was conducted because of potential questions that may arise around this object. The main idea with the speedometer that lits up from the velocity zero km/h all the way to the current velocity, was overall received as fun and was considered to convey a sense of luxury instead. However, there were subjects that received this feature as disturbing but thought the standard speedometer was way to boring. Therefore, the speedometer in all concepts was exchanged to the combination model.

10 CONTINUATION

After executing the final evaluation, the one of the speedometer with the different pointers, it was considered that an evaluation in the simulator with the three models animated could be of big interest. Seeing the models on a paper in a smaller scale than in full scale and in "reality" might change the subjects' opinions. One idea which emerged during the Speedometer survey was that the three concepts could be combined into one by using a dimmer to control the luminous intensity by oneself or automatically adjusted after the surrounding light conditions.

There were also discussions about if the concept D would convey other feelings if the fuel level indicator and the warning symbols were to be placed nearer to the speedometer; would it make the concept more symmetric? If the lines were made thinner, would the concept be received as less cluttered then? More detailed tests of each concept with small changes might therefore also be of interest.

When developing the final concept in the future, the criteria in the function specification should be considered before manufacturing. One example is the illumination; it has to be suitable and adjusted to the surrounding environment. The size of the fonts depends on the distance between the driver and the cluster; can there be a connection between moving the seat back and forth, the size of the font changes?

11 DISCUSSION

11.1 SPSS

The result from the evaluation made in SPSS might have been affected of a number of factors. Some of the subjects did not choose any placement of the instruments and warning symbols in the questionnaire, and there were also questions they did not answer at all, like age and whether or not they had a drivers license. A few of the questions were not included in the questionnaire when it was conducted on the Swedish subjects which, if they had been included, could have given a different result in the end.

It must also be discussed if it was wrong to include the subjects who thought an instrument was important but would want it in another display than the cluster. Was it wrong to include that subject's desire to have the instrument at all?

When it comes to filling in all the answers in SPSS it is easy to write a number wrong, if this happened it may also have affected the end result.

The time spent to learn the computer programme SPSS took some attention from the real project. Also, since the programme was learnt on a basic level it is possible some mistakes was done during the process.

11.2 QUALITY SURVEY

The quality survey was conducted via e-mail which means that the subjects in that case was not able to ask questions as easily, which in return means that the questions in the survey could have been misinterpreted. The qualities chosen for the survey maybe should have been different or more or fewer in numbers, and maybe they should have been explained better to the subjects. These are all factors that might have affected the result.

11.3 EYE-TRACKING

The appearance of concept A and C was very much alike; the outcome of the eye-track test must surely have been dependent on the differences in the concepts.

If the pictures had switched places during the test, the subjects may have come to different conclusions. It might have been better and might have made the subjects think more before answering, at the same time they could have been confused and focused on the wrong things.

What the subjects were told about the different concepts before the test could have affected in both a positive and a negative way. Some of the subjects maybe thought a lot about what the different objects in the cluster was and how they worked and was afraid to ask.

A few of the subjects were asked whether it was positive or negative that there were no tachometer and the answers varied. But none of them had actually detected that the

tachometer were missing and no one else asked about it. This could imply that looking at an instrument cluster on a computer screen is not realistic enough; it is hard to imagine how the subjects would react on the same cluster in real life.

11.4 EVALUATION OF SPEEDOMETER

The pictures of the concepts tended to be quite dark and a bit misleading in the colors when it was printed. It was not so obvious that the cluster was displayed in the right environment because the background turned out almost the same color. Some of the subjects thought the light in the speedometer was too yellow and bright, which was not quite the intention. The pointer in the standard speedometer may not have been a good representation of the standard pointers in cars today.

11.5 OVERALL

Possibly the number of subjects in the different surveys should have been larger to make the result more trustworthy. Most of the subjects were Swedish students, representing a younger group of the population and also studying at a university of Technology which might give opinions of a different aspect compared to the overall population.

It was also discussed if it might be possible to invert the light in the speedometer, depending on day or night to make it easier to distinguish the velocity. This would mean that the areas that are lit up turns dark and vice versa, while the numbers and marks always stays the opposite from their background.

Maybe some of the subjects had not come in contact with as many warning symbols since the car hopefully do not show them all the time. This means that the subjects did not know what to expect or look for in the cluster presented to them.

Since the desired instruments did not differ as much as first thought, the project plan was changed during the project. Instead of finding one concept for the Swedish market and one for the American market, the concentration was focused on finding a combined concept that suited both markets. However, the few differences detected were kept in mind the whole time.

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APPENDIX

Questionnaire concerning information in automobiles

The Department of Human Work Sciences at Luleå University of Technology is participating in an OPTIVe project (Optimized System Integration for Safe Interaction in Vehicles) which purpose is to investigate, evaluate and demonstrate methods and technical solutions for safe, efficient, and cost effective integration of HMI (Human Machine Interaction) systems in cars. This is in cooperation with the Swedish Department of Transportation, Volvo Car Corporation and Volvo Technology. The specific goal of this survey is to gain knowledge about how to improve the type of information being presented to the driver.

You can help us by answering this questionnaire. The results will presented in such a way that no individual can be identified. Please help us in gaining knowledge about how future vehicles should be designed for the drivers.

When you have answered this questionnaire please give it to Prof. Billy Lewter.

Thank you for your participation.

Sincerely,

Phillip Tretten
Dept. of Human Work Sciences
Luleå University of Technology
971 87
Luleå, Sweden
Phone: (46) 920 492855
E-mail: phillip.tretten@ltu.se

Part I. Warning symbols

Information displayed in automobiles is found in the windshield (area 1) and in three areas of the dashboard (areas 2-4). An example of these areas is shown below. **Remember** that information placed in the windshield (area 1) is transparent and would not impair your vision.

Now, imagine yourself in the act of **buying a new private vehicle**. Please answer the following questions to the best of your knowledge. Remember there is no right, or wrong, answer, it is ***your*** opinion that is of interest. Please mark the number that you feel best fits ***your*** opinion. Choose also where ***you*** feel the information found in each question should be placed in the dashboard, an example is given below.

Example:

Warning symbol for *steering failure* is important to me.

1 2 (3) 4 5 6 7
Not at all true *Very true*

Warning symbol for *low window washer fluid* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *improper oil pressure* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *low tire pressure* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *low fuel level* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *parking brake engaged* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *improper engine temperature* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *electrical charging system failure* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *airbag not in function* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *Anti-lock Braking System (ABS) failure* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning for *poor road conditions* (slippery road, icy, rainy, poor visibility, etc.) is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *engine stall* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *malfunctioning light bulb* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *door is ajar* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Warning symbol for *electrical malfunction* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

CHECK **Warning symbol meaning *engine in need of service* is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Are there any *warning symbols* that you feel are important and would add to this list? If so please add it in the avaliable space given below.

_____
_____
_____
_____
_____
_____

Part II. Driver information

An example of driver information displayed in automobiles is placed below. This information can be found in the windshield (area 1) and in three areas of the dashboard (areas 2-4). **Remember** that information presented on the windshield (area 1) is transparent and would not impair your vision.

Now, imagine yourself in the act of **buying a new private vehicle**. Please answer the following questions to the best of your knowledge. Remember there is no right, or wrong, answer, it is your opinion that is of interest. Mark the number that best fits your opinion, an example is found below.

Example:

***Radiator fluid level* information is important to me.**

1 (2) 3 4 5 6 7

Not at all true *Very true*

***Speedometer* information (vehicle speed) is important to me.**

1 2 3 4 5 6 7

Not at all true *Very true*

***Tachometer* information (motor speed) is important to me.**

1 2 3 4 5 6 7

Not at all true *Very true*

***Fuel level* information is important to me.**

1 2 3 4 5 6 7

Not at all true *Very true*

Motor temperature **information is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Oil pressure **information is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

A *clock* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Actual *outside temperature indicator* is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Seatbelt reminder **indicator is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Indicator showing *which* door/hatch is ajar is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Indicator showing *which* light bulb is malfunctioning is important to me.

1 2 3 4 5 6 7
Not at all true *Very true*

Cruise control indicator **is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Climate control information **is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Entertainment information **is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Mobile telephone information **is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Trip computer **presenting; average economy, fuel consumption, instant economy, miles remaining before empty, etc. is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Scrollable menu of options **showing vehicle status (like service interval, mileage, temperature, vehicle malfunctions, fluid levels, etc) is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Is there any additional ***information*** **given in automobiles that you feel is important and would add to this list? If so please add it in the avaliable space given below.**

_____

_____

_____

Part III. Advanced driver helps

An example of an advanced driver help is shown below. This information can be found in the windshield (area 1) and/or in three areas of the dashboard (areas 2-4). **Remember** that information presented on the windshield (area 1) is transparent and would not impair your vision.

Now, imagine yourself in the act of **buying a new private vehicle**. Please answer the following questions to the best of your knowledge. Remember there is no right, or wrong, answer, it is your opinion that is of interest. Mark the number that best fits your opinion, an example is also found below.

Example:

***Steering assistant* used for lane changing is important to me.**

1 2 3 4 5 (6) 7

Not at all true *Very true*

***Image of road obstacles and other vehicles* is important to me (similar to the example above).**

1 2 3 4 5 6 7

Not at all true *Very true*

***Image of road to help the driver in conditions of poor visibility* is important to me (similar to the example above).**

1 2 3 4 5 6 7

Not at all true *Very true*

Navigator with direction helps **is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Adaptive cruise control **information (automatically keeps your vehicle from getting too close to the vehicle in front of you) is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Parking aids **indicating vehicle position in relation to other cars and obstacles is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Electronic brake assist **information (assists your vehicle in quickly braking for obstacles that you, the driver, did not respond to) is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Excessive speed indicator **(alerts driver when the speed limit is surpassed) is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

External Vehicle Speed Control **(assists drivers in keeping the government-defined speed limit) is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Video image **of backseat so that you do not need to turn around to see what the passengers/children are doing is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Lane change aid **information (alerts you if there is another vehicle in hard to see areas when you attempt to change lanes) is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Shift light for sport driving **(shows you when to shift for optimal acceleration) is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Shift light for economical driving **(shows you when to shift for optimal economical driving) is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Econo-meter **(shows an accumulated value of economical driving, showing how much total energy is saved) is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Advanced driver menu **where you can choose what language, functions and different options are to be avaliable when driving is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Advanced driver options **where you can choose where *information* is to be shown is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Adaptable display **(where the information displayed adapts to the situation, like cold start, cruising or rush-hour traffic, there only relevant information is presented) is important to me.**

1 2 3 4 5 6 7
Not at all true *Very true*

Are there any additional *driver helps* that you feel are important and would add to this list? If so please add it in the avaliable space below.

_____

_____

_____

_____

_____

_____

Sociodemographical questions

Sex
□ Female □ Male

Race
□ Caucasian □ Colored □ Hispanic □ Asian □ Indian □ Other

Age _____

Personal status
□ Single □ Single with children □ Married/ Partner
□ Married/Partner with children

If children, How many? _____ **Ages** _____

Please choose your level of education
□ Practical □ High school □ College □ Other _____

Approximate yearly income in dollars
□ - 10,000 □ 10,001 – 20,000 □ 20,001 – 30,000 □ 30,001 – 40,000
□ 40,001- 60,000 □ 60,001 - 80,000 □ 80,001 -

Do you have a drivers license? □ No □ Yes, How long? _____

The vehicle I am most familiar with, own, drive or have ridden in, is…
Brand_____Model_____Year____

a. The vehicle I would like to own is…
Brand_____Model_____Year____

b. Why?

_____

_____

Why do you like the particular design?

_____

_____

***Rank the order of importance* you place on these items when you are deciding to buy a new private automobile.**
1 is most important to 5 least important

□ exterior design
□ interior design
□ feel of quality
□ practical
□ feels safe

Do you have experience in these areas?

Acting	**Yes**	☐ Interest ☐ Hobby ☐ Educated ☐ Field of employment
	No	☐
Art	**Yes**	☐ Interest ☐ Hobby ☐ Educated ☐ Field of employment
	No	☐
Architecture	**Yes**	☐ Interest ☐ Hobby ☐ Educated ☐ Field of employment
	No	☐
Automobiles	**Yes**	☐ Interest ☐ Hobby ☐ Educated ☐ Field of employment
	No	☐
Fashion	**Yes**	☐ Interest ☐ Hobby ☐ Educated ☐ Field of employment
	No	☐
Music	**Yes**	☐ Interest ☐ Hobby ☐ Educated ☐ Field of employment
	No	☐
Product Design	**Yes**	☐ Interest ☐ Hobby ☐ Educated ☐ Field of employment
	No	☐

Thank you for your participation

Sweden and USA (214 pcs.)

Warning symbols
Low oil pressure 5.76
Low fuel level 6.39
Parking brake engaged 5.22
High motor temperature 6.03
Charging system failure 5.25
ABS failure 5.67
Electrical failure 5.21

Driver information
Speedometer 6.45
Fuel level 6.25
Motor temp. level indicator * 5.0

Advanced driver helps

Sweden (144 pcs.)

Warning symbols
Low oil pressure 5.99
Low fuel level 6.27
Parking brake engaged 5.28
High motor temperature 6.08
Charging system failure 5.26
ABS failure 5.83
Electrical failure 5.18

Driver information
Speedometer 6.57
#Tachometer 5.19
Fuel level 6.23
Motor temp. level indicator *

Advanced driver helps

USA (68 pcs.)

Warning symbols
Low oil pressure 5.28
#Low tire pressure 5.25
Low fuel level 6.63
Parking brake engaged 5.09
High motor temperature 5.94
Charging system failure 5.24
ABS failure 5.35
Electrical failure 5.28
#Service engine 5.30

Driver information
Speedometer 6.19
Fuel level 6.29
Motor temp. level indicator * 5.00
#Clock 5.63

Advanced driver helps

Women both Sweden and USA (90 pcs.)

Warning symbols
Low oil pressure 5.58
Low fuel level 6.63
Parking brake engaged 5.29
High motor temperature 5.99
Charging system failure 5.27
ABS failure 5.61
Electrical failure 5.40
Service engine 5.14

Driver information
Speedometer 6.39
Fuel level 6.43
Oil pressure level 5.12
Clock 5.60

Advanced driver helps

Women Sweden (40 pcs.)

Warning symbols
Low oil pressure 6.08
Low fuel level 6.68
Parking brake engaged 5.53
High motor temperature 6.10
Charging system failure 5.33
Airbag not in function 5.08
ABS failure 5.85
Electrical failure 5.35

Driver information
Speedometer 6.83
Fuel level 6.64
Motor temp. level indicator *
Oil pressure level 5.30
Clock 5.53

Advanced driver helps

Women USA (50 pcs.)

Warning symbols
Low oil pressure 5.18
Low tire pressure 5.34
Low fuel level 6.60
Parking brake engaged 5.10
High motor temperature 5.90
Charging system failure 5.22
ABS failure 5.42
Electrical failure 5.44
Service engine 5.40

Driver information
Speedometer 6.04
Fuel level 6.26
Clock 5.66

Advanced driver helps

Men both Sweden and USA (120 pcs.)

Warning symbols
Low oil pressure 5.89
Low fuel level 6.19
Parking brake engaged 5.16
High motor temperature 6.07
Charging system failure 5.22
ABS failure 5.74
Electrical failure 5.08

Driver information
Speedometer 6.48
Tachometer 5.28
Fuel level 6.11
Motor temp. level indicator * 5.33
Trip computer 5.11

Advanced driver helps

Men Sweden (102 pcs.)

Warning symbols
Low oil pressure 5.95
Low fuel level 6.10
Parking brake engaged 5.18
High motor temperature 6.07
Charging system failure 5.21
ABS failure 5.84
Electrical failure 5.12

Driver information
Speedometer 6.46
Tachometer 5.32
Fuel level 6.06
Motor temp. level indicator *
Trip computer 5.08

Advanced driver helps

Men USA (18 pcs.)

Warning symbols
Low oil pressure 5.56
#Low tire pressure 5.00
Low fuel level 6.72
Parking brake engaged 5.06
High motor temperature 6.06
Charging system failure 5.28
ABS failure 5.17
#Service engine 5.00

Driver information
Speedometer 6.61
Tachometer 5.06
Fuel level 6.39
Motor temp. level indicator * 5.33
Oil pressure level 5.00
Clock 5.56
Trip computer 5.28

Advanced driver helps

Age group 0-20 years Sweden and USA (90 pcs.)

Warning symbols
Low oil pressure 5.59
Low fuel level 6.26
Parking brake engaged 5.11
High motor temperature 5.99
Charging system failure 5.09
ABS failure 5.69
Electrical failure 5.24

Driver information
Speedometer 6.43
Fuel level 6.14
~~Motor temp. level indicator *~~

Advanced driver helps
~~External brake assistant *~~

Age group 21-30 years Sweden and USA (108 pcs.)

Warning symbols
Low oil pressure 5.87
Low fuel level 6.45
Parking brake engaged 5.23
High motor temperature 6.06
Charging system failure 5.30
ABS failure 5.64
Electrical failure 5.19

Driver information
Speedometer 6.44
Tachometer 5.02
Fuel level 6.31
Motor temp. level indicator * 5.18
Oil pressure level 5.07
Clock 5.07

Advanced driver helps
~~External brake assistant *~~

Age group 31-40 years Sweden and USA (4 pcs.)

Warning symbols
Low oil pressure 5.50
Low tire pressure 5.00
Low fuel level 6.25
Parking brake engaged 5.25
High motor temperature 6.00
Airbag not in function 5.50
ABS failure 6.75
Poor driving conditions 5.25
Door ajar 5.50

Driver information
Speedometer 6.25
Fuel level 5.67
Motor temp. level indicator * 7.00
Oil pressure level 5.25

Advanced driver helps
~~External brake assistant *~~
Excessive speed indicator 5.75
External speed control 5.25
Lane change help5.00

Age group 41-50 years
Sweden and USA (3 pcs.)
Warning symbols
Low oil pressure 6.67
Low fuel level 7.00
Parking brake engaged 6.00
High motor temperature 6.67
Charging system failure 6.67
ABS failure 5.67
Poor driving conditions 5.33
Malfunctioning light 5.00
Door ajar 5.00
Service engine 5.33
Driver information
Speedometer 6.67
Fuel level 6.67
~~Motor temp. level indicator~~ *
Oil pressure level 5.00
Clock 5.33
Outside temperature 5.33
Climate control status 5.67
Scrollable menu 5.22
Advanced driver helps
External brake assistant * 6.00
Lane change help 6.33

Group 51- years
Sweden and USA (4 pcs.)
Warning symbols
Low oil pressure 6.75
Low tire pressure 5.25
Low fuel level 7.00
Parking brake engaged 6.25
High motor temperature 6.50
Charging system failure 6.75
Airbag not in function 5.75
ABS failure 6.50
Malfunctioning light 5.25
Door ajar 6.00
Electrical failure 6.50
Service engine 6.50

Driver information
Speedometer 7.00
Fuel level 7.00
Motor temp. level indicator * 6.00
Oil pressure level 5.50
Which door is ajar 6.00
Which light is malfunctioning 5.75

Advanced driver helps
Navigator 5.50
ACC adaptive cruise control 5.75
Parking helps 6.00
~~External brake assistant *~~
Excessive speed indicator 5.00
External speed control 5.00
Lane change help 5.50

Without driver license
Sweden and USA (27 pcs.)
Warning symbols
Low oil pressure 5.41
Low fuel level 6.48
High motor temperature 5.59
Charging system failure 5.07
ABS failure 6.00
Electrical failure 5.22
Service engine 5.07

Driver information
Speedometer 6.48
Fuel level 6.37
Motor temp. level indicator * § 7.00
Oil pressure level 5.19

Advanced driver helps
External brake assistant *§ 7.00

§ only one without driver license. This makes the mean 7.00

With driver license
Sweden and USA (181 pcs.)
Warning symbols
Low oil pressure 5.82
Low fuel level 6.36
Parking brake engaged 5.29
High motor temperature 6.09
Charging system failure 5.29
ABS failure 5.64
Electrical failure 5.23

Driver information
Speedometer 6.45
Fuel level 6.24
~~Motor temp. level indicator *~~
Clock 5.01

Advanced driver helps
~~External brake assistant * ¤~~

¤ very few answers

Driving experience 0 years
Sweden and USA (19 pcs.)

Warning symbols
Low oil pressure 5.58
Low fuel level 6.42
High motor temperature 5.53
Charging system failure 5.11
ABS failure 5.79
Poor driving conditions 5.11
Electrical failure 5.21
Service engine 5.32

Driver information
Speedometer 6.42
Fuel level 6.32
Motor temp. level indicator * 7.00
Oil pressure level 5.26

Advanced driver helps
External brake assistant * 7.00

Driving experience 1 year
Sweden and USA (13 pcs.)

Warning symbols
Low oil pressure 5.69
Low fuel level 6.00
Parking brake engaged 5.15
High motor temperature 6.08
Charging system failure 5.15
Airbag not in function 5.15
ABS failure 5.69

Driver information
Speedometer 6.62
Fuel level 5.62
~~Motor temp. level indicator~~ *

Advanced driver helps
~~External brake assistant~~ *

Driving experience 2-4 years
Sweden and USA (114 pcs.)

Warning symbols
Low oil pressure 5.83
Low fuel level 6.22
Parking brake engaged 5.16
High motor temperature 6.08
Charging system failure 5.17
ABS failure 5.63
Electrical failure 5.28

Driver information
Speedometer 6.51
Tachometer 5.15
Fuel level 6.21
~~Motor temp. level indicator~~ *

Advanced driver helps
~~External brake assistant~~ *

Driving experience 5-10 years
Sweden and USA (39 pcs.)

Warning symbols
Low oil pressure 5.54
Low fuel level 6.67
Parking brake engaged 5.38
High motor temperature 5.95
Charging system failure 5.26
ABS failure 5.46

Driver information
Speedometer 6.15
Fuel level 6.31
Motor temp. level indicator * 5.00
Oil pressure level 5.18
Clock 5.79
Trip computer 5.26

Advanced driver helps
~~External brake assistant~~ *
Lane change help 5.08

Driving experience 11- years
Sweden and USA (10 pcs.)

Warning symbols
Low oil pressure 6.60
Low tire pressure 5.10
Low fuel level 6.90
Parking brake engaged 6.00
High motor temperature 6.50
Charging system failure 6.40
ABS failure 5.90
Malfunctioning light 5.00
Door ajar 5.30
Electrical failure 5.60
Service engine 5.60

Driver information
Speedometer 6.70
Fuel level 6.78
Motor temp. level indicator * 5.75
Oil pressure level 5.20
Which light is malfunctioning 5.00

Advanced driver helps
~~External brake assistant~~ *
Lane change help 5.30

Single Sweden and USA (161 pcs. 64w/97m)
Warning symbols
Low oil pressure 5.78
~~Low tire pressure~~ W
Low fuel level 6.33
Parking brake engaged 5.16
High motor temperature 6.08
Charging system failure 5.27
ABS failure 5.72
Electrical failure 5.19
~~Service engine~~ W

Driver information
Speedometer 6.42
Tachometer 5.00 M
Fuel level 6.17
~~Motor temp. level indicator *~~ M
~~Clock~~ W
~~Trip computer~~ M

Advanced driver helps
_____

Single with children Sweden and USA (3 pcs. 3w)
Warning symbols
Low washer fluid 5.33
Low oil pressure 7.00
Low tire pressure 5.67
Low fuel level 7.00
Parking brake engaged 6.33
High motor temperature 6.33
Charging system failure 5.67
Airbag not in function 5.67
ABS failure 5.33
Poor driving conditions 6.33
Door ajar 5.00
Electrical failure 6.00
Service engine 5.67

Driver information
Speedometer 6.67
Fuel level 7.00
Motor temp. level indicator *7.00
Oil pressure level 6.33

Clock 5.67
Outside temperature 5.33
Climate control status 5.00
Trip computer 5.67

Advanced driver helps
Lane change help 5.00

Married/partner Sweden and USA (36 pcs. 17w/18m)
Warning symbols
Low oil pressure 5.56
Low fuel level 6.53
Parking brake engaged 5.33 W
High motor temperature 5.81
Charging system fail. 5.06 W
~~Airbag not in function~~ W
ABS failure 5.33
Electrical failure 5.22
Driver information
Speedometer 6.50
~~Tachometer~~ M
Fuel level 6.53
Motor temp. level indicator * 5.50
~~Oil pressure level~~ W
Clock 5.17 W
~~Seatbelt reminder~~ W
~~Climate control status~~ M
Trip computer 5.14
Advanced driver helps
External brake assistant *5.75

Married/partner with children Sweden and USA (7 pcs. 4w/3m)
Warning symbols
Low oil pressure 6.14
~~Low tire pressure~~ W
Low fuel level 6.57
Parking brake engaged 5.86
High motor temperature 6.29
Charging system failure 6.00
Airbag not in function 5.86
ABS failure 6.71
Poor driving conditions 5.00
~~Malfunctioning light~~ W
Door ajar 5.71 W
Electrical failure 5.57
~~Service engine~~ W

Driver information
Speedometer 6.57
Fuel level 6.43
Motor temp. level indicator * 5.33
Oil pressure level 6.14
~~Clock~~ W

~~Seatbelt reminder~~ W
Which door is ajar 5.43 W
Which light is malfunctioning 5.14 W
~~Scrollable menu~~ M

Advanced driver helps
Image of road in poor weather 5.14
Navigator 5.14 W
~~ACC Adaptive cruise control~~ W
~~Parking helps~~ W
~~External brake assistant *~~ M
Excessive speed indicator 5.00 W
Video of passengers 5.57 W
Lane change help 6.14
~~Shift light for economy driving~~ W

Sweden vs. USA Single (161 pcs. 101S/60U)

Warning symbols
Low oil pressure 5.78
~~Low tire pressure~~ **U**
Low fuel level 6.33
Parking brake engaged 5.16 S
High motor temperature 6.08
Charging system failure 5.27
ABS failure 5.72
Electrical failure 5.19
~~Service engine~~ **U**

Driver information
Speedometer 6.42
Tachometer 5.00 **S**
Fuel level 6.17
~~Motor temp. level indicator *~~
~~Oil pressure level~~ **S**
~~Clock~~ **U**

Advanced driver helps
~~External brake assistant*~~

Sweden vs. USA Single with children (3 pcs. 2S/1U)

Warning symbols
Low washer fluid 5.33 **S**
Low oil pressure 7.00
Low tire pressure 5.67
Low fuel level 7.00
Parking brake engaged 6.33
High motor temperature 6.33
Charging system failure 5.67
Airbag not in function 5.67
ABS failure 5.33
Poor driving conditions 6.33
~~Motor stall~~ **U**
~~Malfunctioning light~~ **U**
Door ajar 5.00 **U**
Electrical failure 6.00
Service engine 5.67

Driver information
Speedometer 6.67
Fuel level 7.00
Motor temp. level indicator *7.00
Oil pressure level 6.33

Clock 5.67 **S**
Outside temperature 5.33 **S**
~~Seatbelt reminder~~ **U**
~~Which door is ajar~~ **U**
~~Malfunctioning light~~ **U**
~~Cruise control information~~ **S**
Climate control status 5.00 **S**
~~Entertainment system statement~~ **S**
Trip computer 5.67 **S**
~~Scrollable menu~~ **U**

Advanced driver helps
~~Navigator~~ **S**
~~External brake assistant*~~
~~Excessive speed indicator~~ **S**
~~External speed control~~ **U**
~~Video of passengers~~ **S**
Lane change help 5.00 **U**
~~Shift light for economy driving~~ **S**
~~Advanced options in menu~~ **S**

Sweden vs. USA Married/ partner (36 pcs. 32S/4U)

Warning symbols
Low oil pressure 5.56
~~Low tire pressure~~ **U**
Low fuel level 6.53
Parking brake engaged 5.33
High motor temperature 5.81
Charging system failure 5.06
ABS failure 5.33
~~Door ajar~~ **U**
Electrical failure 5.22
~~Service engine~~ **U**

Driver information
Speedometer 6.50
~~Tachometer~~ **U**
Fuel level 6.53
Motor temp. level indicator * 5.50
~~Oil pressure level~~ **U**
Clock 5.17
~~Outside temperature~~ **U**
~~Seatbelt reminder~~ **U**

~~Which door is ajar~~ **U**
~~Which light Is malfunctioning~~ **U**
~~Cruise control information~~ **U**
~~Climate control status~~ **U**
~~Entertainment system status~~ **U**
~~Phone status~~ **U**
Trip computer 5.14 U
~~Scrollable menu~~ **U**

Advanced driver helps
~~Image of road in poor weather~~ **U**
~~Navigator~~ **U**
~~ACC adaptive cruise control~~ **U**
External brake assistant *5.75
~~Video of passengers~~ **U**
~~Lane change help~~ **U**
~~Shift light for economy driving~~ **U**
~~Advanced options in menu~~ **U**

Married/partner with children (7 pcs. 4S/3U)

Warning symbols
Low oil pressure 6.14
~~Low tire pressure~~ **U**
Low fuel level 6.57
Parking brake engaged 5.86
High motor temperature 6.29
Charging system failure 6.00
Airbag not in function 5.86
ABS failure 6.71
Poor driving conditions 5.00 **S**
Door ajar 5.71
Electrical failure 5.57
~~Service engine~~ **U**

Driver information
Speedometer 6.57
Fuel level 6.43
Motor temp. level indicator * 5.33
Oil pressure level 6.14
~~Clock~~ **S**
~~Outside temperature~~ **S**

Which door is ajar 5.43
Which light is malfunctioning 5.14
~~Trip computer~~ **S**
~~Scrollable menu~~ **S**

Advanced driver helps
~~Image of road hinders and cars~~ **U**
Image of road in poor weather 5.14 **U**
Navigator 5.14
~~ACC Adaprive cruise cont.~~ **U**
~~Parking helps~~ **U**
~~External brake assistant *~~
Excessive speed indicator 5.00 **S**
Video of passengers 5.57
Lane change help 6.14
~~Shift light for economy driving~~ **S**
~~Adjustable display~~ **S**

Education Practical (1 pcs.)
Warning symbols
Low oil pressure 7.00
Low fuel level 7.00
High motor temperature 7.00
Charging system failure 5.00
Airbag not in function 6.00
ABS failure 6.00
Malfunctioning light 5.00
Electrical failure 5.00
Service engine 5.00
Driver information
Speedometer 7.00
Tachometer 6.00
Fuel level 7.00
Motor temp. level indicator *
Oil pressure level 6.00
Clock 5.00
Scrollable menu 5.00
Advanced driver helps
Image of r. poor weather 5.00
ACC adaptive cruise con. 6.00
Lane change help 6.00
Shift light for economy driving 6.00

Education Highschool (18 pcs.)
Warning symbols
Low oil pressure 6.22
Low fuel level 6.33
Parking brake engaged 5.22
High motor temperature 6.00
Charging system failure 5.11
ABS failure 5.94
Electrical failure 5.17

Driver information
Speedometer 6.50
Fuel level 6.17
~~Motor temp. level indicator *~~
Oil pressure level 5.00
Trip computer 5.00

Advanced driver helps
_____

College (192 pcs.)
Warning symbols
Low oil pressure 5.71
Low fuel level 6.39
Parking brake engaged 5.23
High motor temperature 6.03
Charging system failure 5.26
ABS failure 5.65
Electrical failure 5.22

Driver information
Speedometer 6.44
Fuel level 6.25
Motor temp. level indicator * 5.05

Advanced driver helps
_____

W only women wants this instrument

M only men wants this instrument

S only Sweden wants this instrument

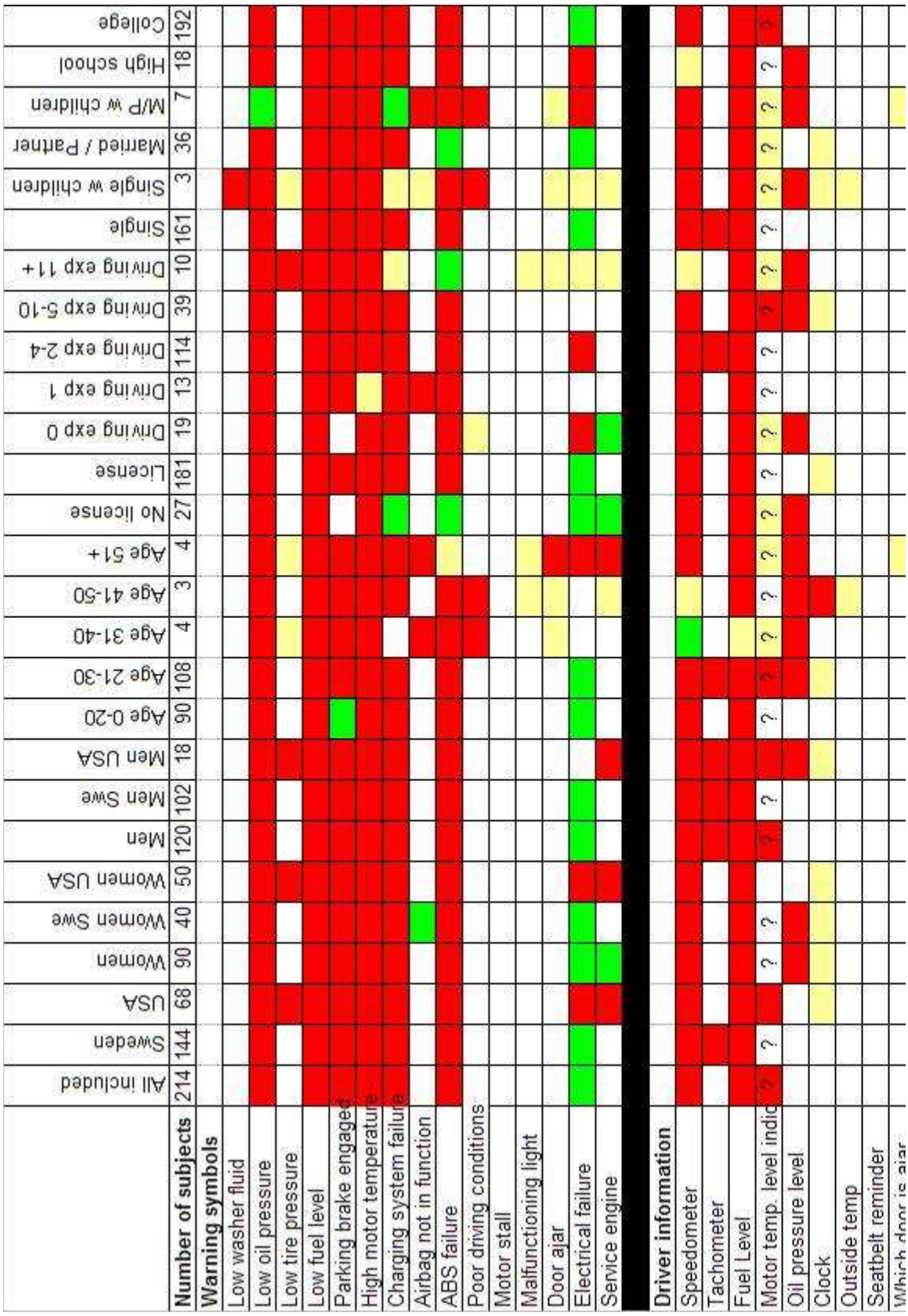
U only USA wants this instrument

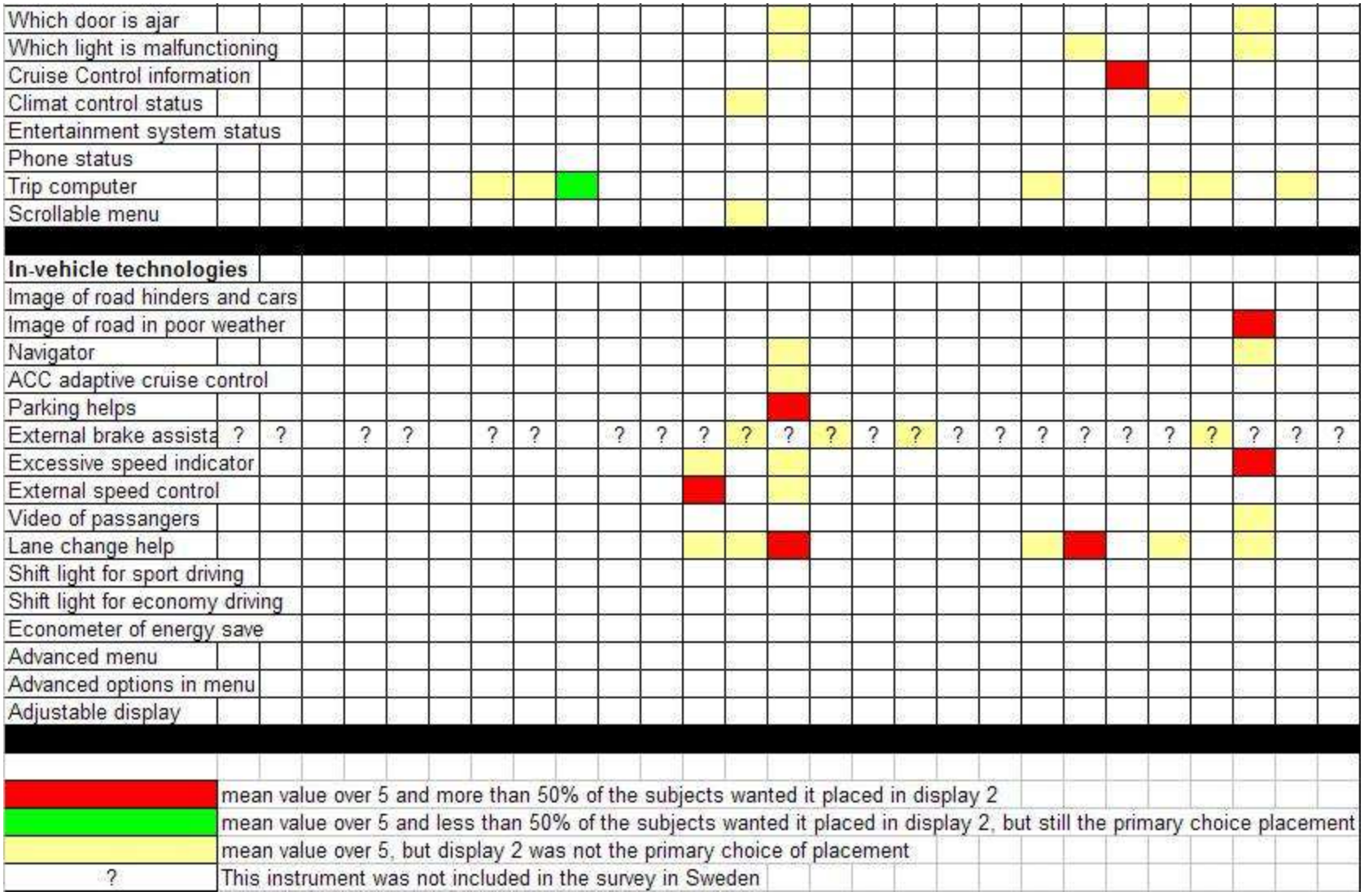
*** only in the questionnaire for the USA**

~~Strikethrough~~ not preferred by this group

Red more than 50%

Green under 50% but still number 1


Number of subjects
All included
Sweden
USA
Women
Women Swe
Women USA
Men
Men Swe
Men USA
Age 0-20
Age 21-30
Age 31-40
Age 41-50
Age 51+
No license
License
Driving exp 0
Driving exp 1
Driving exp 2-4
Driving exp 5-10
Driving exp 11+
Single
Single w children
Married / Partner
M/P w children
High school
College
Warning symbols
Low washer fluid
Low oil pressure
Low tire pressure
Low fuel level
Parking brake engaged
High motor temperature
Charging system failure
Airbag not in function
ABS failure
Poor driving conditions
Motor stall
Malfunctioning light
Door ajar
Electrical failure
Service engine
Driver information
Speedometer
Tachometer
Fuel Level
Motor temp. level indic
Oil pressure level
Clock
Outside temp
Seatbelt reminder
Which door is ajar


Which door is ajar
Which light is malfunctioning
Cruise Control information
Climat control status
Entertainment system status
Phone status
Trip computer
Scrollable menu
In-vehicle technologies
Image of road hinders and cars
Image of road in poor weather
Navigator
ACC adaptive cruise control
Parking helps
External brake assista
Excessive speed indicator
External speed control
Video of passangers
Lane change help
Shift light for sport driving
Shift light for economy driving
Econometer of energy save
Advanced menu
Advanced options in menu
Adjustable display
mean value over 5 and more than 50% of the subjects wanted it placed in display 2
mean value over 5 and less than 50% of the subjects wanted it placed in display 2, but still the primary choice placement
mean value over 5, but display 2 was not the primary choice of placement
?
This instrument was not included in the survey in Sweden

	Valid percent									
	Exterior design		**Interior design**		**The feeling of quality**		**Practical**		**Feels safe**	
x5 Most important	0.207	1.035	0.059	0.295	0.306	1.530	0.253	1.265	0.251	1.255
x4 More important	0.197	0.788	0.156	0.624	0.219	0.876	0.174	0.696	0.219	0.876
x3 Important	0.149	0.447	0.220	0.660	0.260	0.780	0.153	0.459	0.182	0.546
x2 Less important	0.202	0.404	0.344	0.688	0.122	0.244	0.174	0.348	0.134	0.268
x1 Least important	0.244	0.244	0.220	0.220	0.092	0.092	0.247	0.247	0.214	0.214
Sum	**1**	**2.918**	**1**	**2.487**	**1**	**3.522**	**1**	**3.015**	**1**	**3.159**

Ranked buying criteria:
1 The feeling of quality
2 Feels safe
3 Practical
4 Exterior design
5 Interior design

5 = red mark, mean value 6-7
4 = red mark, mean value 5-6
3 = green mark, mean value 6-7
2 = green mark, 5-6
1 = white mean value over 5, but not favored in display 2

NR	CRITERION	IMPORTANCE		
		BOTH	SWE	USA
Warning symbols				
1	Warn about low window washer fluid level	-	-	-
2	Warn about improper oil pressure	4	4	4
3	Warn about low tire pressure	-	-	4
4	Warn about low fuel level	5	5	5
5	Warn about parking brake engaged	4	4	4
6	Warn about improper engine temperature	5	5	4
7	Warn about electrical charging system failure	4	4	4
8	Warn about airbag not in function	-	-	-
9	Warn about ABS failure	4	4	4
10	Warn about poor road conditions	-	-	-
11	Warn about engine stall	-	-	-
12	Warn about malfunctioning light bulb	-	-	-
13	Warn about door is ajar	-	-	-
14	Warn about electrical malfunction	2	2	4
15	Warn about engine in need of service	-	-	4
Driver information instruments				
16	Indicate Vehicle speed (speedometer)	5	5	5
17	Indicate motor speed (tachometer)	-	4	-
18	Indicate fuel level	5	5	5
19	Indicate motor temperature*	4	?	4
20	Indicate oil pressure	-	-	-
21	Indicate time	-	-	1
22	Indicate outside temperature	-	-	-
23	Remind of seatbelt	-	-	-
24	Indicate which door/hatch is ajar	-	-	-
25	Indicate which light bulb is malfunctioning	-	-	-
26	Indicate cruise control	-	-	-
27	Incorporate climate control indicator	-	-	-
28	Indicate entertainment information	-	-	-
29	Indicate mobile telephone information	-	-	-
30	Incorporate trip computer	-	-	-
31	Incorporate scrollable menu of options showing vehicle status	-	-	-
Advanced driver information instruments				
32	Display image of road obstacles and other vehicles	-	-	-
33	Display image of road to help the driver in conditions of	-	-	-

	poor visibility			
34	Incorporate navigator with direction helps	-	-	-
35	Incorporate adaptive cruise control (ACC) information	-	-	-
36	Aid when parking	-	-	-
37	Indicate electronic brake assist information★	-	-	-
38	Indicate excessive speed	-	-	-
39	Indicate external vehicle speed control	-	-	-
40	Display video image of backseat	-	-	-
41	Aid when changing lane	-	-	-
42	Incorporate shift light for sport driving	-	-	-
43	Incorporate shift light for economical driving	-	-	-
44	Indicate econo-meter	-	-	-
45	Incorporate advanced driver menu	-	-	-
46	Incorporate advanced driver options	-	-	-
47	Incorporate adaptable display	-	-	-

NR	CRITERION	IMPORTANCE	
		WOMEN	MEN
Warning symbols			
1	Warn about low window washer fluid level	-	-
2	Warn about improper oil pressure	4	4
3	Warn about low tire pressure	-	-
4	Warn about low fuel level	5	5
5	Warn about parking brake engaged	4	4
6	Warn about improper engine temperature	4	5
7	Warn about electrical charging system failure	4	4
8	Warn about airbag not in function	-	-
9	Warn about ABS failure	4	4
10	Warn about poor road conditions	-	-
11	Warn about engine stall	-	-
12	Warn about malfunctioning light bulb	-	-
13	Warn about door is ajar	-	-
14	Warn about electrical malfunction	2	2
15	Warn about engine in need of service	2	-
Driver information instruments			
16	Indicate Vehicle speed (speedometer)	5	5
17	Indicate motor speed (tachometer)	-	4
18	Indicate fuel level	5	5
19	Indicate motor temperature★	-	4
20	Indicate oil pressure	4	-
21	Indicate time	1	-
22	Indicate outside temperature	-	-
23	Remind of seatbelt	-	-
24	Indicate which door/hatch is ajar	-	-
25	Indicate which light bulb is malfunctioning	-	-

26	Indicate cruise control	-	-
27	Incorporate climate control indicator	-	-
28	Indicate entertainment information	-	-
29	Indicate mobile telephone information	-	-
30	Incorporate trip computer	-	1
31	Incorporate scrollable menu of options showing vehicle status	-	-
Advanced driver information instruments			
32	Display image of road obstacles and other vehicles	-	-
33	Display image of road to help the driver in conditions of poor visibility	-	-
34	Incorporate navigator with direction helps	-	-
35	Incorporate adaptive cruise control (ACC) information	-	-
36	Aid when parking	-	-
37	Indicate electronic brake assist information*	-	-
38	Indicate excessive speed	-	-
39	Indicate external vehicle speed control	-	-
40	Display video image of backseat	-	-
41	Aid when changing lane	-	-
42	Incorporate shift light for sport driving	-	-
43	Incorporate shift light for economical driving	-	-
44	Indicate econo-meter	-	-
45	Incorporate advanced driver menu	-	-
46	Incorporate advanced driver options	-	-
47	Incorporate adaptable display	-	-

NR	CRITERION	IMPORTANCE			
		WOMEN SWE	WOMEN USA	MEN SWE	MEN USA
Warning symbols					
1	Warn about low window washer fluid level	-	-	-	-
2	Warn about improper oil pressure	5	4	4	4
3	Warn about low tire pressure	-	4	-	4
4	Warn about low fuel level	5	5	5	5
5	Warn about parking brake engaged	4	4	4	4
6	Warn about improper engine temperature	5	4	5	5
7	Warn about electrical charging system failure	4	4	4	4
8	Warn about airbag not in function	2	-	-	-
9	Warn about ABS failure	4	4	4	4
10	Warn about poor road conditions	-	-	-	-
11	Warn about engine stall	-	-	-	-
12	Warn about malfunctioning light bulb	-	-	-	-
13	Warn about door is ajar	-	-	-	-
14	Warn about electrical malfunction	2	4	2	
15	Warn about engine in need of service	-	4	-	4
Driver information instruments					

16	Indicate Vehicle speed (speedometer)	5	5	5	5
17	Indicate motor speed (tachometer)	5		4	4
18	Indicate fuel level		5	5	5
19	Indicate motor temperature★	?	–	?	4
20	Indicate oil pressure	4	–	–	4
21	Indicate time	1	1	–	1
22	Indicate outside temperature	–	–	–	–
23	Remind of seatbelt	–	–	–	–
24	Indicate which door/hatch is ajar	–	–	–	–
25	Indicate which light bulb is malfunctioning	–	–	–	–
26	Indicate cruise control	–	–	–	–
27	Incorporate climate control indicator	–	–	–	–
28	Indicate entertainment information	–	–	–	–
29	Indicate mobile telephone information	–	–	–	–
30	Incorporate trip computer	–	–	1	2
31	Incorporate scrollable menu of options showing vehicle status	–	–	–	–
Advanced driver information instruments					
32	Display image of road obstacles and other vehicles	–	–	–	–
33	Display image of road to help the driver in conditions of poor visibility	–	–	–	–
34	Incorporate navigator with direction helps	–	–	–	–
35	Incorporate adaptive cruise control (ACC) information	–	–	–	–
36	Aid when parking	–	–	–	–
37	Indicate electronic brake assist information★	–	–	–	–
38	Indicate excessive speed	–	–	–	–
39	Indicate external vehicle speed control	–	–	–	–
40	Display video image of backseat	–	–	–	–
41	Aid when changing lane	–	–	–	–
42	Incorporate shift light for sport driving	–	–	–	–
43	Incorporate shift light for economical driving	–	–	–	–
44	Indicate econo-meter	–	–	–	–
45	Incorporate advanced driver menu	–	–	–	–
46	Incorporate advanced driver options	–	–	–	–
47	Incorporate adaptable display	–	–	–	–

The Instrument Cluster's main function: Inform the driver about the state of the automobile.

5 Feature is critical. I would not consider an instrument cluster without this feature.
4 Feature is highly desirable, but I would consider an instrument cluster without it.
3 Feature would be nice to have, but is not necessary.
2 Feature is not important, but I would not mind having it.
1 Feature is undesirable. I would not consider an instrument cluster with this feature.

NR	CRITERION	IMPORTANCE	WEIGHT FACTOR	WEIGHT COEFFICIENT
A. Labels and warnings conveys information safely while in use				
A.1 ***Incorporate easy detection***				
1	Incorporate suitable shapes	3	0.102	0.306
2	Incorporate suitable sizes	4	0.102	0.408
3	Incorporate right colors for clarification	5	0.102	0.510
4	Incorporate suitable number of colors for clarification	3	0.102	0.306
5	Incorporate suitable contrast	4	0.102	0.408
6	Incorporate lighting (illumination)	5	0.102	0.510
A.2 ***Incorporate comprehensibility***				
7	Incorporate unambiguous information	4	0.056	0.224
8	Incorporate clearly understandable information	4	0.056	0.224
9	Incorporate interpretable information	5	0.056	0.280
10	Incorporate recognizable information	3	0.056	0.168
A.3 ***Incorporate legibility***				
11	Incorporate suitable contrast between character and background	5	0.097	0.485
12	Incorporate suitable distance between characters/words/rows	3	0.097	0.291
13	Incorporate suitable size of characters	4	0.097	0.388
14	Incorporate suitable typography	3	0.097	0.291
15	Incorporate right colors for clarification of characters	4	0.097	0.388
A.4 ***Incorporate readability***				
16	Incorporate suitable placement	3	0.082	0.246
17	Incorporate suitable orientation	4	0.082	0.328
18	Incorporate available standards	5	0.082	0.410
19	Incorporate minimal extraneous information	4	0.082	0.328
20	Incorporate concise information	3	0.082	0.246
21	Incorporate familiar labels if possible	4	0.082	0.328
22	Incorporate appropriate icons/symbols	5	0.082	0.410
23	Incorporate suitable borders between labels	3	0.082	0.246
B. Instruments conveys information safely while in use				
B.1 ***Incorporate easy detection***				
24	Incorporate suitable shapes of the instruments	4	0.117	0.468

25	Incorporate suitable sizes of instruments	4	0.117	0.468
26	Incorporate suitable placement	5	0.117	0.585
27	Incorporate suitable orientation	5	0.117	0.585
28	Incorporate right colors for clarification	4	0.117	0.468
29	Incorporate lighting (illumination)	5	0.117	0.585
30	Incorporate suitable contrast	4	0.117	0.468
31	Incorporate adjustable luminance and contrast	3	0.117	0.351
B.2 ***Incorporate comprehensibility***				
32	Incorporate intelligible, self-evident and distinct feedback	4	0.107	0.428
33	Incorporate safe reading	5	0.107	0.535
34	Indicate clearly any required actions	4	0.107	0.428
B.3 ***Incorporate concise information***				
35	Incorporate appropriate number of instruments	4	0.026	0.104
B.4 ***Incorporate discernible information***				
36	Incorporate suitable number of colors for clarification	3	0.015	0.045
B.5 ***Incorporate information clearly***				
37	Indicate clearly by labels	3	0.061	0.183
38	Incorporate immediate feedback	4	0.061	0.244
39	Incorporate suitable dials and gauges	5	0.061	0.305
B.6 ***Incorporate information consistently***				
40	Incorporate uniformly arranged gauges	3	0.020	0.060
41	Incorporate uniformly arranged dials	4	0.020	0.080
B.7 ***Incorporate legibility***				
42	Incorporate suitable scales	4	0.092	0.368
43	Incorporate suitable pointers	4	0.092	0.368
C. Instrument cluster looks meticulously designed				
44	Convey function	5	0.036	0.180
45	Convey quality	4	0.036	0.144
46	Convey aesthetics	4	0.036	0.144
47	Convey a sense of safety	5	0.036	0.180
D. Incorporate controls for communication with the				
D.1 ***Incorporate comprehensibility***				
48	Convey function	4	0.071	0.284
49	Convey belongingness	4	0.071	0.284
50	Convey a sense of easy to use	4	0.071	0.284
51	Incorporate suitable labels	3	0.071	0.213
52	Incorporate suitable shape	4	0.071	0.284
53	Incorporate suitable orientation	3	0.071	0.213
54	Incorporate immediate feedback	4	0.071	0.284
55	Incorporate intelligible, self-evident and distinct feedback	4	0.071	0.284
D.2 ***Incorporate easy detection***				
56	Incorporate suitable placement	5	0.117	0.585
57	Incorporate suitable size	4	0.117	0.468
58	Incorporate appropriate controls	5	0.117	0.585

Criteria	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	C	D1	D2	Correction factor +	Sum of point P_i	Weight factor k_i
A1	-0	2	1	1	1	0	2	2	2	2	1	2	2	1	1	20	0,102
A2	-2	0	0	0	0	0	2	2	1	2	0	2	1	0	3	11	0,056
A3	-1	1	1	1	1	2	2	2	2	2	1	2	0	1	5	19	0,097
A4	-2	0	0	2	2	1	2	1	2	1	2	1	0	7	16	0,082	
B1	-2	2	2	2	2	2	1	2	2	1	9	23	0,117				
B2	-3	2	2	1	2	1	2	2	1	11	21	0,107					
B3	-12	2	1	1	0	0	0	0	13	5	0,026						
B4	-14	1	1	0	0	0	0	15	3	0,015							
B5	-11	2	1	2	1	0	17	12	0,061								
B6	-16	0	0	1	0	19	4	0,020									
B7	-6	2	1	0	21	18	0,092										
C	-16	0	0	23	7	0,036											
D1	-11	0	25	14	0,071												
D2	-4	27	23	0,117													
														Sum	196,0	1,00	

0 Less important
1 As important
2 More important

Acura
Alfa Romeo
Am General
American Motors
Aston Martin
Audi
Avanti
Bentley
BMW
Buick
Cadillac
Chevrolet
Chrysler
Citroën
Corvette
Daewoo
DAF
Daihatsu
Delorean
De Tomaso
Dodge
Eagle
Ferrari
Fiat
Ford
Geo
GMC
Honda
Hummer
Hyundai
Infiniti
Isuzu
Jaguar
Jeep
Kia
Lada
Lamborghini
Lancia
Land Rover
Lexus
Lincoln
Lotus
Maserati
Maybach
Mazda
Mercedes-Benz
Mercury
Merkur
MG
Mini
Mitsubishi
Morgan
Nissan
Oldsmobile
Opel
Panoz
Peugeot
Plymouth
Pontiac
Porsche
Qvale
Renault
Rolls-Royce
Rower
Saab
Saleen
Saturn
Scion
Seat
Skoda
Smart
Ssangyong
Sterling
Subaru
Suzuki
Toyota
Volkswagen
Volvo
Yugo


A
Welcome


B


C


D
P R N D M


E


F


G


H


I


J

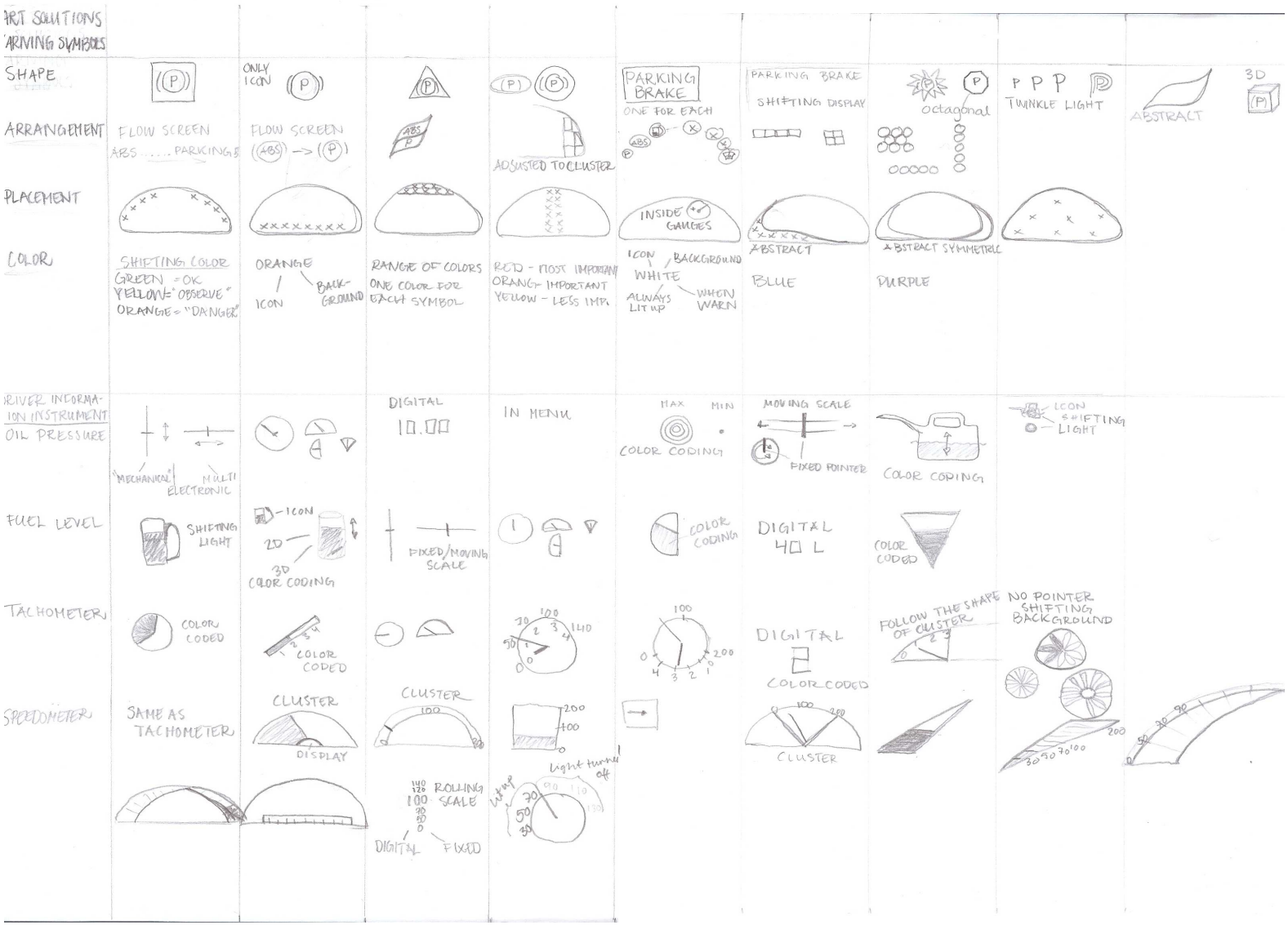

K

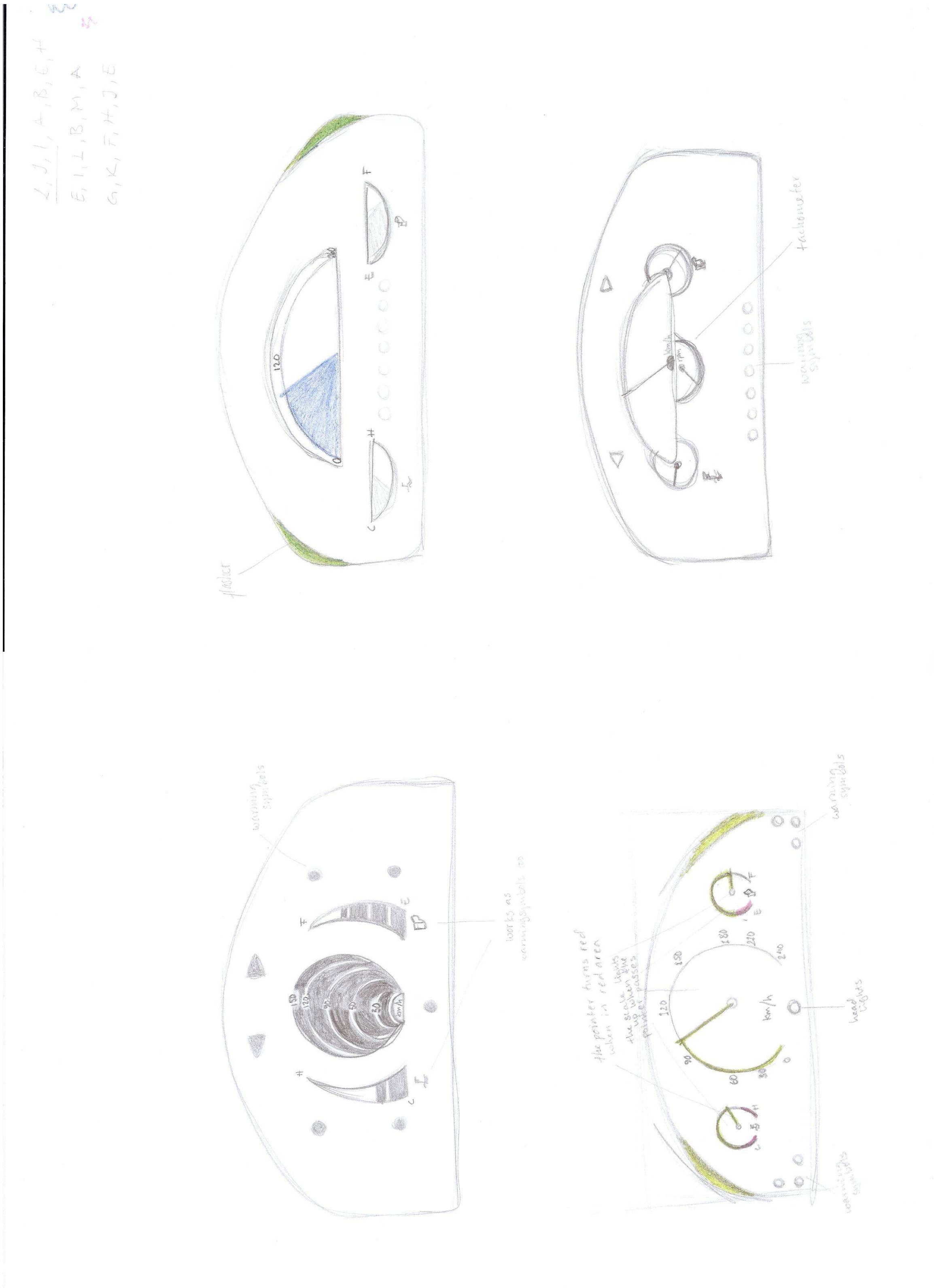

L


M
10:51

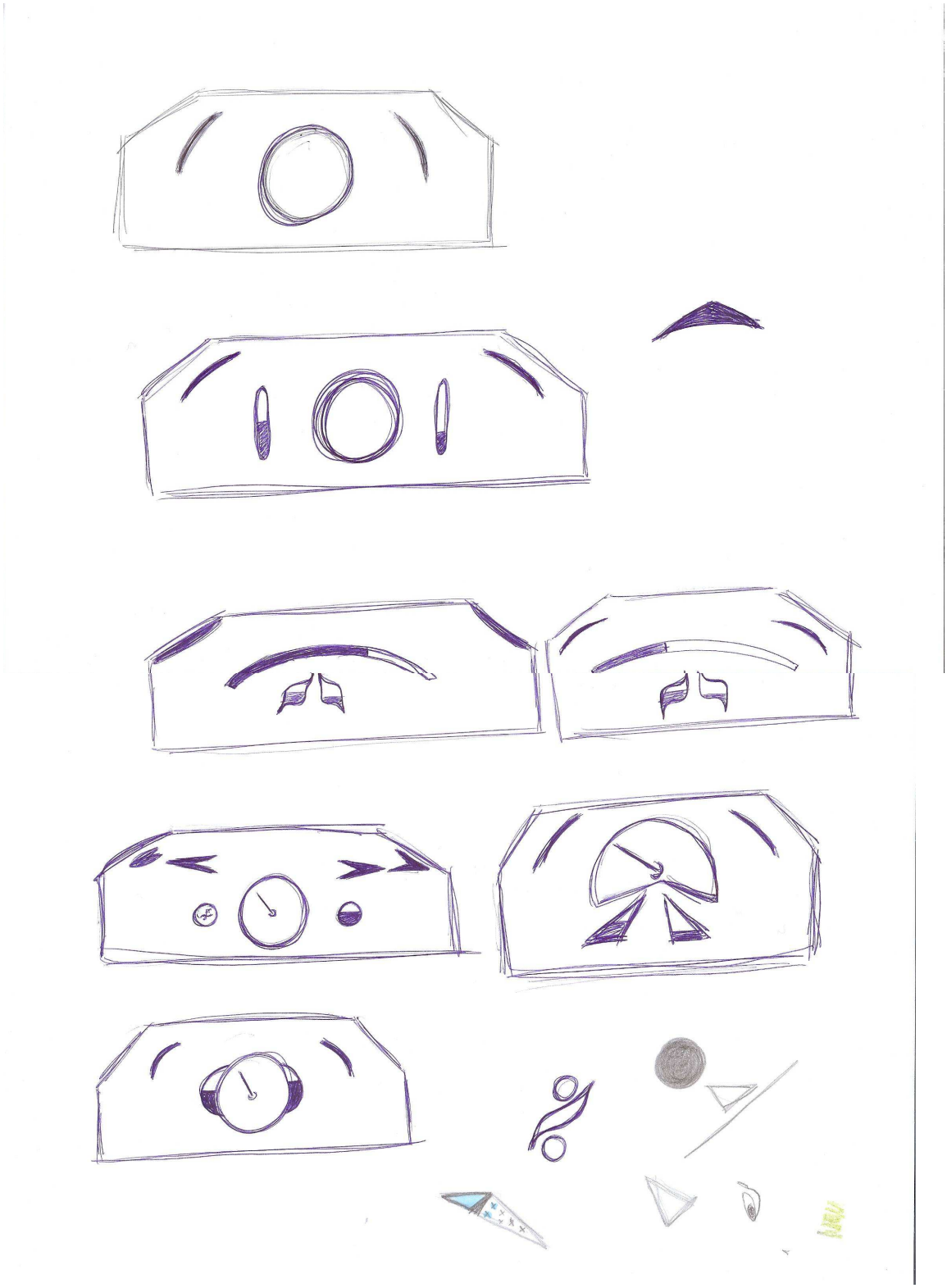
	Subject number	1	2	3	4	5	6	7	8	9	10	11	12	13	A	B	C	D	E	F	G	H	I	J	K	L	M
	Gender	W	W	M	W	W	W	W	W	W	M	M	M	W													
	Age	24	25	25	24	25	25	53	24	62	53	23	59	21													
	Driving experience	5	1	7	6	7	0	34	6	26	35	5	40	0													
1	Most handsome	L	L	H	J	B	E	I	L	I	J	L	A	M	1	1			1			1	2	2		4	1
2	Ugliest	F	G	G	K	G	G	H	G	J	K	G	E	G					1	1	7	1		1	2		
3	Most modern	L	I	J	I	B	E	L	L	L	J	M	L	M		1			1				2	2		5	2
4	Most unfashionable	G	G	G	G	G	G	G	G	B	G	K	B	G		2					10				1		
5	Most exclusive	B	J	B	B	B	E	B	B	I	E	B	F	B		8			2	1			1	1			
6	Cheapest	G	K	G	G	K	G	D	G	B	M	G	G	G		1		1			8				2		1
7	Most sporty	J	J	H	E	A	L	E	H	M	J	A	K	M	2				2			2		3	1	1	2
8	Most messy	F	F	C	C	G	K	F	F	K	K	F	C	K			3			5	1				4		
9	Most masculine	L	A	L	I	L	L	E	M	K	J	A	I	M	2				1				2	1	1	4	2
10	Most feminine	E	E	J	E	J	B	L	J	L	F	I	M	E		1			4	1			1	3		2	1
11	Most safe	L	H	H	E	I	C	E	E	D	I	D	A	H	1		1	2	3			3	2			1	
12	Easiest to comprehend	I	L	I	E	I	E	M	I	M	M	D	A	H	1			1	2			1	4			1	3
13	Most attractive	B	I	M	E	E	B	I	L	L	E	M	A	J	1	2			3				2	1		2	2

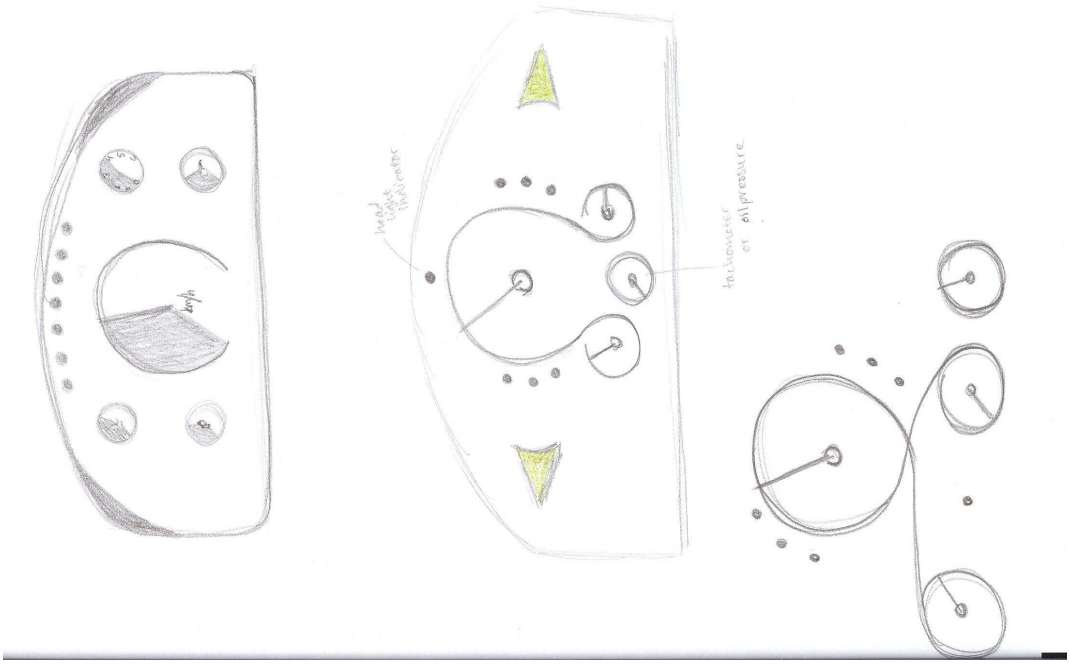
A- Acura TSX
B- Bentley Arnage R
C- BMW 335 Coupe
D- Cadillac Escalade
E- Dodge Calliber
F- Infiniti QX
G- Jeep Wrangler
H- Mazda MX5
I- Mercedes Benz CL
J- Mitsubishi Eclipse
K- Saab 9-7 X
L- Toyota RAV4
M- Volvo S80

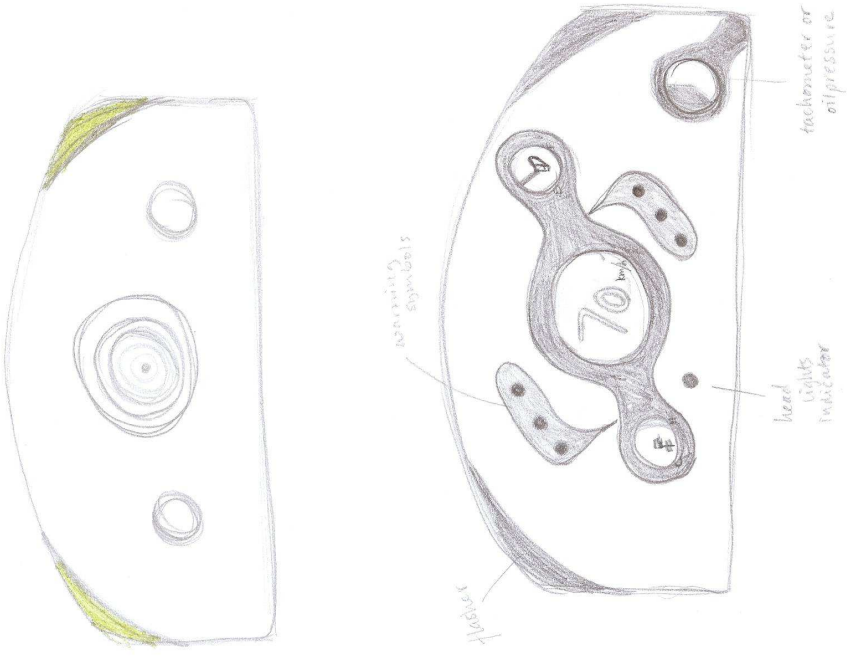

ART SOLUTIONS
ARKING SYMBOLS
SHAPE
ARRANGEMENT
PLACEMENT
COLOR
ONLY ICON
FLOW SCREEN
ABS ..... PARKING
ADJUSTED TO CLUSTER
PARKING BRAKE
ONE FOR EACH
PARKING BRAKE
SHIFTING DISPLAY
Octagonal
PPP
TWINKLE LIGHT
ABSTRACT
3D
INSIDE GAUGES
SHIFTING COLOR
GREEN = OK
YELLOW = OBSERVE
ORANGE = "DANGER"
ORANGE
ICON
BACK-GROUND
RANGE OF COLORS
ONE COLOR FOR EACH SYMBOL
RED - MOST IMPORTANT
ORANG- IMPORTANT
YELLOW - LESS IMP
ICON / BACKGROUND
WHITE
ALWAYS LIT UP
WHEN WARN
ABSTRACT
BLUE
ABSTRACT SYMMETRIC
PURPLE
RIVER INFORMA-ION INSTRUMENT
OIL PRESSURE
FUEL LEVEL
TACHOMETER
SPEEDOMETER
DIGITAL
10.00
IN MENU
MAX
MIN
COLOR CODING
MOVING SCALE
FIXED POINTER
COLOR CODING
ICON
SHIFTING LIGHT
MECHANICAL
MULTI ELECTRONIC
SHIFTING LIGHT
ICON
2D
3D
COLOR CODING
FIXED/MOVING SCALE
COLOR CODING
DIGITAL
40 L
COLOR CODED
COLOR CODED
COLOR CODED
CLUSTER
DISPLAY
CLUSTER
SAME AS TACHOMETER
ROLLING SCALE
DIGITAL
FIXED
Light turned off
DIGITAL
2
COLOR CODED
CLUSTER
FOLLOW THE SHAPE OF CLUSTER
NO POINTER SHIFTING BACKGROUND

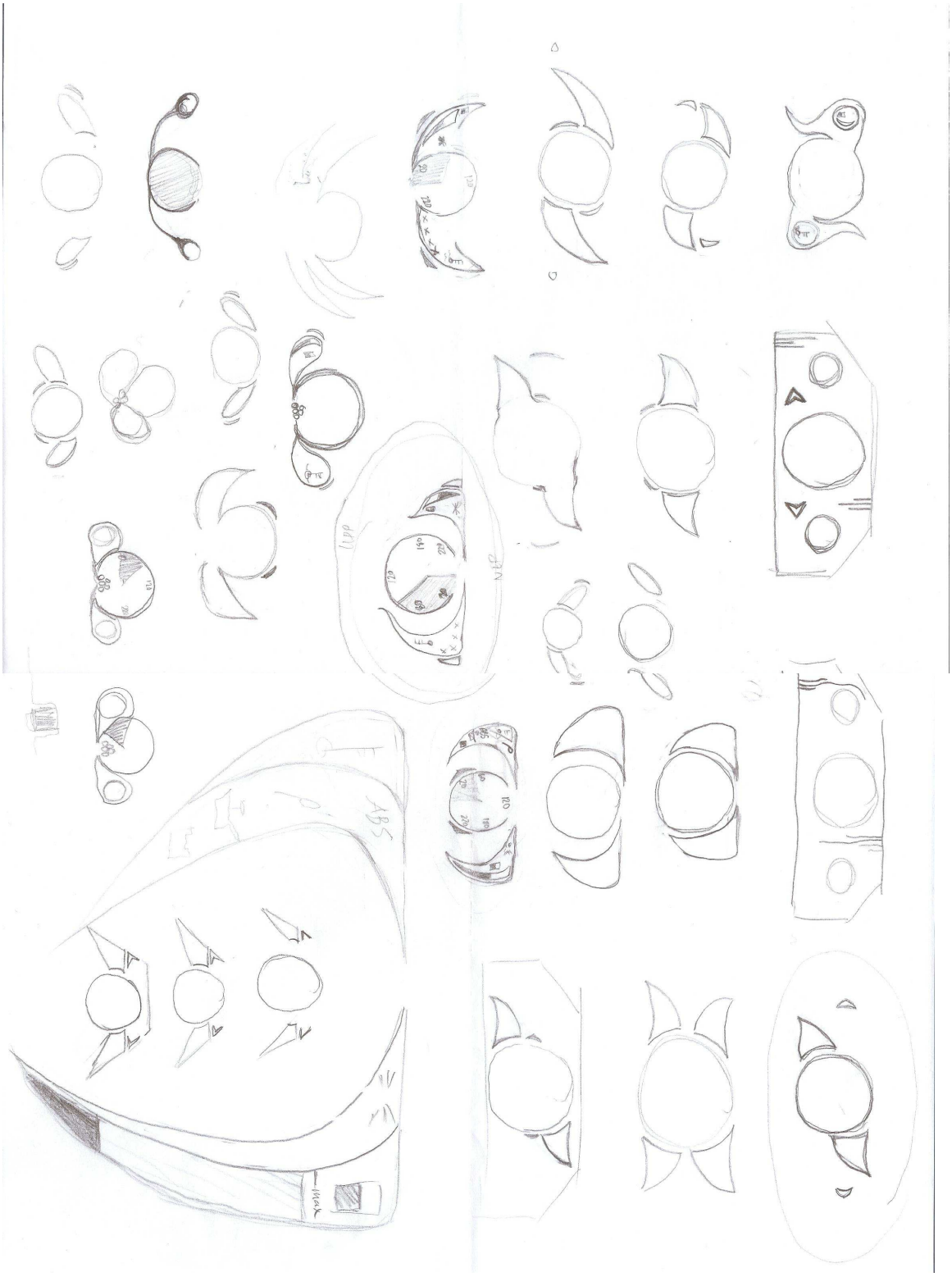


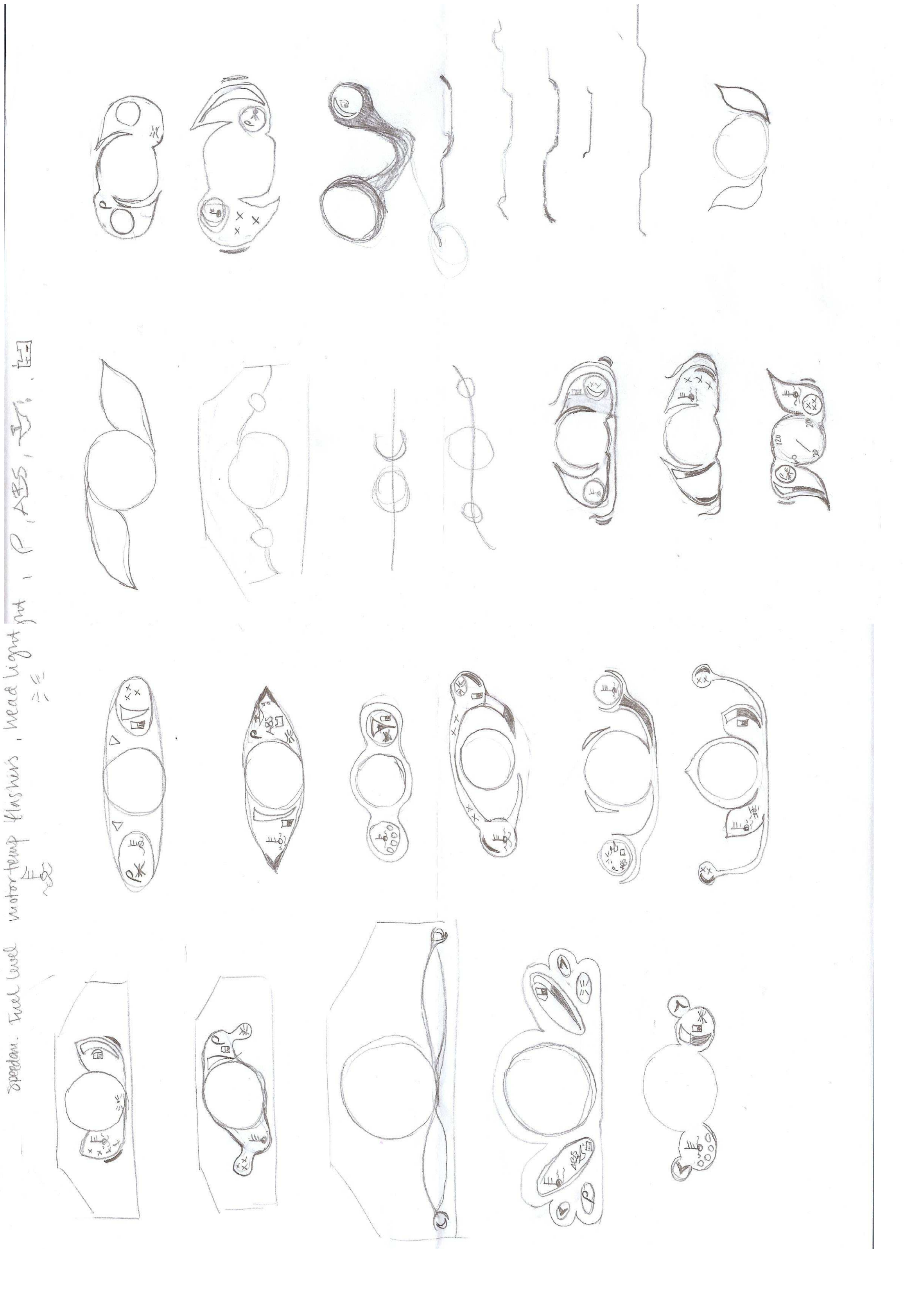

30, 50, 70
120
Tachometer
Benzin
Motortemp
Akkuzeit
Benzin
Motortemperatur
Batterie
ABS
warning symbols
the more turn white
& the exact velocity
is displayed in white
the numbers turn white
"light lines" warning
warning symbols
speedometer
headlight
low light
warning symbols
WARNING

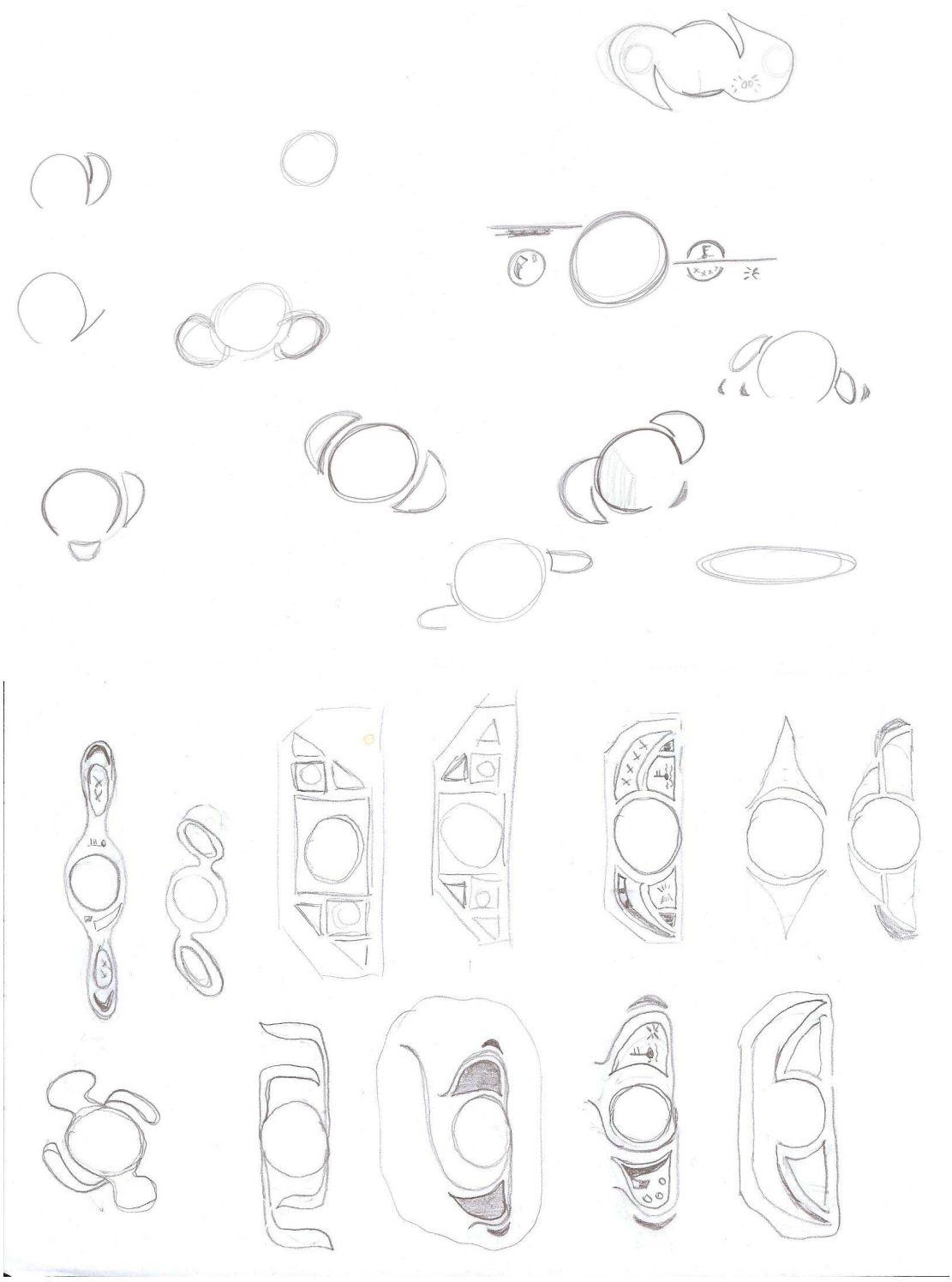


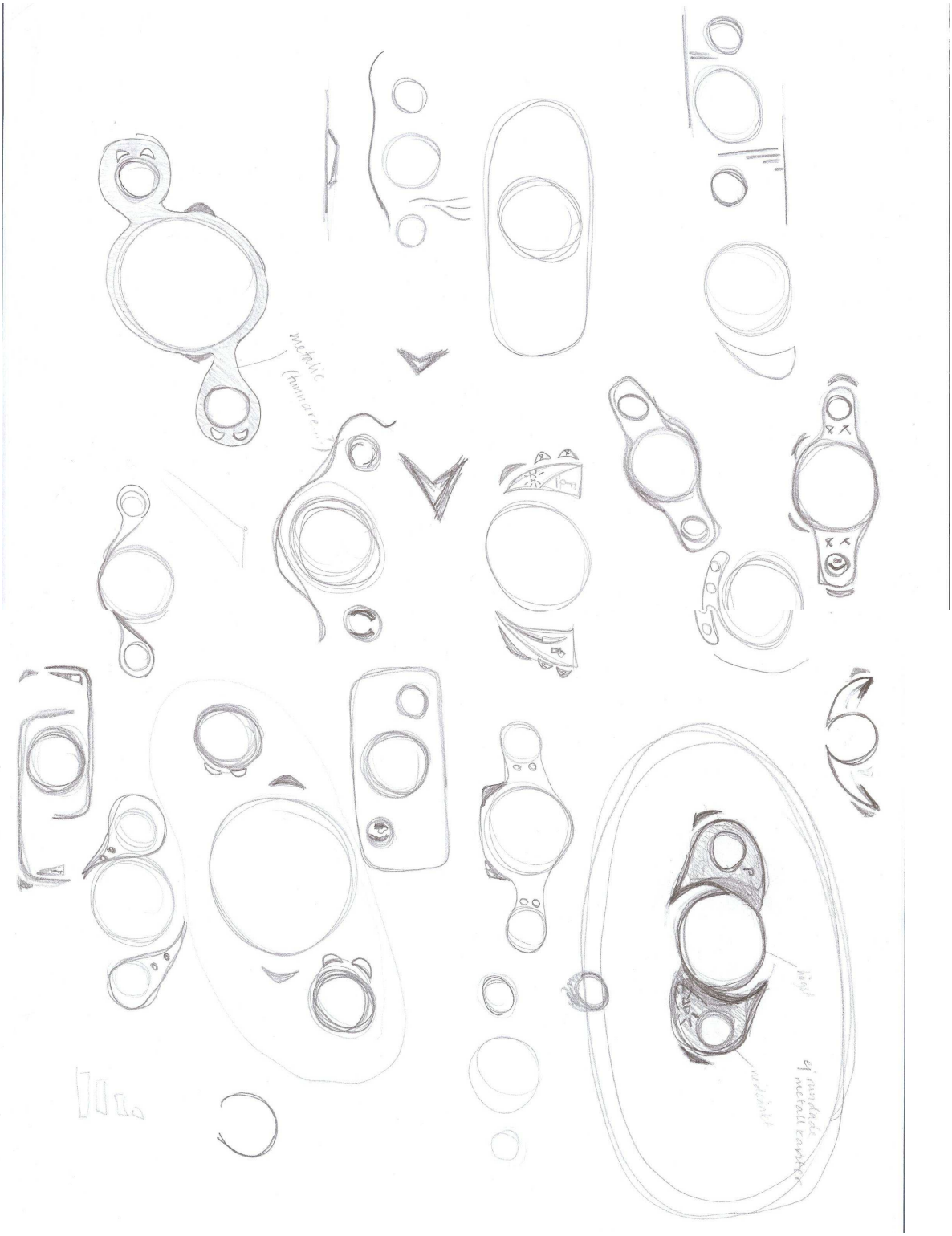

km/h
tachometer
et oilpressure

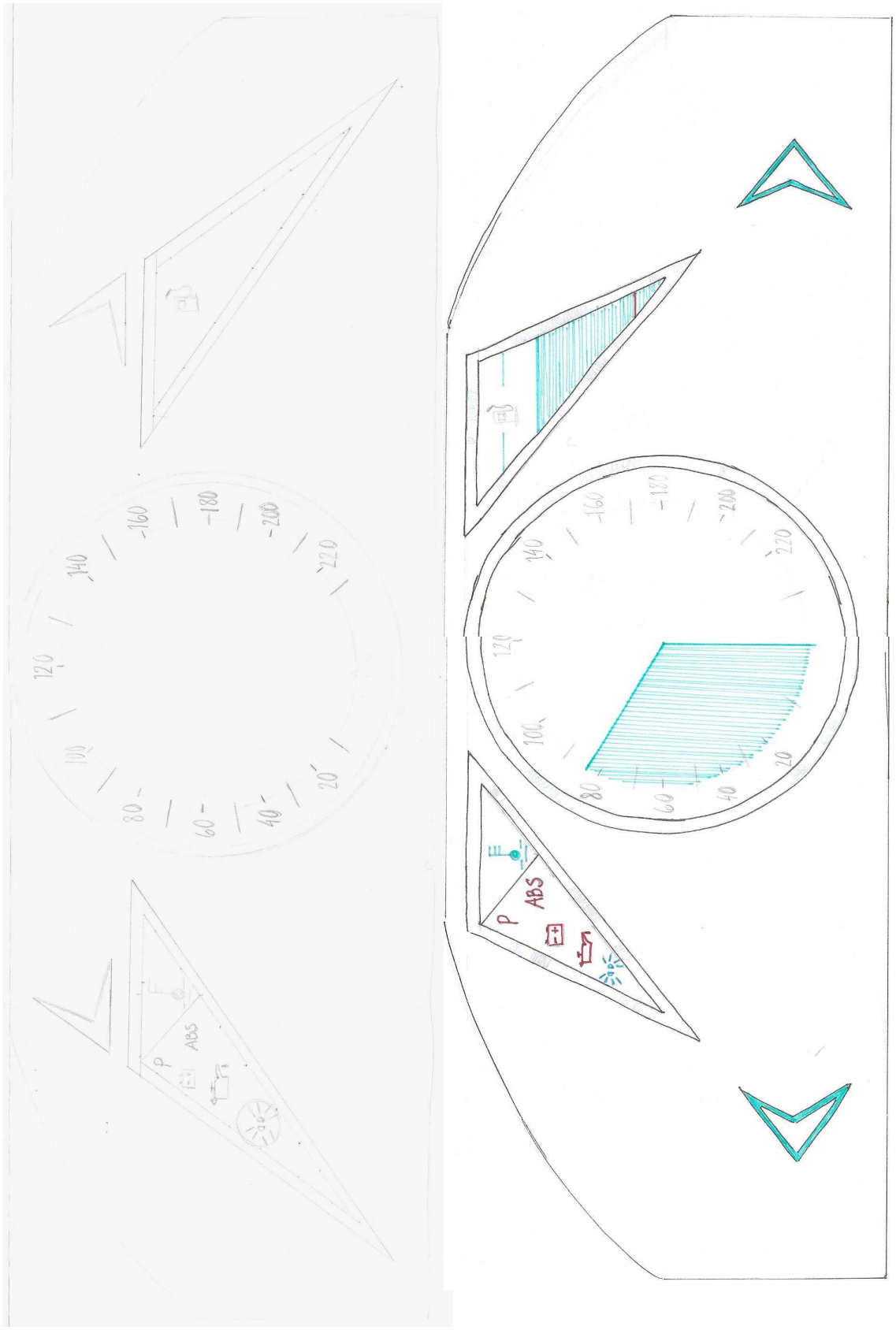

tachometer or
oilpressure
70
km/h
warning
symbols
head
lights
indicator

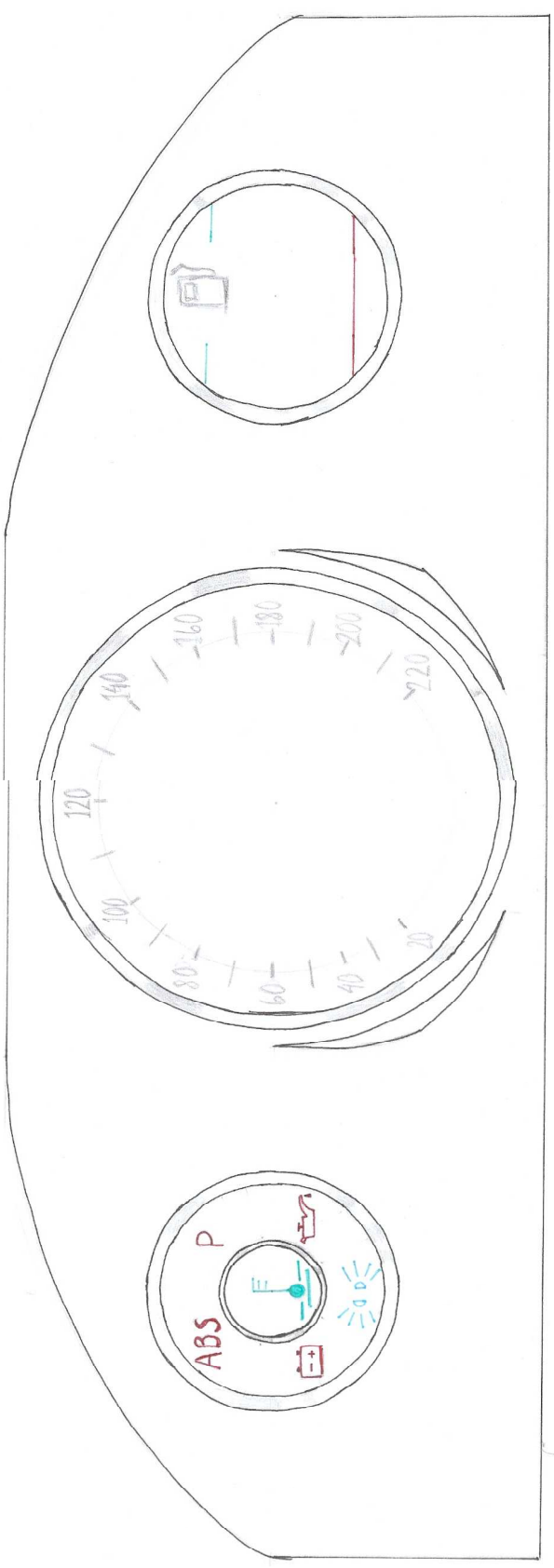


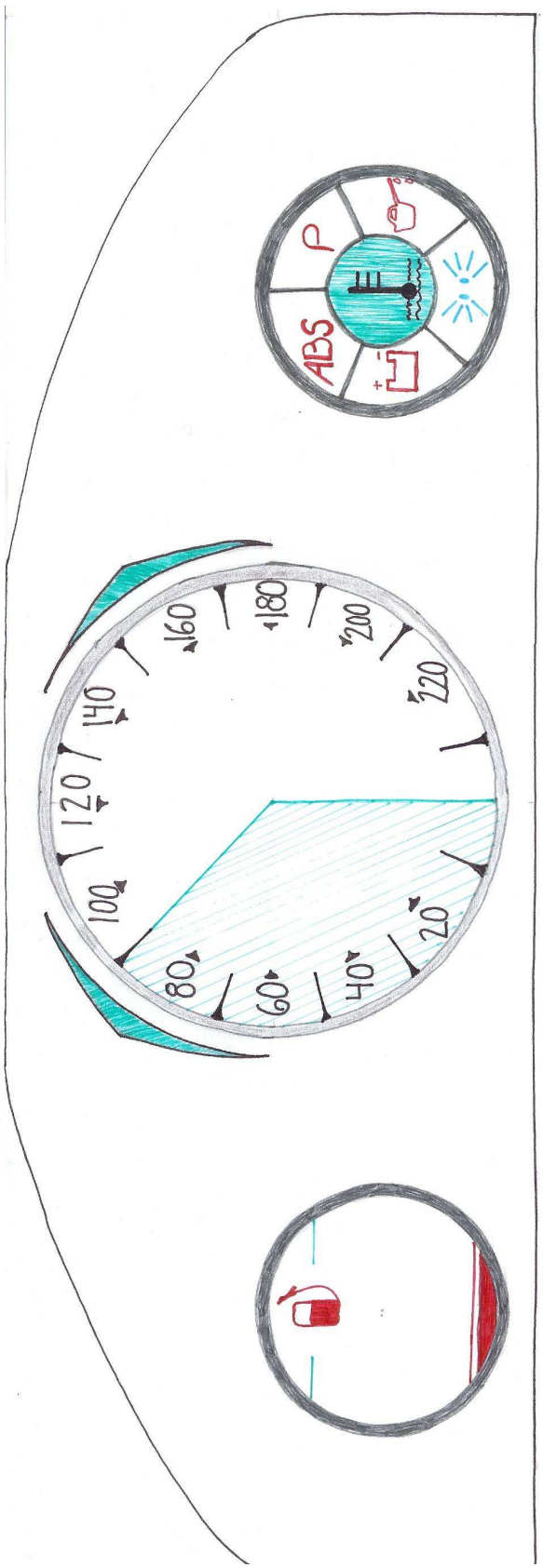

Speedom. Fuel level motor temp flashers, head light

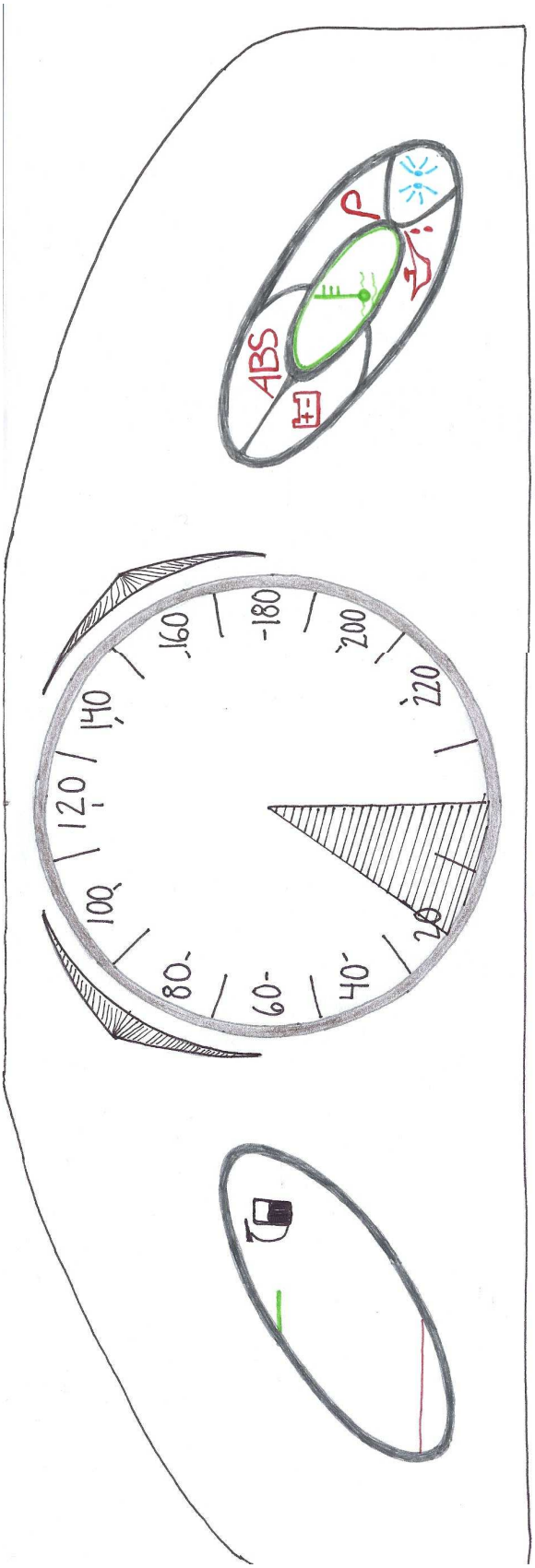


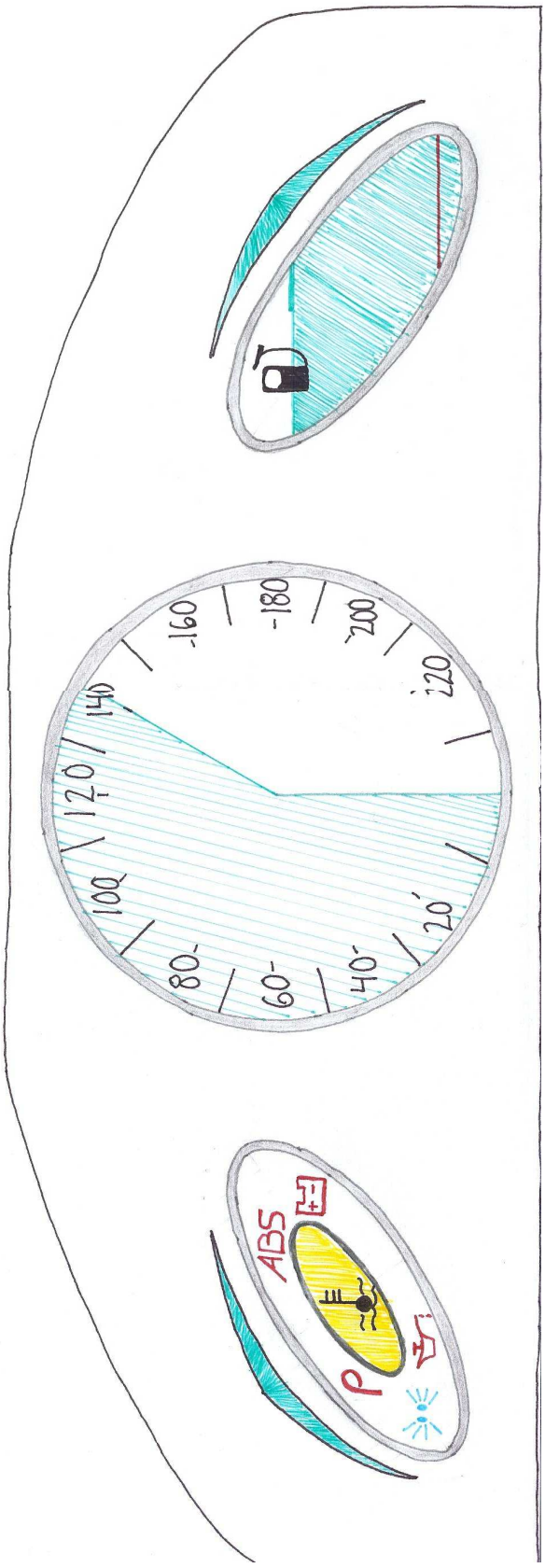

metallic (bronze...)


-160
-180
-200
-220
140
120
100
80
60
40
20
E
P
ABS


ABS
P
E
F
20
40
60
80
100
120
140
160
180
200
220


ABS
P
E
F
20
40
60
80
100
120
140
160
180
200
220


ABS
P
-160
-180
200
220
140
120
100
80
60
40
20


-160
-180
200
220
140
120
100
80
60
40
20
ABS
P


120
140
160
180
200
220
100
80
60
40
20
485


A
km/h
20
40
60
80
100
120
140
160
180
200
220


B
km/h
20
40
60
80
100
120
140
160
180
200
220


C
100
120
140
160
180
200
220
km/h
80
60
40
20

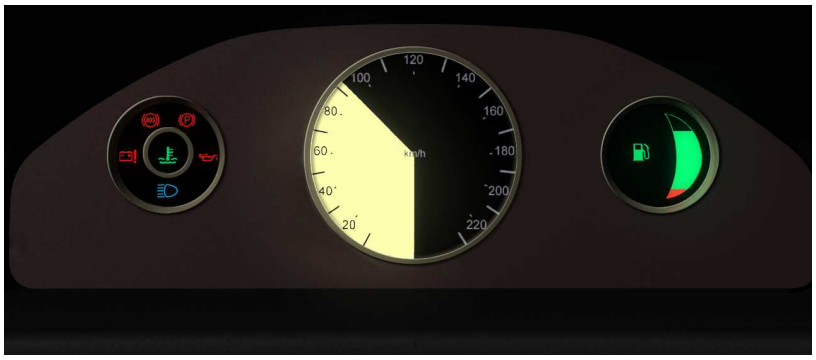

D
100
120
140
160
180
200
220
km/h
80
60
40
20

Vi läser Ergonomisk design och produktion och håller på att försöka avsluta vårt examensarbete. För detta är vi nu i stort behov av er hjälp! Examensarbetet görs i samarbete med bland annat universitetet och Volvo car corporation och går ut på att ta fram designförslag på en instrumentpanel efter svenskars och amerikaners önskemål.

Här under ser du tre bilder. Det enda som skiljer sig mellan bilderna är hastighetsmätaren. Vi skulle nu vilja att du betygsätter attraktiviteten hos var och en av hastighetsmätarna, under varje bild står en förklaring till funktionen. Försök även att motivera ditt svar så utförligt du kan, detta för att vi själva ska kunna motivera varför personer tycker att just en mätare är attraktiv. Vill du, får du även gärna skriva ditt namn och telefonnummer ifall vi behöver ställa några följdfrågor.

Tack på förhand!
Mvh
Louise Persson & Malin Rundqvist

Namn:
Telefonnummer:



1 = Minst attraktiv
7= Mest attraktiv

1 2 3 4 5 6 7

A: Området fylls i upp till den hastighet du kör i.

1= Minst attraktiv
7= Mest attraktiv

1 2 3 4 5 6 7

B: Området fylls i upp till den hastighet du kör i men hastigheten visas med en starkare pointer.

1= Minst attraktiv
7= Mest attraktiv

1 2 3 4 5 6 7

C: Hastigheten visas med en pointer.