Contents

1 Acknowledgement

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Last, but not the least, I thank my family and friends for their love and co-operation at every step.

2 Background of project and Institute Profile

Our team from Industrial Design Centre comprising of Edu Mohan(myself), Jaison Jacob, Naveed Ahmed and Sourabh Pateriya was selected for a student exchange program on the basis of the resume submitted at the Institute of Ergonomics (IAD), Technical University of Darmstadt, Germany.

IAD specializes and carries out continuous research in the field of ergonomics with focus on vehicle ergonomics, work organization and production ergonomics.

During the 6-week exchange programme, the team worked on various workshops and one major project. While the project was three weeks long, the workshops usually were as short as two or three days. The participation of the students varied depending upon the workshop and the project. I worked on a project in close collaboration with Joachim Röttger, a bachelor student in mechanical engineering while the team of interaction designers worked on a separate project.

The content in this report is structured and divided based on the projects and workshops done. They have been ordered according to the duration and amount of work done during each assignment.

3 Structure of IaD and Mangement

TU DARMSTADT has many disciplines such as Electrical Engineering, Mechanical Engineering, Architecture, etc, etc

- Each of these disciplines are called faculties (Fachbereich in German (FB))
- Example: Faculty of Mechanical Engineering

Every faculty in turn has many “sub faculties” (Fachgebiet in German)

- Example: Faculty of Mechanical Engineering has many “sub facultlies” such as Production Engineering, Automobile Engineering, Ergonomics, etc
- Each of the sub faculty is headed by a Professor with full control and independent charge of the sub faculty

The Institute for Ergonomics (Institut für Arbeitswissenschaft (IAD)) is a sub faculty in the Faculty of Mechanical Engineering and is headed by Prof. Ralph Bruder

IAD headed by Prof. R. Bruder has 4 principle areas of research i.e., 4 research groups

- Vehicle Ergonomics – headed by Dr. B. Abendroth
- Production Ergonomics – headed by Dr. K. Schaub
- Work Design and Work Organization – headed by Dr. R. Helbig / Dr. C. Koenig
- Product Ergonomics – headed by Dr. M. Kauer

IAD has in total 38 staff members, off which 28 Scientific staff. Every member of the scientific staff belongs to one of the research groups mentioned above. All staff members typically work on Government funded or Industry funded projects. Project work is in additional to University work i.e., Teaching Assistantship, Supervising of Masters and Bachelor Thesis, etc. There are around 15 PhD students at IAD and 6 External from the industry. All the PhD students at IAD report to their Research Group Leader for everyday project work and Prof. Bruder for his/her PhD. Their PhD is over and above their external project work and University work. Mostly the PhD topic will be closely related to the external project they are working on. In addition to it there are 10 Administrative and Technical staff.

4. Design Recommendations for Proreta

Figure A : at Griesheim test field

Proreta is a driver-assistance system for cars that aims at reducing road accidents by minimizing driver errors during high-speed travel. As part of the system, the driver has an additional option for steering the car using Proreta, other than the steering wheel. As part of the assignment, the team worked on ideating various input methods and feedback mechanisms for steering the car. The team consisted of interaction and product designers who worked with the existing Proreta team to come up with recommendations.

Below are the various options that were discussed during the ideation process. In the current context, a 'turn' would primarily mean a lane change. Proreta is project currently in progress at the Institut für Arbeitswissenschaft (IAD), Technische Universität Darmstadt, Germany. The project is owned by Dipl.-Ing. Matthias Pfromm.

Input Methods: Hand Gestures

Touch gesture tracking pads behind the steering wheel on the periphery and relatively smaller ones in the front can be used as input mechanisms. The track pad at the back would be used for 90 degree turns while the ones in the front would be for lane change.

A counter-clock-wise movement of the hand on the larger track pad would indicate a left turn and vice-versa. The smaller track pad would mainly be used by the thumb and for lane changes.

Figure B : Input methods

Indicator Lever

The indicator lever is a default control that is used by the drivers while taking any kind of turn. In the driver-assistance mode, the indicator lever can act as an input mechanism to imply lane change or a turn. The car would then make a turn depending upon its location and environment. Using this method, the car retains standard controls and the driver need not necessarily learn new ways of providing input.

Buttons

Exploiting the current trend of alternative controls, buttons can be provided on the steering wheel that can be used indicate a turn. These would be simple push buttons that would require only a single press to give input to the system. As these will be at the nearest accessible region on the steering wheel, the driver can comfortably and easily provide input with minimum physical effort. The buttons can be designed to be intuitive and can also contain feedback.

Feedback Mechanisms


Figure C : A/V feedback


Figure D : LED Strip


Figure E : Haptic Feedback

Audio/Visual

Audio-based feedback can be given to the driver about the direction of turn. It can be a direct voice communication or a tone depicting the direction. Information can be shown visually in the main visual unit on the dashboard too. The instrument panel in-front of the steering wheel can display the direction of turn through visual cues and graphic elements. Audio feedback is a common feature in cars and using it in current scenario would make Proreta a more integrated system.

Using the LED strip

The LED strip on the dashboard which is currently used for proximity warning can also be used for showing the direction of turn. Controlled and moving patterns can be created through the LED strip to show the direction, intensity and degree of turn that would be made. Other than this, the colour of the LED can be used for ambient lighting inside the car to control the mood of the driver. The driver can hence be made more alert and vigilant depending upon the current driving conditions.

Haptic Feedback

Vibration in the steering wheel is a very powerful method for feedback. Other than alerting the driver about the turn, this is more direct in case of an accidental or unintentional input. Similar feedback can also be given through the seat of the driver. Unlike other suggestions, the feedback from this method would be restricted to the driver and other passengers would not know the next move. This system can be coupled with other feedback mechanisms as a critical alerting method or a fail-safe.

5 Main Project

5.1 Design Brief

As a result of an Advanced Design Project(ADP) in IaD, TU Darmstadt, a Warning and alert system for rail-side workers safety was developed. It constitutes mainly of 3 types of warning/alert signals

- Visual
- Acoustic; and
- Tactile

The visual signal incorporates LEDs into the worker's safety glasses and display warning/alert signals using various combination of LED colour and flashing patterns. Two prototypes of the same was developed as a result of the ADP. After conducting a series of systematic tests and user studies, it was found that a function for adaptive brightness control should be added to the system for it to function with better efficiency in safety application.

The objective of this project is to study the existing prototype of safety glasses with automatic track warning systems. Identifying the problems in the existing design and giving design recommendations for glasses in the direction of design, usability and manufacture.

5.2 Introduction to ALARP

(Developing and testing of warning / alerting system for railway trackside workers. J. Wakula, M. Schultheis, et-al)

Safety of railway workers is a serious concern of most industrialized countries. Surface transport workers are facing very high risks since they often operate without service interruptions. The railway situation is even more peculiar, since vehicles are constrained to tracks and therefore drivers have much less margins to react in case of emergencies and therefore workers are much more exposed to injuries and fatalities. This vision is supported by many analyses and published reports

- Most staff fatalities and serious injuries continue to be as a result of being hit by a train;

- Most staff member deaths occurred in open line accidents, whereas most serious injuries to staff members were incurred in accidents in stations.

Therefore safety requirements for railway trackside workers are very strict and necessary.

In Germany today stationary railway automatic track warning systems (ATWS) are being used at railway construction sites. ALARP (A railway automatic track warning system based on distributed personal mobile terminals) is project partially funded by the European Commission whose goal is the study, design and development of a safety-critical Automatic Track Warning System (ATWS) for railway track-side workers

ALARP is a consortium of companies and universities from 5 European countries: Italy, Germany, Great Britain, Austria and Israel.

This topic concentrates on conceptual models for warning / alerting signals and devices with ergonomic man-machine-interfaces (HMI).

Figure 1: Stationary ATWS

The ALARP concept is based on two main components: the track-side train presence alert device (TPAD, see fig. 2) and a set of distributed, wearable, robust, trustable and highly reliable, wireless Mobile Terminals (MTs) to inform the workers about possible approaching trains and/or other events that could put their safety at risk. The ALARP system will be able to inform the workers about approaching trains on the track, maintenance events on power lines and/or safety equipment in the concerned tracks, emergencies on tracks, keep track of the status and location of the workers.

ALARP ATWS will be able to realize following operating conditions of devices:

-Selectively inform trackside workers about:

O Approaching trains on the track,

O infrastructural maintenance events (e.g. on power lines) that may generate hazard conditions for workers,

O Emergencies on tracks and tunnels near the workers (e.g. fires in a tunnel, toxic smoke, etc.),

O Escape routes in case of emergencies;

-Monitoring of:

O The workers' location inside the working areas,

O The workers' status (responding or not)

The Mobile Terminals (MTs) are wearable devices which operate in a railway worksite, to execute the real-time and safety critical service of notifying to the railway worker a train approaching the worksite or the occurrence of hazardous situation (e.g., workers missing or not responding).

The main functionalities of the MTs are:

- to provide the workers information on alerts and warnings on approaching trains, events that could put at risk their safety;
- to support communication between the members of the working group;
- to support the role of the Controller Of Site Safety (COSS) by using a specific interface;
- to automatically verify the health of the workers and alert the rest of the group; if necessary,
- To check if the neighbour MTs are getting the right alarm signal, and if not notify it to the COSS.

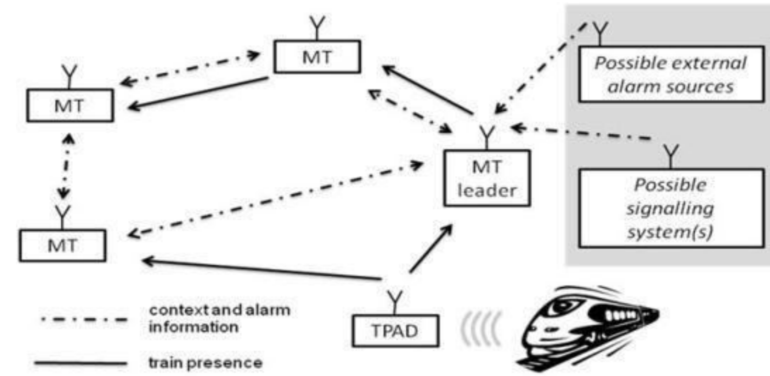


Figure 2: The ALARP concept

5.2.1 Warning / alerting models

Two conceptual models are proposed for warning / alerting signals /information stream from MT based on ergonomic rules and principles.

First conceptual model includes four different levels (see fig. 3). Warning signals on level 1 and level 2 will be provided by devices with ergonomic man-machine-interfaces (HMI). For example for level 1 visual and for level 2 acoustic signals are exploited. For level 3 tactile signals could be suitable. By "warning" a visual signal could be used at the beginning of the process. In case if any feedback or reaction from worker has not been received by MT an acoustic signal will follow. A tactile signal could make support for visual and acoustic signals. This means a cascading of "warning" information from MT to the worker.

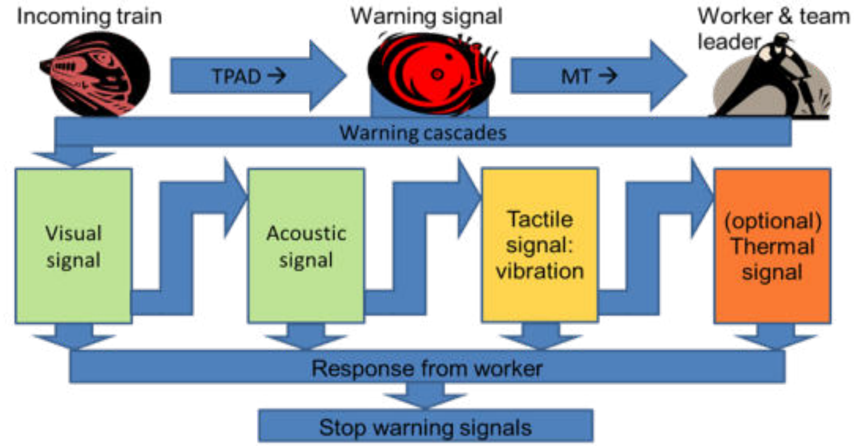


Figure 3: Conceptual model for WARNING

Another conceptual model will be preferred for "alerting" of the railway worker (see figure 4). In this case different kind of signals - visual and acoustic and/or tactile - will be provided to the worker at the same time in order to be sure that the worker receives the signals and reacts on these.

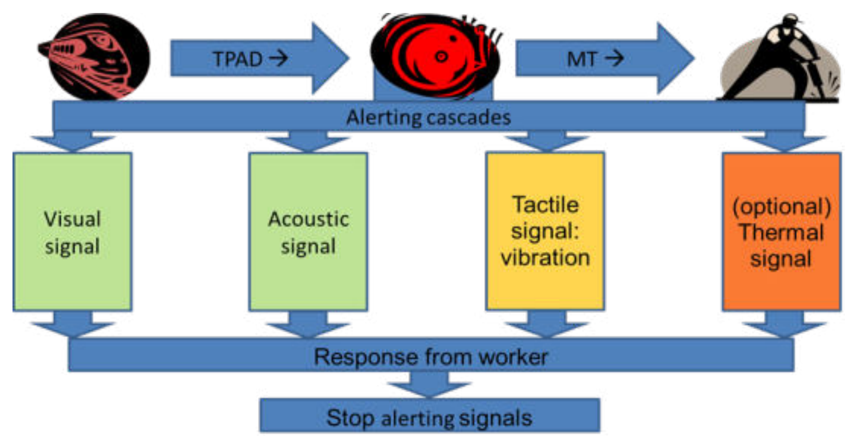


Figure 4: Conceptual model for ALERTING

The "alerting" model includes more signals which works simultaneously for different human channels (senses) to make sure that railway worker has received the signal. The process does not need to transfer a lot of information. After the warning / alerting signals have been received and confirmed by the worker, the process has been completed (figure 5).

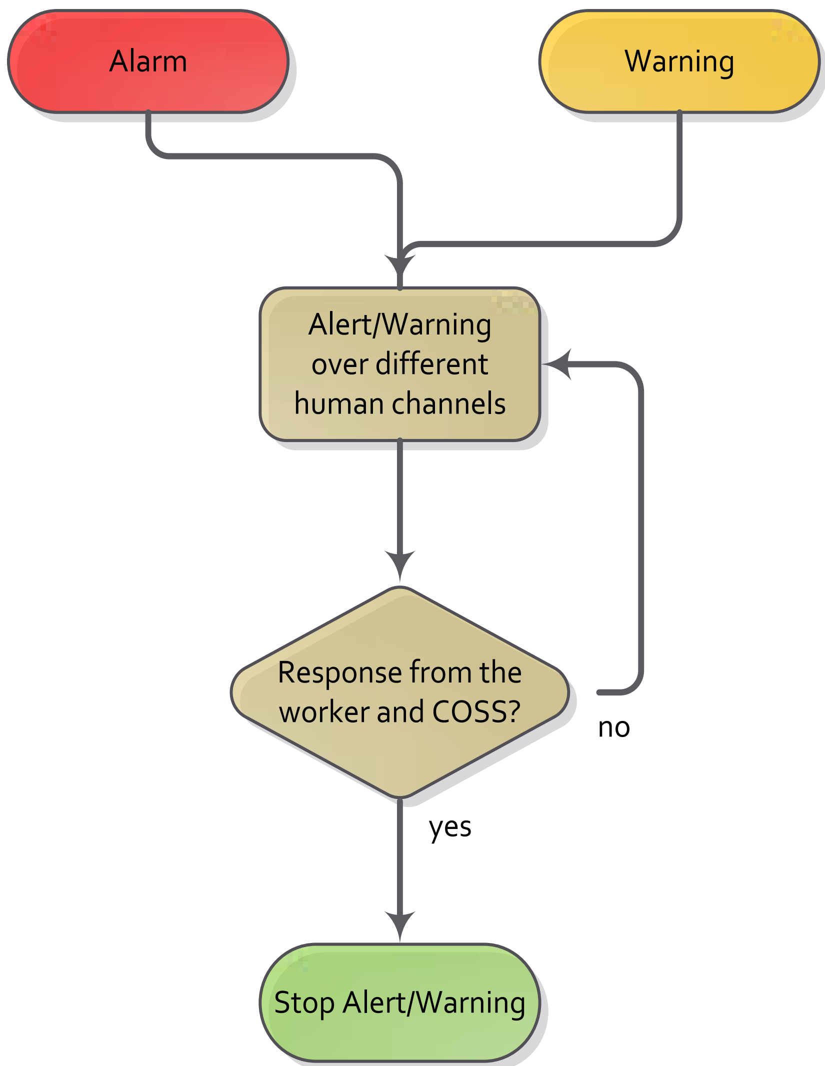


Figure 5: Overview of alerting /warning process

5.2.2 Visual warning / alerting signals and devices

The concept for visual warning / alerting includes:

-In the first phase to use flashing lights (e.g. using diodes) in order to capture the attention of the worker.

-In the second phase visual warning and /or alerting signals will be sent to HMI device / e.g. glasses or head mounted display/ in order to inform the worker about warning situation;

-Third phase is: Worker receives the signals and gives feedback using MT; at the same time he makes some decisions.

For this solution existing hardware (LEDs, flashing lights, MYVU video glasses, Vuzix video glasses, see figures 6, 7) have been analysed.

Figure 6: MYVU video glasses (http://www.thevideoglasses.com/myvu.htm

These were the final concepts proposed
•Concept for a head mounted visual warning- /alerting system with LEDs, flashing lights, (fig. 7)
•Video Glasses (fig. 8)

Figure 7: Alerting system with LEDs (IAD: Ringwald u.a., 2011)

Short description of technology of bright LEDs (flashing LED)
O Luminous Intensity ◊ up to 18000 mcd
O Different colors for warning-/alerting state
O Flashing with different frequencies
O Power: Max 4,3 Volt (20mA)

Figure 8: Concept for a head mounted visual system on the side of the visual range (Kellersmann 2011)

Short description of technology related to MYVU video glasses:
O Display system - V3 SolidOptex; Transmissive LCD Micro Display
O Resolution 640x480
O 24 bit colour depth
O Viewable Area - 22.5 degrees diagonal
O Display focal distance - 2 meters
O Video inputs: Composite video, Component Video
O Li-Polymer Battery, functioning life - 4 hours

5.3 The visual warning system and existing prototypes

A systematic Comparison of all found solution variants and their Combinations were selected and two promising concepts and developed. This comparison was based on criteria such as the visibility of the signals, the Comfort, the health risks and possible impairment of view. The high luminosity LEDs on the glasses edge generates a visual signal. The two Glasses concepts differ in the positioning and colour of the LEDs and the Execution with clear or diffused light.

The visibility of the warning signs of all prototypes was verified by testing. Through this showed that the brightness LEDs in the goggles even with strong Sunlight are clearly visible. Attached to the vest, the visibility insufficient. At low ambient lighting levels, however it comes to glare LED wearer, which is why an adaptive implementation is recommended depending on the light conditions.

According to DIN EN 842 (2009), a flashing signal between 2 Hz and 3 Hz for visual alerts are recommended. With the combination of acoustic and visual signals, the recommended DIN EN 981 (2009) Red light signals for danger signals (emergency, alert, stop, ban, failure) and red light flashes (I.e., light having a duration of less than 0.5 s, corresponding to a frequency higher than 2 Hz) for emergency evacuation. Orange or yellow light signals means caution (Attention required, change of state intervention), while blue light signals an means (action, protection, special attention to safety-relevant control with priority or measure).

The existing visual warning signals are as follows

Signal	Meaning	Colour	Time Course
Alerting	Train on same track	Red	Flashing
Warning	System failure	Red	Steady
Warning	Train on adjacent track	Yellow	Flashing

Table 1

5.3.1 Prototype 1

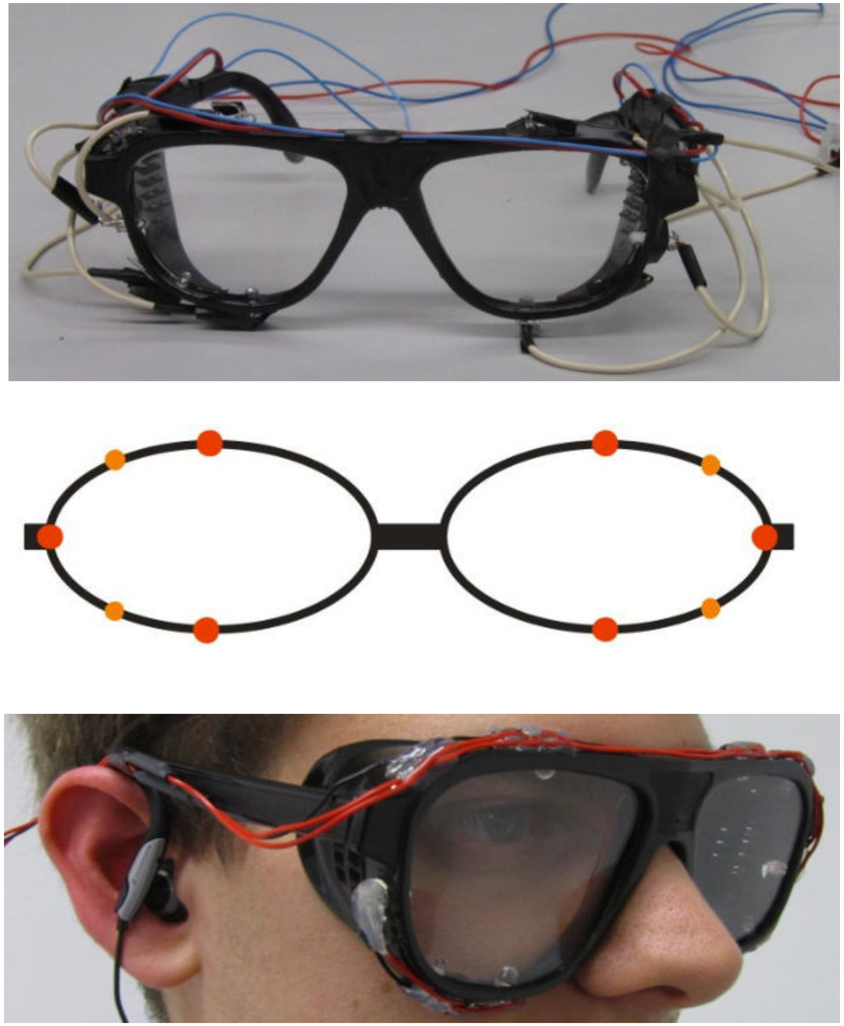


Figure 9: Prototype 1 and schematic diagram

5.3.2 Prototype 2

Figure 10: Prototype 2 and schematic diagram

5.4 Expert Review of existing prototypes

Based on the interview, I divided the outputs into three major areas

5.4.1 Thomas Pfeiffer, Dipl.-Psych. Psychologist

HMI: If the colours are displayed in the periphery of the vision, there is a chance to get confused between the colours because the colours sensing is weaker in that region. The secondary and tertiary signals can be found annoying because they interfere with work more frequently than the primary signals and yet is not so important as the primary signal. The worker doesn't have to immediately react to these signals, thus there is a possibility where the worker can gradually learn to ignore these signals. Therefore the primary signal should also be well distinguishable so that the worker doesn't ignore that as well. Low priority signal can also be a distraction if it occurs in between a precision job.

Construction Parameters: The position of different coloured lights has to be distinguishably different for even the colour blind people to understand it. Intensity of light should be proportional to the ambient lighting conditions. The secondary signals can have a snooze function.

Aesthetics: The design is purely functional, aesthetics holds a minimum value.

5.4.2 Michael Schultheis, Dipl.-Ing Engineer, usability and product ergonomist

Human Machine Interface Factors: He finds the overall design very basic and just as a prototype to display the functionality of the unit. According to him the prime priorities are the safety and comfort of the workers because the workers would be working for around 4-8 hours. The positioning and number of the LEDs are not according to any study conducted.

Construction Parameters: It is recommended to have a wired unit as the battery weight can be avoided and having a wireless unit can be making the unit more vulnerable to errors. In the current case, errors made can lead to even loss of life. There should be a solution to reduce the intensity of light into the eye, adapting to various external conditions.

Aesthetics: The aesthetics was not given a high significance but it would be appealing for the worker if the product is aesthetically appealing.

Expert Review of existing prototypes

5.4.3 Pratap K.S, M.Des
Designer and usability analyst

Human machine interaction factors: Safety is prime priority. It should be easy to wear and remove. It shouldn't obstruct the field of vision in anyway. The amount of light falling into the eyes can be made directly proportional to the priority of the signal. It should be comfortable and functional. It shouldn't slip off the face, even if it does, the worker should be able to put it back with his gloves on. Factors to ensure the worker doesn't forget it.

Construction Parameters: Side shield found good in existing design. Integrating with the helmet. Number of LED lit up at a point of time depends on the warning intensity level. LEDs can form a film like stricture in front of the glasses. A narrow beam of light could go through the centre of the field of view.

Aesthetics: The design is purely functional, aesthetics holds a minimum value.

5.5 Literature Research

The LED components are only capable of briefly exceeding radiation safety limits. e.g. in the event of control circuit failure. However, if lenses or other optical systems alter the intensity of radiation, a photo biological assessment of the luminaries needs to be performed regardless of the LED radiation data. In this case, the LED data represent an important "raw data" variable. Control gear also plays a key role here because the operating points and mode of operation of LED modules (e.g. pulsed operation or operation outside normal operating point data) are determined by the control gear. (Federation of National Manufacturers Association for Luminaires and Electro technical Components for Luminaires in European union 2009) The main Hazard which the LEDs cause is thermal in nature. The thermal hazard potential, in contrast, is of concern primarily for LEDs with wavelengths in excess of around 560 nm, which takes in colours such as (yellow), amber, red and hyper-red. However this effect is so small as to be negligible. (OSRAM Opto semiconductors 2012) Blue and White LEDs may cause eye illness because of the infrared and ultraviolet light, red and yellow LEDs are not problematic. (L.Udovicic 2013)

However, all point-like light sources are considered to be safe by the standard and do not require additional warning markings, but prolonged direct viewing into these sources must be avoided especially at short distances. Maximum exposure times for the lamps are 200 seconds or longer, but people will close their eyes or look away in such cases (instinctive aversion reaction). This holds for the high-luminance LED sources just as much as for the high-luminance light sources that have traditionally been used for general lighting for many years. (Global Lighting Association 2012)

While using visual warning signals, the warning should be in an angle of +/- 30° of the main view in horizontal and vertical directions. The frequency of flashing lights for warnings should be between 2-3 Hz (Deutsches Institut fuer Normung e. V. 2008). Constant Red is the colour for failure, constant yellow the one for attention. Flashing red light means danger and immediate emergency response is required or evacuation is necessary (Deutsches Institut fuer Normung e. V. 2008).

Direct viewing of the Sun on midday cause a light density of 1,600,000,000 cd/m^2. The light density in the night is 0.001 cd/m^2. For a visual warning to get noticed the light density of it must be brighter than the ambient light density but if the difference is too big, the eye gets dazzled. (http://www.filmscanner.info/Fotometrie.html n.d.) The LEDs used in the prototypes give 16.000mcd (red) or 14.080mcd (yellow). (J. Ringwald 2011)

5.6 Market Research

5.6.1 About safety glasses

Each day, about 2,000 U.S. workers suffer a job-related eye injury requiring medical treatment, according to The National Institute for Occupational Safety and Health (NIOSH). In addition, roughly one third of these injuries require treatment in hospital emergency rooms, with 100 injuries resulting in one or more days of lost work.

For protective eyewear meant for industrial or occupational use in the US, the governing document is ANSI Z87.1, and it has been in existence, through several iterations, for almost 40 years. OSHA in its regulations specifically cites Z87.1 as the minimum performance requirement for protective eyewear, effectively giving it the weight of law. Where a hazard assessment in the workplace indicates that eye/face protection is needed, such protection must be provided, and it must comply with this ANSI standard

Protective eyewear is a crucial part of any safety program and there are many different kinds of eyewear on the market from which to choose, like the one on the right side. Their design, features, functionality and even the materials from which they are made all affect their performance. Lens coatings are one of those features that have a major impact on the effectiveness of protective eyewear.

Choosing the right lens coatings not only help keep employees safe and comfortable in the workplace, but can also translate into fewer injuries, increased productivity and an overall healthier bottom line.

Advances in plastic lens technology, particularly the development of polycarbonate material, have created incredibly strong, flexible and lightweight lenses. Polycarbonate lenses, because of their higher refractive index (they bend light more than glass), are thinner and lighter than both standard plastic and glass. They also have higher impact resistance than glass, which shatters under force, making polycarbonate lenses the lens of choice for protective eyewear.

Figure 11: http://www.professionalequipment.com/product_images/Full/40517_big.jpg

5.6 Market Research

5.6.2 Lens Coatings

Lens coatings offer a variety of uses and applications. In each and every formulation they provide critical properties to enhance protective eyewear. The options that are available today benefit workers in most environments, encouraging higher compliance levels. They increase the eyewear's chemical resistance, UV and infrared protection, and ensure visual clarity by increasing scratch or fogging (figure 13) resistance without detracting from the comfort levels characteristic of lightweight polycarbonate eyewear.

With advances in technology, new coatings are being developed all the time to address the safety needs of the marketplace. With so many coating options, choosing the right option can sometimes be confusing. Fortunately, manufacturers can assist companies in selecting the proper eyewear and lens coatings for specific work environments, and in doing so can help them deliver effective protection levels that meet strict ANSI and OSHA guidelines. Selecting eyewear and coatings that offer the best functionality, style and comfort can help increase user compliance. The results are a safer workplace, fewer incidents of eye injury, and ultimately increased productivity and profitability.

Figure 12: http://janggatehnik.com/images/safety_equip/Safety_goggles_uvex_9305.jpg

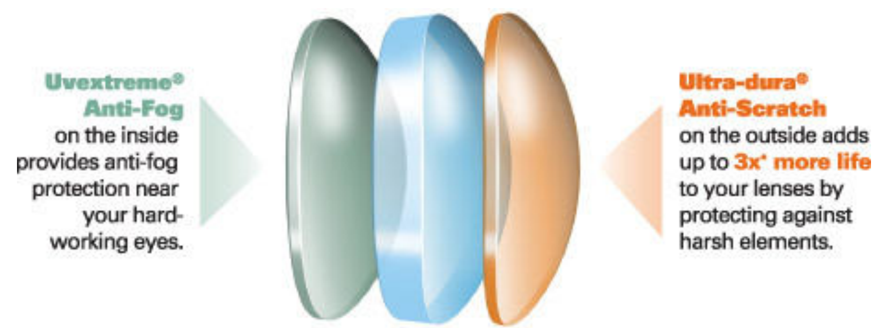


Figure 13: http://uvex.us/uploadedImages/Technology/Uvex_Dura-streme_Illustration_4c.jpg

5.6.3 Diachronic and Synchronic Analysis

Research on various systems which include visual signals were done.

5.6.3.1 The 4iii

The 4iiii corporation developed a sports monitoring system,(right side top) which provides the performance feedback without distracting the user from the activity. Coloured LEDs and voice prompts guide user to personal targets pre-sets with the 4iiii app for heart rate, speed, cadence and power. User can focus on your goals; from a personal best to a podium position. Safety while conducting sports related activities such as jogging cycling is the objective behind this product

Figure 14: http://4iiii.com/product-sportiiiis/

5.6.3.2 Recon Instruments Airwawe

Airwawe(right side bottom) provides the user with essential information. Recon's HUD tracks and displays real-time performance information including speed, distance, jump airtime, altitude, and vertical descent, instantly transmitted direct-to-eye. Precision GPS allows on-hill navigation and enables the tracking of buddies and points of interest. The HUD also gives the user direct access to SMS messages, caller ID and the control of music playlists from either an Android™ smartphone or iPhone® (iPhone 4S and above). The user decides what information they see and when they see it using the wireless, glove-friendly remote.

Figure 15 : http://reconinstruments.com/staging1226/news/post.php?s=2012-10-31-oakley-airwavetm-goggles-to-use-recons-pioneering-headsup-display-technology

5.7 Comparison of existing Solutions

Study also stated that a specific set of glasses are not in existence for the railway workers, however a set of guidelines are given in various health safety articles.(Eye Protection at the Work Site, Government of Alberta, June 2012).

A systematic comparative study was conducted on the safety aspects of the existing solutions. As a result, the advantages and disadvantages of different glasses were noted . The safety glasses suiting the users condition of work was found out.

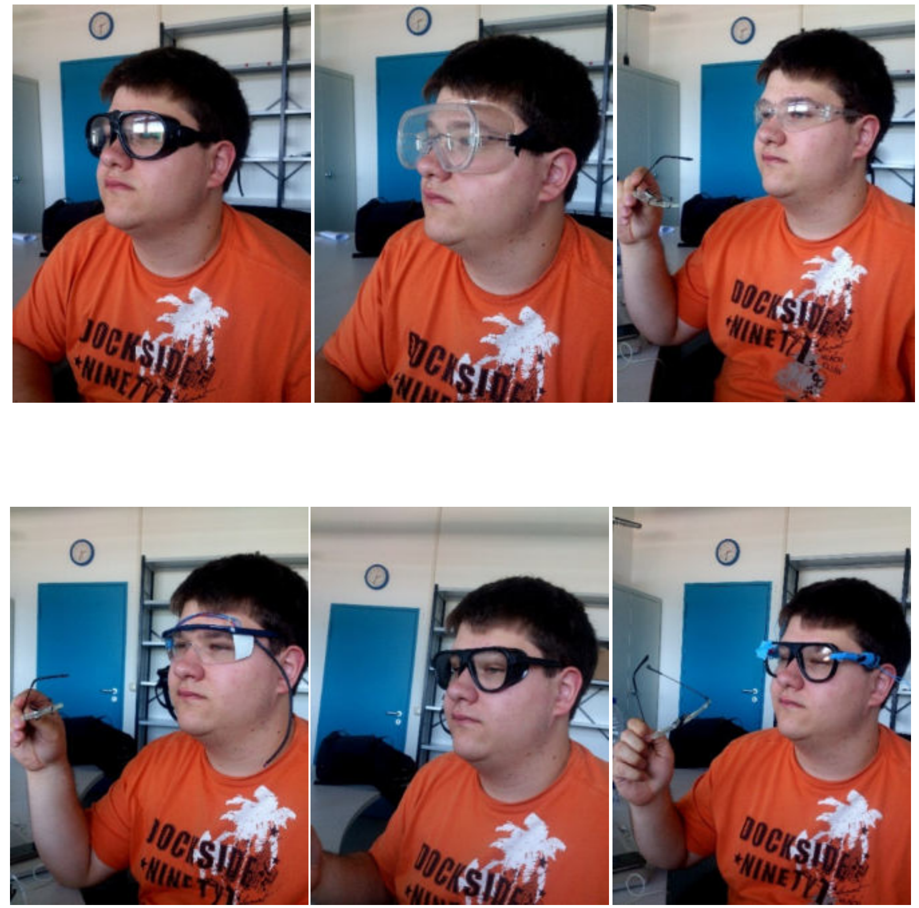


Figure 16: Testing existing prototypes

5.8 Classification of various type of Goggles

Classification of various types of safety goggles and the functions they serve

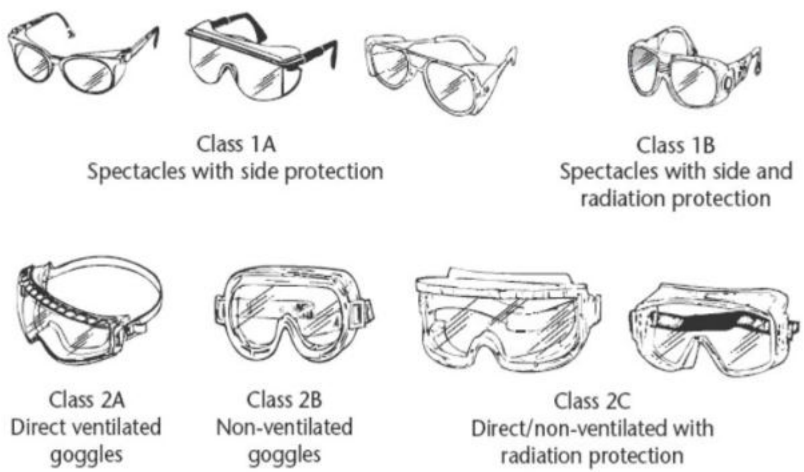


Figure 16: Eye Protection at the Work Site, Government of Alberta, June 2012

Nature of Hazard	Hazardous activities involving but not limited to	Spectacles Class 1		Goggles Class 2		
		A	B	A	B	C
Flying objects	Chipping, scaling, stonework, drilling; grinding, buffing, polishing, etc; hammer mills; crushing; heavy sawing, planing; wire and strip handling; hammering, unpacking, nailing; punch press, lathe work, etc.	✓		✓	✓	
Flying particles, dust, wind, etc	Woodworking, sanding; light metal working and machining; exposure to dust and wind; resistance welding (no radiation exposure); sand, cement, aggregate handling; painting; concrete work; plastering; materials batching and mixing	✓		✓	✓	
Heat, sparks, and splash from molten materials	Babbiting, casting, pouring molten metal; brazing, soldering; spot welding, stud welding; hot-dipping operations		✓			✓

Eye Protection at the Work Site, Government of Alberta, June 2012

5.9 Initial Insights

Considering the things revealed during market study, expert reviews, primary and secondary literature research, the following insights were generated as feature which the end product may have.

- Back strap
- Failsafe
- Side and periphery protection
- LED film
- Cushion/Padding
- Dust Prevention
- Snooze Function
- Warning separation
- EL Wire
- View Angle consideration
- Anti Fogging
- Helmet clip
- Lighting Fibres
- Temperature Resistance
- Frame colour
- Quality and finish
- Has LED lighting
- Polaroid lenses
- Not annoying
- Carrying case
- Coloured lenses
- Environment friendly
- External Unit which could go with existing glasses
- LED beam
- Wire connector
- Comfortable
- Water Resistance
- Diffused Warning signal

5.10 Insights Finalised

Out of the insights generated, five of the below shows insights were chosen. The insights were chosen according to their relevance in present context, supported by key findings from various publications and the recommendations of the experts.

Factors	Document	Expert
Diffused Warning signal	Optical and Photo biological Safety of LED, CFLs and Other High Efficiency General Lighting Sources, 2012	All
View Angle consideration	DIN EN 842, 2009	Designer, psychologist
Warning separation	DIN EN 981, 2009	All
Side and periphery protection	Occupational Health and Safety Bulletin 2012, Eye safety and Protection, UVEX	Designer, Engineer
Failsafe	Europäische Normung Automatischer Warnsysteme, 2005	Engineer

5.11 Revised Design Brief

The insights generated were sorted out and the features which the product must have were found out. A revised design brief was formulated with the following key points in mind

1) Diffused Light source of warning signal

Prolonged direct viewing directly into point sources must be avoided especially at short distances and can cause eye illness says the Optical and Photo-biological Safety of LED, CFLs and Other High Efficiency General Lighting Sources, 2012, Published by Global Lighting Association and it is also recommended by all experts.

2) View Angle Consideration

it is mentioned in the DIN EN 842, published by Deutsches Institute fur Normung, in 2009 that while using visual warning signals, the warning should be in an angel of +/- 30° of the main view in horizontal and vertical directions. Similar recommendations were made by all the experts as well

3) Location and type of warning lights and displays

Warning with different colours should be distinguishably separate so that the workers, wont ignore the primary high priority warnings. The secondary warnings occur more frequently and the worker may learn to ignore it, hence the primary warning should be noticeable because it involves higher risks. Mentioned in DIN EN 981, published by Deutsches Institute fur Normung in 2009. The psychologists Mr. Thomas recommends it highly and other experts also mentioned it.

4) Failsafe

The worker needs to know about the functional status of the equipment he is using. It is mentioned as a necessity in Europäische Normung Automatischer Warnsysteme, 2005 by Dr. Knut Dumke. Engineering expert Mr. Michael recommended for this feature.

5) Fulfilling Protective eyewear requirements of work condition

conducting study on existing prototypes, the nature of work and the occupational hazards involved, the glasses with side shields and protection around the periphery of the frame is chosen. The summary is based on the findings in the of Occupational Health and Safety Bulletin, published in June 2012, by Govt. of Alberta and Eye safety and Protection guide by UVEX. Similar mentioning was made in the reviews by the experts in engineering and designing field.

5.12 Concepts Generation

Four concepts were developed on how the warning/alert signal should be displayed to the user.

5.12.1 LED light source and Polymer film diffuser

The pointed source of the LED light can be easily diffused by using a polymer or film such as PET. The intensity of the light passing through can be varied with the thickness of the film.

Figure 17: https://dzevsq2emy08i.cloudfront.net/paperclip/technology_image_uploaded_images/9671/default/Light_diffusion_Film.jpg?1335201216

5.12.2 Light through etched glass

An etching, a depression or projection on the lens surface can reflect light when it falls from a perpendicular direction. This phenomenon can be used to display a warning/ alert signal to the user

Figure 18: http://i00.i.aliimg.com/photo/v0/632356092/laser_etched_glass_block_with_led_light.jpg

5.12 Concepts Generation

Four concepts were developed on how the warning/alert signal should be displayed to the user.

5.12.3 Electro Luminescent(EL) wire light source

EL wires can be used as a light source. The light produced by EL wires are diffused in nature. The flexibility of EL wire makes it easy to install and handle.

Figure 19: https://dzevsq2emy08i.cloudfront.net/paperclip/technology_image_uploaded_images/9671/default/Light_diffusion_Film.jpg?1335201216

5.12.4 Light Throw

When a light is projected through a glass from a perpendicular direction of vision, a glow is produced closer to the area of light source due to refraction. This can be used to display a signal.

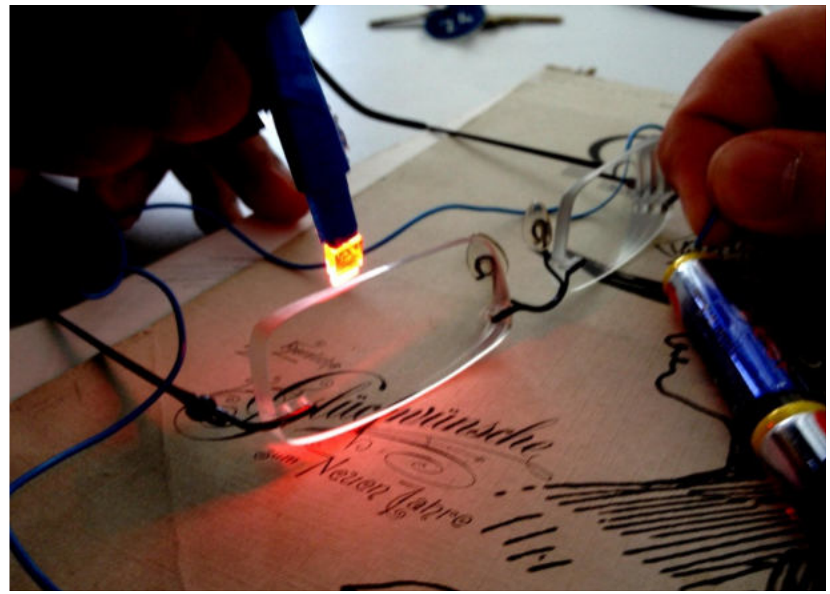


Figure 20

5.13 Concept Evaluation

The four concepts were evaluated by myself and project partner using the matrix method, under various factors(Left most column)

Factors	LED with Pet Film	LED with Etched Glass	Wire Variations	LED throw
Diffusing light	0.3	0.1	0.3	0.3
View Angle Consideration	0.25	0.25	0.25	0.25
Brightness Control	0.4	0.2	0.4	0
Day and Night time compatibility	0.33	0.33	0.33	0
Clear field of vision	0.15	0.2	0.3	0.35
Heating	0.25	0.25	0.25	0.25
Colour Separability	0.25	0.35	0.4	0
Independent unit functionality	0.5	0.5	0	0
Assembly line Complexity	0.1	0.2	0.35	0.35
	2.53	2.38	2.58	1.5

The EL wire concept survived with maximum weightage.

5.14 Form Explorations

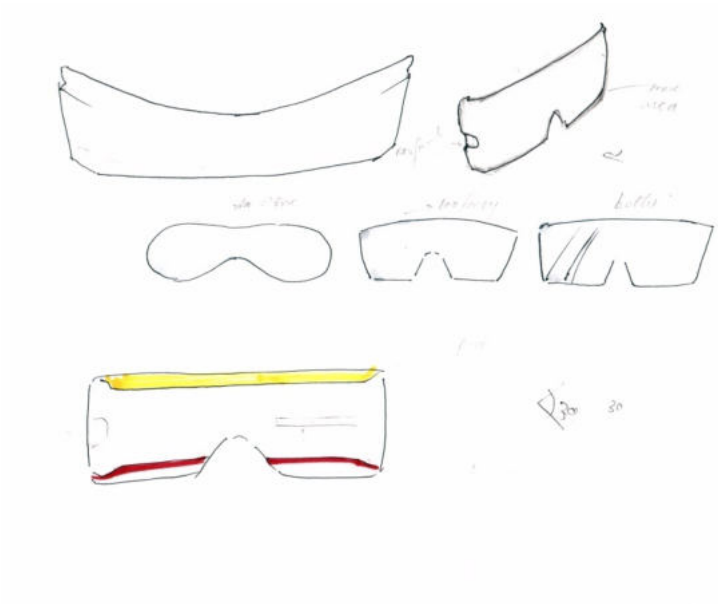
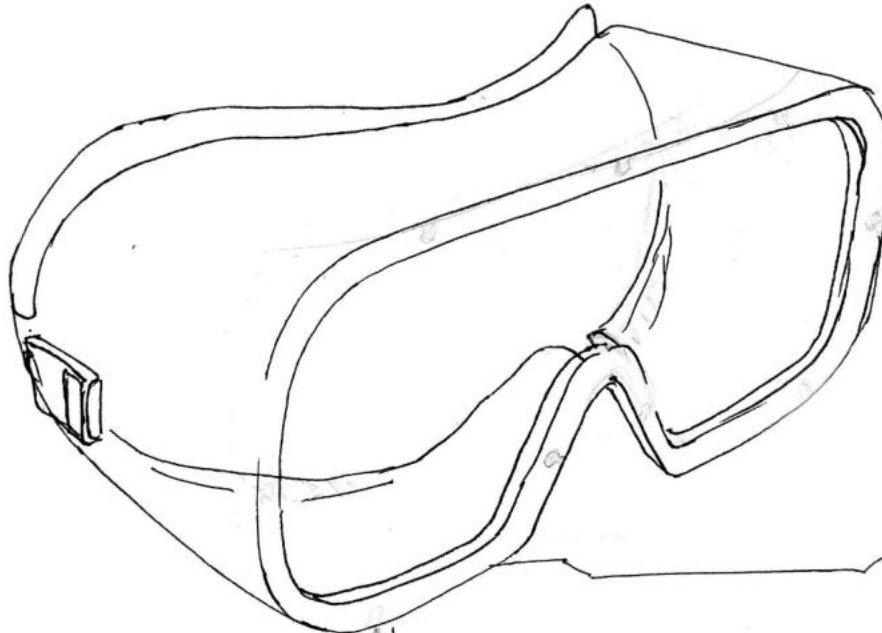
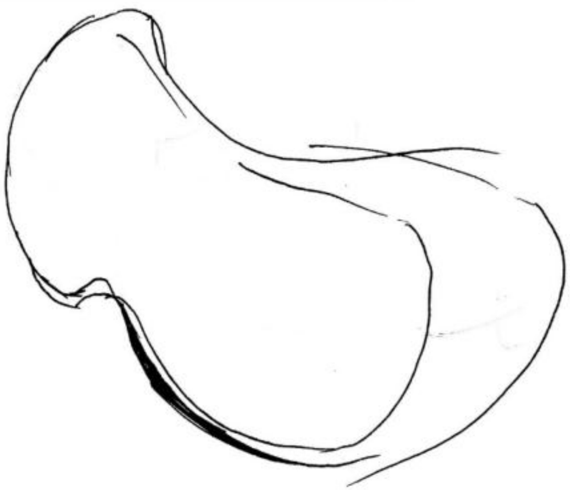
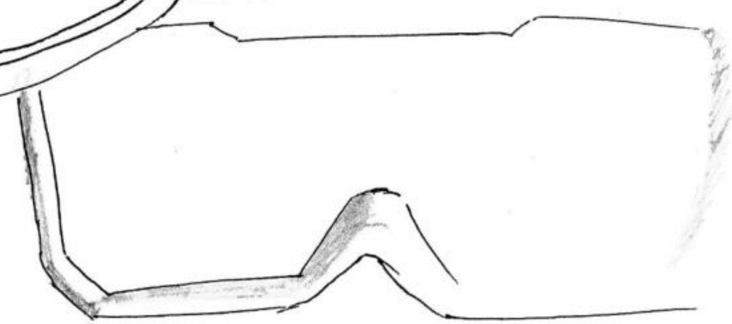


Figure 21







Initially these were the forms generated. Various expressions were explored and the this was narrowed down to rugged and precise.

5.15 Final Form

With the approach to create a strong and rugged form, the bottom was finalized. Additionally ventilation was added as lines on the top part of the shell to add functionality and to give a more precise feel.

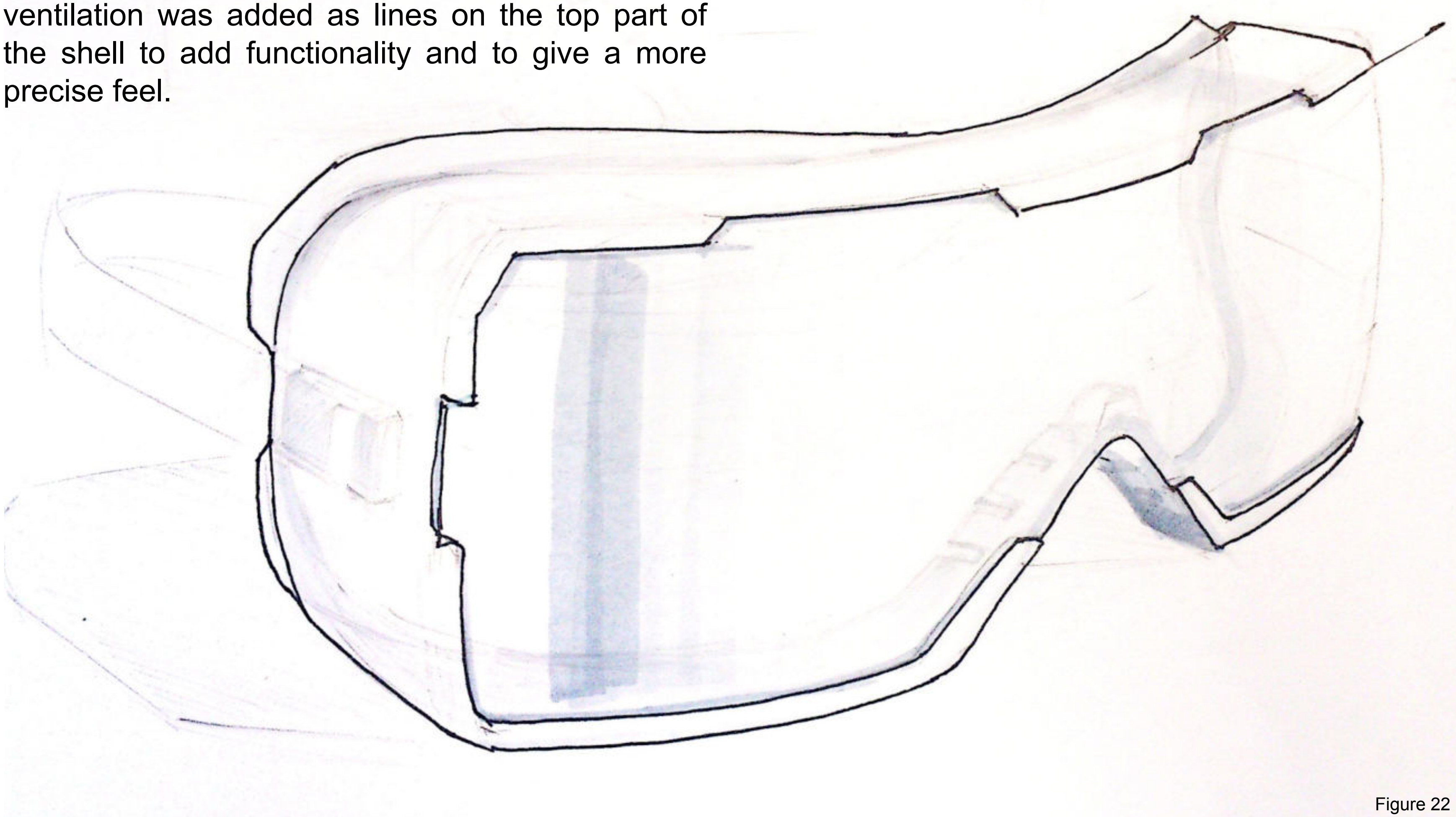


Figure 22

5.16 Final Product and Prototypes

The final product will have a polycarbonate lens mounted on a latex frame. The frame will be transparent to ensure more visibility. Use of latex will ensure flexibility and perfect fit of the contour of the glass on the users face.
The nose pads are form a ribbed structure to ensure maximum comfort and fit.

The polycarbonate lens ensures light weight and high impact resistance to flying objects. The ribs on the top forms indirect ventilation to keep the heat off the worker's face. They also strengthens the frames

Figure 23

Figure 24

5.16 Final Product and Prototypes

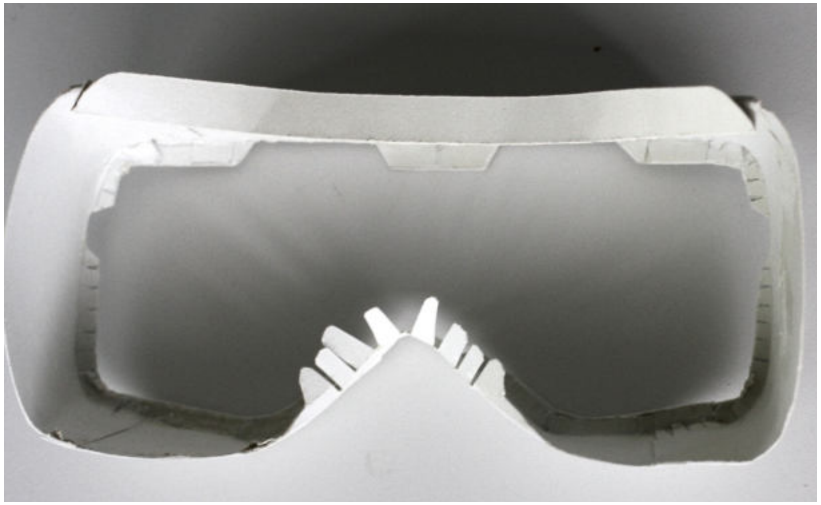


Figure 25, 26, 27

5.17 Function



Figure 28, Figure 29,Figure 30

The **primary** (figure 28) signal is shown by a flashing red light with a spot on the field of view. The bottom part is illuminated, as that is the area in the periphery of the human eye where maximum attention is captured. The spot is only on one side of the glass because one side is enough to capture attention. It doesn't block the field of view also

The **secondary** (figure29) signal is shown by a glowing yellow light on the top side of the glasses. The light remains constant to let the worker know that he should be alert but doesn't annoy the worker by capturing too much attention between a precision job

The **system failure** (figure30) signal is shown by a glowing blue spot in the field of view. This light is powered by a secondary power source within the frame in case a connection from the main power terminal is cut

About The Trip

Germany is a place where people want things planned completely. The trains come on time, the local busses travel on time, even the parties end on time. This was the most important thing I learned about the place.

The trip had two parts, one was the pre-trip planning and two, the trip itself. The planning part can be considered as a bit more difficult than the trip part. but the anxiety and excitement helps you get through all of it! I had my passport ready so that pain was saved. The next major step is getting the visa, also where we faced our first problem. The online token had to be taken before actually going to the German consulate(which we didn't know). So we had to go there again and got the visa actually just a day before the actual trip, while the tickets were already booked. The travel was 14 hours and another 4 hours of transit time in Kuwait.

Even though the visa procedure etc was hectic, the whole outcome of the trip was totally worth it. Primary motive, the project which itself had so much to teach us. The "German" way of doing things itself was a great experience. Interactions and co-existence with Germans and other people who don't even speak English was an exciting experience.

The weekdays are mostly work-filled and the weekends were pure travel and fun. We travelled to Frankfurt, Heidelberg, Europa-Park (Rust, near France border), Amsterdam(Netherlands), Berlin, Cologne and Prague.

The greatest experiences among all was the Bungee jumping in Frankfurt, the Silver Star roller coaster in Europa-Park and the incident that I missed the train on the way back from Prague. Had to stay in Nuremberg whole night!

The must see places I would say is the Castle/Church of Cologne, The Prague castle, Heidelberg and Amsterdam. For a person with high adrenalin rush, Europa-Park is a dream come true. The whole of Germany is a dump yard of history and architecture. As my dear friend mentioned "everyone and everything has a story,, and what's the fun if we just pass by, when the story lies just a brick away..? see as many castles as you can (burgs and doms), notice each sculpture, each carving, they're not simply standing there. some face east, some face west, some face each other... notice how the 'coat of arms' (the shield) changes its design from city to city, and how the iconography is repeated throughout the city then. It's fun even writing these things!"

Things to keep in mind

Keep checking bahn.de for special offers and discounts.
http://www.mitfahrgelegenheit.de Car pooling the cheapest way to travel.!

Be on Time!

5.18 References

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