

WEARABLE FOR JALAAI (BRICK FIRING)WORKERS FOR THERMAL PROTECTION

ARJUN PRASANTH | 156130011
GUIDED BY PROF GG RAY

Jalaai workers

The process of baking and strengthening of green bricks by baking at 900-1000°C for a specified time is called jalaai. The workers who perform this task are known as Jalaai workers.



Continual kilns like this can operate without stopping for months and even years as workers steadily fire fresh batches of bricks.

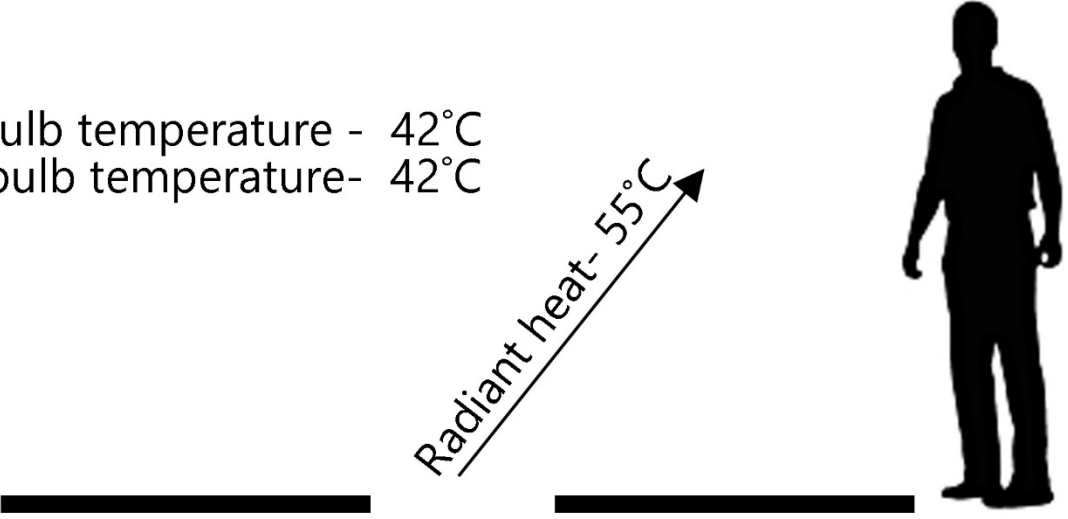


- To maintain the right temperature inside the kiln by charging coal
- Opening and closing of air vent as required
- To determine the time for baking the bricks they need to look through the holes by checking the colour of the chute
- To charge the coal, they break large chunks of coal to smaller pieces
- A typical work-rest cycle of a Jalaai worker is to work for 15-20 min followed by a rest pause for 45/60 minute.

Occupational hazards

Dry bulb temperature - 42°C
Wet bulb temperature- 42°C

Radiant heat- 55°C

A diagram illustrating occupational heat hazards. It features a black silhouette of a person standing on the right side. To the left of the person is a horizontal line representing a fire hole. An arrow points from the fire hole towards the person, labeled 'Radiant heat- 55°C'. Below the fire hole, the text 'Kiln temperature- 900-1000 ° Celsius' is written.

FIRE HOLE

Kiln temperature-
900-1000 ° Celsius

Challenges and issues in brick sector in India



Central Pollution Control Board (CPCB) has recognised the brick production industry as a highly resource and energy intensive and polluting industry owing to prevalence of obsolete production technologies. While, the clusters are the source of local air pollution affecting local population, agriculture and vegetation; at a global scale they also contribute to climate change.

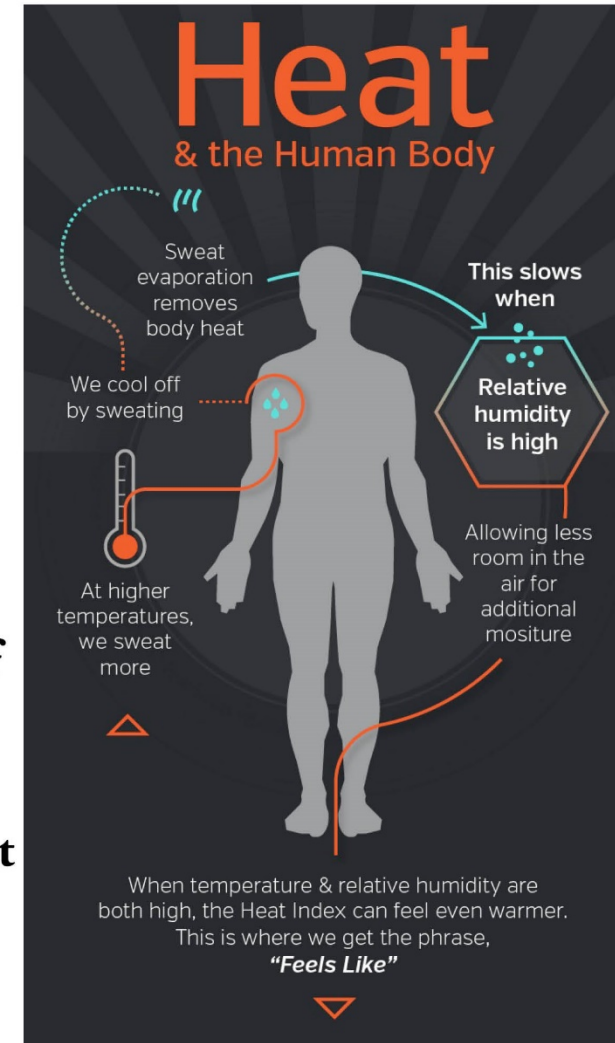
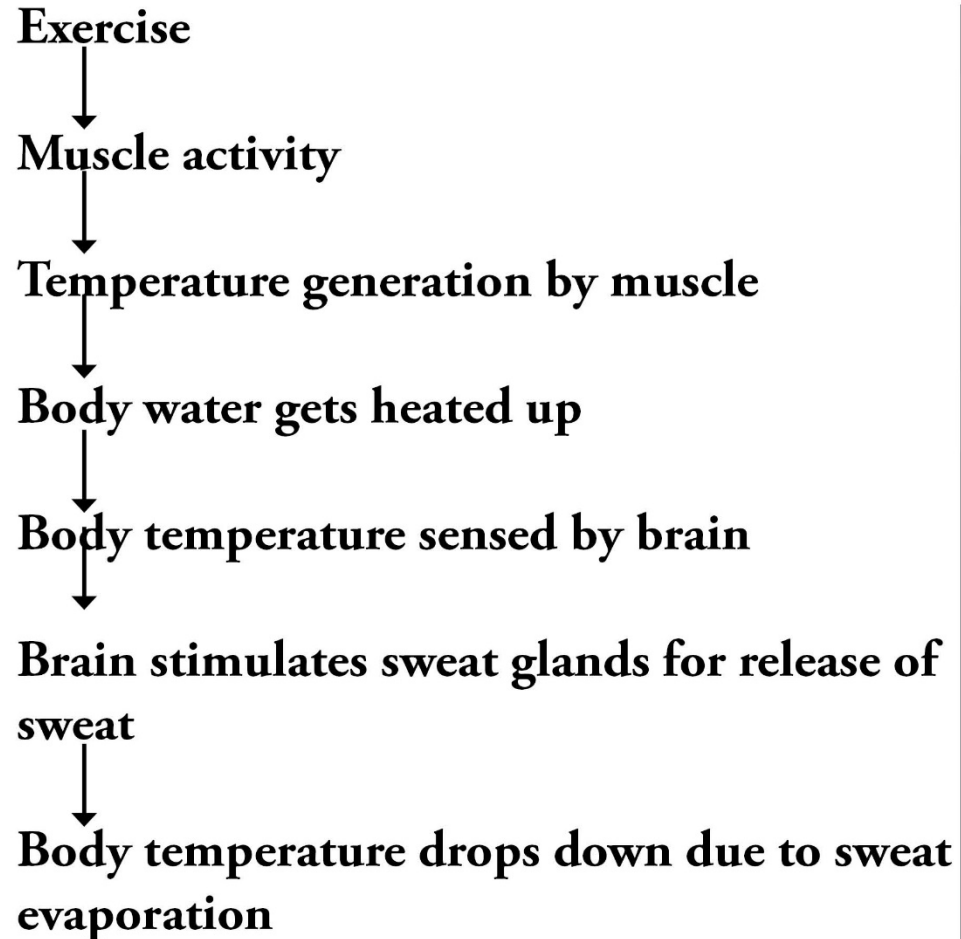
Associated Socio-Economic Issues



The workers in the brick industry are subjected to extreme working conditions and poor remuneration. Currently in India, brick manufacturing is a labour-intensive sector, with crude techniques causing considerable worker drudgery. They are also exposed to high concentrations of Respirable Suspended Particulate Matter (RSPM), during monitoring and regulating the fire, as the furnace chamber is covered with ash (ash acts as insulator)

The nature of the work requires skilled labour especially for moulding and firing. There is large scale migration towards the major brick production clusters every season due to this.

Heat loss mechanism



Thermal control mechanism of body

Constant body temperature

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graph TD; A[Constant body temperature] --> B[External source]; A --> C[Internal source]; B --> B1[• Temperature gradient( Difference between air temperature and skin temperature)]; B --> B2[• Airflow]; B --> B3[• Humidity ( Humidity directly proportional to thermal heat load in body because sweat will not get evaporated)]; C --> C1[• Muscle contraction due to work];
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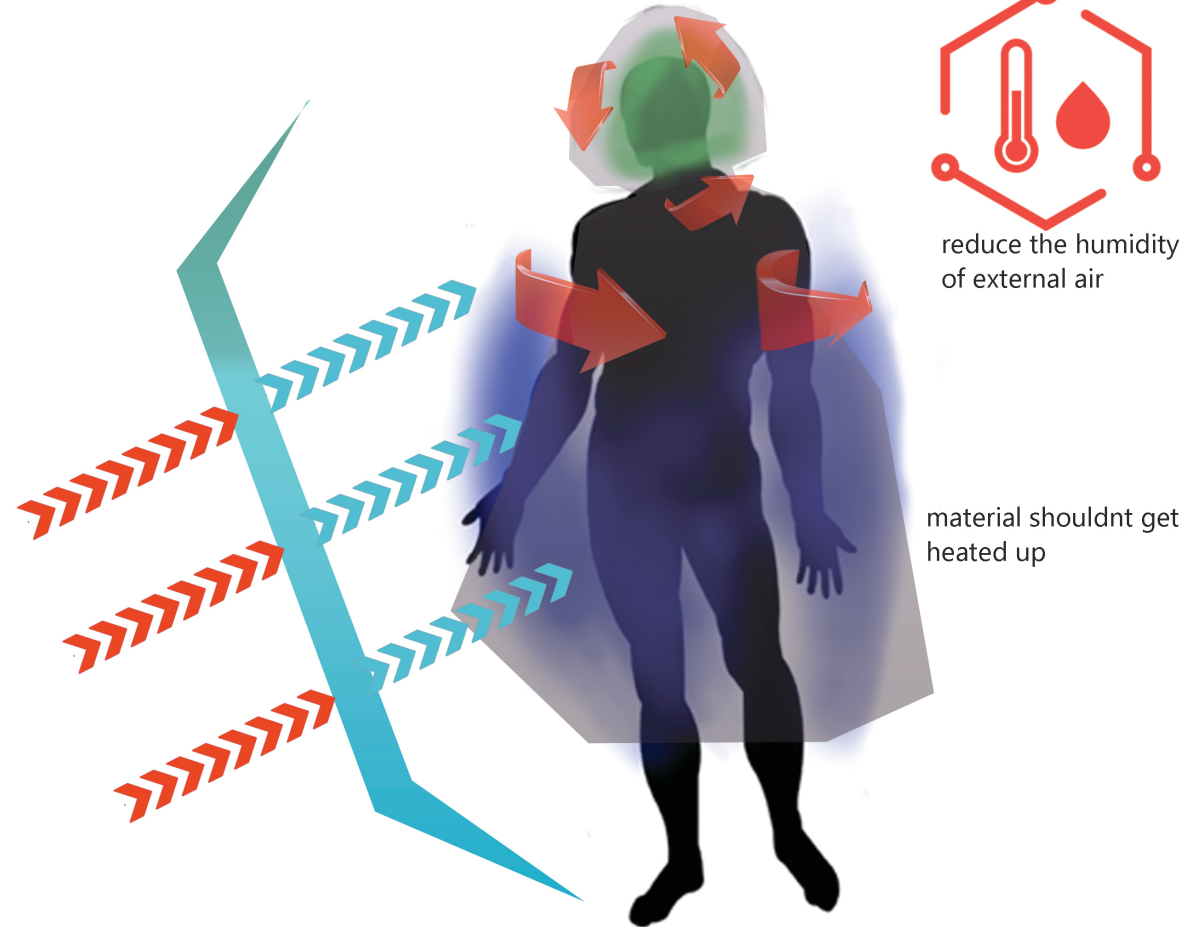
External source

- Temperature gradient(Difference between air temperature and skin temperature)
- Airflow
- Humidity (Humidity directly proportional to thermal heat load in body because sweat will not get evaporated)

Internal source

- Muscle contraction due to work

Methods to protect from external load of heat



- Reduce the temperature gradient between the surface of the skin and external air. This can be done by putting heat reflective external jacket around the body
- External heat to be reached mostly by the process of radiation, so material shouldn't gets heated up (not increases its own temperature)
- Reduce the temperature before in contact with outer skin.
- Increase the airflow in the body to increase sweat evaporation which will give cooling effect to the body.
- Reduce the humidity of the external air.

Heat Stress:

Heat stress is the condition in which the body exposed to high temperatures is unable to control its core temperature by sweating or other natural cooling methods and is prone to several heat induced illnesses.

The types of heat induced illnesses that can occur are the following:

i) **Heat Stroke**

ii) **Heat Exhaustion**

iii) **Heat Cramps**

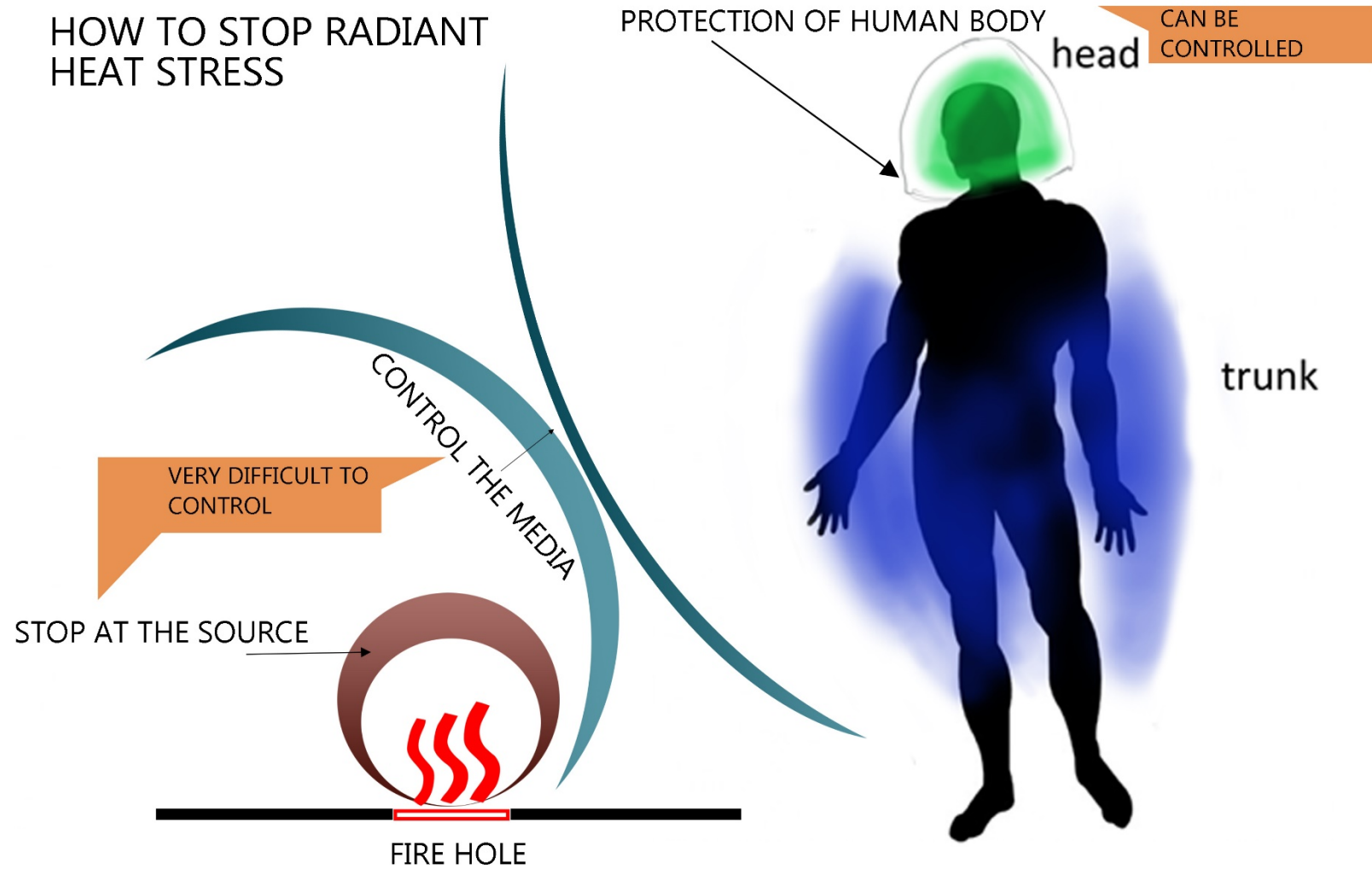
iv) **Heat Rash**

v) **Rhabdomyolysis**

vi) **Heat Syncope**

How to stop radiant heat stress

HOW TO STOP RADIANT HEAT STRESS



Miracool Hard Hat Pad



Existing cooling techniques

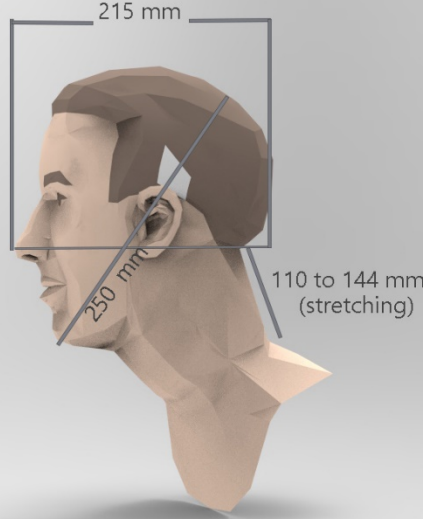
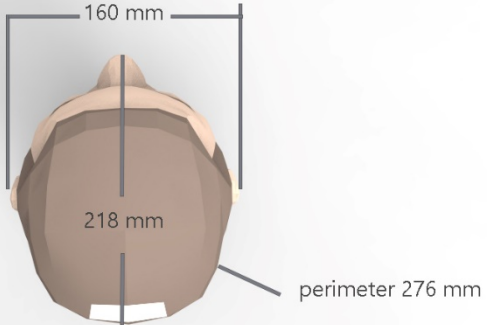
Solar Powered Safety Helmet Hard Ventilate Hat with Cooling Fan

Kuchofuku Air-Conditioned Helmet

Project brief

- Design of a system for the Jalaai (brick firing) workers to sustain them while working under high radiant heat temperature(55-60 ° Celsius).
- This project, in particular, is aimed at reducing the radiant heat being experienced by the workers with special reference to their face and neck region.
- Addition of cooling effect and sweat control in helmet.

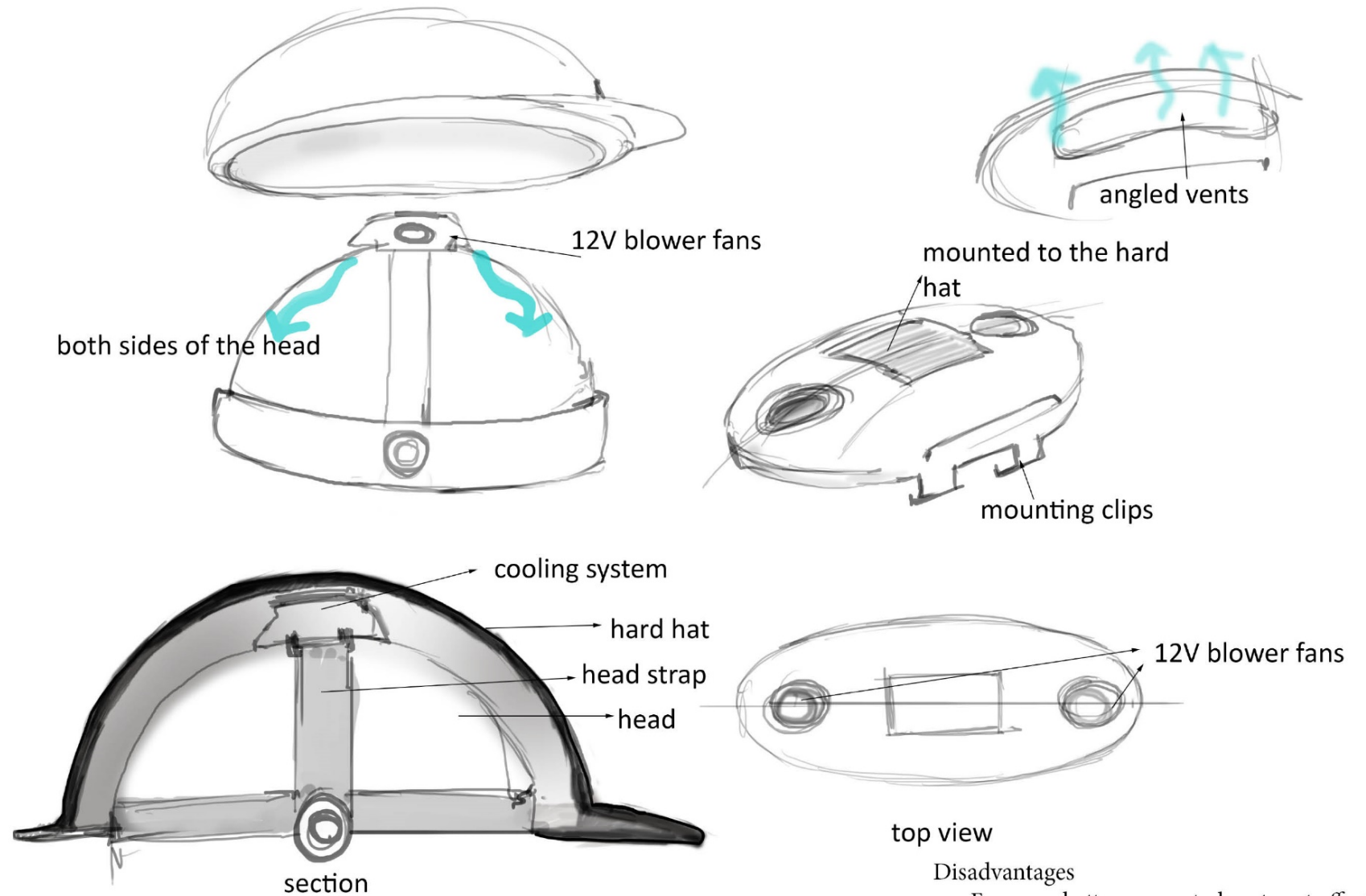
Basic human head anthropometry data



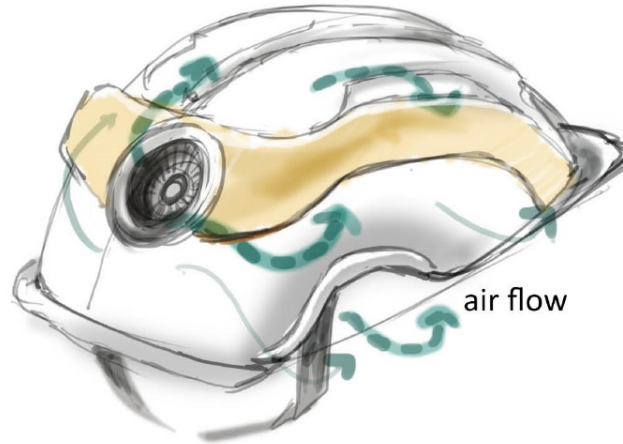
Keywords for
concept generation



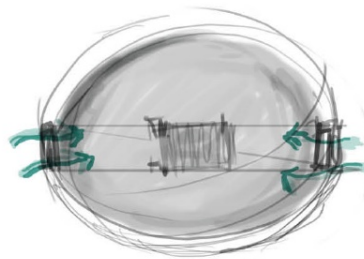
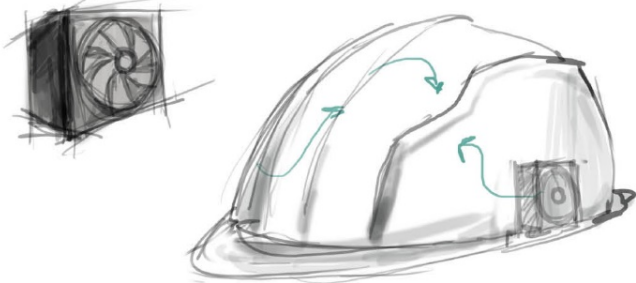
Concept of cooling system for hard hats



Concept of cooling system for hard hats



9V blower fan



air flow

Disadvantages

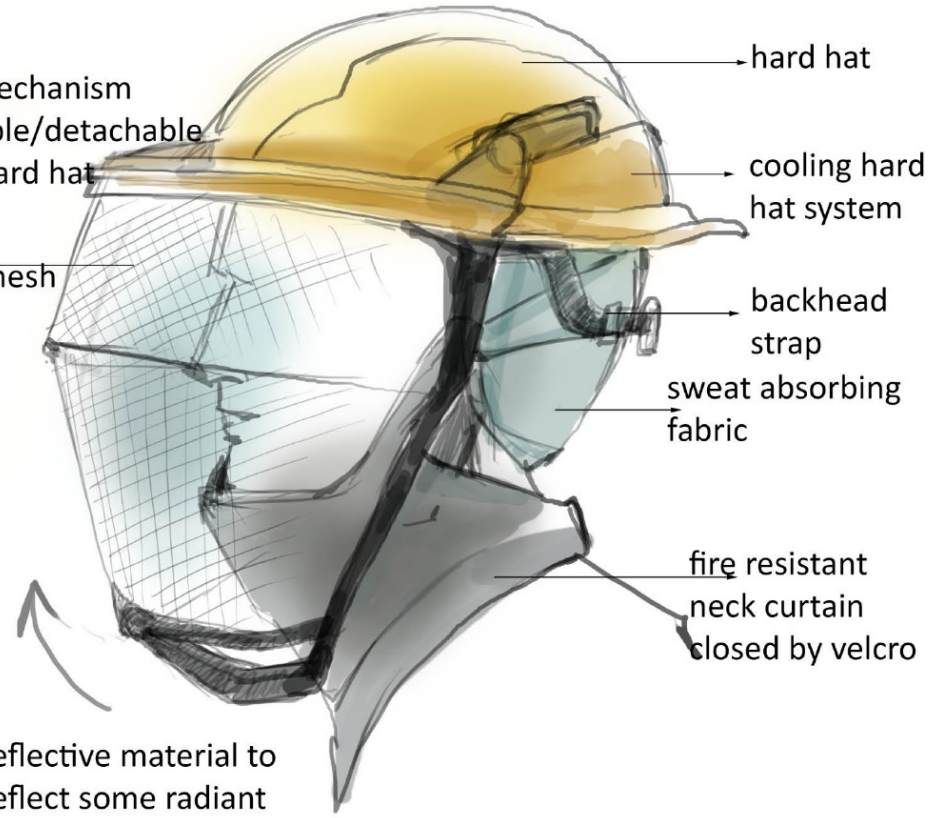
- Fan runs battery operated, not cost effective

Concepts for visor and neck protection system 1



hinge mechanism
attachable/detachable
to the hard hat

copper mesh



hard hat

cooling hard
hat system

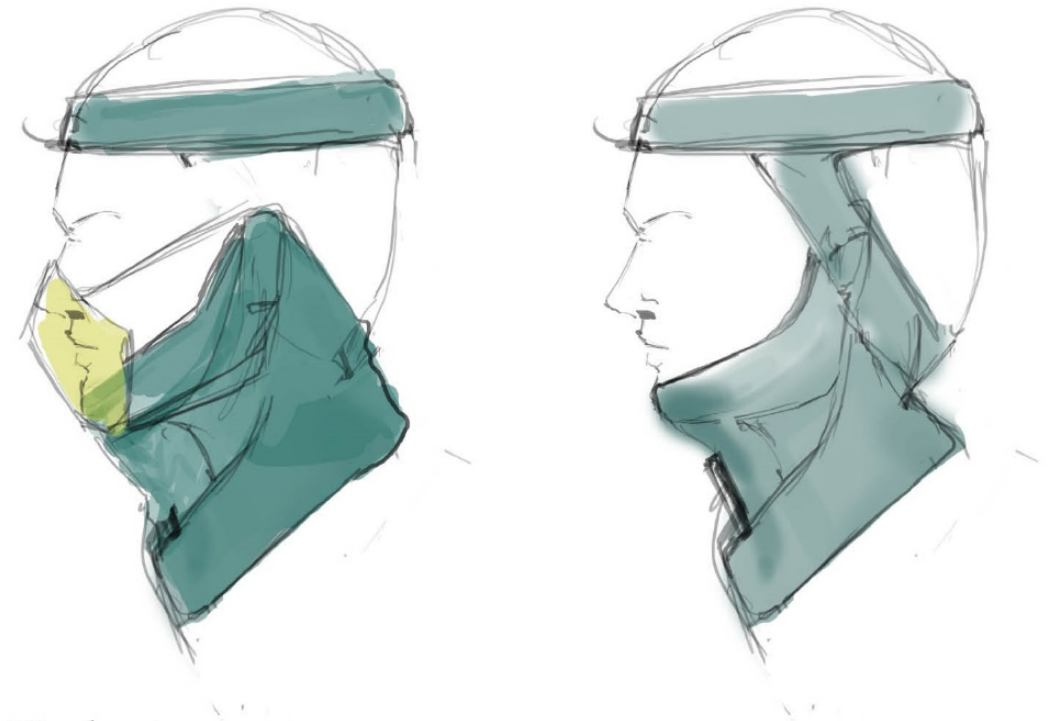
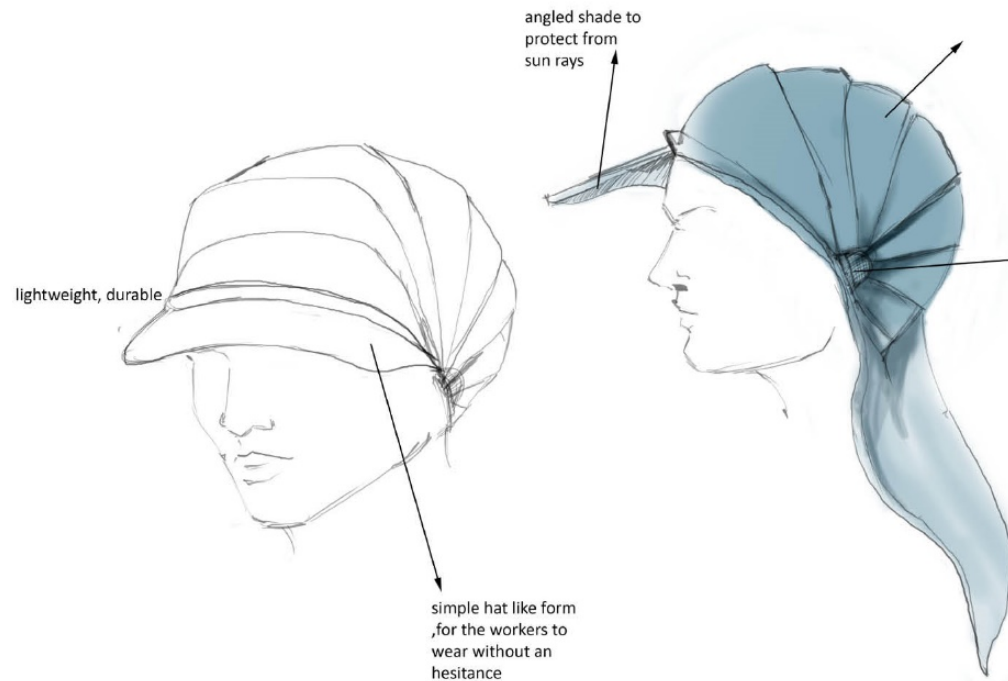
backhead
strap

sweat absorbing
fabric

fire resistant
neck curtain
closed by velcro

reflective material to
reflect some radiant
heat

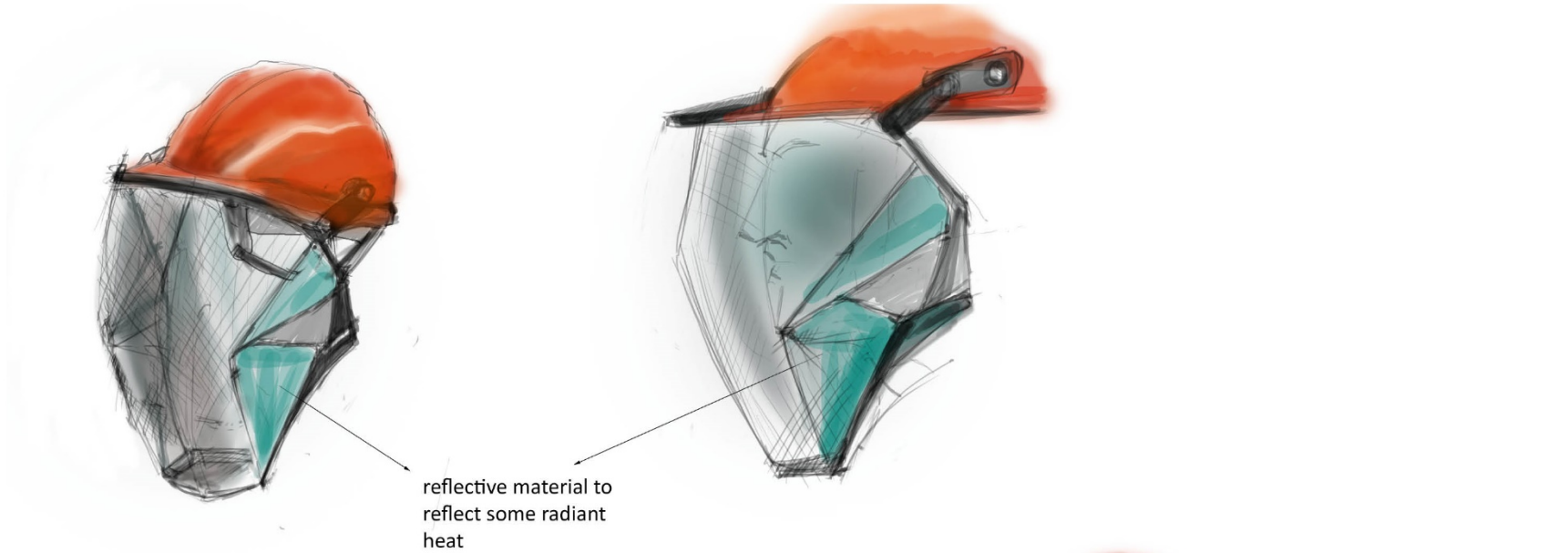
Ideations for head and neck protection system



Disadvantages

- A sense of congestion at the neck and chin portion when subjected to longer duration of work at extreme conditions of temperature, as it is closely in contact with the larger part of the body.

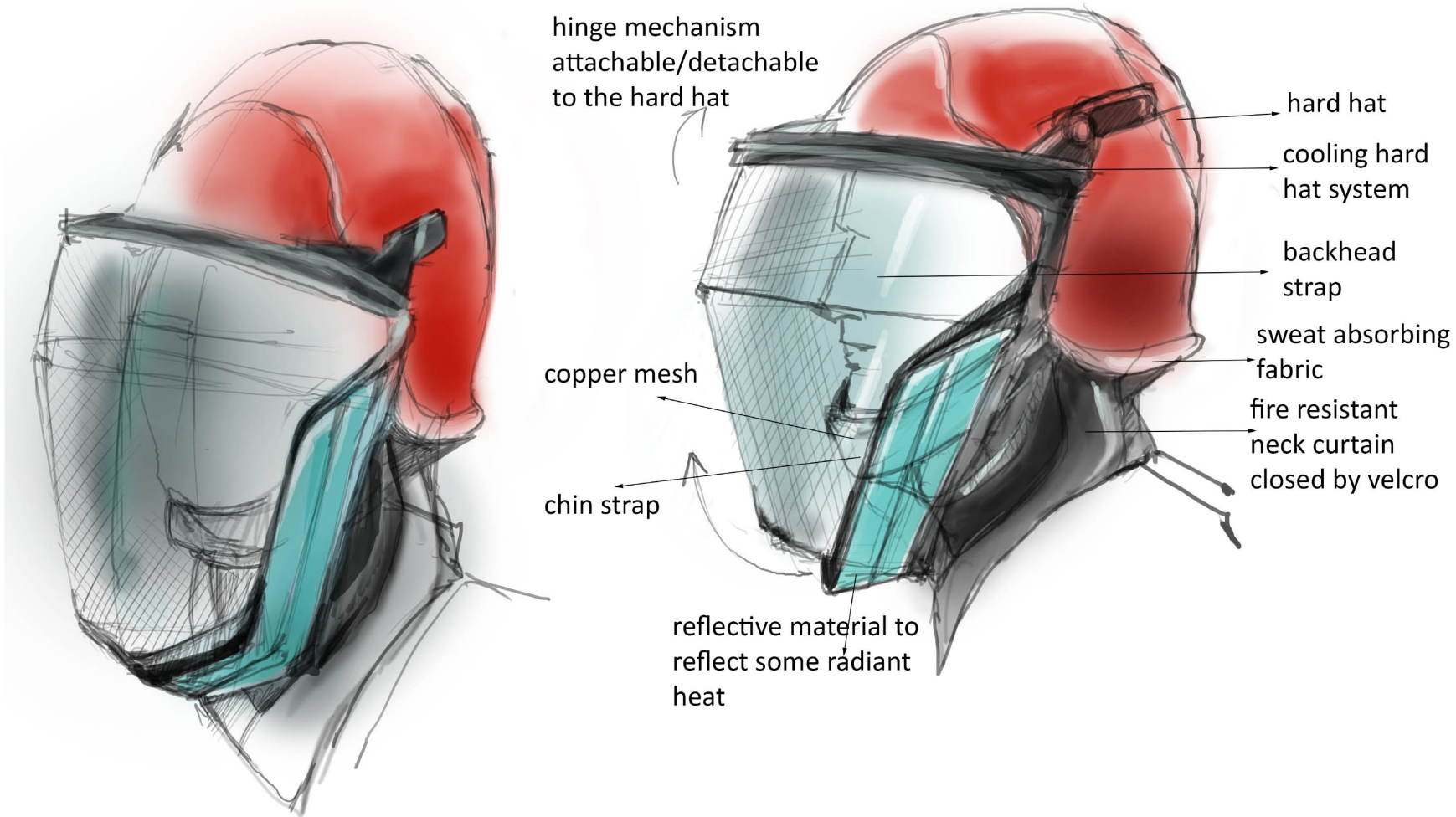
Visor design options

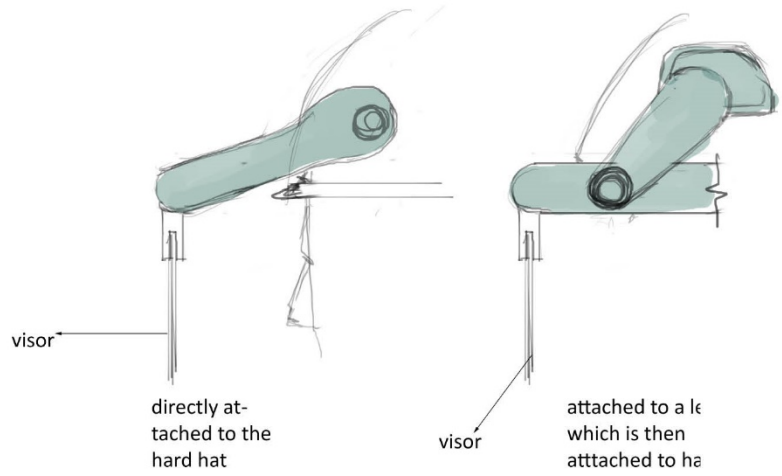


Visor design options



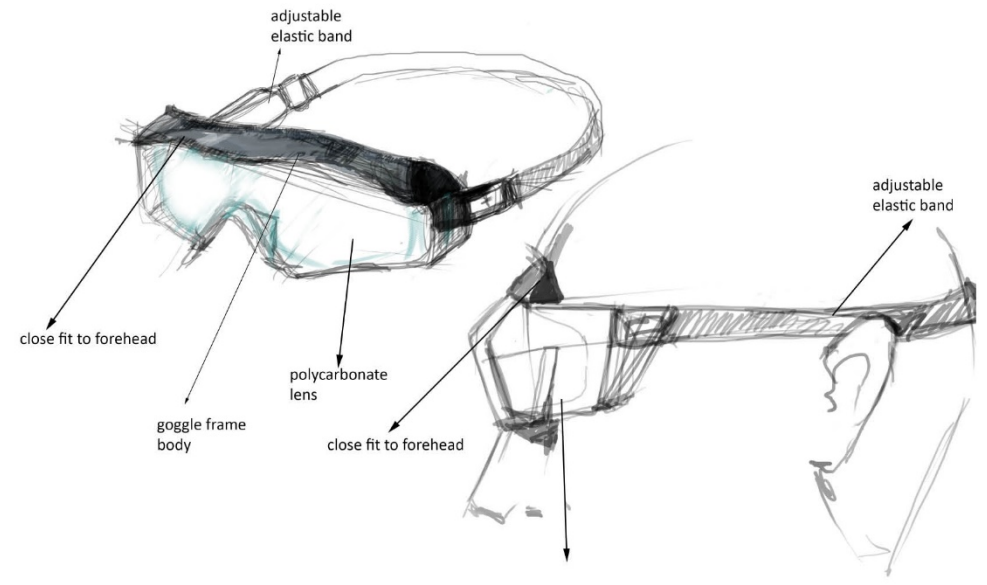
Concepts for visor and neck protection system 2



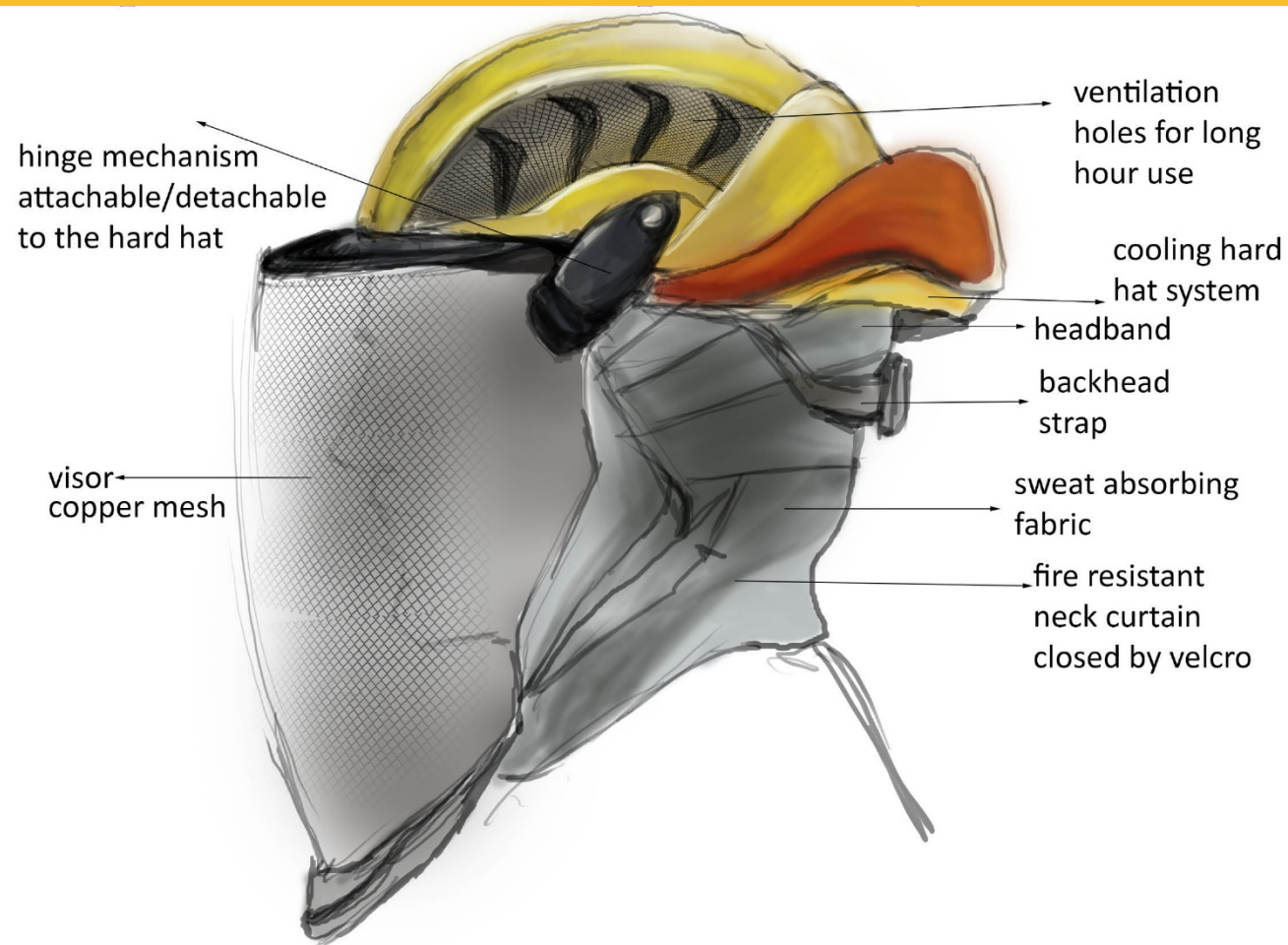


Separate eye protective wear concept

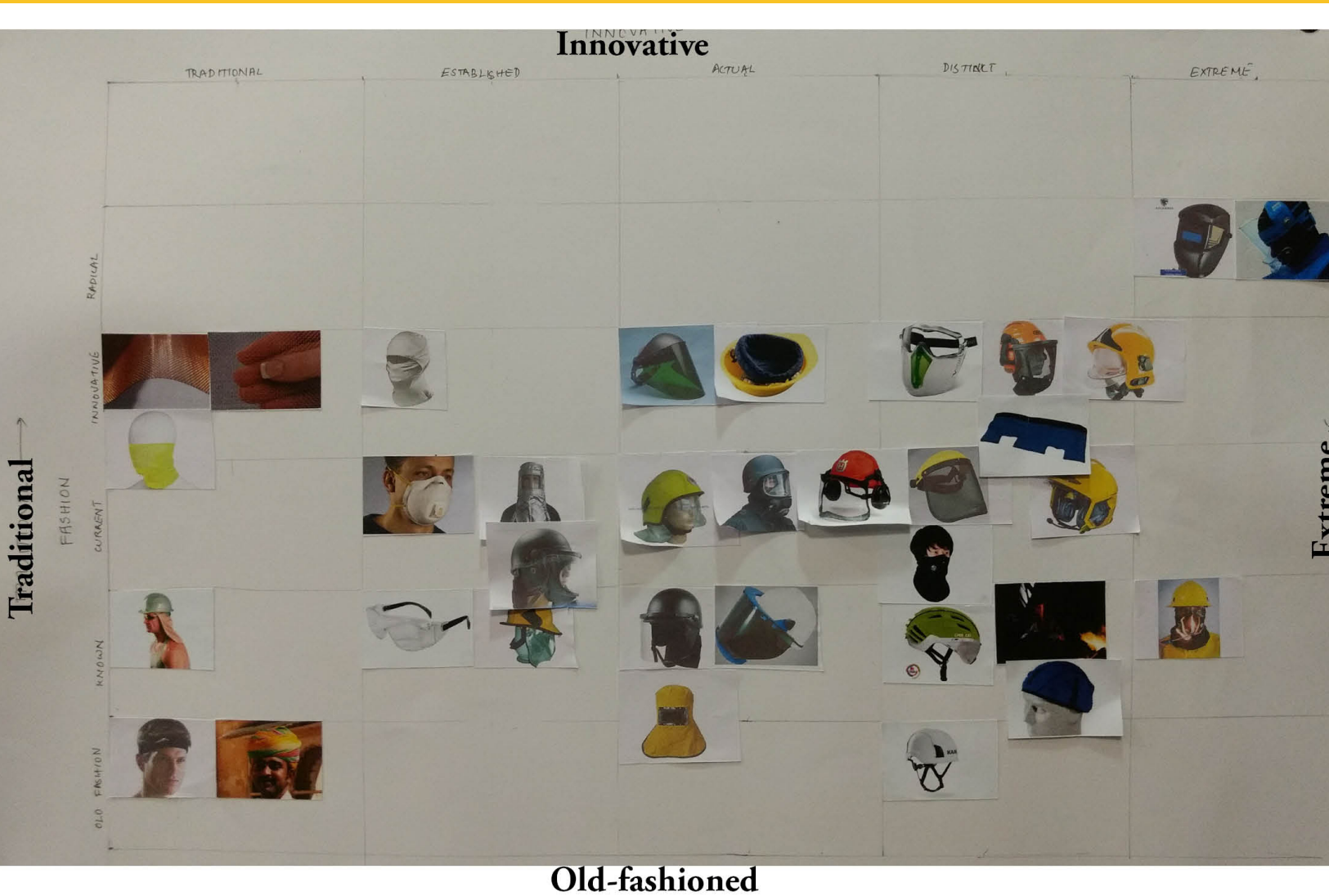
Connection of visor to hard hat



Concepts for visor and neck protection system 3



Visual perception matrix

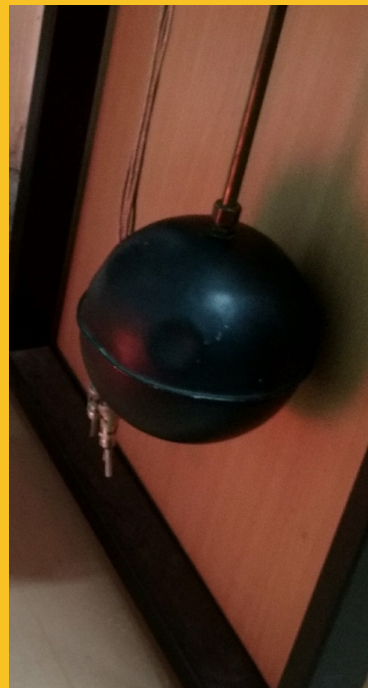


By perceiving the characteristics of the existing products in the market helps in a great deal towards the concept generation and apprehend the design logic behind it. The similar images related to the product were collected and arranged in a matrix with the axis traditional, innovative, old fashioned, extreme. Then you can determine the zone and jonour of product you want to design.

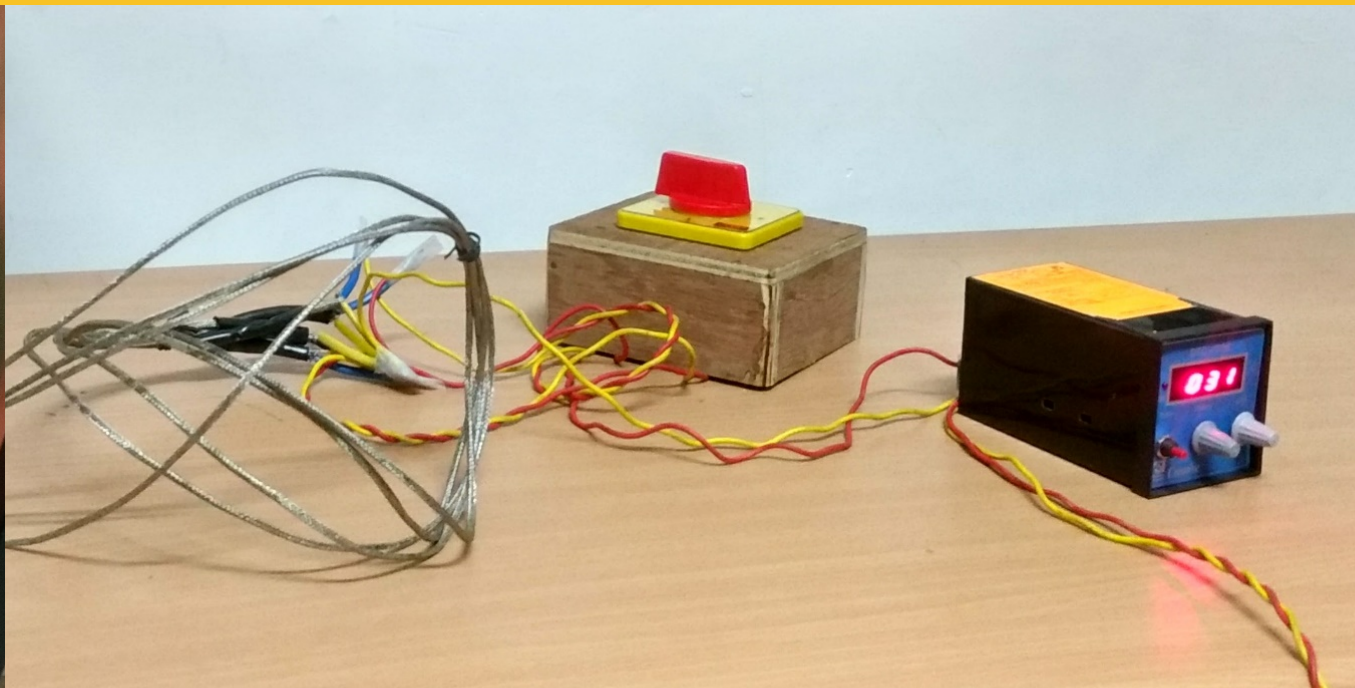
Material selection experimentation



Room heater(radiant type)



Globe
temperature(to
measure radiant
heat temperature)



Heat sensor

Material selection experimentation



acrylic

Sensors inside and outside

Wire mesh

Globe temperature (to measure radiant heat temperature)

Room heater (radiant type)

Heat sensor

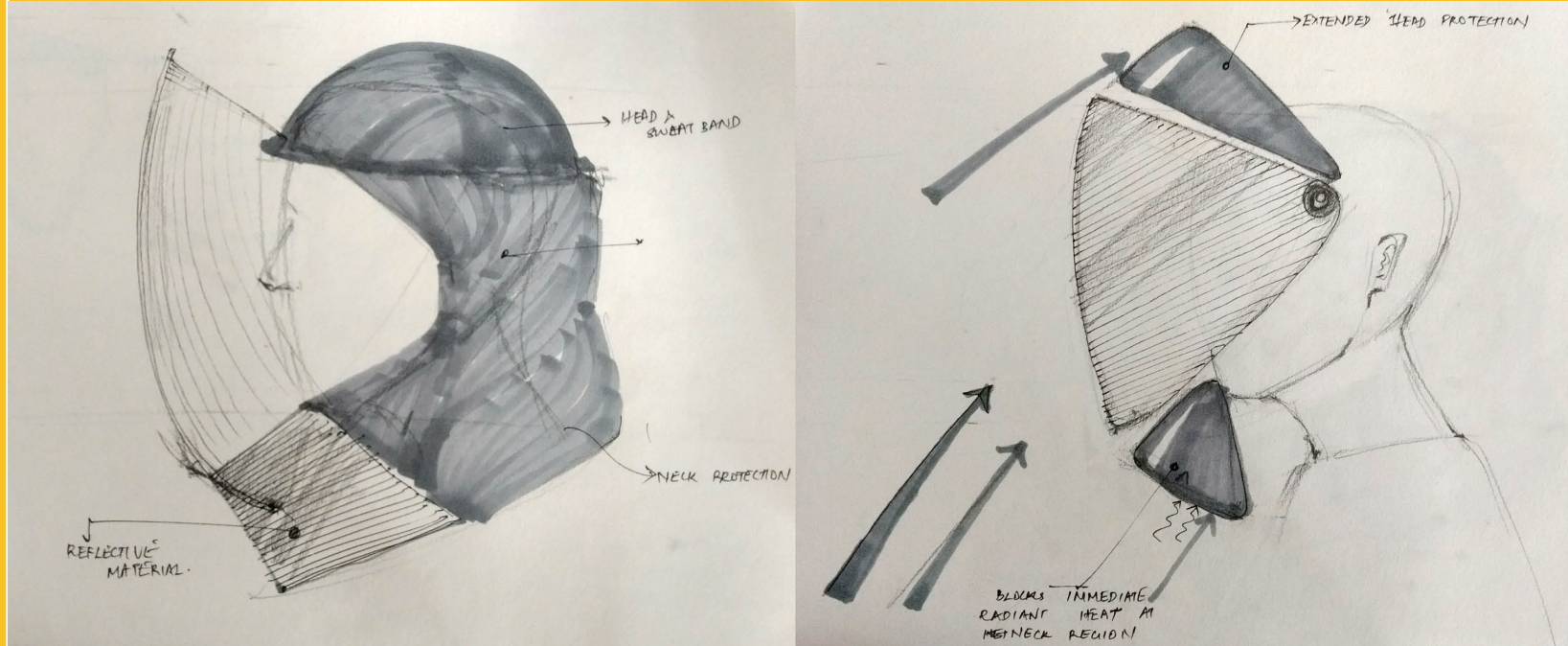
MATERIAL ANALYSIS

VISOR

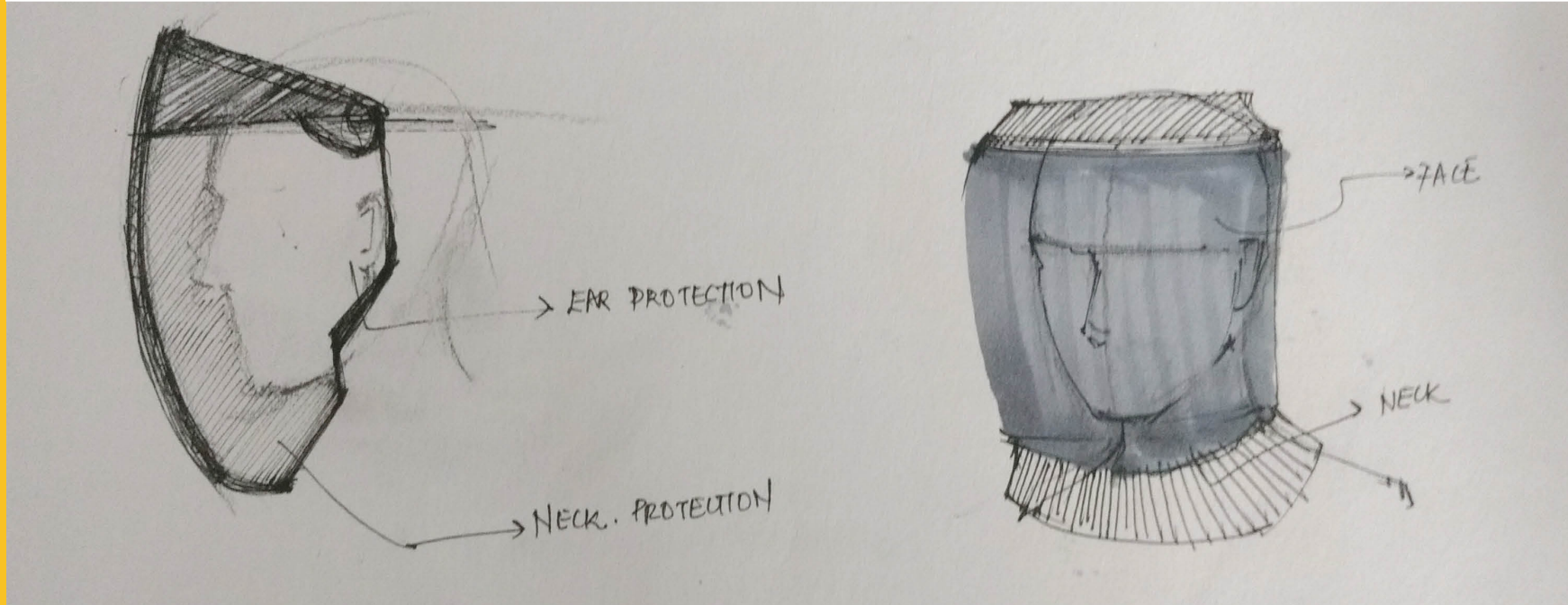
- Highly heat resistant with a low thermal conductivity coefficient
- High transmission of visible light (400-700 nm)
- Lightweight
- Durable
- Cost effective
- The radiant heat deflection element is preferably made of an aluminum-based material. Industrial grade aluminized polyester is preferred which is capable of reflecting up to 97% of radiant heat.

Acrylic is lightweight (1.18 g/cm^3), transparent, durable with a high transmittance in the visible region. Its total light transmission is 92%

Basic concept representation



Basic concept representation



Concept visor



Top part of head and neck to be covered. Visor extended



According to the profile of head and reducing the area of vision

Concept

Inspirational images

Head band and neck protection



Beekeepers suit



Indian traditional turban

Concept

Inspirational images

Head band and neck protection

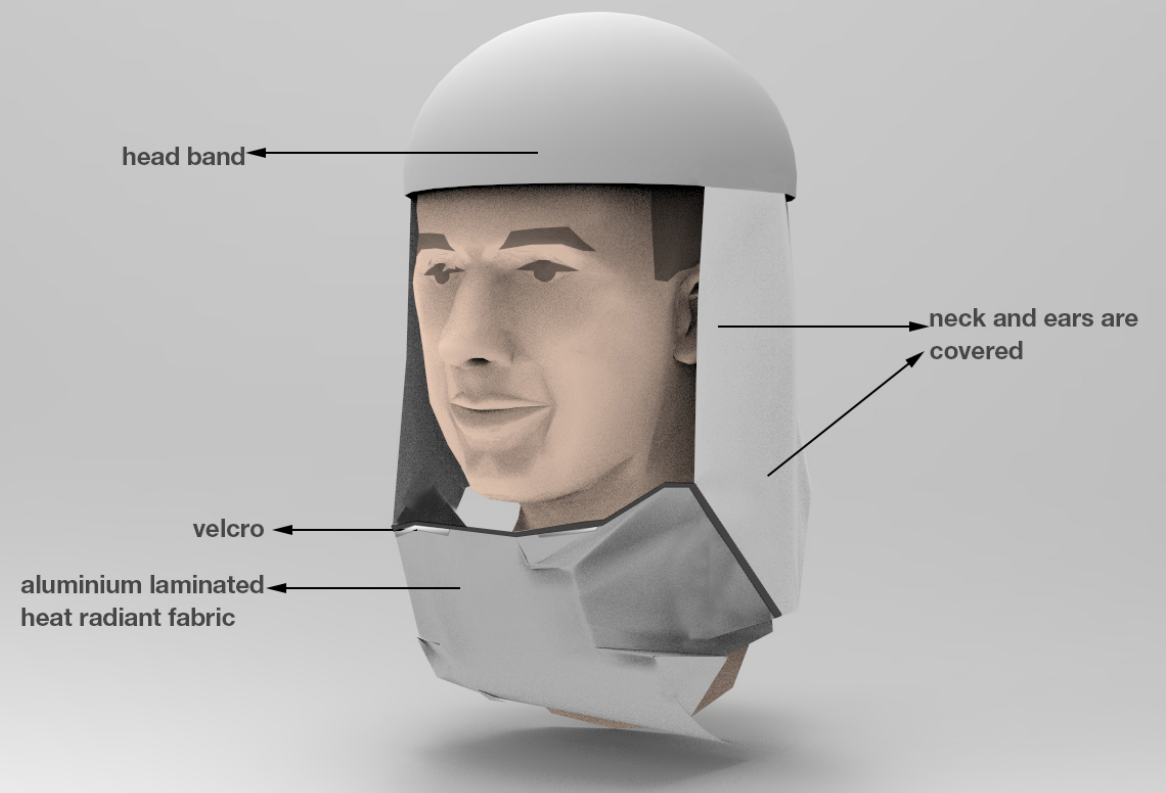


www.alamy.com - EBGB12

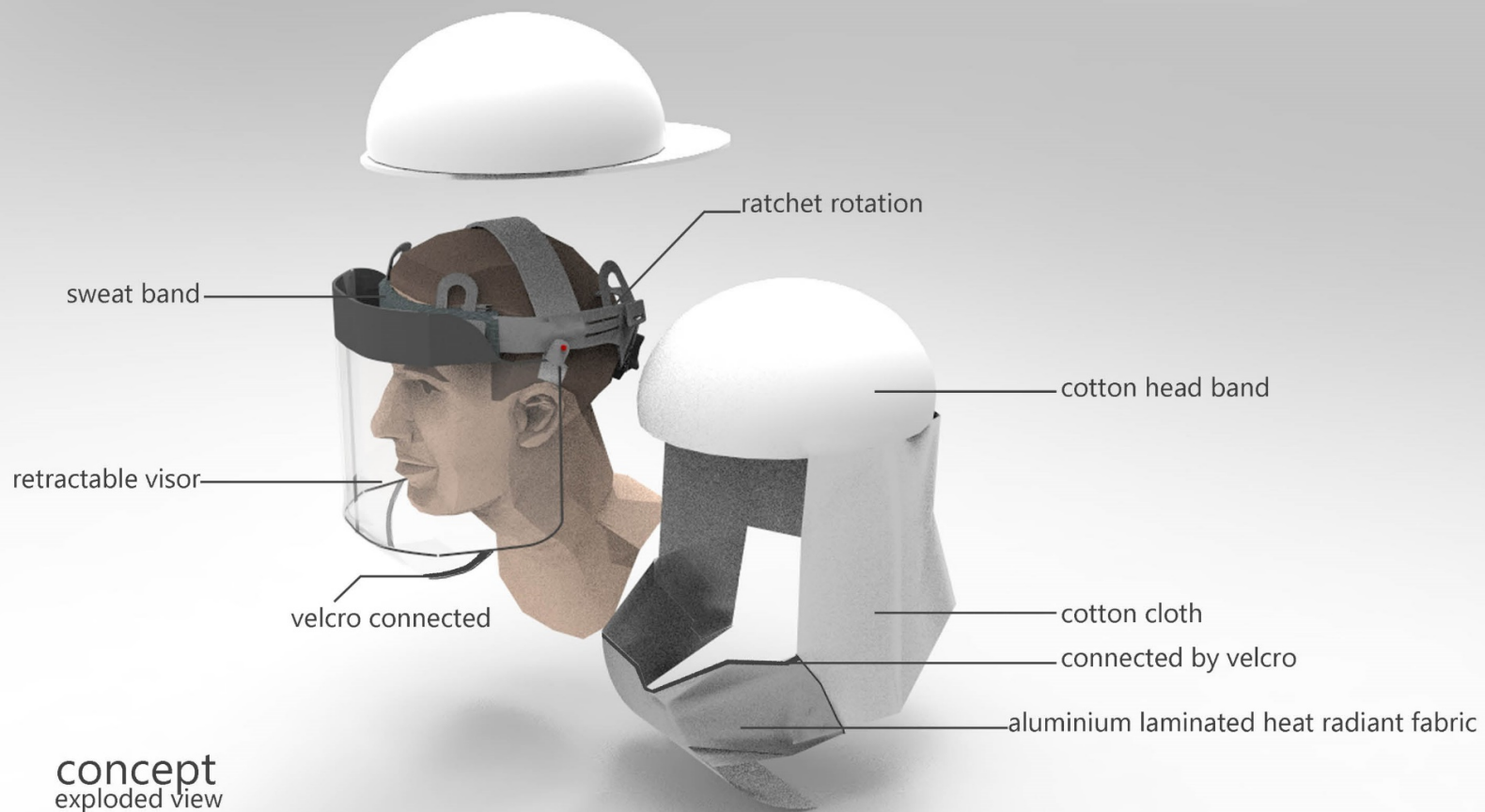


Concept

Head band and neck protection



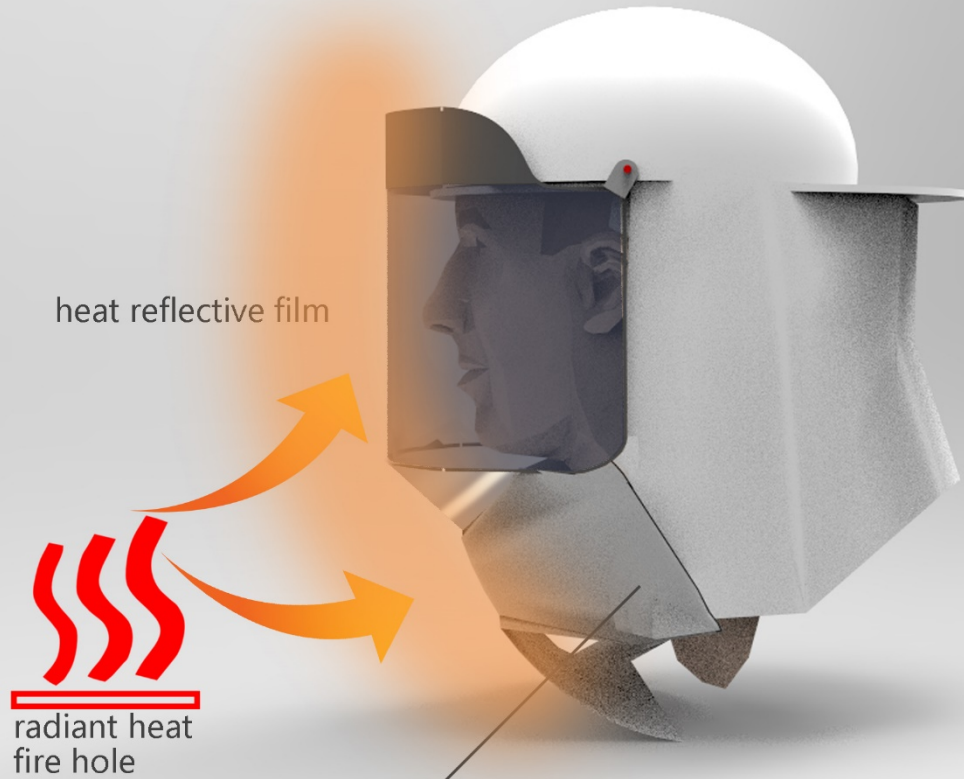
Concept 1



Concept 1



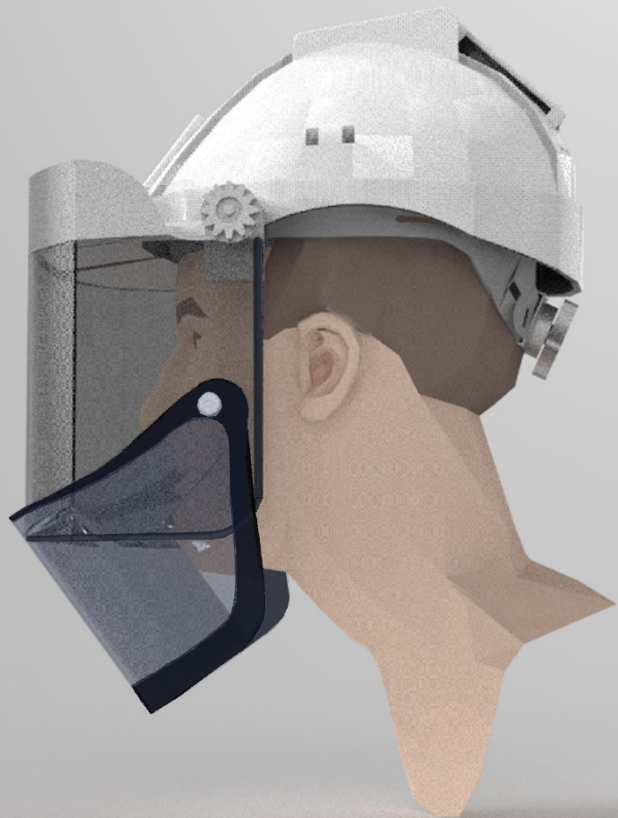
to withstand immediate radiant heat at face and neck region



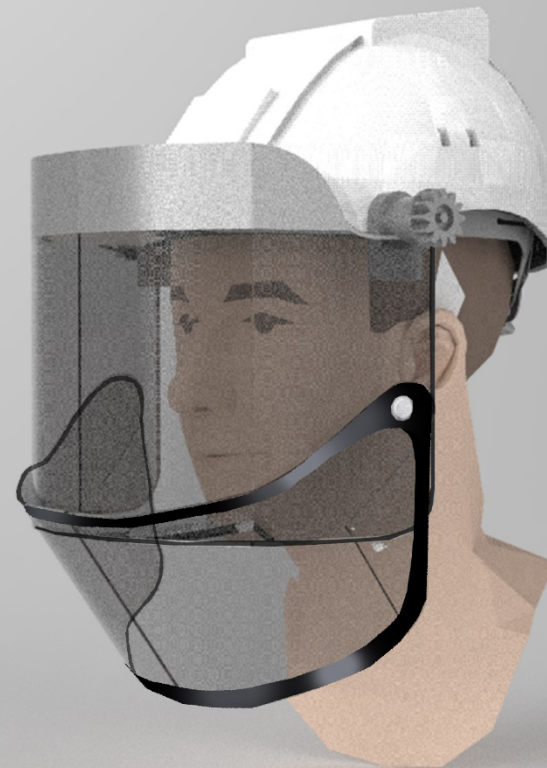
aluminium laminated heat radiant fabric

concept

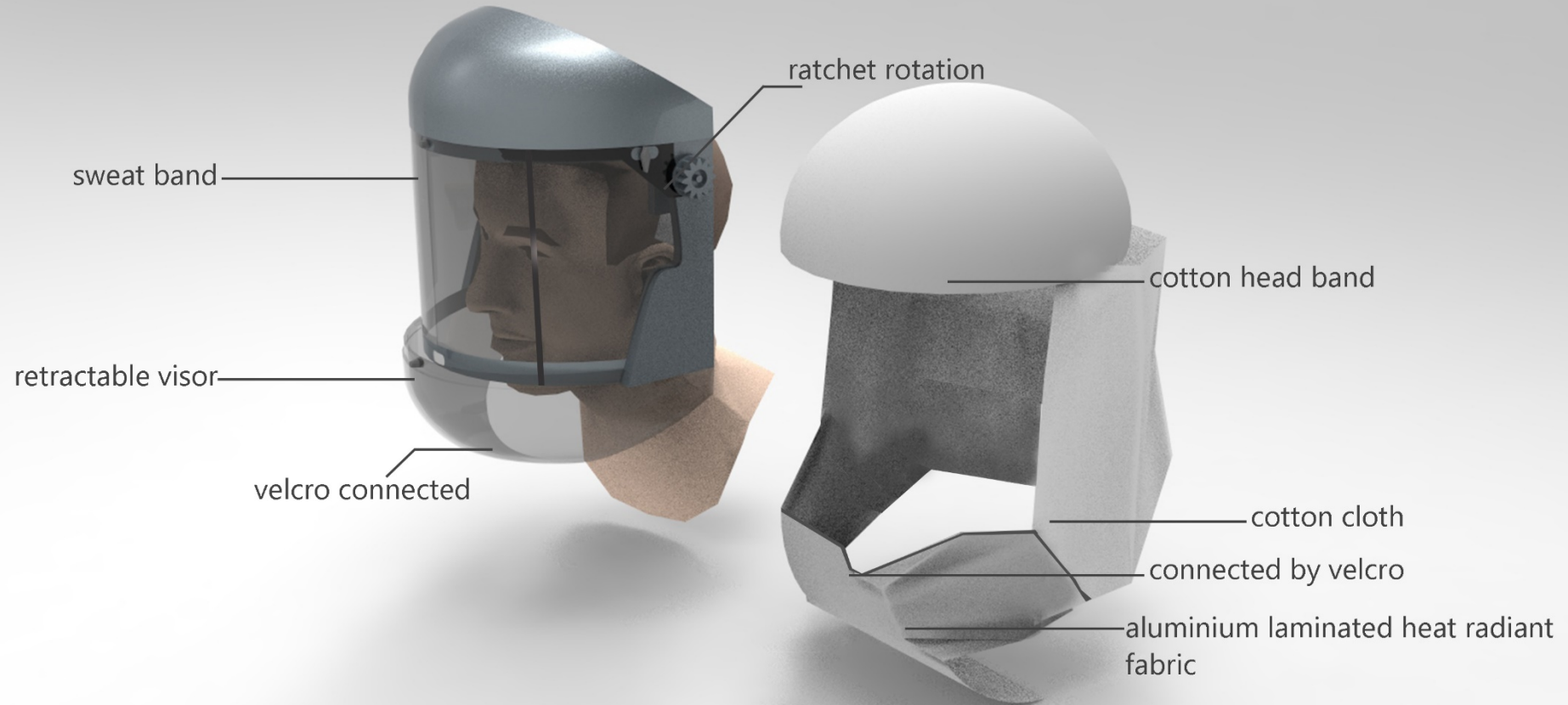
Concept 1



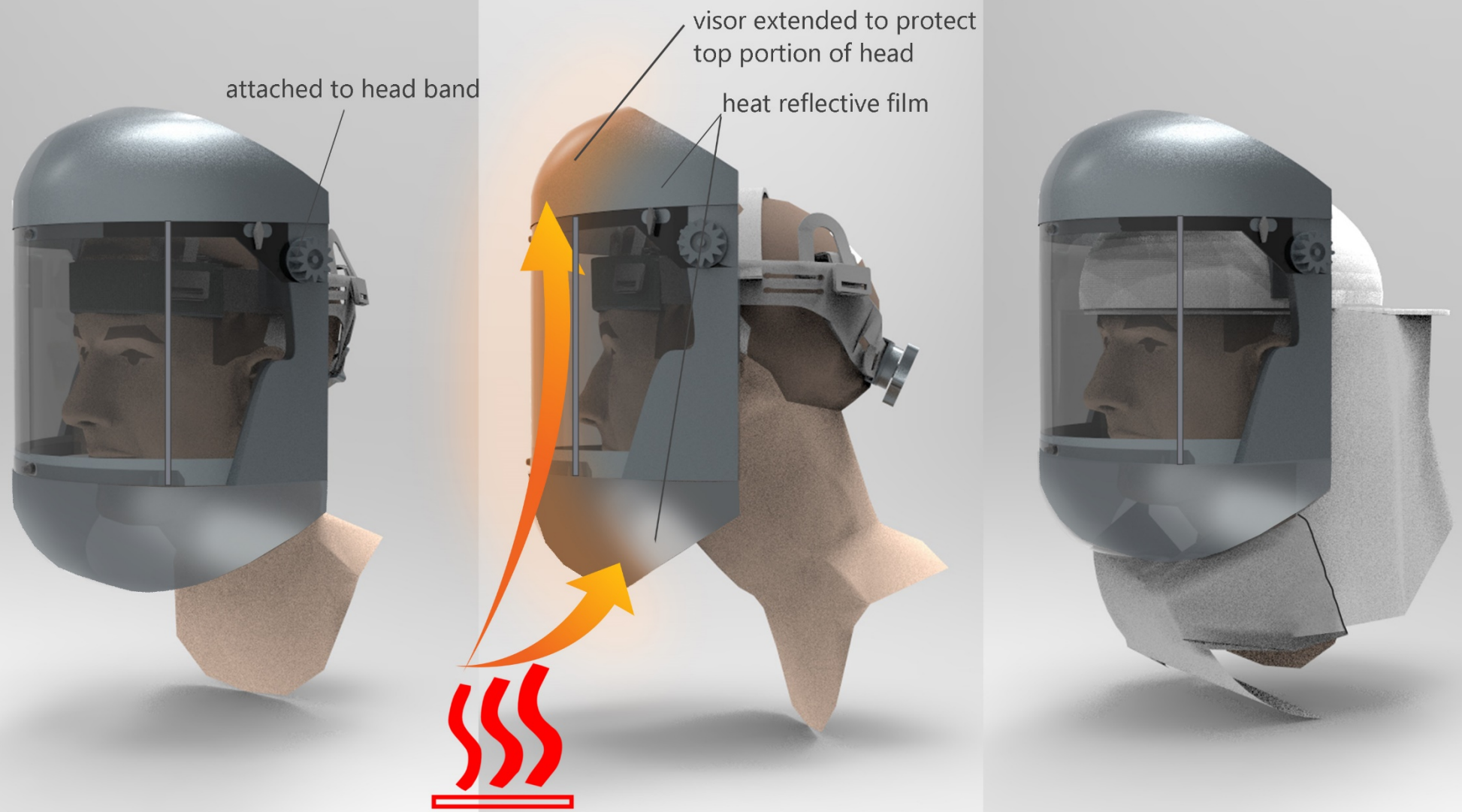
concept
retractable visor



Concept 2



Concept 2



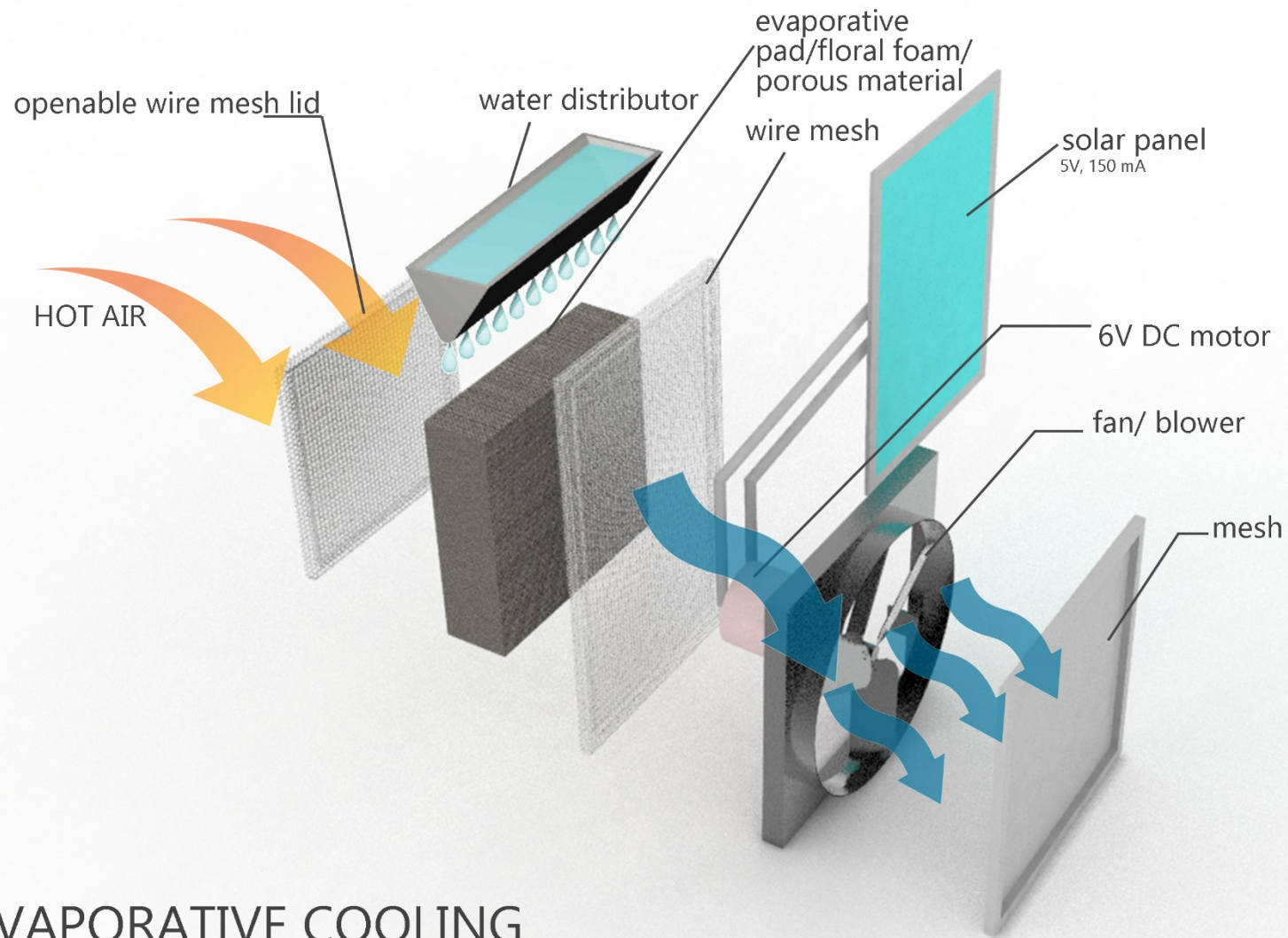
concept
retractable visor

Concept 2



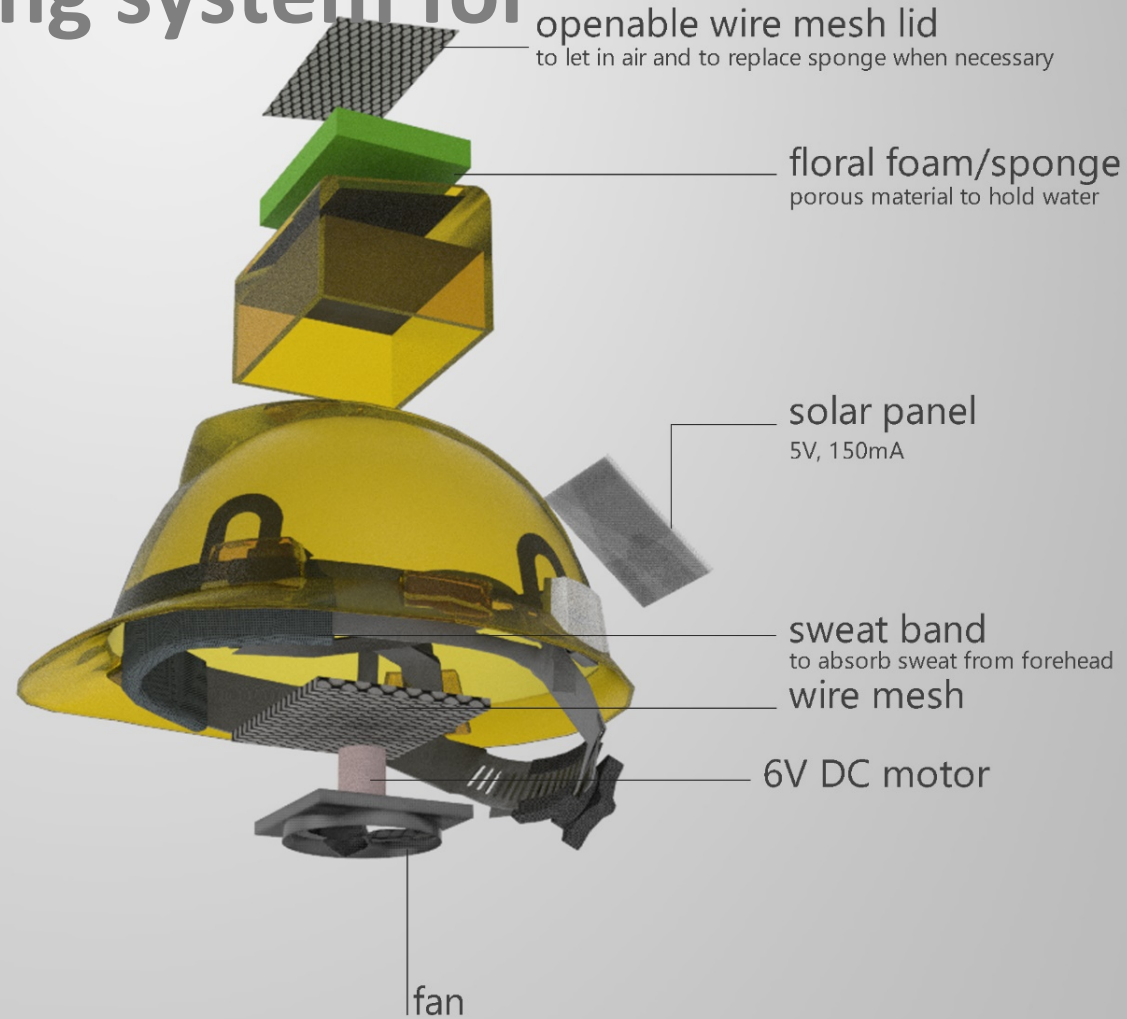
Description

- The main principle behind designing the equipment was that of insulation against heat from the environment. So, the appropriate ways to insulate the worker without intervening into his natural work process.
- The total weight of the helmet is comfortable for the worker working for 8-10 hours under radiant heat temperature of 55-60 degree Celsius
- The retractable visor enables the worker to talk to their fellow workers without taking their helmet off and spit both of which are very essential to their natural way of work.
- The ventilation also prevents the visor from becoming foggy.
- The product does not require any maintenance
- The cleaning wiper is slid through the channel in the middle so that the visor cannot be dusty as the environment is dusty.
- Heat reflective aluminized polyester film which is capable of reflecting 97 % of radiant heat.
- Visor is extended at the top part of the head so as to protect from immediate radiant heat
- The helmet also contains ventilation holes with has a filter which filters the dust from the environment and makes the air that the workers are breathing cleaner and healthier.
- The ventilation also prevents the visor from becoming foggy

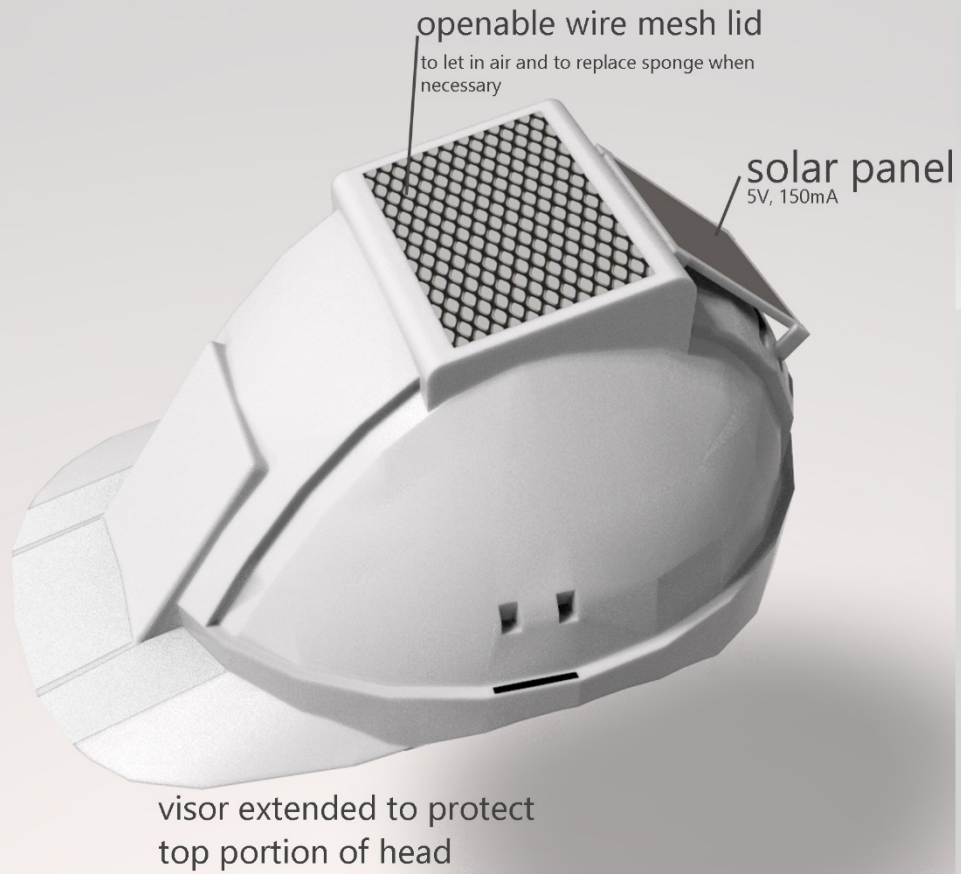


EVAPORATIVE COOLING CONCEPT

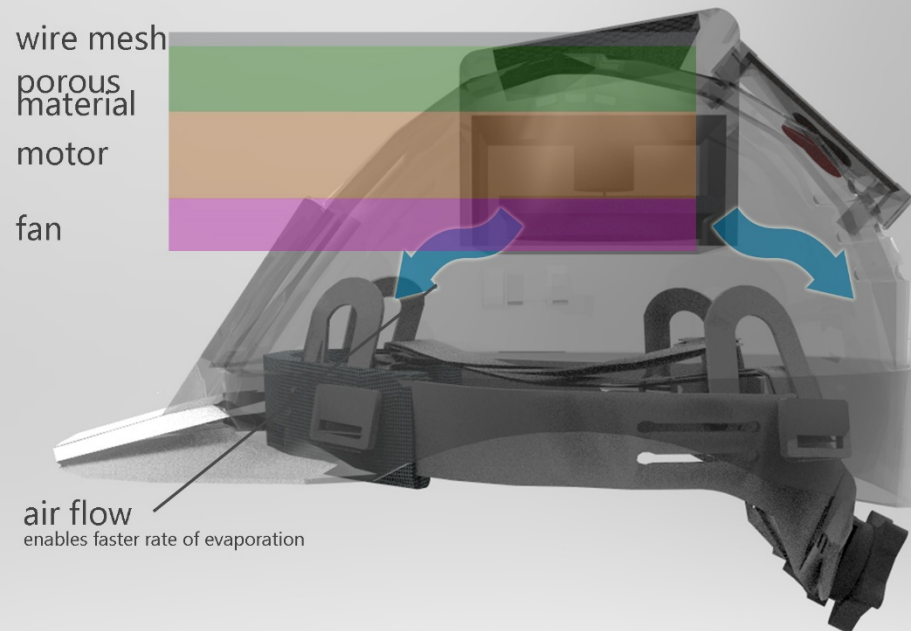
Solar powered fan and affordable cooling system for head



concept
exploded view



HARD HAT



Prototypes for testing



OBJECTIVES TO BE IDENTIFIED

- The total weight of the helmet is comfortable for the worker working for 8-10 hours under radiant heat temperature of 55-60 degree Celsius
- To analyse the process of pouring water over the porous material at regular intervals of time and its level of easiness

Brief description

- The main principle behind designing the equipment was that of insulation against heat from the environment. So, the appropriate ways to insulate the worker without intervening into his natural work process.
- The total weight of the helmet is comfortable for the worker working for 8-10 hours under radiant heat temperature of 55-60 degree Celsius
- The retractable visor enables the worker to talk to their fellow workers without taking their helmet off and spit both of which are very essential to their natural way of work.
- The ventilation also prevents the visor from becoming foggy.
- The product does not require any maintenance
- The cleaning wiper is slid through the channel in the middle so that the visor cannot be dusty as the environment is dusty.
- Heat reflective aluminized polyester film which is capable of reflecting 97 % of radiant heat.
- Visor is extended at the top part of the head so as to protect from immediate radiant heat
- Taking the concept of evaporative cooling, to enable body temperature drop by sweat evaporation, helmet is designed. This enables faster rate of evaporation of sweat from the surface of the head.
- The process of pouring water over the porous material at regular intervals of time and its level of easiness for the evaporative cooling technology

Working scenario



How the value is added?

- This wearable solves the issue of heat stress experienced by the body when exposed to high temperatures when the body is unable to control its core temperatures by sweating or other natural cooling methods and when it is prone to different heat induced illness like heat stroke, heat exhaustion, heat cramps, heat rash, rhabdomyolysis, heat syncope.
- The fan helps to blow air and thereby increase the comfort level of the worker. The flow of air helps reduce the heat felt by the worker as a result of convection. Despite the head being fully covered, the worker will not feel as uncomfortable as the fan circulates air.
- The value spent by the organisation is totally worth it in the longer run when considering the health factor of the workers.
- An awareness of personal care, hygiene etc. is evoked through this initiative

strengths

- Completely caters to the Indian climatic conditions .
- Frugal design
- Easy to maintain
- Relation to the current head wearable, inspired from traditional turban style design which covers head and neck region
- Easily to manufacture
- Cost effective innovative product
- Abrasion resistant
- Cloth acts as a radiator, absorbs more sweat after the water is dried out, and dissipates on the surface.
- Durable
- Sustainable technology
- Easily fit to head
- Portable
- Non harmful to the body parts

Weaknesses

The workers are not aware of the health issues while working under the high radiant heat temperature(55-60 Celsius)

The jalaai workers cant buy their own set of wearable as they cant afford it, so the contractors should assist for the purchase of the wearable .

The NGO's should come up to spirit up with their own business model.

Opportunities

Solar powered evaporative cooling technology technique is not feasible in most of the occasions as the water has to be refilled . But this can be done in this scenario as the process of refilling can be done during the resting time after 15-20 minutes of work

Threats

As the product is easy to manufacture and sold there is a chance of emergence of another company with the same technology

Dying out of the technology of brick firing in Indian scenario will result in threat to the business

There is a chance of economic downturn as the health awareness is not prevailing in most parts of India

Services could be changed over time

Thank you