Industrial Design Project III

DESIGN OF DASHBOARD OF MID-SEGMENT CAR FOR INDIAN MARKET

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Submitted in the partial fulfillment of the requirement of the post-graduate degree of
Master of Design in Industrial Design

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Approval Sheet

The Industrial Design Project II

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Guide…………………………………………………………………………

Chairperson……………………………………………………………………

Internal examiner………………………………………………………………

External examiner………………………………………………………………

Abstract

Automobile industry today is developing at a very fast and rapid rate. This has lead to a wide choice for the user to select from. This dense competition has forced manufacturers to develop and adopt new technologies from all walks of life. Automobile today has ceased to exist just as a mode of conveyance and has become a matter of experience.

Along with this 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, in the simplest way, to determine how to act in a certain situation. A user interface is the part of a product or a 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. To construct functioning user interfaces one has 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.

This project deals with the driver car interface, tries to enhance the driving experience by solving the problems at the cognitive level by making the interface as simple and as intuitive as possible.

Acknowledgements

There are many people whose assistance helped me in this project and I would like to thank them all.

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1. Introduction:

Fig. 1: Typical car dashboard in Indian market (MS Wagon R)

1.1 Role of a Dashboard:

The dashboard of a car is the most critical interface for communication between the driver and the car. Today, a typical dashboard comprises of two sections: (a) Human Machine Interface(HMI) through controls and displays and (b) the utility area. (see fig. 1)

The single basic purpose of the dashboard is to communicate rich and dense assortment of information in an instant. There no place for useless content through which our eyes and brains must sort. To achieve this, what people see must be the result of thoughtful and skillful design.

Thus, a dashboard is mostly a visual display cluster of the most important information needed to achieve one or more objectives, consolidated and arranged on a single screen so the information can be monitored at a glance-Few Stephen.

Gauges and signals may look aesthetically beautiful but should not lose their main purpose of communicating to the driver the necessary information at a glance.

The controls should be ergonomically positioned based on their usage and should be standard to all the cars. The controls allow the driver to monitor and alter various aspect of the car.

A dashboard also acts as the connect between the driver & the passenger and for two drivers of two different cars. Thus, it is the basic interface for the driver with his surroundings.

Hence, a good dashboard is the one that serves the purpose of getting what you need, easily and quickly.

1.2 Aim of the Project:

The project aims at designing the dashboard of a mid-segment car for Indian market. The objective of this project is to develop a design from the point of view of enhancing the user-interaction and usability of the dashboard by understanding the current user requirements. The design should be easy to comprehend and only necessary information displayed.

The project also aims to create a design suitable for a bigger target group.

1.3 Need for the Project:

With adaptation of technology from race car into production cars for daily use, the number of systems monitoring the functioning of an car has gone up drastically. Hence, there is need to accommodate these new systems. Also the user is demanding for new monitoring display systems. Simply, adding these systems and their information displays to the existing system creates a lot of clutter and cognitive load on the driver.

Also with the changing trends users are demanding more usable dashboards. Also the interior space of a car is playing a major role in innovation in Indian as well as world market.

It is necessary that a car is comfortable and easy to drive, which means that the seating should be right with all the sub-systems placed and positioned at right place and are easy to understand. Comfort definition of a vehicle is segment specific. Defining comfort for specific segment of vehicle is very important to understand the customers' needs. Hence, despite having guidelines and standards, it is necessary to validate comfort parameters when we design a new vehicle, keeping in mind the needs of specific population and segment (R. G. Rajhans, 2008)

Addressing all these issues needs a holistic outlook towards dashboard design so as to have all the systems and their sub-systems in unison with each other.

1.4 Scope of the Project:

The project looks at the dashboard as comprising of: Instrument cluster, Steering wheel, Center console and the Co-driver side area (see fig. 2). The dashboard is for a car in Indian market scenario in the price bracket of Rs. 4-6 lakh (base model price). The design is to be implemented considering near future requirements i.e. in next 5 years. The project addresses the issues related to cognitive aspect of information transfer between human and the vehicle as well as the utility requirements of the dashboard for the concerned market segment based on ergonomic requirements.

The project does not attempt to address the issues related to aesthetics and manufacturing of the dashboard as well as the problems concerning to external visibility.

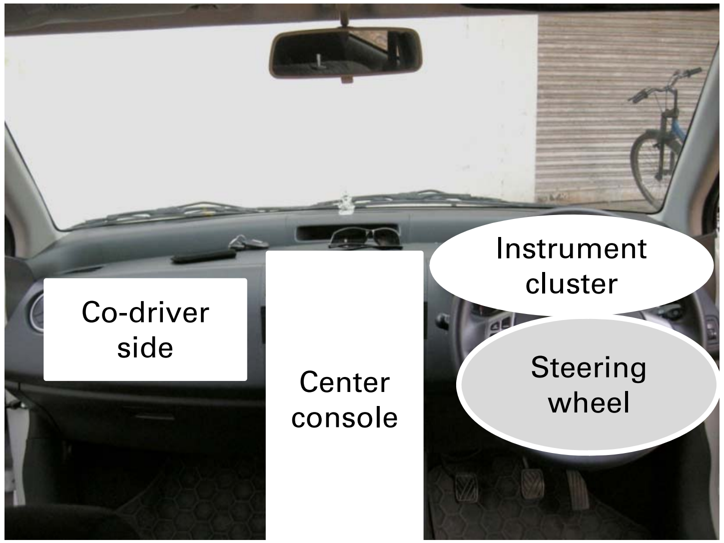


Fig. 2: Components of the dashboard

2. Literature Review:

2.1 User Interface:

An interface is that part of a product or system, which communicates with the user how to act, in the simplest way possible using clues like audio, visual and feel. 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 is and what actions need do be performed. Secured systems are easy to understand and use, the probability to take wrong actions and make mistakes becomes smaller (Danielsson, 2001).

Many technological innovations rely upon user interface to elevate their technical complexity to a usable product. Technology alone may not win user acceptance and subsequent marketability. The user experience, or how the user experiences the end product, is the key to acceptance. And that is where user interface enters the design process.

The importance of good user interface can be the difference between product's acceptance and rejection in the marketplace. If end-users feel it is not easy to learn, not easy to use, or too cumbersome, an otherwise excellent product could fail. Good user interface can make a product easy to understand and use, which results in greater user acceptance.

Thus, for an user interface to be effective it has to be intuitive as well as fool proof for the user.

The following sections describe the various aspects, that make an interface effective.

2.2 Attention:

When driving a vehicle, the driver has to perform multiple tasks that load his mental resources. The skills required for successful driving are developed over a period of time with practise and proper training. The driver needs to balance his attention. While designing car dashboard it is necessary to understand the priority of the information to be conveyed and the kind of attention required for error-free driving.

It is well-known that the demands for our attention vary with the situations and three different sorts of attentions can be distinguished (Danielsson and Noyes, 2001).

- *Selective attention* occurs when there is an abundance of information and we have to choose what we shall pay attention to. 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.
- *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.
- *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. A total deterioration of both tasks might be the result if divided attention is not successful.

Other external factors which control our attention have to do with how conspicuous the information is. Three of the factors are: colour, movement and placement of various gauges signals.

2.3 Colour:

We humans have the ability to tell the difference between millions of colours, but yet colours should be used with caution. Too many colours may distract and confuse the user of a system. Also different colours have different meaning and different associations to different people. The psychological, physiological and cultural effects of colours should not be ignored (Russel, 1991).

For example, as yellow being the most visible colour contrast to black using yellow increases visibility but in the nature the combination of yellow and black is used as a warning sign for danger and hence should be used with caution.

There should be a maximum number of seven colours 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 colours should be used (Kroemer, 2001). The discrimination plays a big role in well-designed systems. The colours must be separated widely in wavelength and not only differ in the amount of one primary colour to get different shades of the same colour. Following combinations can be suitably used:

- green, yellow, orange, red, and white;
- blue, cyan, green, yellow, and white; and
- cyan, green, yellow, orange, and white.

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

- reds with blue;
- reds with cyan; and
- magentas with blues.

Fig. 3: Use of colour blue in displays (source: www.featurepics.com & www.carbodydesign.com)

The colour 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 colour 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 colours should not be used for small figures in large displays that might enter this area. The use of opposing colours may in some cases enhance the display, but in other cases work as damaging. Shape and colour together could work as redundant cues and aid the users who have visual weaknesses. The size of the objects coded with colours should be increased, if the number of colours increases.

Text conveys by two means: the meaning of the word itself and the meaning derived from the colour of text. Improper colour can result into conflict of response.

For e.g.

STOP! **GO!**

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. Here, conflict arises as green symbolises ‘okay’ and red symbolises ‘stop’ or ‘warning’ which conflicts it literal meaning of he words.

2.4 Expression:

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. The expression of an entity (gauge, symbol) conveys its character, identity and function (Louise Persson). A good expression conveys the exact conceptual model of the entity and hence makes the interface intuitive.

2.5 Placement & Orientation:

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. colour marking could here enhance the effect. This helps the user to understand functions and operations needed.

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.

Similarly, orientation along with placement helps to group and inter link various symbols on an interface.

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 colours. When the user has to manage a large amount of information, the gestalt factors make it easier.

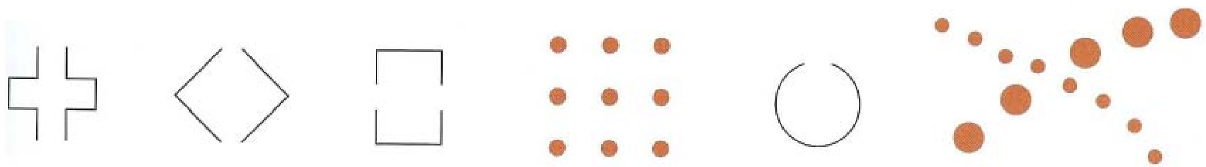


Fig. 4: Various arrangements that make a gestalt

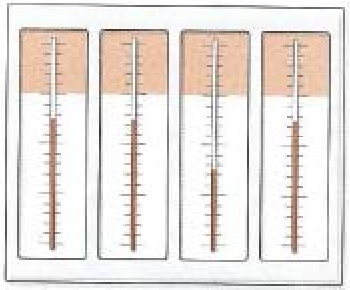


Fig. 5 (a)

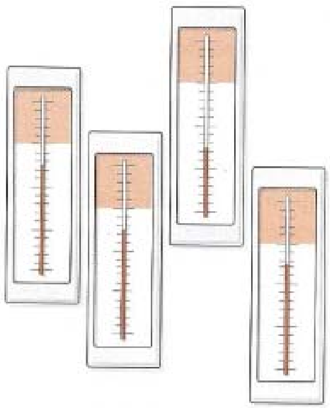


Fig. 5 (a)

Fig. 5: Parallel perception

Instruments which are functionally connected should be placed close to each other and the placement ought to follow good principles of gestalt, see fig. 5 (Danielsson, 2001) below for an example. 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.

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.

2.6 Types of Display:

The information that a display conveys should 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 (Rodgers,1983).

According to *Kroemer, 2001* the "four cardinal rules" for displays are:

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

Displays can be classified into three types; qualitative, quantitative, and check displays on the basis of the information they are suppose to provide.

Fig. 6: Speedometer- Quantitative Display

Qualitative displays: These displays indicate approx. value (range) for an equipment or the rate of change of a variable. When the rate of change is of higher, 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. For e.g.(see fig. 6) in an analog speedometer the user not only detects what speed the vehicle has but also how far above or below the posted speed limit he is driving. Perception of qualitative information is quicker with analog kind of displays.

Fig. 7: Vernier Caliper
(source: www.arc-bg.com)

Fig. 8: Temperature indicator

Quantitative displays: These displays provide the user exact information in form of precise numerical value. When the user needs only a quantitative value from the readout a digital is preferred over a dial. The risk of error decreases with a digital since the user does not have to consider scale markings and calculate the desired value. For e.g. (see fig 7) Vernier caliper is difficult to read with a dial but with a digital (quantitative) display the reading is instantaneous.

However, this only applies to a slow rate of change and when the user is only in need of an exact value. Another disadvantage with digital displays is the risk of misinterpreting the numbers, like confusing a 3 for an 8, or 1 for a 7.

Check displays: These displays indicate the state of an equipment. They indicate if certain state exists or not. For e.g. (see fig 8) temperature indicator red shows hot condition while green icon means permissible range.

2.7 Elements of Display:

Legibility	Character on background colour combination
Very good	Black on white Black on yellow
Good	Yellow on black White on black Dark blue on white Green on white
Fair	Red on white Red on yellow
Poor	Green on red Red on green Orange on black Orange on white
Very Poor	Black on blue Yellow on white

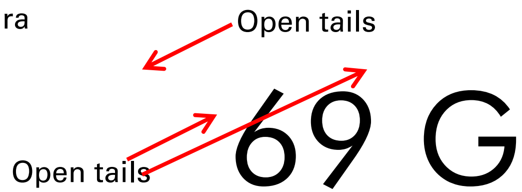
Table 1: Legibility of combinations of character and their backgrounds

Displays comprise of various elements like icons, text, scales and markings, pointers, etc. These elements contribute to the effectiveness of a display.

Type face: The kind of type face used decides the readability of a display. Following are few thumbs rules according to *The measure of a man & woman* :

- All character must read vertical but no vertical words
- Serif type face should be avoided
- Size of font for viewing distance of 710mm should be
    - Critical moving scales: 5-8 mm
    - Critical stationary scales: 3-8 mm
    - Non-critical scales: 1.3-5 mm
- Closed type faces should be avoided and type with open tails should be used.

  For e.g. Futura



For the characters to be legible certain contrasting colour combinations should be followed (See table 1).

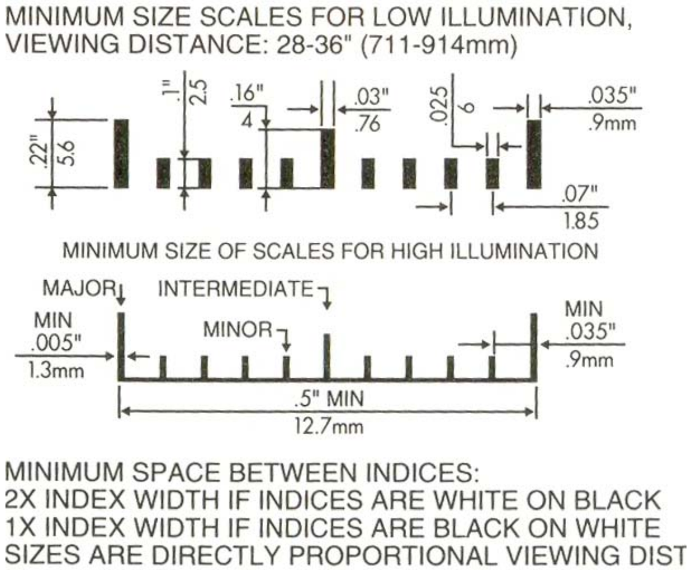


Fig. 9: Recommended scale markings (*Henry Dreyfuss, 1993*)

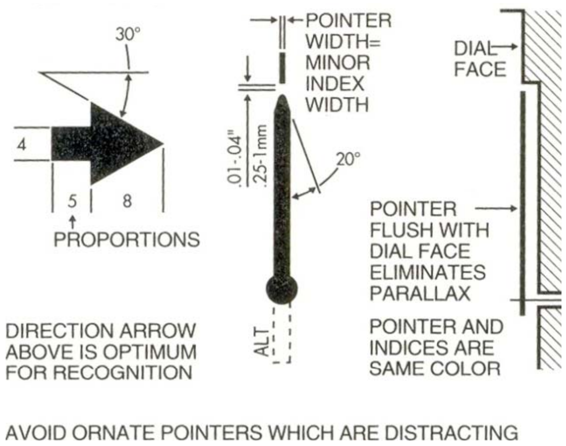


Fig. 10: Recommended pointers & arrows (*Henry Dreyfuss, 1993*)

Scale and markings: The general rule when using scale is that it should be simple, uncluttered and easy to understand. It should prevent the user from need of guessing the value. Also the resolution should be such that it gives required information correctly, not more not less. See fig. 9.

Pointers and arrows: 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. A recommended pointer & arrow size for optimum recognition is as shown in the fig. 10

Display illumination: A display needs to be carefully chosen weighing the merits and demerits based on kind of application and environment. The placement and the orientation of the display also depends on its type.

Electronic displays are emissive type displays while mechanical displays are reflective type. It means electronic displays are self illuminating and are ideal in low light conditions while mechanical displays use ambient light by reflecting it and hence should be used in good light condition.

Other than this there are other disadvantages like; electronic displays are prone to glare and can become illegible, mechanical displays have problem with parallax error.

One more major advantage of electronic displays is the flexibility they allow, to modify a display as per requirement.

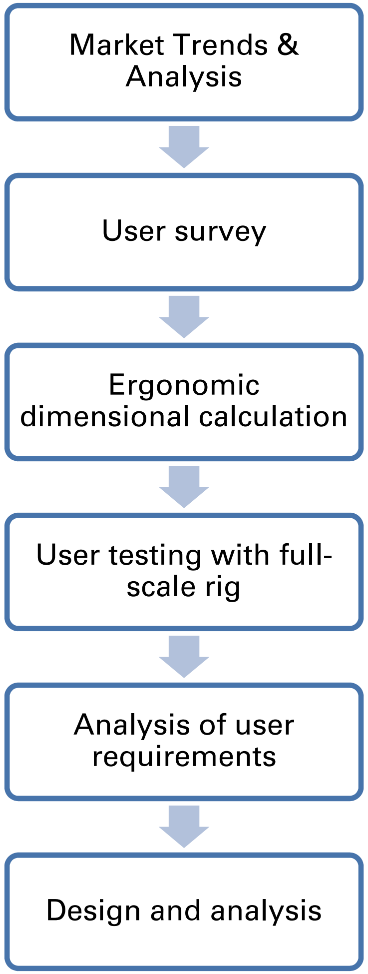


Fig. 11: Stages

3. Methodology:

The study of literature and understanding the practical applications of the various theories of interface design led to following way of exploring and designing a dashboard, which was further refined at every stage of the project. The project aims at understanding exact user requirements and hence understanding users problems and their expectation from cars of tomorrow is critical. Following are the major stages of the project as highlighted in fig. 11:

Market trends and analysis: Before actually gauging the user requirements it was necessary to understand what markets, international as well as Indian, have to offer today and tomorrow.

User survey: To understand the current user requirements user survey was conducted that lead to numerous insights in good and bad design existing today. This survey was to be conducted over e-mail as well as in person. This lead towards finalising the scope and area of project to work on.

Ergonomic dimensional calculation: In order to understand the effects of viewing angle, viewing distance and position of various controls, a brief study of dimensions was necessary.

User testing with full-scale rig: With the basic analysis of user survey a mock up test rig was to be made to understand user expectation when actually enacting the various activities involved in driving a car. Both audio and video recording was used.

Analysis of user inputs: The various inputs and requirements were to be analysed by using technique of affinity diagram, thereby identifying the core problem. This also involved inputs from personal experience of driving.

Design and Analysis: With the clear categorisaton and highlighting of design insights the dashboard the dashboard was to be divided into following four sections:

- Instrument cluster
- Steering wheel
- Center console
- Utility of dashboard (at the co-driver side)

While designing each of these sections, it was kept mind to avoid any conflicting of design.

This was to be followed by proper amalgamation of all the sections to create homogeneous and ergonomically correct dashboard that would be easy and intuitive to use.

4. Data Collections and Research:

4.1 Market Trends and Analysis:

The existing markets, Indian as well as international, are very volatile, and there have been some very serious attempts towards appealing the user with intriguing designs. New and exciting dashboard designs have emerged in form of concept as well as production cars.

In order to understand the market trends in India the dashboards of cars in this segment were analysed. The most prominent cars in this segment are:

- Maruti Suzuki: Swift, Esteem , Wagon R, Zen Estilo
- Hyundai: Santro, i10, Getz
- Tata: Indica, Indigo
- Chevrolet: Spark, Aveo U-VA and few others.

Dashboards today are moving from typical greys to two tone and three tone dashboard. A lot of choice is available to the user to choose from different interiors depending on the make of the car.

All the instrument clusters in this segment are more or less the same as far as the equipment list goes and the major difference being the placement of various gauges and types of displays.

There are few cars in market having very radical displays, as far as Indian market is concerned. These include the new Tata Indica Vista, Chevrolet Spark, Honda Civic and Maruti Suzuki A-star.

Fig. 12: Tata Indica Vista (source: www.team-bhp.com)

Fig. 13: Chevrolet Spark (source: www.team-bhp.com)

(Ref. fig 12 & 13)These two models have shifted the basic instrument cluster from the conventional position of in front of the steering wheel to the center of the dashboard. Though Chevrolet has kept the warning signals in front, Tata has moved these too. The best position for placement of these gauges is in front of a person's eyesight. Moving these to center of dashboard are against the principle of visual ergonomics which states that the response time is higher for any visual away from the center of the eyesight cone.

Also the LCD display, in Tata Indica vista, loses visibility when harsh sunlight falls on it from the windscreen which can be hazardous. Such positioning of the instrument cluster should be avoided.

The hazard warning switch in Indica is positioned much lower on the dashboard, which shouldn't be the case as this is an emergency switch. The plain top surface of the Indica is good as it doesn't get reflected in the windshield during daytime. The grey tone of the top surface aids this.

Fig. 14: Honda Civic(source: www.hondacarindia.com)

Fig. 15: Maruti Suzuki A-star (source: www.marutisuzuki.com)

(Ref. fig 12 & 13)Honda Civic was the first car in India to have such a radical instrument cluster. It has a digital speedometer and an analog tachometer. The two stage instrument cluster is attractive and the blue halo in the tachometer has resulted into being the major attraction for buyers. The digital speedometer is advertised by Honda as cockpit styled dashboard.

Although the digital speedometer is intriguing it can be a bit tiring when driving the car as the speed never stays steady and the display keeps flickering right in front of your eye.

Also a speedometer need not convey the exact quantitative information but a range of speed, which is also easier to detect at a glance. (ref: type of displays in chap. 3)

Maruti A-star which was launched recently is a toned down version the initial concept car that was launched. The production though carries some essence of radical interiors contrary to its exterior. It has a big speedometer that also houses a multi-function display. It has a pop-out tachometer on the right side of the speedometer.

Also the other cars in market were studied to identify the Dos and Don'ts.

4.2 User Survey:

With the detailed analysis of dashboards of cars in Indian market and with personal experience of driving a user questionnaire was prepared to identify, understand and classify the problems faced by the users. Also the user expectations from cars to come were identified.

The user survey was done over the internet, personally and also contextually with the user sitting in his/her vehicle.

The questionnaire is as attached in appendix A.

4.3 Ergonomic Dimensional Calculations:

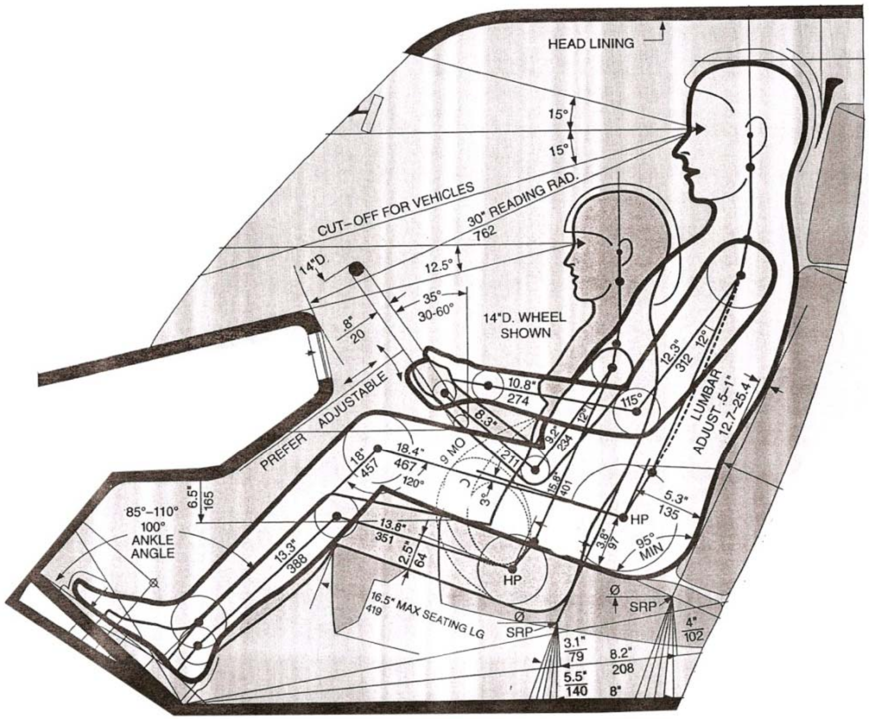


Fig. 16: Ergonomic dimensional calculations (adapted from Henry Dreyfuss, 1993)

The basic dimensional requirements for the dashboard were calculated as per the guidelines given by Henry Dreyfuss, 1993. The calculations were done for user range of 5th percentile Indian woman and 95th percentile Indian man.

All the anthropometric calculations done are as per Indian anthropometric data (D. Chakrabarti).

Following basic dimensions (marked with red arrows) were calculated.

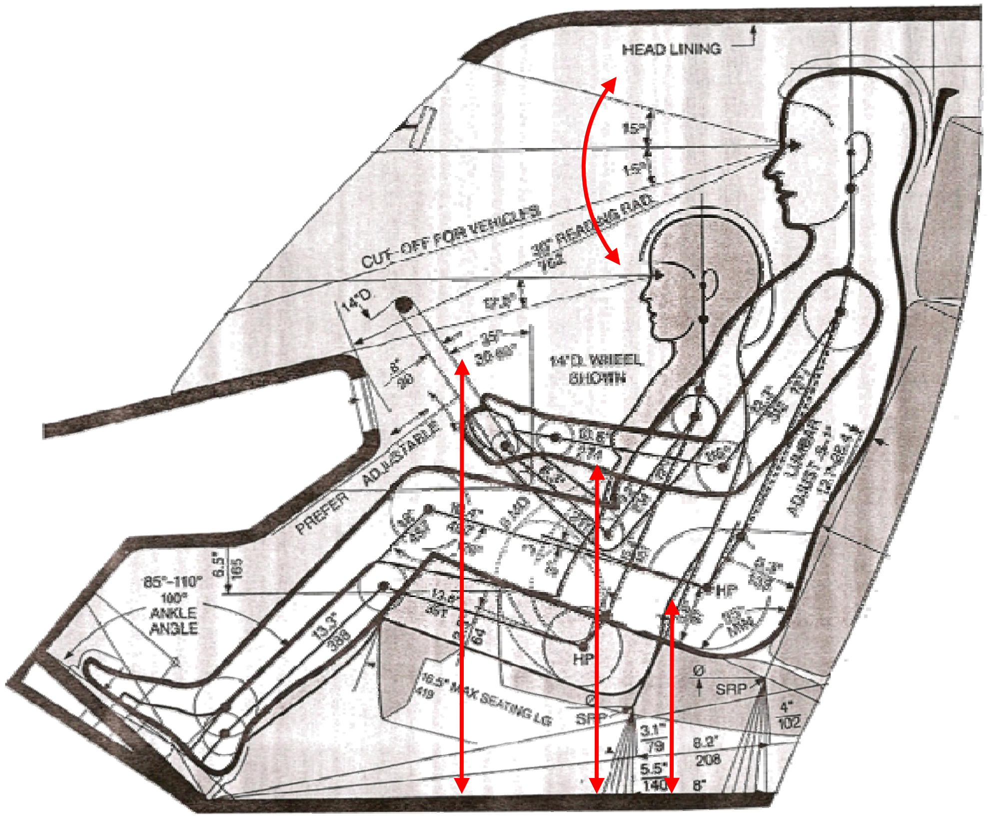


Fig. 17: Ergonomic dimensional calculations (adapted from Henry Dreyfuss, 1993)

These dimensions were calculated so as to accommodate maximum population of Indian origin reasonably. Hence the 2D mannequins for 5th percentile Indian female (small female) and 95th percentile Indian male (large male) were used.

5. Design Brief:

At the very outset of the project it was decided to address the issues related to ergonomics and user interface of the dashboard. Based on the user feedback and market analysis following is the design brief:

Core benefits:

The existing dashboards in market are more of a modified designs trying to accommodate new technologies with old layouts and designs. This project looks forward to have completely new dashboard designed for the new upcoming technologies and interfaces in this segment.

The design addresses the basic issue related to information transfer with the existing dashboards by reducing the cognitive load on the driver thereby making the driving experience more enjoyable with reduced stress levels.

User Profile:

The design is targeted towards broader range of users. This includes all Indians male & female allowed to drive a four wheeled vehicle as per RTO rules. The design looks to accommodate users under wide range on anthropometric setups. The design accommodates Indians from 5th percentile female to 95th percentile male.

Limitations:

Considering the time constraint for this project, the project tries to address the issues related to ergonomics and the problems arising due to information transfer. The analysis is based on the responses given by the users. The number of users is also limited and larger user group can lead to better analysis.

User safety:

Making driving a stress-free and safe is the single basic goal of this project. The driver is provided with all safety features and the design aims at achieving error free operation where the interface is intuitive and fool-proof.

Product positioning:

The product is targeted for a segment of cars with ex-showroom cost in the range of Rs. 4-6 lakhs (base model). The design allows the use of technology currently not available in this segment, but can be easily made available in near future.

Thus, the design enhances the usability of the dashboard of a mid-segment car in Indian market by simplifying the communication between the vehicle and its user thereby reducing the cognitive load while driving the vehicle.

The design is segment specific.

6. Design and user testing on a rig:

6.1 Instrument Cluster for Test Rig:

Based on the user responses, and the expectations of users from the cars of tomorrow few layouts of instrument clusters were made. These instrument clusters comprised of existing instrument clusters, new designs and some concept vehicle instrument cluster. These were then modified based on the user feedback.

The user demands from the user survey were contrary to the literature review and analysis done earlier. These contradicting aspects were introduced into the designs and showed to the user. Here inverse approach was adopted so as to make users realise that a dashboard needs to be simple than attractive.

Following were the basic clusters used for testing.

Fig. 18: Instrument Cluster 1 (adapted from www.istockphoto.com)

(Refer fig. 18)This design was selected for its nearness to conventional speedometer and tachometer. The cluster provides minimal, but adequate information about the status of the car and its various sub-systems. It also has a tachometer that exists in many cars today with rpm in variation of 100 times rather that 1000 times which can be confused with the speedometer.

Fig. 19: Instrument Cluster 2 (adapted from www.istockphoto.com)

(Refer fig. 19)This Instrument cluster replaces all needles with bar graphs that move along arcs. This cluster provides al basic information, but uses needle-less concentric speedometer and tachometer.

Fig. 20: Instrument Cluster 3 (adapted from www.istockphoto.com)

(Refer fig. 20)The earlier idea of concentric speedometer and tachometer is maintained but gauges are with traditional needles though not full length and with more space in between them. Few users had hinted that the steering wheel blocks the view of big clusters and would like combined displays. Hence the idea of concentric gauges.

Fig. 21: Instrument Cluster 3 (adapted from www.istockphoto.com)

(Refer fig. 21)Some users intended at having all the information that can be made available including gear position, fuel in liters, mileage, radio station, vehicle status, etc. hence almost every information regarding a vehicle is provided in this instrument cluster. It also shows clock within the cluster itself

Fig. 22: Ford EV instrument cluster (source: http://jalopnik.com)

(Refer fig. 22)Ford has created this cluster for its future hybrid vehicle in colaboration with design firms IDEO and Smart Design to especially point out the driver how driving affects fuel efficiency thereby encouraging drivers to drive at right speed and right rpm.

This instrument cluster was chosen as it provides variety of information in a very compact way.

6.2 Other Components for Test Rig:

Along with predesigned instrument cluster the user was provided with all the basic signals that are generally displayed on the instrument cluster (see fig. 23). Also gauges like speedometer, tachometer, fuel gauge temp. gauge were provided for complete configurability as shown in fig. 24.

Fig.23: Symbols and signals commonly seen in cars today (adapted from www.istockphoto.com)

Fig.24: Gauges commonly used in cars today (adapted from www.tutorialized.com)

6.3 User Testing on The Rig:

Fig.25: Full scale test rig

In order to understand the various aspects of user interaction with the dashboard it was necessary to study this interaction at true scale. Hence, based on the dimension calculated for 5th percentile woman and 95th percentile male, a test rig was built out of Styrofoam mounted on wooden frame. This allowed for accessing the contextual data not available from user surveys. Lengthy user studies were done with 4 user, documenting the conversations using audio and video capturing devices. Users were provided complete flexibility of configuring their own dashboards by adding in new gauges or signals as well as deleting few that exist on the current dashboard.

Each study lasted around one hour allowing enough contextual information to flow in. The number was limited due unavailability of users to come to the rig for testing.

The various layouts generated by the users were documented and also proper feedback was obtained for the instrument clusters discussed in the previous section. Also the ergonomic dimensions were validated.

Fig.26: User study analysis

6.4 Analysis:

The audio and video were analysed for design insights. These inputs & statements gathered from the user survey and the user testing on the rig were then analysed by clustering them. The various inputs were grouped searching for affinities generated by supporting as well as contradictory statements made by various users.

The user testing allowed for user highlighting various problems that slipped out of user survey. This included situations like charging phones, asking for directions etc.

Based on this affinity analysis, insights were drawn for users expectations from cars of future. These inputs were used while designing the various components and interfaces of the dashboard.

Data obtained outside the scope of project was neglected.

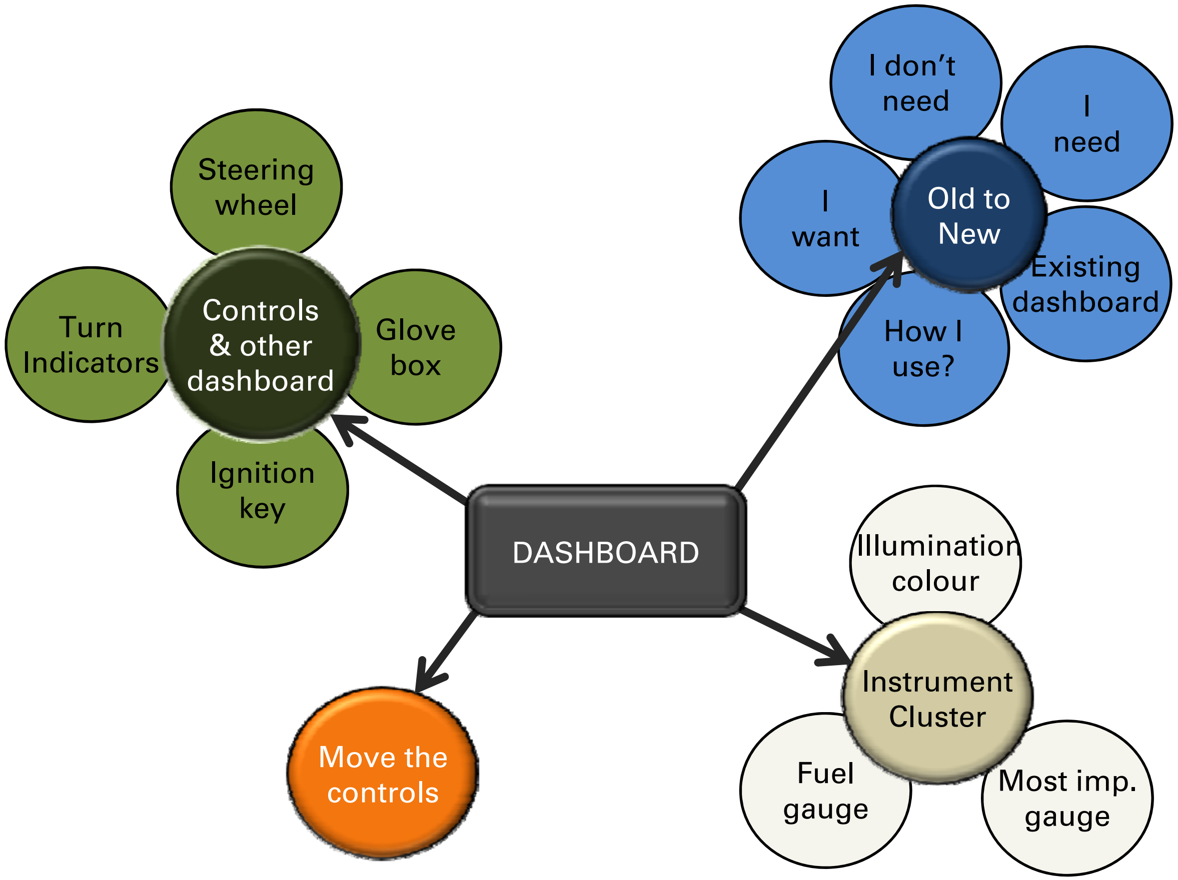


Fig.27: Affinity diagram

6.5 Affinity Diagram:

The affinity diagram was generated as shown. After the clusters were made these were grouped under a heading to allow to identify core problem area. For e.g. all the comments that were clustered into:

- I don't need,
- I need,
- I want,
- How I use and
- How my existing dashboard feels

were grouped under one sub heading of change required from old to new dashboards. This quickly identified the basic things that need to be avoided and new things needed.

Based on the inferences from the affinity diagram a detailed design process was carried out for the various parts of a dashboard.

7. Design and Analysis:

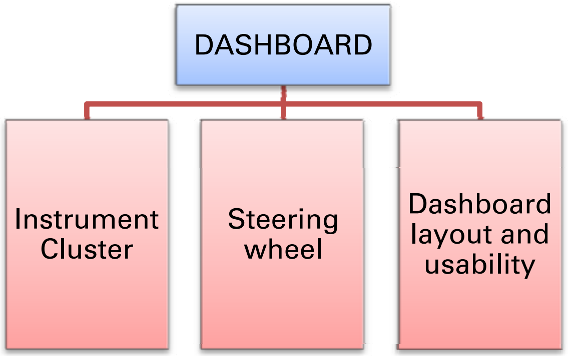


Fig.28: dashboard structure

7.1 Introduction:

For further design process the dashboard was split into three different sections as follows:

- Instrument cluster
- Steering wheel
- Dashboard layout and usability.

This was done as the problems in these sections involved are different and hence need to be solved using different tools and different methods. The instrument cluster involves majorly visual design and the problems are at cognitive level, while the steering wheel involved physical product user interaction and dashboard layout & usability involves problems arising due to layout that doesn't comply to ergonomic principles of usage.

7.2 Instrument Cluster:

Here the scope was limited to modifying gauges, if any, and their placement but not to rework the form of various warning symbols.

7.2.1 Composition of the Instrument Cluster:

Understanding the function of an instrument cluster, it was clear that all and only those gauges, signals and displays need to go on the instrument cluster which are required while driving. Any other information that is not required while driving but gives status of the system which is not required to be analysed and responded to while driving is displayed only when the vehicle is powered on or is displayed on the multimedia interface on the center console.

Following information displays were shortlisted to go on the instrument cluster. These were further grouped into 2 sections as follows:

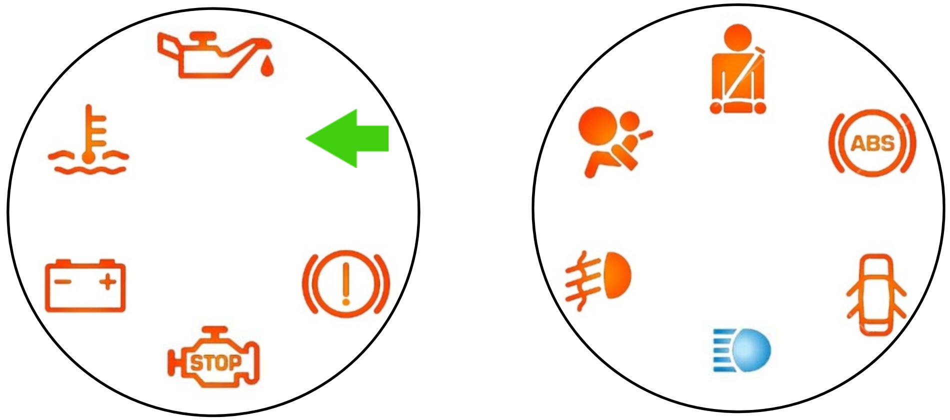
1. Gauges

Gauge	Type	Remark
Speedometer	Critical	Needs to convey approx value within range
Tachometer	Critical	Need not convey quantitative value
Odometer	Non-critical	Needs to convey exact value
Fuel gauge	Semi-Critical	While driving needs to convey very approx value, but should provide enough info. when needed
Temp. gauge	Critical	Should not provide quantitative value, should warn well in advance of danger
Trip meter	Non-critical	Should convey exact value besides Odometer

Table 2: Gauges

2. Signals and symbols:

The signals and symbols on the instrument cluster were identified as follows:



Hazards & warnings Indicators

Fig.29: Signals & symbols classification

7.2.2 Zone Priority Marking:

A good instrument cluster gives information on the basis priority level of the information. The most important set of information should occupy the most visible positions so that it gives necessary information at a glance, but a hazard warning should be such that it attracts the drivers attention. Hence it is necessary to divide the instrument cluster in form of priority zones.

A user survey was conducted to identify these priority zones. A basic form of instrument cluster was selected based on the ergonomic calculation and the existing dimensions of instrument clusters in market today. This cluster was further divided into zones as follows and users were asked to rank the zones based on priority of vision.

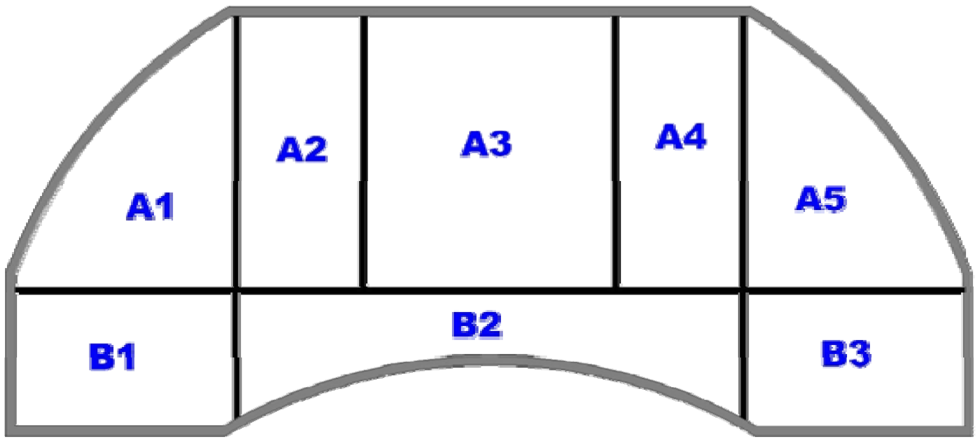


Fig.30: Instrument cluster outline
Size: 30 cm X 13 cm (bounding box)

The result with survey sample size of 31 (of both genders) was as follows:

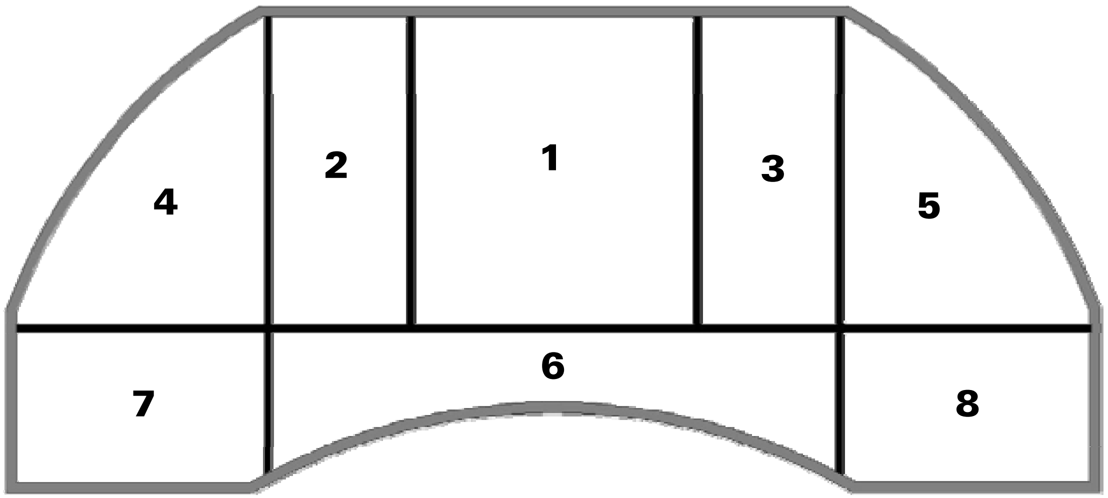


Fig.31: Instrument cluster priority zones result

Following were the inferences drawn from the result:

- Central area has the maximum priority
- The vision moves from top to bottom
- The priority level is higher for left side that right. This may be because of two reasons: we tend to write from left to right ;and also India being a right hand drive country we tend to focus towards the left of our vision.

7.2.3 Design of Gauges:

Each gauge was analysed for its function and kind of information it conveys. Based on this gauges were designed as follows:

Speedometer:

A speedometer needs to convey qualitative information within a range and should be visible to the eye at a glance while driving. Also it need not specify the exact speed at which the car is moving. This qualifies it to be a analog display.

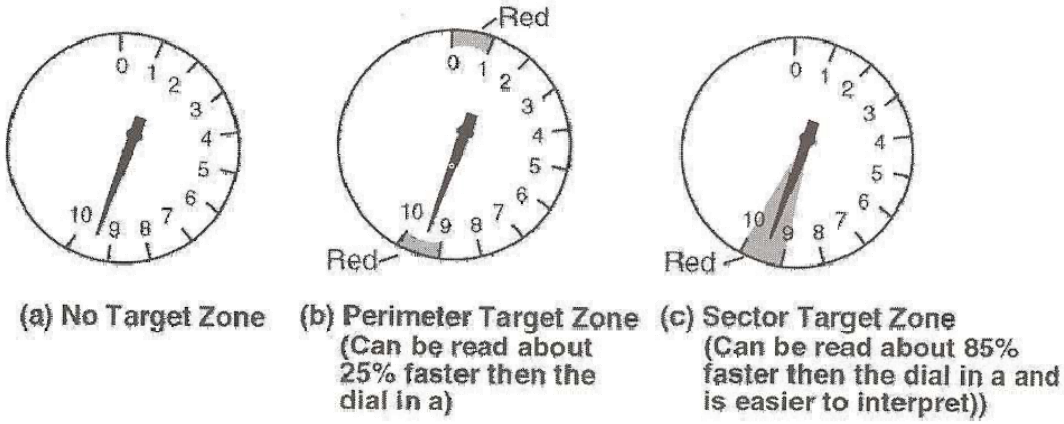


Fig.32: Target zone marking

As per the book Rodgers,1983 target zone marking allows for faster response as shown above. Hence a speedometer with sector target zone marking the range of speed along with needle would be faster to read at a glance while driving.

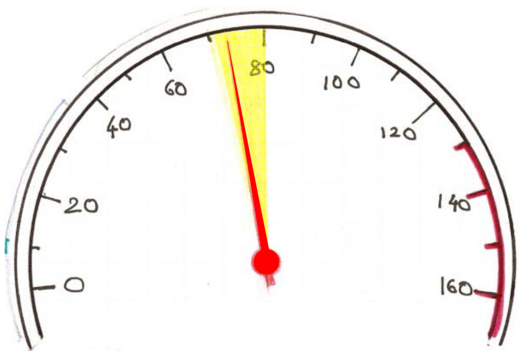


Fig. 33: Basic speedometer with target sector marking.

Tachometer:

Very similar to speedometer tachometer needs to convey qualitative information, but here the range of rpm of the engine that needs to be known is still wider. Also a tachometer is used to identify if a car is being driven at proper rpm so as to achieve good fuel economy or power. The rpm needs to be on the lower side for better fuel economy but while overtaking or climbing uphill there is need for extra torque from the engine and hence the engine should be at higher rpm.

Thus a tachometer can be well utilised even if it display only the zone i.e. economy or power very high rpm. Hence following ideas were tried out:

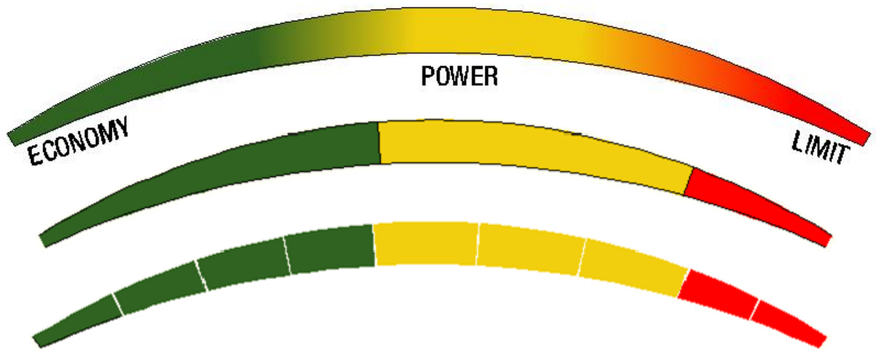


Fig. 34: New tachometer

The idea didn't seem to work well even though it conveyed the information as it lacks the character of a meter, (tachometer) and fails to be identified as a tachometer. Similar kind of display exists with TVS brand motorcycle with two bulbs indicating power and economy mode but riders complained that their motorcycle didn't deliver good fuel economy even when driven in economy mode.

Hence it was decided to stick to the conventional tachometer.

Fig.35: Combined fuel and temperature gauge (adapted from http://vector.tutsplus.com)

Temperature gauge:

Conventionally temperature gauge is displayed in form of needle gauge and many a times in the same circular dial as the fuel gauge. A driver need not know the exact engine temperature nor is he required to know the range. Only a warning of moving towards higher temperature and high temperature is more than adequate. Hence the well established symbol of temperature can be used. The symbol would glow mild orange when the engine starts moving towards higher temp. and turns red when it reaches very temp. This would also attract the drivers attention unlike conventional gauge where the driver has to keep track of the needle position.

Fig.36: Temperature gauge symbol

Fuel gauge:

Conventional fuel gauge is displayed in form of needle gauge and it conveys qualitative information and the user has to calculate the amount of fuel left from his previous experiences. Also many a times the markings on the gauge are not linear as the gauge gives readout in logarithmic manner and not linear manner. This is due to usage of potentiometer and a float that moves angular manner while fuel level changes linearly (vertically). Hence a fuel gauge needs to show quantitative information, of how many liters of fuel is left. Also readout mentioning how many kms. a vehicle can be driven with existing fuel supply can be helpful, but care needs to be taken to avoid information overload as this value need not be monitored by the user continuously.

Following iterations were done:

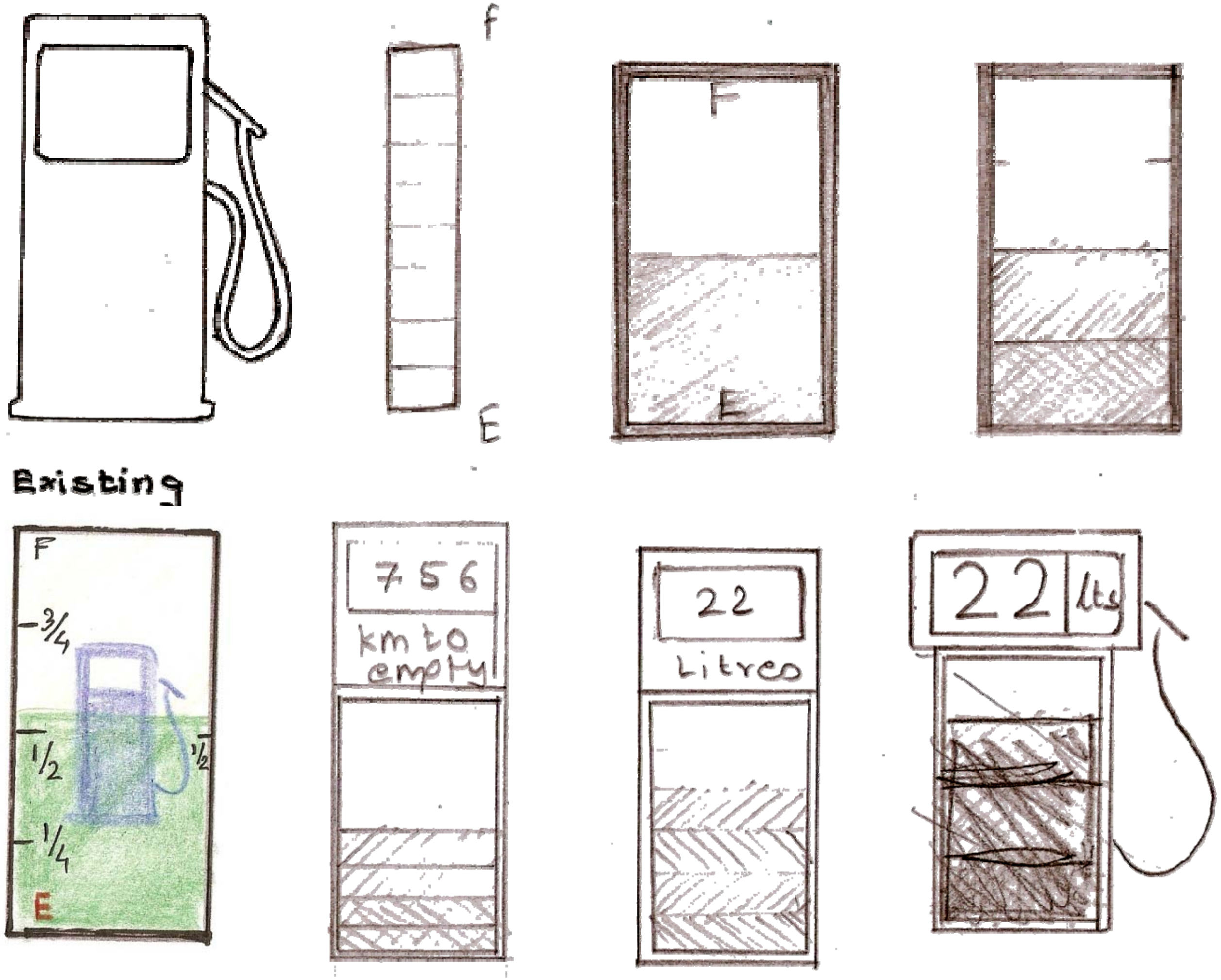


Fig.37: Iteration for fuel gauge

Following was finalised as the idea of displaying the fuel gauge where in the amount of fuel is displayed on user demand.

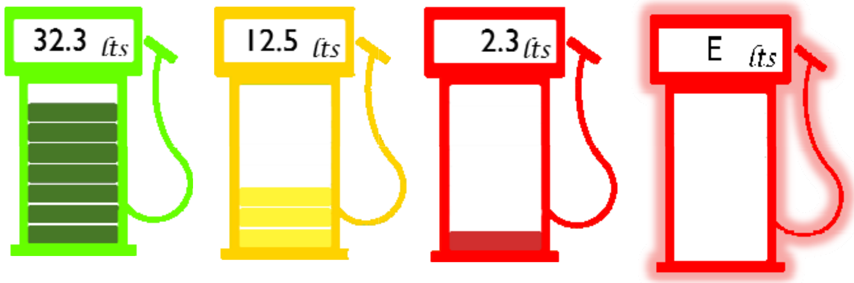


Fig.38: New concept for fuel gauge

7.2.4 Ranking of Gauges:

Ranking of basic gauges was done with a user survey with a sample size of 12. Also the rankings obtained from the first user survey and the user testing were used. Following was the result:

1. Speedometer
2. Fuel gauge
3. Handbrake ON warning
4. Odometer/ Low oil warning
5. Turn indicators
6. Temperature gauge
7. High beam ON
8. Tachometer
9. Trip meter

7.2.5 Layout and Final Concept:

Based on the rankings of gauges and the priority zone marking various layouts were generated. As the guidelines were developed from the user surveys, an iterative process was followed, wherein each design was improved upon in the next design.

The iterations were as follows:

Iteration 1:

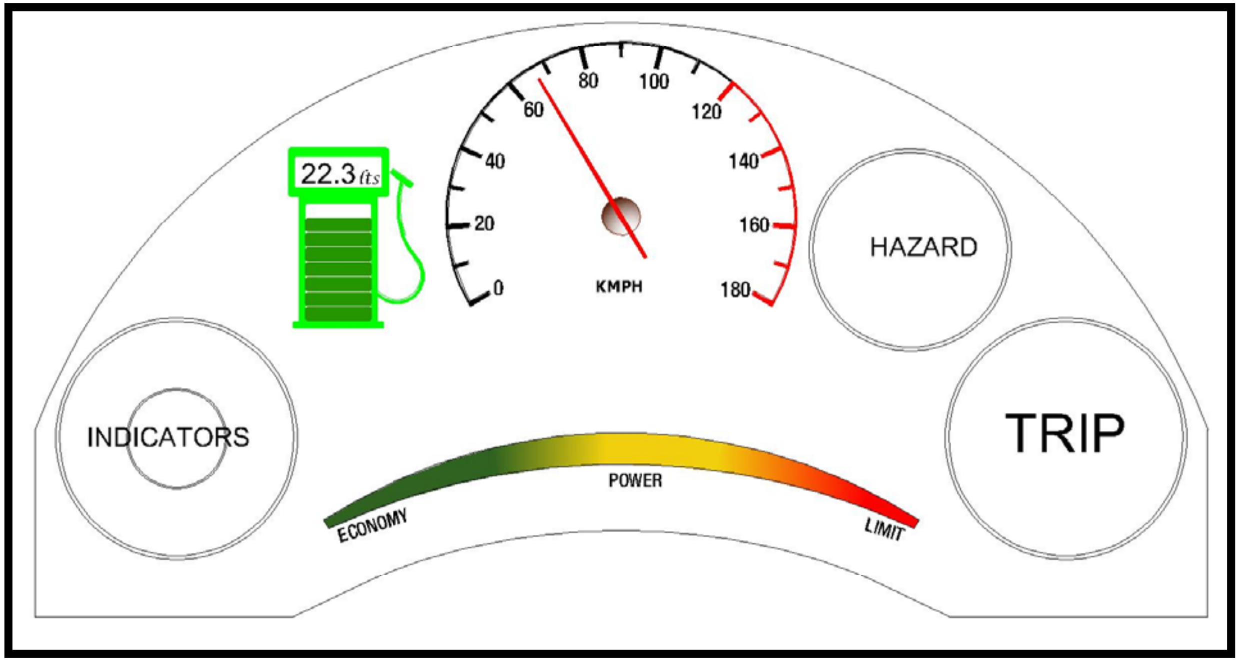


Fig.39: Instrument cluster iteration1

Here the layout was generated exactly as per the findings of the user survey. Although the layout was as per the surveys the fuel gauge was looking more prominent than any other gauge especially when compared to speedometer.

Iteration 2:

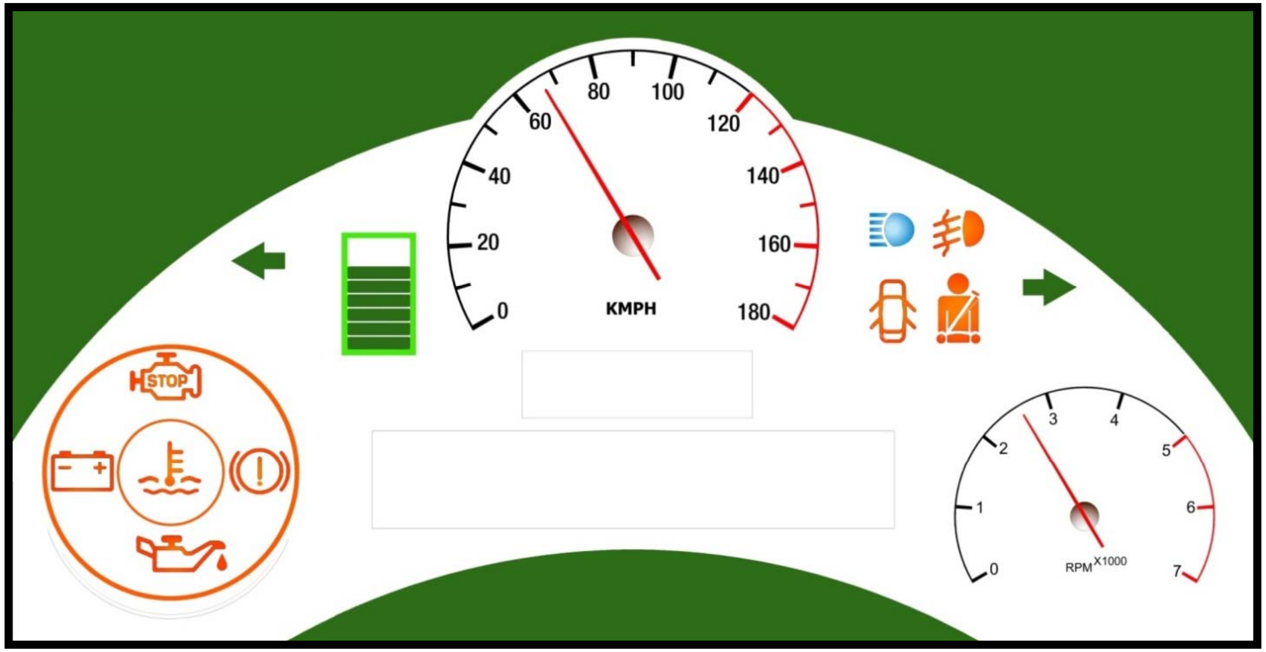


Fig.40: Instrument cluster iteration 2

Fig.41: Warning signals

In order to make the speedometer more prominent than any other gauge or display, a hump was provided at the center of the instrument cluster. Also the conventional tachometer was used to balance the hazard signals on the left. When a car is powered ON conventionally all warning displays lit up indicating their perfect functioning. When these signals are arranged in linearly, if a signal positioned at the end of a row or column doesn't glow it becomes very difficult to detect malfunctioning. When these are arranged in a circle any missing signal when car is powered ON can be identified easily. See fig. 41

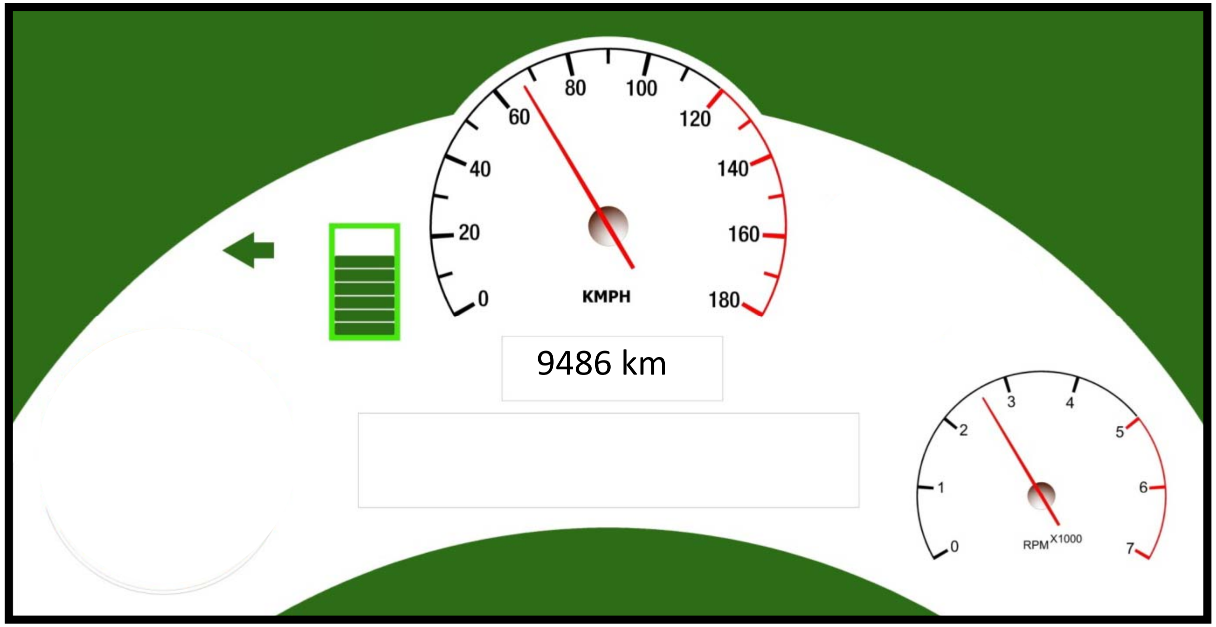


Fig.42: Instrument cluster iteration 2 in normal driving condition

The major problem with this setup was that during normal driving condition, without hazard signals glowing the cluster looked empty, unbalanced and unpleasing to the eye. Hence there was the need to balance the cluster considering the gauges that remain visible during normal driving condition as shown in the figure above.

Iteration 3:

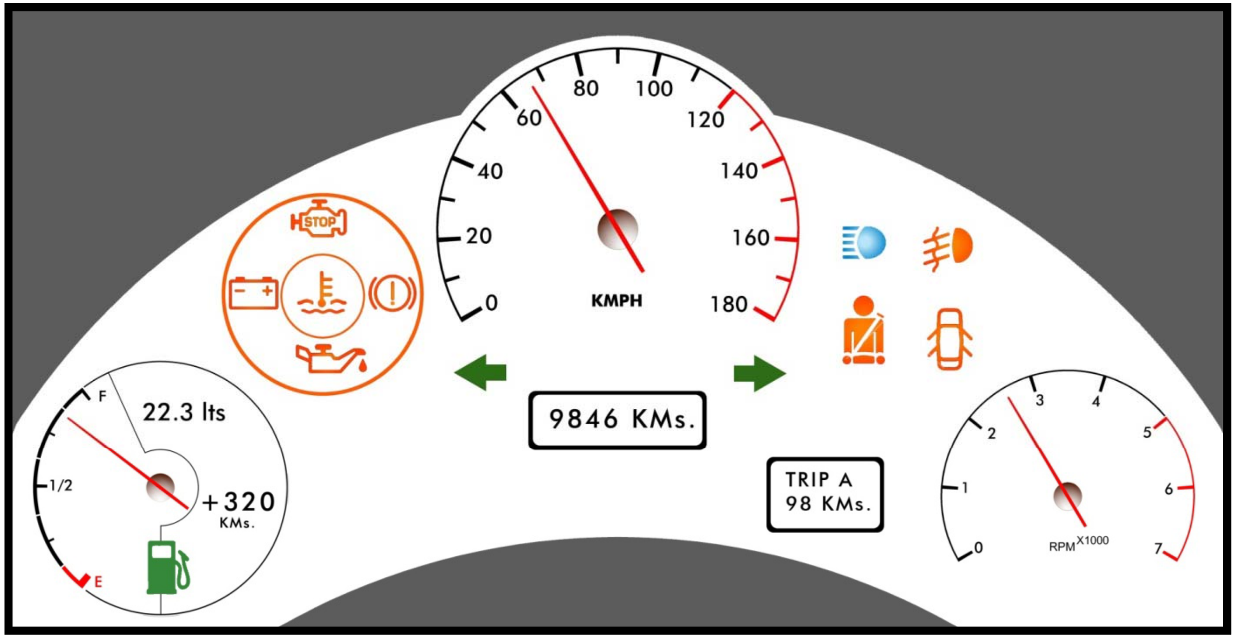


Fig.43: Instrument cluster iteration 3

As shown above the tachometer was balanced with traditional type of fuel gauge displaying quantitative value of fuel in liters as well as distance that can be covered with the available fuel supply.

Also the turn indicators in previous iteration looked disconnected, hence applying gestalt principles (discussed in chap. 2), they were brought closer.

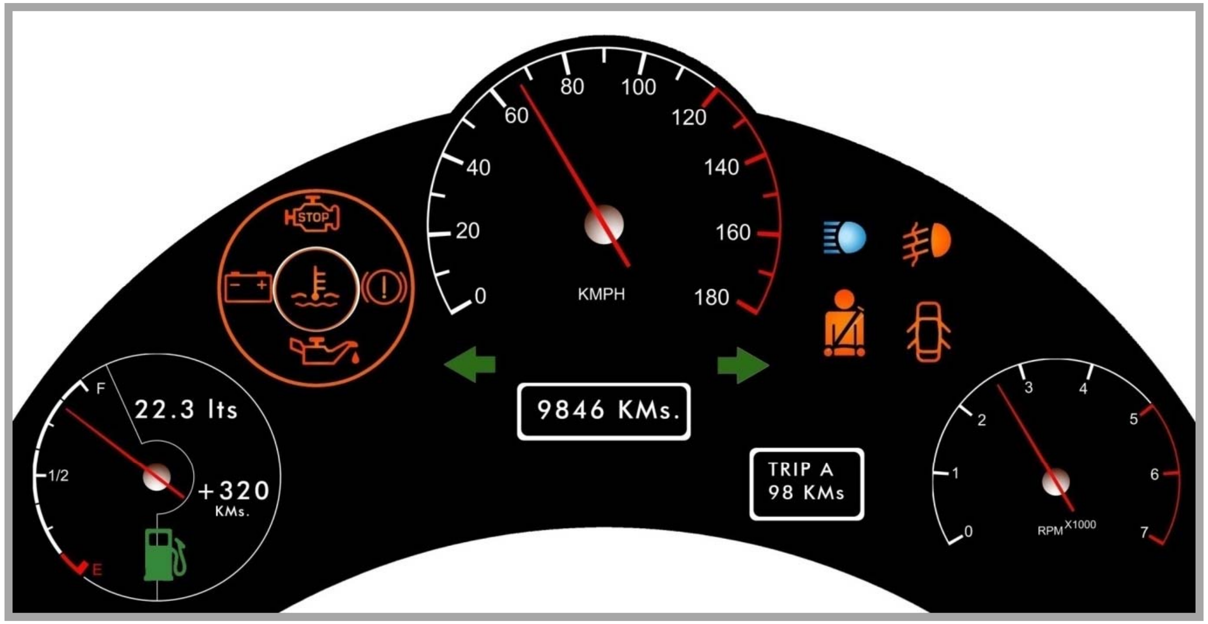


Fig.44: Instrument cluster iteration 3 at night (low light condition)

Cluster would have black background during night driving in order to reduce glare due to emissive properties of the LCD display.

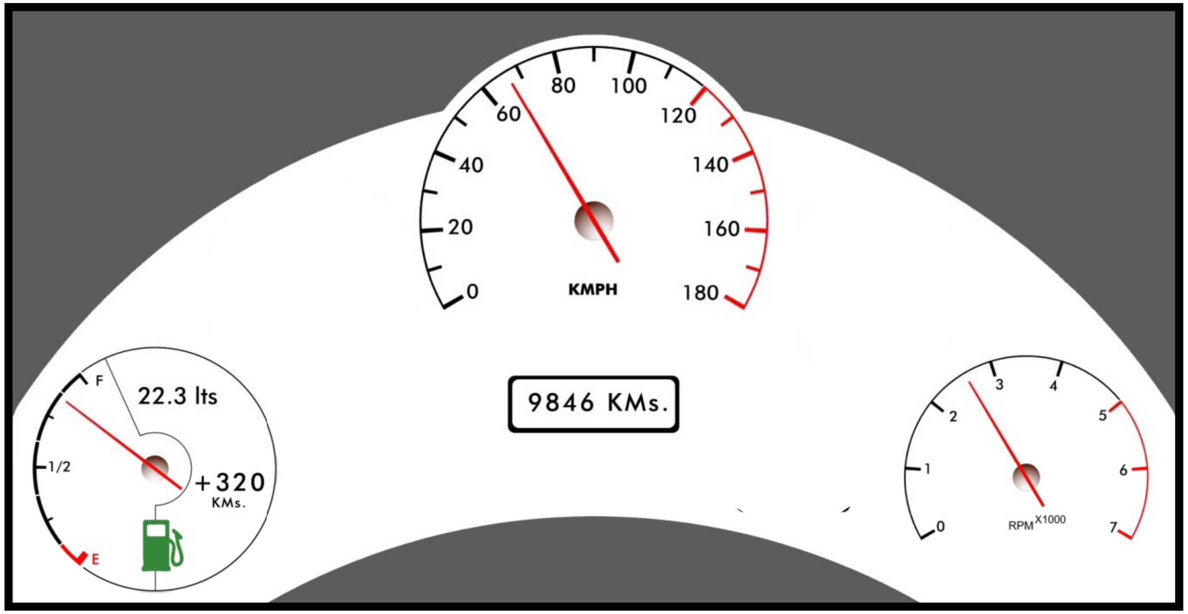


Fig.45: Instrument cluster iteration 3 normal driving condition

Although the problem of balancing was fairly solved, the three gauges looked totally unconnected with the cluster looking very empty in normal driving condition.

Hence there was a need to make a more compact looking cluster, where it looks balanced in normal driving condition as well as doesn't look empty.

Final Concept:

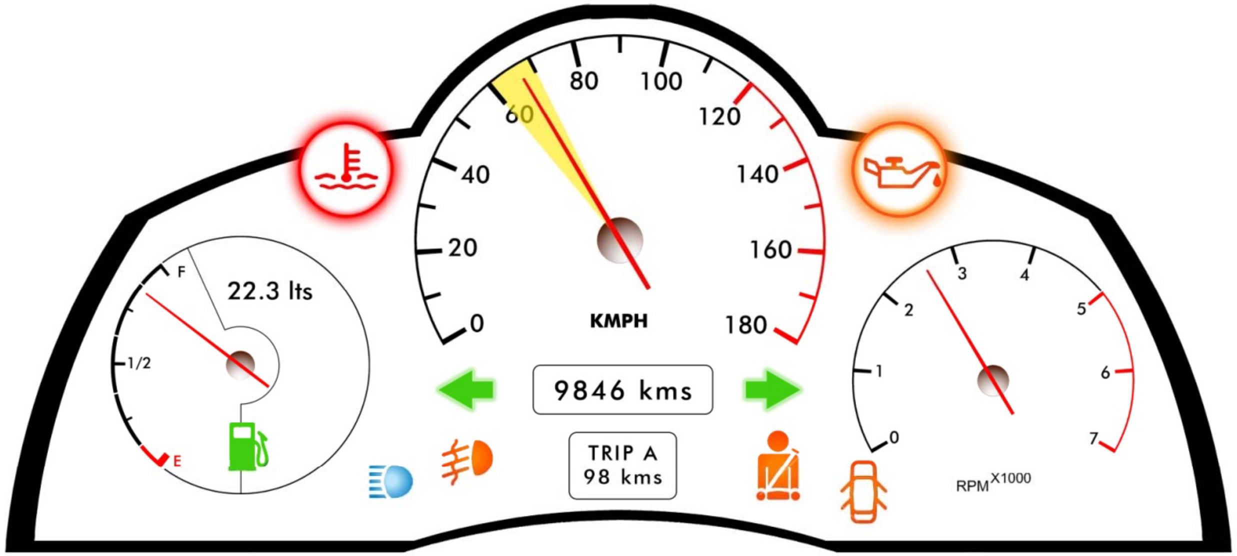
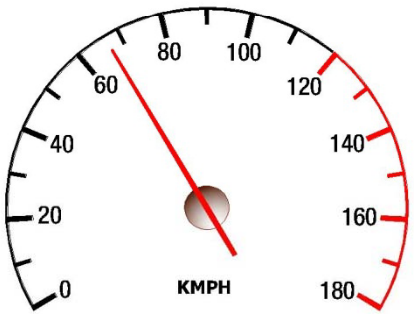
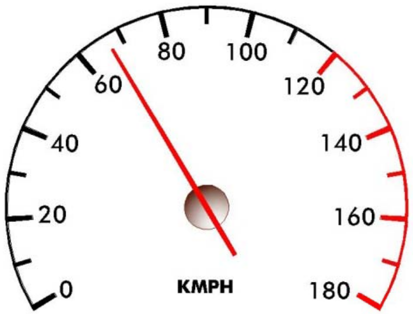


Fig.46: Instrument cluster Final concept



Old using Helvetica font



New using futura font

Fig.47: Use of open typeface

Following was the final layout generated for the instrument cluster, wherein hazard warning would glow on the two sides of the speedometer, and the indicator signals are positioned at the lower part of the cluster.

Also the font used was changed from Helvetica to Futura as Futura has open tails ends unlike Helvetica.

Also an indication for the engagement of reverse gear is indicated.

Following are the various stages for daytime driving condition.

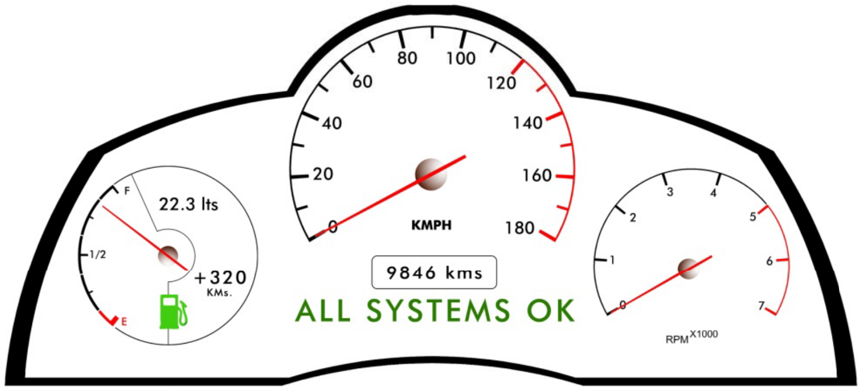


Fig.48: Instrument cluster final concept when the car is powered ON

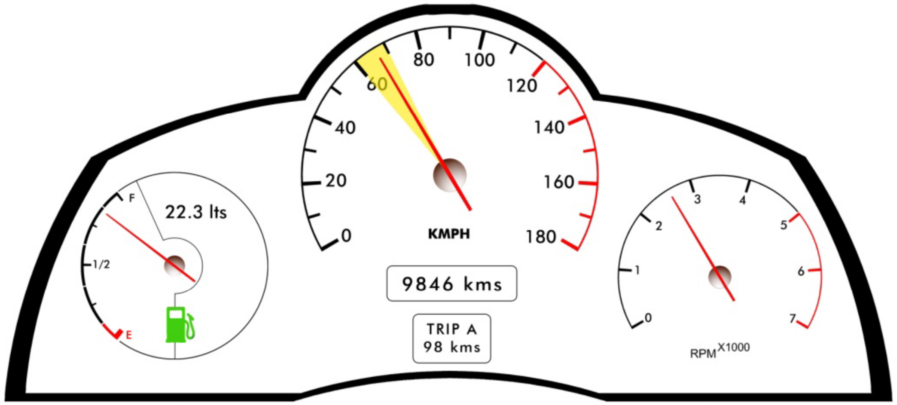


Fig.49: Instrument cluster final concept when the car is normal driving condition

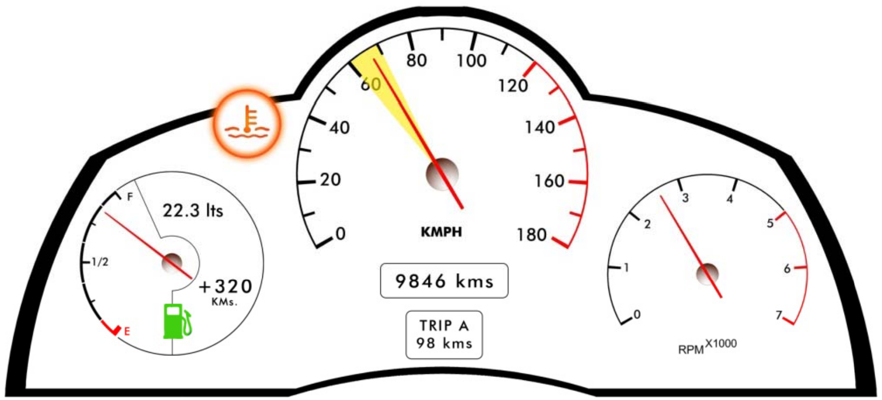


Fig.50: Instrument cluster final concept when the Temperature warning symbol comes ON

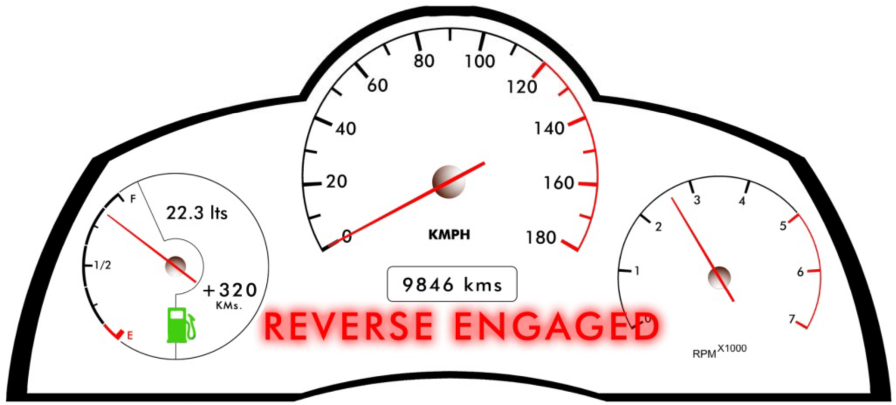


Fig.51: Instrument cluster final concept when the reverse gear is engaged

For night (low light) driving, when the illumination in cabin is low, the best suited colour combination is white with black background. White background in low light condition would be too bright and distracting for the eye. Following is how the cluster would look when in night mode.

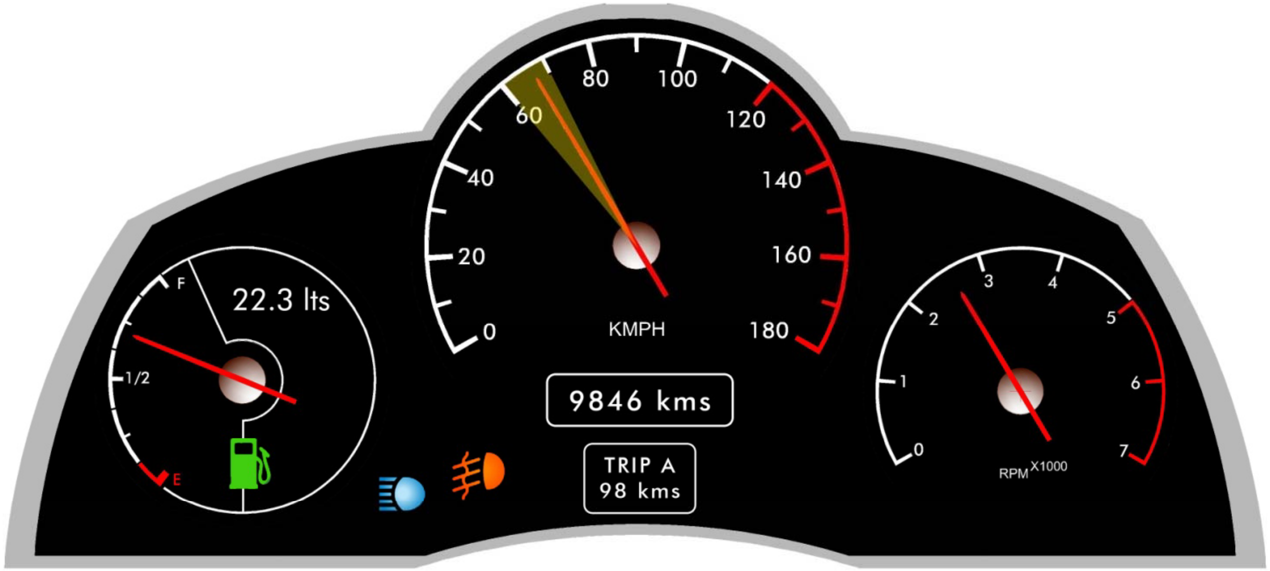


Fig.52: Instrument cluster for night driving

To allow for this kind of flexibility, with the instrument cluster interface, an LCD screen is the most suitable. Also it allows for upgrading the instrument cluster and incorporating new interactive systems. A super-bright sunlight visible LCD display should be use to allow for clear visibility even in bright light condition.

7.3 Steering Wheel:

Steering wheel is the major component at the disposal of the driver for controlling the car. The effective and responsive interaction of the steering system is very important for stress free driving experience.

7.3.1 Components of Steering Wheel:

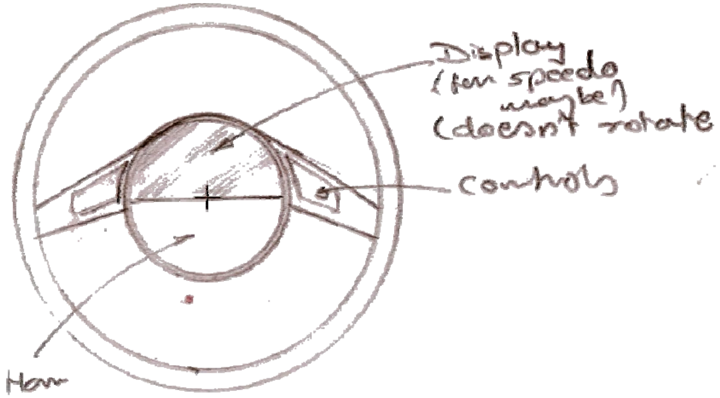
The major controls on the steering wheel are :Horn, turn indicators, Headlamp controls, Wiper controls. Also there are audio controls and fog lamp controls on the steering stock.

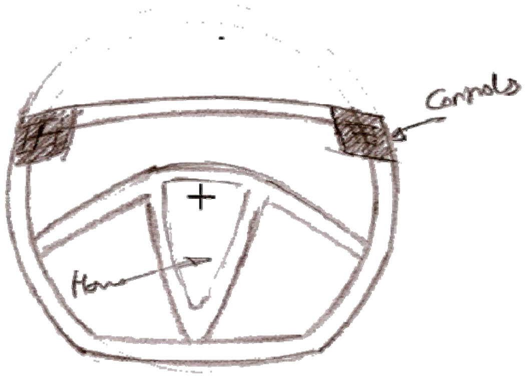
7.3.2 Ideation and Concept Generation:

Multiple ideas were generated based on different kinds of user-steering wheel interaction.

The ideas were then clustered based on the mode of interaction and technology used.

Cluster 1: The ideas with complete steering wheel having rim all-round were grouped together. This allowed for ease usage when the steering wheel has to be rotated multiple number of times while parking. These are more of traditional steering wheels





Display at the center
doesn't rotate.

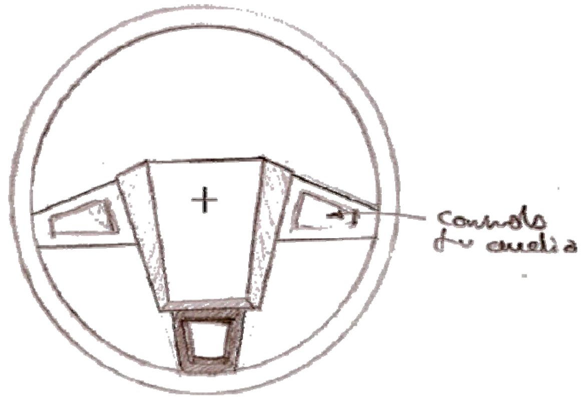


Fig.53: Steering wheel
cluster 1

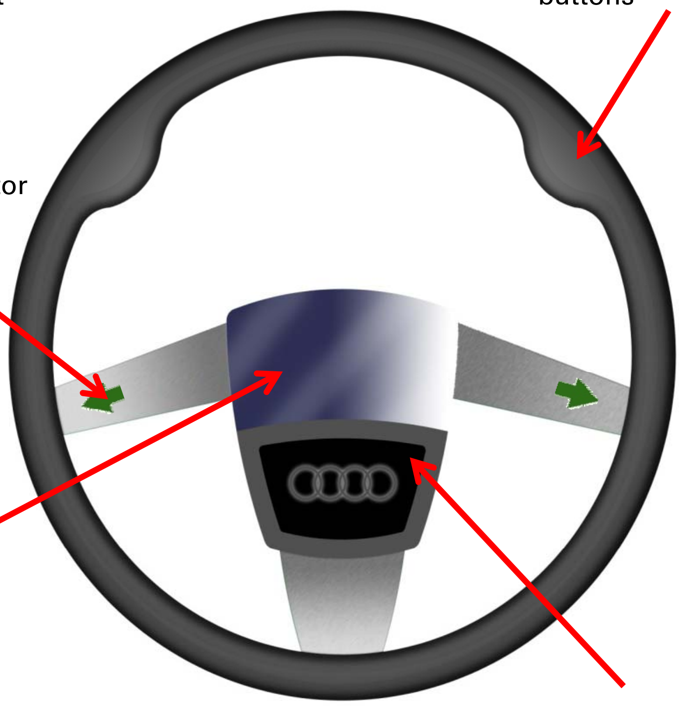


Fig. 54: Steering wheel concept 1

Concept 1:

This concept is more of conventional looking with complete circular rim. It has a touch sensitive display at the center in the upper half. The display is a MFD with basic audio controls that are generally positioned on the steering wheel arms. It also displays audio track playing. The display is controlled using only finger tips and if any larger surface comes in contact like entire palm or thumb, the display acts like a normal horn. The lower part of the center is a conventional horn.

As a result the driver need not worry about where he is pressing when the needs is to sound the horn.

The turn indicator controls are move from the stocks mounted on steering wheel column to the arms.

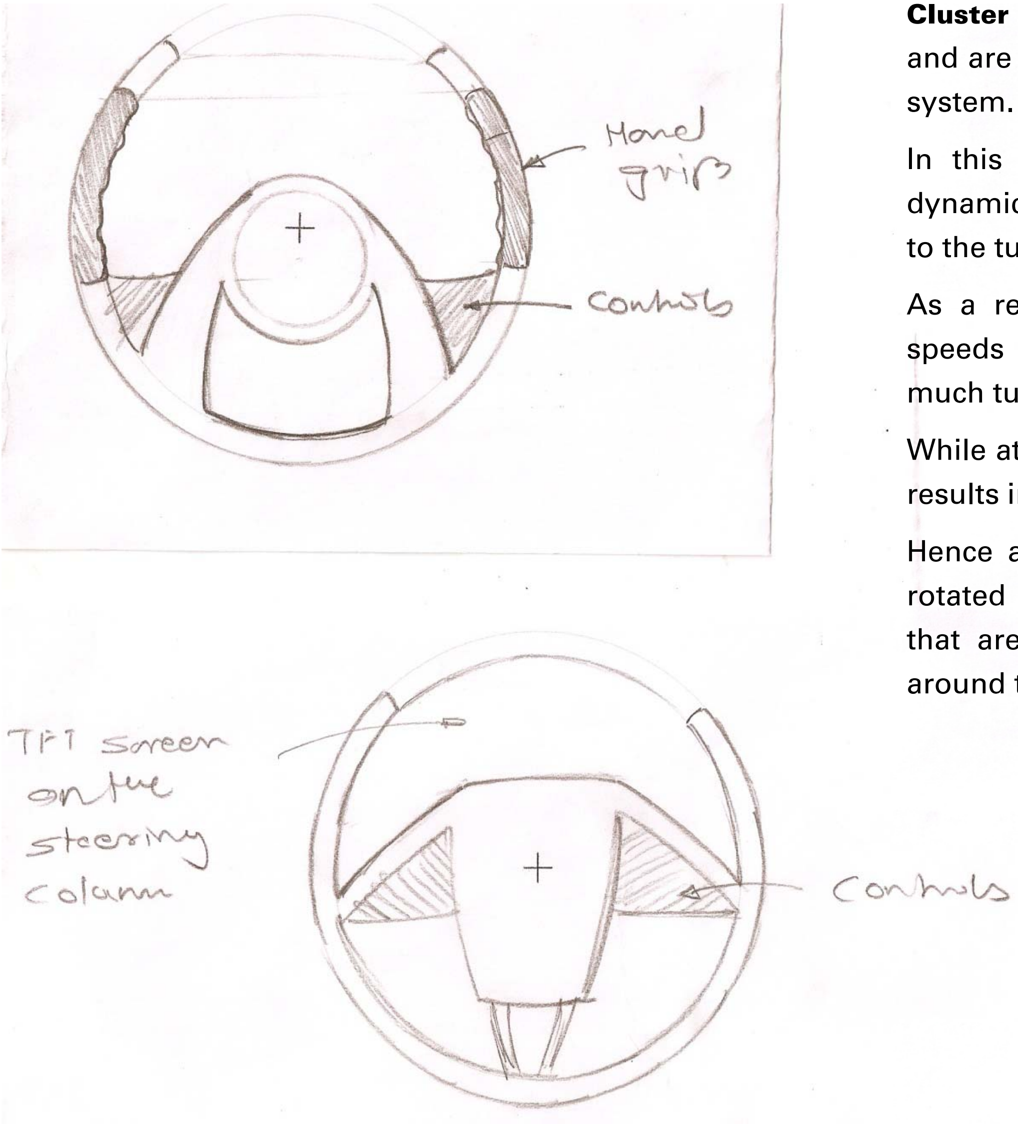


Fig.55: Steering wheel cluster 2(a)

Cluster 2: These ideas have incomplete steering wheel rim and are based on the use of speed sensitive power steering system.

In this kind of steering system a computer in the car dynamically alters the ratio of rotation of the steering wheel to the turning of the vehicle i.e. turning of the tyres.

As a result the steering becomes less sensitive at high speeds and a small rotation of the wheel doesn't cause much turning of the tyres.

While at lower speeds a small turning of the steering wheel results into sharper turning of tyres.

Hence at any given time the steering wheel need not be rotated even complete 360°. This allows steering wheels that are wide but smaller in height making more space around the drivers thighs.

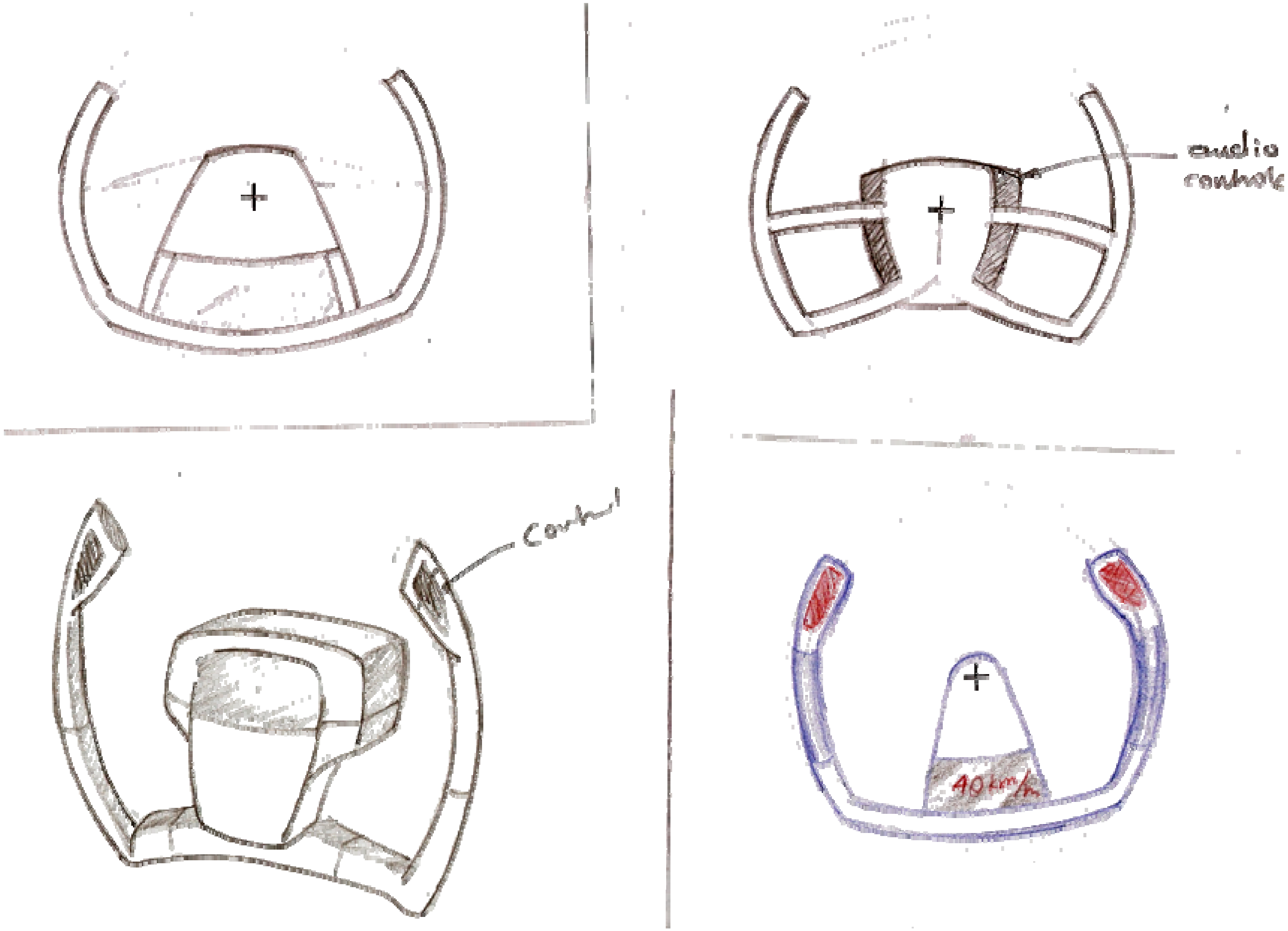


Fig.56: Steering wheel cluster 2(b)

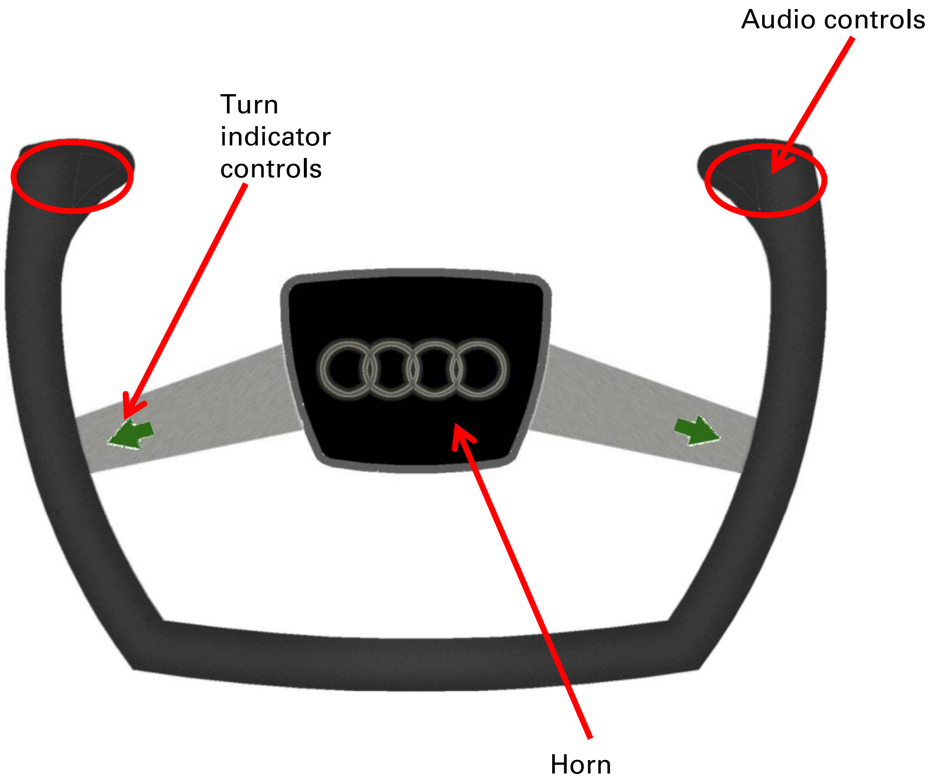


Fig.57: Steering wheel concept 2

Concept 2:

As discussed earlier this concept utilises the freedom acquired due to use of speed sensitive power steering.

Due absence of wheel rim at the top, it provides an unobstructed view of instrument cluster, which is one of the major problems with existing steering wheels.

Also the lower part of rim being horizontal provides more legroom at the tight level.

Cluster 3: This cluster groups relatively radical ideas with very compact steering wheel setup and extendibility. Even these ideas use the concept of speed sensitive power steering.

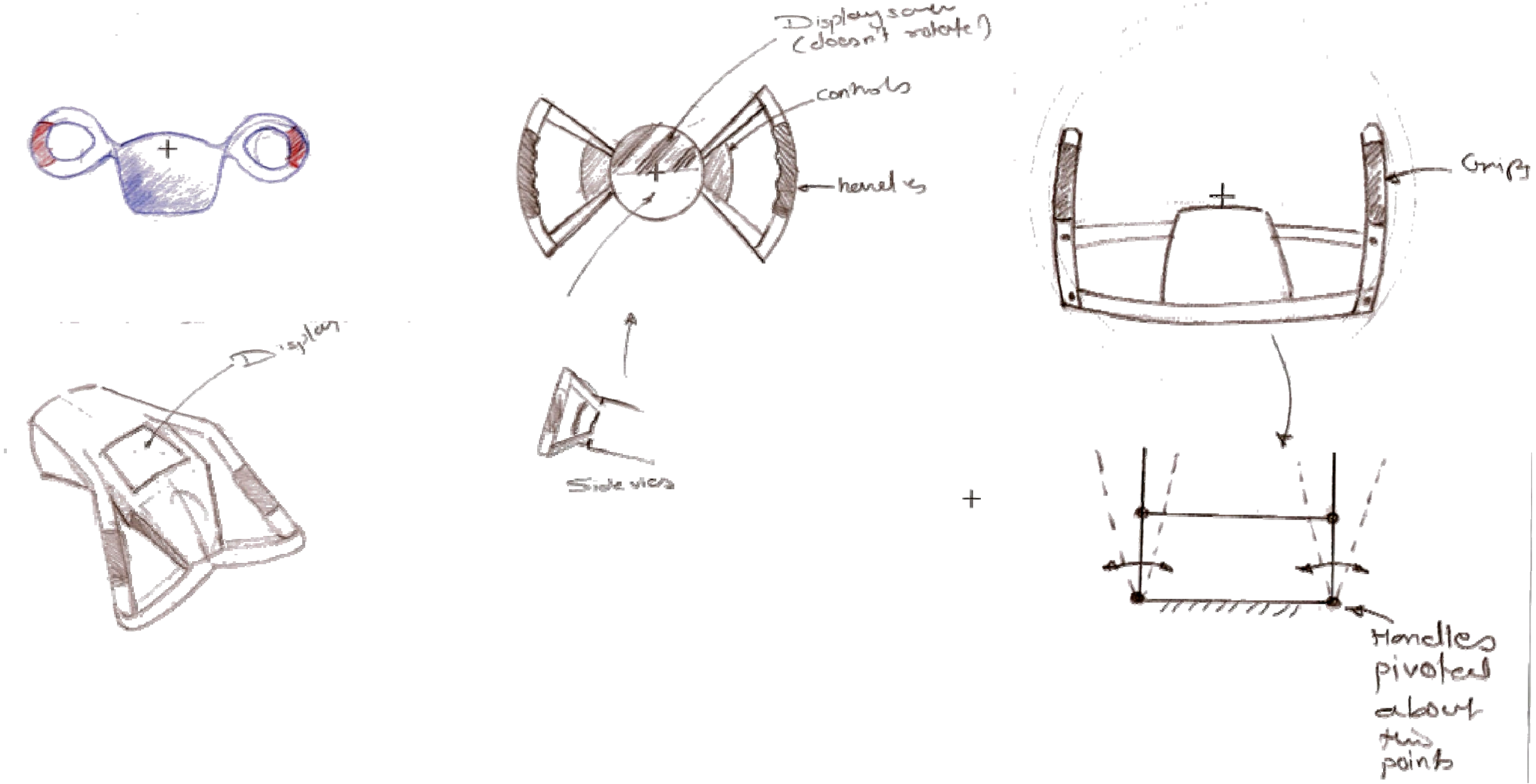


Fig.58: Steering wheel cluster 3

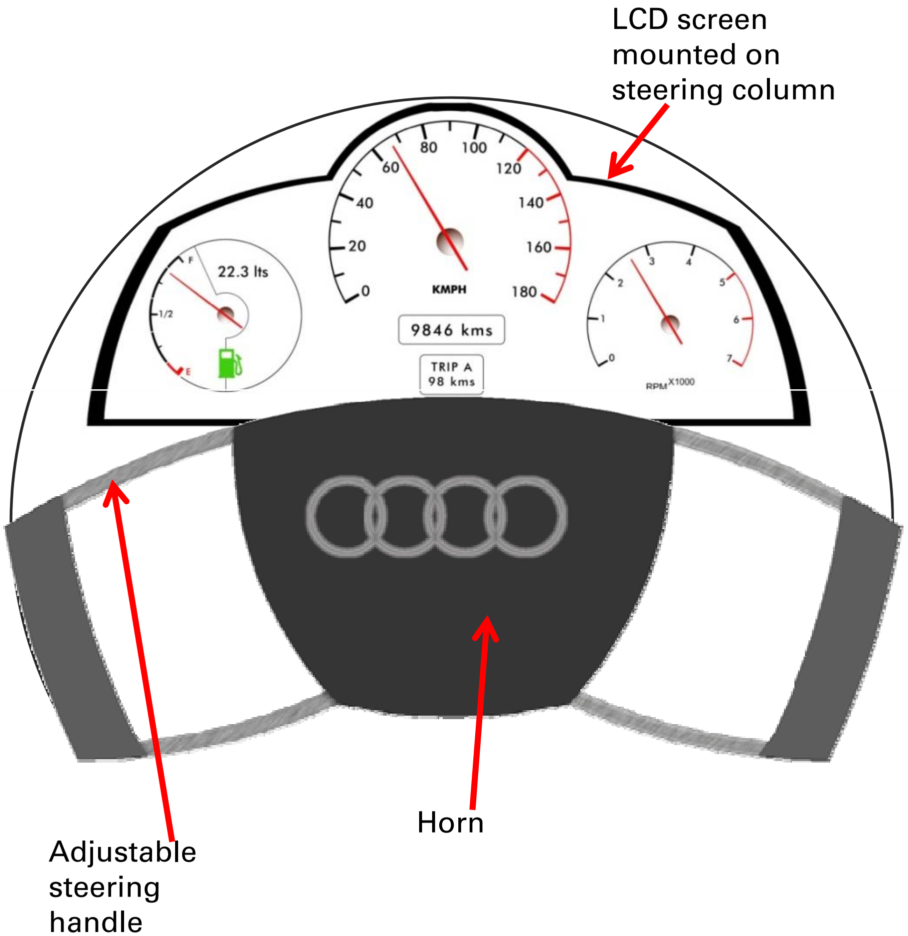


Fig.59: Steering wheel concept 3

Concept 3:

Along with being compact by utilizing the concept of speed sensitive power steering. This concepts also provides with adjustability of the handles.

The two handles retract allowing for larger distance between the handles thereby providing larger diameter steering wheel.

Also a LCD screen is mounted on the steering column, which turns transparent when the engine of the car is switched off, thereby giving the dashboard a clean and pleasant look when the car is in OFF condition.

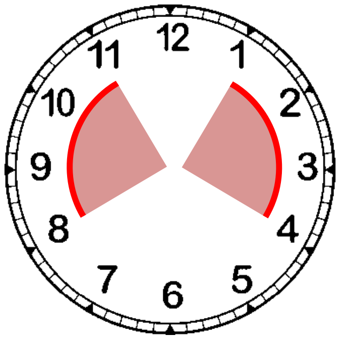


Fig. 60: Region for comfortable grip

7.3.3 Concept Evaluation:

The evaluation criteria is as follows:

- **Comfort due to grip:** The availability of comfortable grip due to the form of the steering wheel is most important. The most ergonomically comfortable position is approx. the range from 1 to 3 and from 11 to 9 corresponding to the dial of clock (see fig. 59).
- **Comfort due to compactness:** Compact steering wheels allow for more legroom around the thigh area and help in easy egress and ingress and hence is the next important criteria.
- **Convenience of controls:** Today the steering wheel has lots of controls on the wheel and the steering column. The mounting of multiple controls on two control stocks on the steering column makes these controls complicated for use.
- **Adjustability of effective wheel dia.:** Adjustability allows usage for people of wider range of stature with comfort. Though this may not be the only solution to the problem.
- **Innovativeness:** An interesting way of interaction and usage can make for a better driving experience.

A self-evaluation of the three concepts for the steering wheel was done using weighted average as follows:

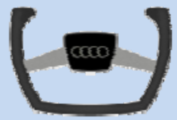
Criteria	Concept 1 	Concept 2 	Concept 3 
Comfort due to grip (5)	10	9	7
Comfort due to compactness (4)	7	10	9
Convenience of controls (3)	7	9	6
Adjustability of effective wheel dia. (2)	0	0	8
Innovativeness (1)	8	6	10
Weighted average	107	**118**	115

Table 3: Steering wheel concept evaluation

7.3.4 Concept Evaluation Analysis:

From the evaluation it is clear that the concept #2 is overall better than the other two concepts.

Though it's the best of all three concepts, it needs to be further optimised for adjustability and comfortable grip. The position of audio controls is the critical positions where it is most convenient to grip the steering wheel. Also it lacks the innovative features like the other two concepts.

Hence further refinements were carried out to enhance the usability of the steering wheel based on the above mentioned aspects.

7.3.5 Concept Refinements:

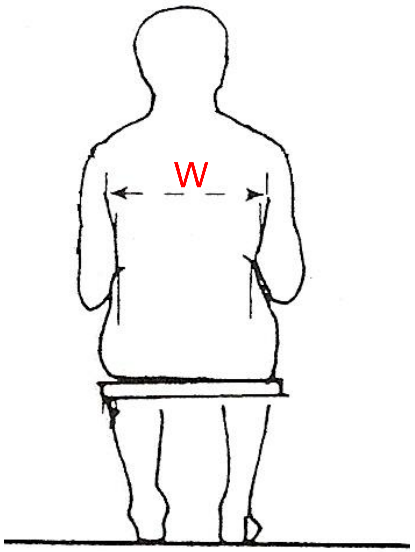


Fig. 61: Chest breadth
(adapted from D. Chakrabarti)

The refinements made to the final concept were as follows:

Comfortable grip: As discussed earlier, the most ergonomically comfortable position or gripping the steering wheel is approx. the range from 1 to 4 and from 11 to 8 corresponding to the dial of clock. Hence there is a need to have the grip for hands in these regions. For this the audio controls need to be shifted. Hence a central touch screen was used similar to the one in concept#1.

Adjustability: Adjustability in itself is not the actual problem. The issue is to accommodate as many people within the ergonomic range of design. The dimension under consideration is the chest breadth at nipple level (refer fig. 60). For Indian population the range for male-female combined from 5th percentile to 95th percentile is 249mm to 354 mm. For adjustability the steering wheel diameter has to vary from 249mm to 354mm, which is 105 mm. It means that the steering arms have to move in and out by over 50 mm on either side. Considering the time constraint of the project, developing the mechanism for adjustability is not feasible.

Hence the problem is solved as follows:

If the wheel has bigger diameter than the chest breadth, the user finds it very uncomfortable than the user with larger chest width than the wheel diameter. Thus, a converging posture of arms is reasonable than the diverging posture. Diverging posture is painful if held for longer duration which is the case in driving. Hence the user group is divided into two groups viz., users with chest width 249mm to 301mm and those with 301mm to 354 mm. Hence the steering wheels will be available in two diameter; 249 mm and 301 mm.

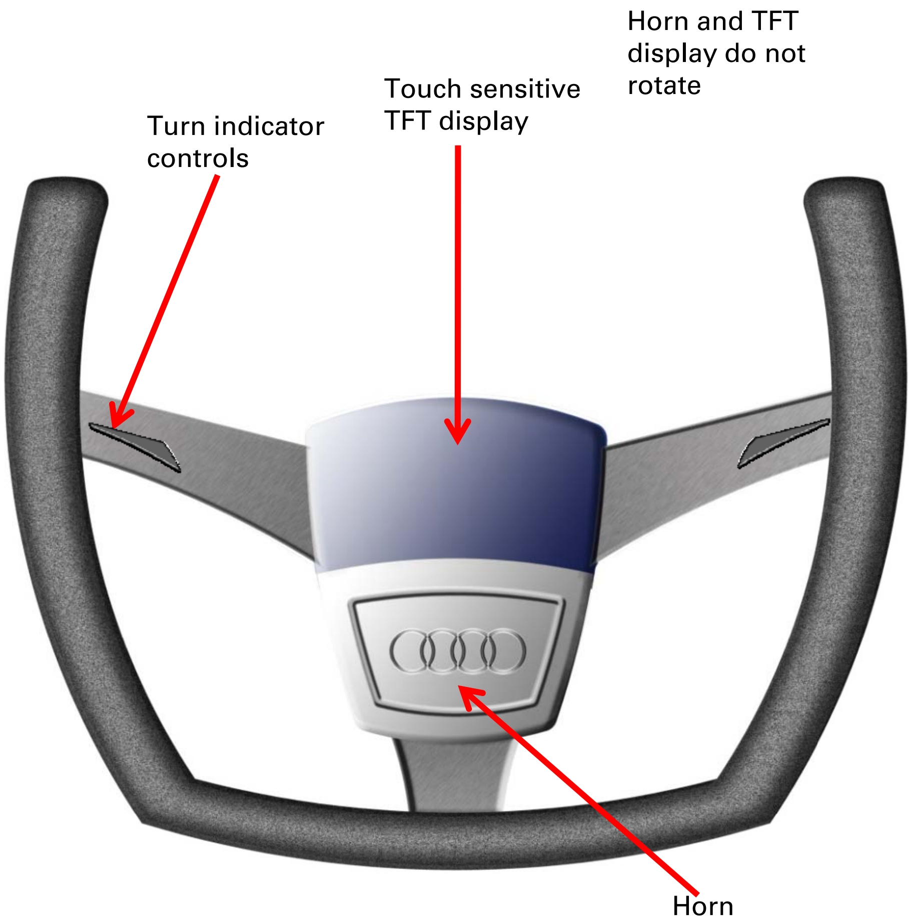


Fig. 62: Steering wheel final concept

7.3.6 Final Concept:

The final concept is a very neat blend of all three concepts. It is based on the concept of speed sensitive power steering.

Features:

Following are the highlighting features of this concept:

- Compact shape provides good legroom around thigh area.
- Comfortable grip
- Thumb operated turning controls
- Available in two sizes, reduces fatigue.
- Touch sensitive audio controls with display.

Description:

It has a touch sensitive display at the center in the upper half which is an MFD with basic audio controls and displays audio track playing. Thus, it also allows for integrating other controls onto the steering wheel. The display is controlled using only finger tips and if any larger surface comes in contact like entire palm or thumb, the display acts like a normal horn. The lower part of the center is a conventional horn.

The thumb operated turn indicator controls allow for stress free driving experience. Also it avoids the confusion created due to placement of turn indicator control stock on either side of the steering wheel depending on the make of the car.

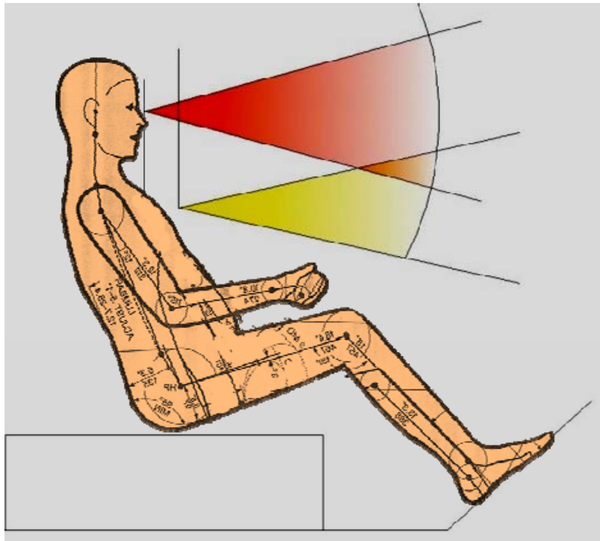


Fig. 63: Viewing angle from side

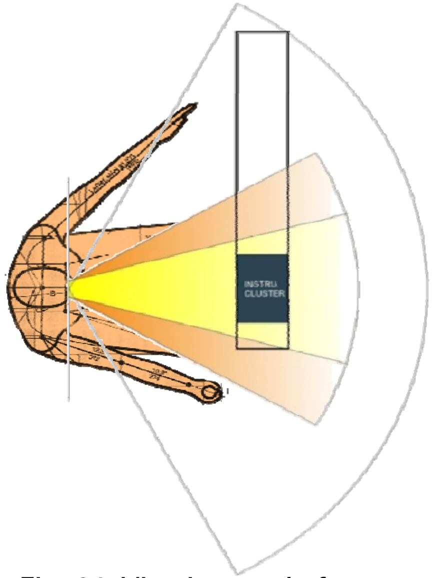


Fig. 64: Viewing angle from top

7.4 Dashboard:

7.4.1 The Dashboard Layout:

The dashboard layout was generated based on the ergonomic requirement of the user range from 5^{th} percentile Indian female to 95^{th} percentile Indian male. 2D mannequins were used as per the guidelines by Henry Dreyfuss, 1993. The dimensions were calculated as follows:

- The figure (refer fig. 62) shows the side view for automobile seating. This view was used to calculate the limiting height of the dashboard, the distance of the dashboard instrument cluster and the viewing angles. Also the lowermost point of dashboard was finalised. The red cone highlights the viewing angle for 95^{th} percentile male and the yellow cone shows the viewing cone for 5^{th} percentile female.
- The top view (fig. 63) was used to finalise the dimension of the instrument cluster and its placement w.r.t. the driver. The central yellow cone shows optimum viewing angle and the outer orange cone shows the acceptable viewing angle. The external most sector shows the viewing angle for binocular angle. Thus the allowable instrument cluster width is 42cm at a height of 70.5 cm from the car floor.

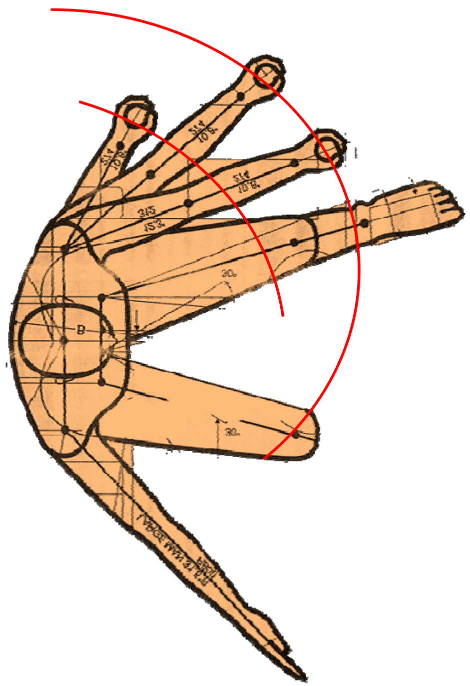


Fig. 65: Arm rotation from top

- The top view was also used to calculate the position of various modules on the dashboard based on the hand movements for both male and female.

Following considerations were made while finalising the layout of the dashboard:

- The air vents have to be away from the top surface of the dashboard, as this is the area that heats up maximum and most of the cooling power is lost due to heating of the top surface.
- The AC controls when set are not altered as frequently as the audio controls, hence the audio controls take higher priority over the AC controls.
- Power outlets should have space to accommodate mobiles and other electronic gadget that needs to be charged.
- There have to be two covered glove boxes to accommodate accessories and other items that a passenger generally carries. Items when kept on the open spaces on dashboard tend to slip while driving.
- The Multi-Media Interface(MMI) occupies the top position, as it used for navigation and interacting with the subsystems which are not of critical nature.

The final dashboard layout is as follows:

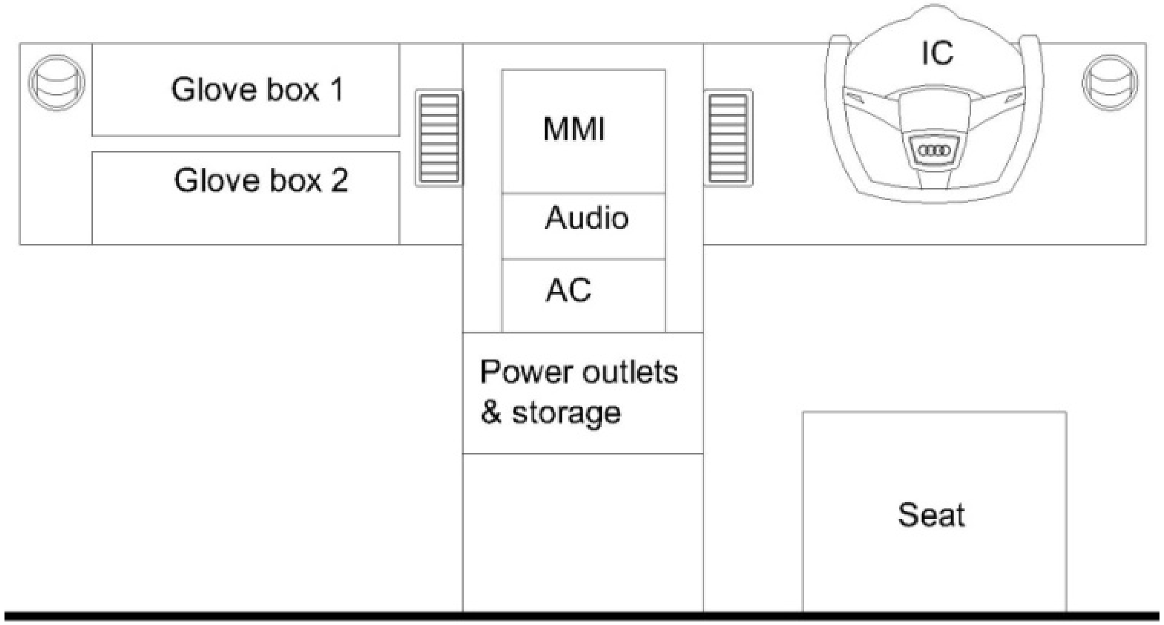


Fig. 66: Basic dashboard layout (Note: IC= Instrument Cluster)

Fig. 67: Area of work for basic expression of dashboard

7.4.2 The Basic Form:

As the project doesn't address the aesthetic issues of the dashboard a thorough ideation for form was not done. But in order to understand the functional aspects that arise due to form of the dashboard basic ideation for the expression was done.

The area selected for generating and selecting the basic expression of the dashboard for the final form is as shown in fig. 66.

This ideation was done to fine tune the, placement of various modules and sub-systems. Also the effect of colour was arrived upon using this ideation.

Following were the ideas generated:

Fig. 68: Ideation for basic dashboard expression

Fig. 69: Ideation for basic dashboard expression

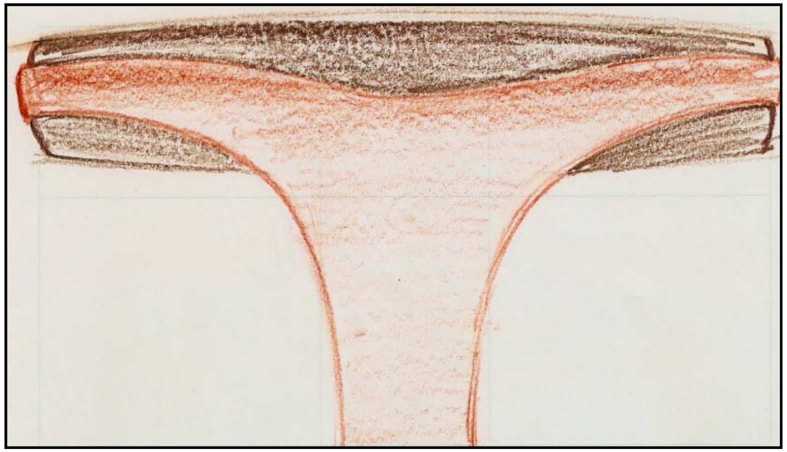


Fig. 70: Selected expression 1
Votes: 9

Fig. 71: Selected expression 2
Votes: 8

User rating:

Users were asked to select best expression for a dashboard from the above 15 ideas. After an user survey of 17 people the ideas shown alongside got the maximum votes.

Hence it was decided to have a final expression that is combination of the two ideas.

Following was selected as the basic element for the expression representing wings:

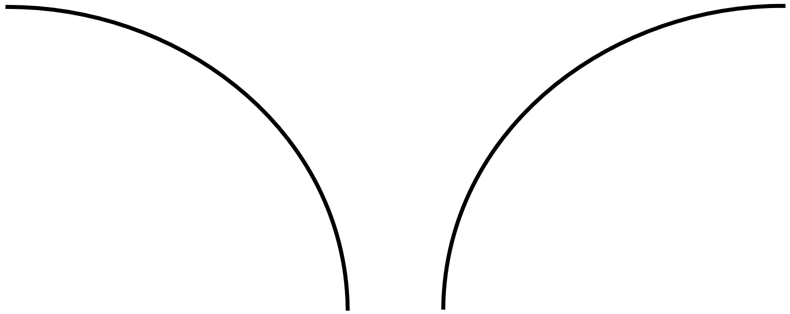


Fig. 72: Basic element in the expression

Fig. 73: Basic form for the dashboard with the various sub-systems

Final form:

The final form for the dashboard using the two expressions is as shown. Also the details from the dashboard layout were added to understand the effect of other components on the expression. Few more details were added. The top center of the dashboard is plane and allows for placement of and idol of lord which is a common practise all over India.

Effect of colour:

The dashboard is two toned dashboard coloured in three stages as shown. The top colour should be of darker shade as it gets reflected in the front windshield during daytime if of lighter shade. Also the colour should not be very vibrant colour so as to prevent any distraction while driving. The colour scheme is done in three stages so as to bring out the effect of wings.

Also grey is best suited as the colour for dashboard for following reasons:

- It is not a very vibrant colour and blends with surroundings well. Hence does not attract too much attention.
- The CLO value of grey is 1 which means, its best for disallowing any exchange of heat from dashboard to surroundings.

Fig. 74: Basic form for the dashboard in 3D modeling software

3D CAD model:

A 3D CAD model was made to understand the blending of various surfaces. Also the 3D CAD model allowed to experiment with colours and check the grey colour scheme for the dashboard. This model was further used to make the final actual model.

8. Final Design:

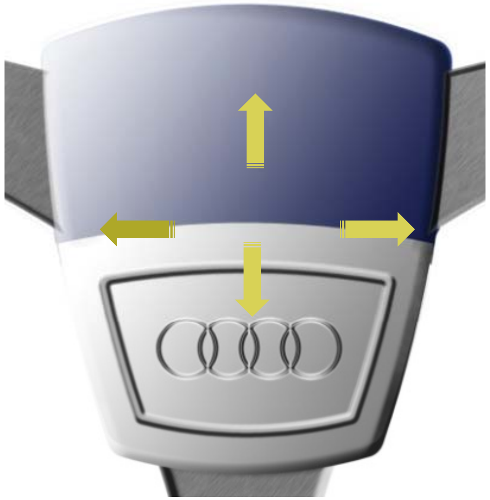


Fig. 75: Gesture audio controls

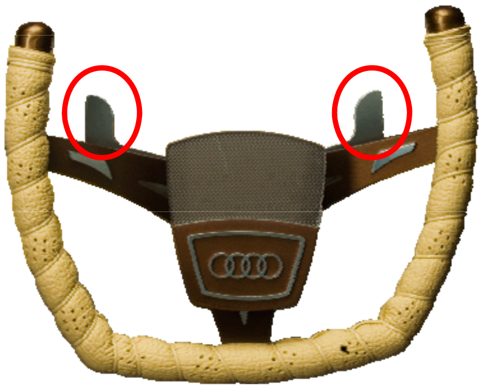


Fig. 76: Paddle shift gear controls

Various refinements were made during the final phase of model making. The full-scale model helped to understand various aspects related to the usability and dimensional ergonomics of the dashboard. Also refinements were made to aesthetics and form.

8.1 Steering Wheel:

8.1.1 Display:

The touch sensitive display would have gesture controls and the details like audio tracks can be displayed only when the display is touched with finger tips and will turn automatically after predetermined time interval. The gestures will control the basic operations. Up-down gesture would increase or decrease the volume and left-right would skip to previous or next track (refer fig. 75). This would totally eliminate the need for reaching out to specific buttons as the entire touch screen will be available for the controls.

8.1.2 Controls:

An automatic gearbox is good and relieves some amount of stress induced due to constant gear changes especially in city driving conditions. But an automatic gearbox can be uncomfortable as it lowers the acceleration of the vehicle while on highway driving. Also an automatic gearbox takes away the fun of driving. Hence a semi-automatic gearbox should be used. The gear change controls should be available on the steering wheel itself in form of paddle shifts, to shift to a lower or higher gear (refer fig. 76)

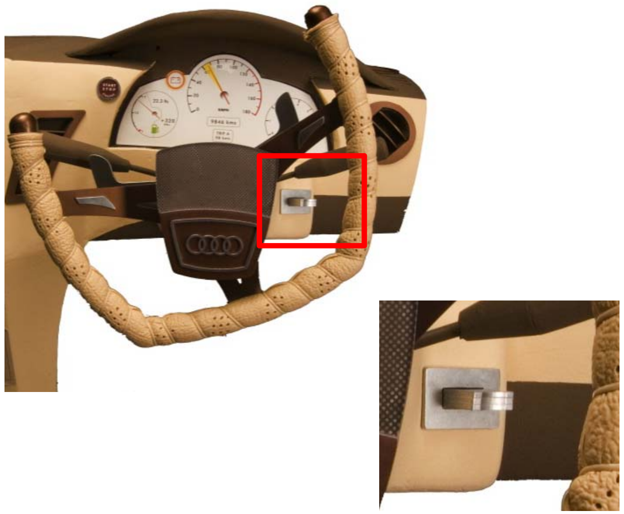


Fig. 77: Smart key

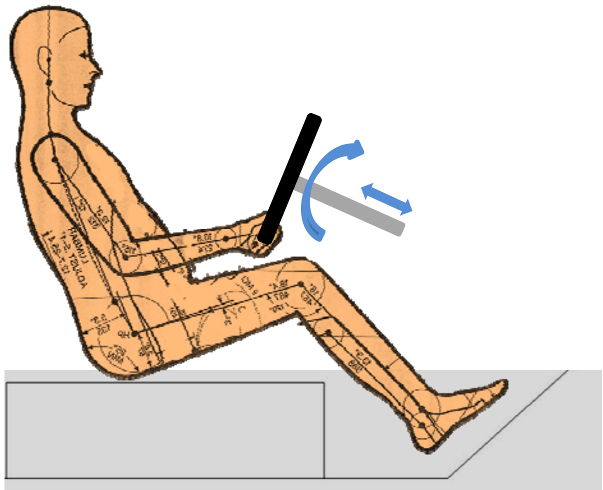


Fig. 78: Adjustability

8.1.3 Ignition key:

The ignition which is generally mounted on steering column faces the window and barely visible to the driver. Here a smart key is used. The key slot is bigger and faces the driver, making it easy to insert the key (refer fig. 77).

8.1.4 Adjustability:

The steering wheel is adjustable for reach and rake (refer fig. 78). The steering column is adjustable for 12.5° on either side of the center position which is at 35° to the horizontal.

The steering wheel is also adjustable for reach and moves within a range of 15 – 30 cm from the dashboard vertical surface.

8.2 Final model photographs:

Fig. 78: Complete dashboard

Fig. 79: Steering wheel close-up

Fig. 80: Steering wheel and Instrument Cluster

Fig. 81: God idol on dashboard

9. Conclusion:

9.1 Challenges and Limitations:

Time was the major challenge in the project and was the single most criteria that decided the scope and approach towards the project. As the design is for tomorrow and not future, the scope was limited to usage of technologies that exist today and can be easily implemented. The technologies used may not be used in automotive sector but are emerging out as new technologies and are best suited to be implemented to enhance the design.

Being a student project it restricted access to virtual simulation used in this industry internationally, limiting the evaluation of the design in actual environment.

The anthropometric calculations as based on the data available from the book Indian Anthropometric Dimensions which lists dimensions with very limited database.

Also the time frame of the project prevented from validating the design from aesthetics and manufacturability point of view.

9.2 Future Scope:

The design is based on the user-vehicle interaction that exists today. There is a need to further simply the interaction by reworking the symbols used in the communication. In future the design needs to be validated using simulation technique, thereby understanding the user responses to the new design.

The current design uses two sets of steering wheels to solve the problem arising due variation in human chest breadth. Work needs to be done to allow adjustability of the steering wheel dimension.

9.3 Learning:

This project has exposed me to a completely new world of ergonomics. It has introduced me to the field of visual ergonomics. It has enriched my knowledge about the cognitive level of thinking that happens while driving a vehicle.

It has exposed me to the world of user survey and user study as tool to understand users and pin point the design insights from it.

Thus, overall the project has been challenging as well as rewarding and has made be believe that design is a process and not just the end-result.

Appendix A:

User Survey #1 questionnaire:

1. How many times do you make trips outside your city driving yourself in a year? How much distance generally, do you cover in such trips?
2. How much highway driving do you do on an average in a year (or on daily basis)?
3. What are the various gauges, signals and controls in your vehicle?
4. Which of these gauges do you use regularly & how?
5. Can you rank them according to their importance based on some criteria? Please mention the criteria.
6. Which are the gauges you don’t use or don’t need?
7. Do you think that you need some more gauges or signals? Have you seen something similar in any other car?
8. Do you think the position of the controls on the steering wheel is appropriate?
9. What about the position of the placement of the turn indicator lever? Where do you prefer it to be?
10. Would you like to move any controls or gauges from steering wheel to the dashboard or vice versa? And where?
11. Where do you prefer the position of the ignition key to be?
12. What should be the composition and the position of the instrument cluster (cluster that is generally in front of the steering wheel)?
13. What about the colour of illumination of the instrument cluster? Specify the one you prefer?

User Survey #1 questionnaire contd.

14. Are you satisfied with your current dashboard with respect to:
    Colour-
    Shape/ form-
    Utility value-
    Feel & quality-
    Clean ability-
15. How would you want your glove box to be? Are there any problems with the glove box existing in your car?
16. Anything else that you like (OR) don't like (OR) need in your car? Does it exist in any other car?
17. Anything else that you liked (OR) didn't like about any other car (which you currently don't drive)?

General Information:
Name:
Age:
Current Vehicle used (with model number and year of manufacture| specify f you drive multiple vehicles regularly):
Daily distance covered:

Appendix B

Signals & symbols used in the design analysis for the instrument cluster:


Low oil pressure.

Engine stalled.


Low battery charge.


Engine overheated.


Parking brake engaged


Turn indicator flashing


Seat belt not worn


Door open

Anti-Lock Braking System not working


Head lamp in deeper mode


Fog lamp ON


Air bag malfunction

Appendix C

Glossary:

Speedometer: A gauge showing the speed of the car.

Odometer: A gauge showing total distance covered by the vehicle.

Tachometer: A gauge showing the rounds per minute (rpm) of the engine.

Fuel gauge: A gauge showing the amount of fuel left in the fuel tank.

Trip meter: A counter display giving the reading of distance covered since it the meter was tripped (adjusted to zero)

Temperature gauge: A gauge showing the engine temperature.

CLO Value: A unit of thermal insulation used for clothing. One clo is intended to represent the insulation required to keep a resting person warm in an indoor room at 70 °F (21.1°C). The rate of a person's heat loss is measured in watts per square meter of skin area per kelvin of temperature difference across the clothing; the value of insulation is measured by the reciprocal of this rate, in square meter kelvins per watt (m^2K/W). One clo is equal to 0.155 m^2K/W or 1.550 togs. (source: http://www.unc.edu)

Appendix D

Abbreviations used:

- HMI – Human Machine Interface
- MS –Maruti Suzuki
- Kms- kilometers
- KMPH- kilometer per hour
- Rpm –rounds per minute
- Mm- millimeter
- IC- Instrument Cluster
- HWWE- Humanizing Work and Work Environment

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