PROJECT 3
GROWTH MONITORING DEVICE FOR INFANTS

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GUIDE:
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What is GROWTH MONITORING?

- Screening tool to diagnose nutritional, endocrine disease at an early stage.

- Measurements are taken starting from birth at regular intervals.

- Frequency of monitoring reduces as the child grows up

AIM of Growth monitoring

- Prevention of disease, malnutrition, death

- Medical referrals

- Parents get sensitized to formation about health and nutrition

- Pediatricians are encouraged to use growth charts for standardization

- Allows recording large scale data and analysis

Measurements needed

- Weight
- Height
- Head circumference

Standard practice

- MUAC
- Chest circumference
- Abdomen circumference

Only for undernourished children

Current scenario

- Most hospitals and clinics ignore growth monitoring since it does not have any immediate consequences

- Weight of the infant is checked often, but the other measurements are rarely taken.

- Often they simply use a measuring tape for length measurement.

Devices used

Length, height measurement
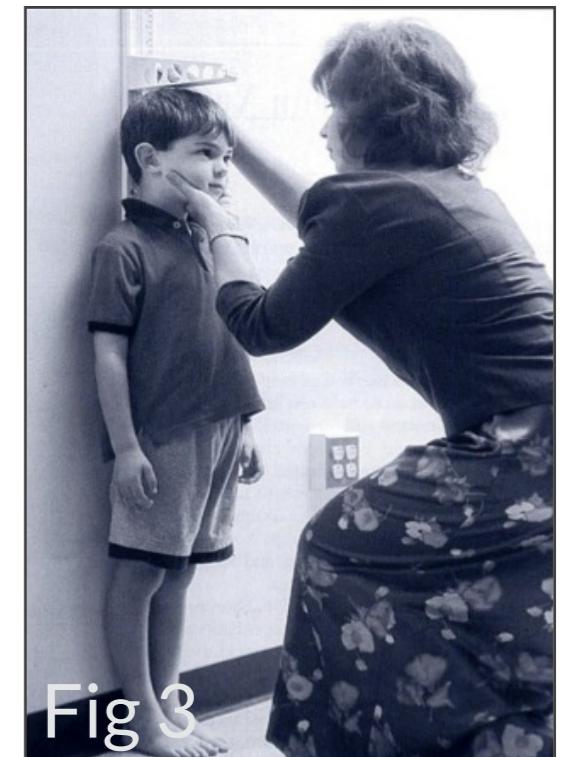

Fig 1

Fig 2

Fig 3

Fig 1: Infantometer is used for measuring length in supine position.

Fig 2: Measuring length of a baby in a rural set up

Fig 3: Measuring the length of a child who can stand steadily by himself using a stadiometer

Devices used

Weight measurement

Fig 1

Fig 2

Fig 3

Fig 4

- Fig 1: Weighing scale for infants less than 1 years of age

- Fig 2: Weighing a child using a spring balance

- Fig 3: Big weighing scale for older children with a railing for them to hold and stand.

- Fig 4: Regular weighing scale

Devices used

Circumference measurement

Fig 1

Fig 2

Fig 3

- Fig 1: Measuring the head circumference

- Fig 2: Measuring MUAC

- Fig 3: Measuring chest circumference

Field Study

Wadia Hospital:

- Government hospital
- Extremely crowded
- Children are examined on a wooden table
- Most of these children are malnourished
- They are rarely weighed or measured.
- Weighing scales and stadiometers are available, but no infantometers

Holy Spirit Hospital

- Private Multi-specialty hospital
- Frequent patients in the pediatric OPD
- They have an infantometer, but take length measuremnts using a measuring tape
- They also have a stadiometer and a weighing scale.

Devices available in Holy Spirit Hospital

Weighing machine

Infant weighing machine
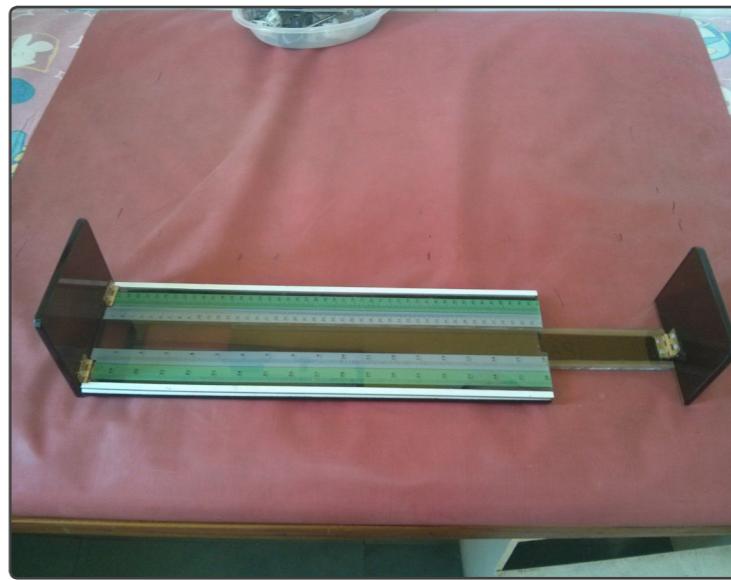
Infantometer
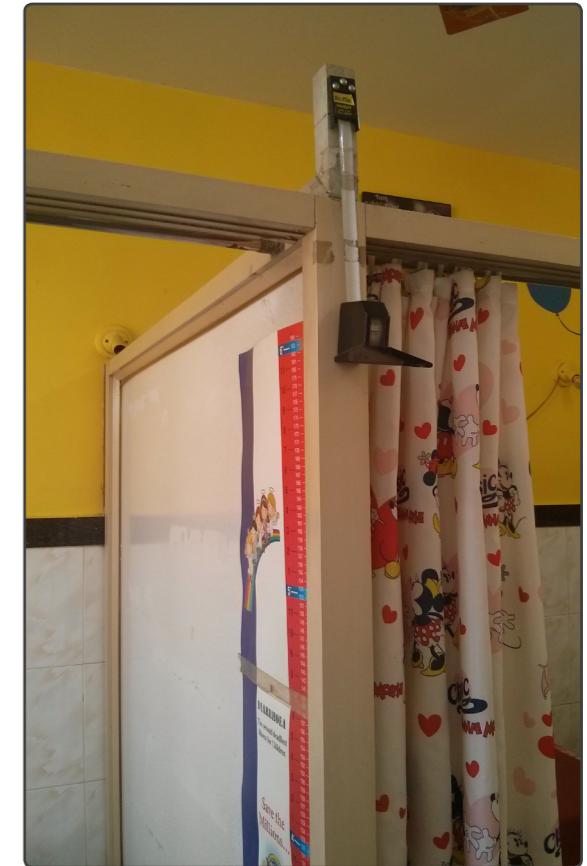
Stadiometer

Inferences from primary and secondary research

Use of infantometer:

. Movement fo infants

. Uncomfortable surface

. Sterilization between uses is necessary

. Number of people for measuring the baby must be reduced.

Accuracy:

. There is a lack of accuracy in the measurement of height or length.

Safety:

. Newborn babies and babies under the age of 6 months are put on the weighing scale. It is necessary to ensure their safety.

. Children between the age group of 1-3 are afraid to get onto the weighing scale.

Time:

- The total time taken for the process must be less.
- It should be hassle free and easy to record and maintain

Portability:

- Doctors should be able to easily carry it to rural areas, PHCs etc.
- Installation must be simple, and the device must be easy to use
- The energy source of this product must also be independent of the facilities provided in the village.

Data Storage:

- Study the need for data storage, analysis of trends, levels of malnourishment, growth patterns in different parts of the country etc.

Design Objective

To allow for easier, faster and more accurate growth monitoring procedures

Design Brief

To design a growth monitoring device which allows for measurement of height, weight and head, chest and abdomen circumference of infants under the age of 1.5 years, and adhere to the following features:

1. Requires less number of people to take readings

2. Portable for easy transportation and use in health camps, etc.

3. Gives high accuracy output

4. Allows for easy sterilization between uses

5. Ensures safety and security of the infant

Users:

Nurses, Doctors, and partially trained health workers in a health camp, rural hospitals or clinics. The system should be easy to carry, set-up, use and dismantle.

Usage scenario:

Small clinics

Health camps

Rural hospitals

Mindmap

Growth Monitoring Device

Weight
- Regular Weighing Scale
- Vegetable Weighing Scale
- Supine → Electronic Weighing Scale → Accurate!
- Weigh in Scale
- Standing → Fear of Stepping on Scale
- Standing → Does Not Want to Leave Parent
- Accuracy

Portability
- Lightweight
- Easy to Instal
- Easy to Carry
- Foldable
- Collapsible

Growth Charts
- Recording
- Provide Feedback
- Plot New Charts
- Info.

Length
- Handheld Device
- Supine
  - Sensors → Proximity → Optical
  - Sensors → Non Contact
  - Image Processing
  - Hold Baby in Position
- Standing
- Tape
- Infantometers
  - Sterilize
  - Sliding Mechanism

Safety
- Comfort
- Hold Child Properly
- Security
- Hygienic

Tape
- Coloured
- Electronic
- Throwaway

Circumferences
- Head
- MUAC
- Chest
- Abdomen
- Sensors
- Attachments onto the Infantometer

Focus points for ideation

- Control the movement of the infant

- Sterilization methods

- Making it a one person job

- Technology available for measurements, such as sensors, scanners etc.

- Analogies from existing measuring devices in the market

- Safe looking product

- Play value for children

- Portable - Detachable, Collapsible etc.

- Support provided for the head

- Non-contact type

Brainstorming

| IDEA	PLUS POINTS	CONCERNS	NEW IDEAS
IMAGE PROCESSING	• Highly accurate • Can fit all shapes and sizes • Can give lengths of various limbs	• Baby staying still ?? • Bending body?? • Prototype time frame? Possible in P3? • Protect child's eyes.	• Instead of putt... put marker in p... • Hanging stuff, play... • Have a scanner
POLARIZED LIGHT BEAM	• Nice, minimalist aesthetics. • Height measurement seems promising	• Child movement is a major concern Material for hygiene. • Cost factor? • Safety of babies' delicate skin.	• Can the baby be checked standing? • CLOTHING for measurement ??
PROXIMITY SENSORS	• Neat measurement technique • Sliding sensor — fixed sen...	• Caps on fingers — Accuracy? └→ How to make sensors align properly?	• Like WACOM — INKLINK pen. Draw straight line, it measures length. • Roller on finger — count rotation — move finger
CIRCUMFERENCES.	• Tape sliding good	• More whacky ideas needed. • Protect face, eyes Inflatable rubber (Bag like)	• Inflatable air pillows — All contours can be measured. • Check circumference or curvature measurements used for clay sculpting.
TAPE	• Throwaway tape. • Cheap • Hygienic.	• Bends, curves will get added • Inaccurate	Disposable • One tape per baby
HYGIENE	• Roll of tissue — good idea.		(1a) Roll of paper could have pre-printed scale
COMFORT, SAFETY	• Soft contouring for baby's body for safety — good	• WHACKYNESS !!	(1a) Inflatable products. Air / Sand / Water? • Heating element — To eliminate cold touch
SPRING LOADED TAPE	• Good for frugal solution. (1a) One head side, one leg side. Pull → Record.		• Piggyback idea — Add flags, play value, sand pit
EYE PIECE	• Calibrated scale. • No extra instrument	• Maybe expensive. • May have a learning curve? • Tech support?	
GLOVE FOR WEIGHT	• Hold in hand. • Does not need to leave lap. • Reduces crying.	• Expensive? Execution? • Big children? • Tech support?	• Weight + height in a VEST like design • Pressure cuff type cloth — with sensors?
HEAD SUPPORTS	• Comfort • Safety		
PLAY VALUE	• Children won't be scared to leave parent	— Might not be priority — It does not take too much time.	• Sandpit, Hanging things • Game for the kid?
SCANNING	3D scanning Photograph baby — process later.	• Expense? Execution Tech support ??	• Barcode type scanner. • Sand Image Processing • Scan baby — xerox ba... • LIVESCRIBE — tech. solution. • Sand KINECT — contours

Concept clusters
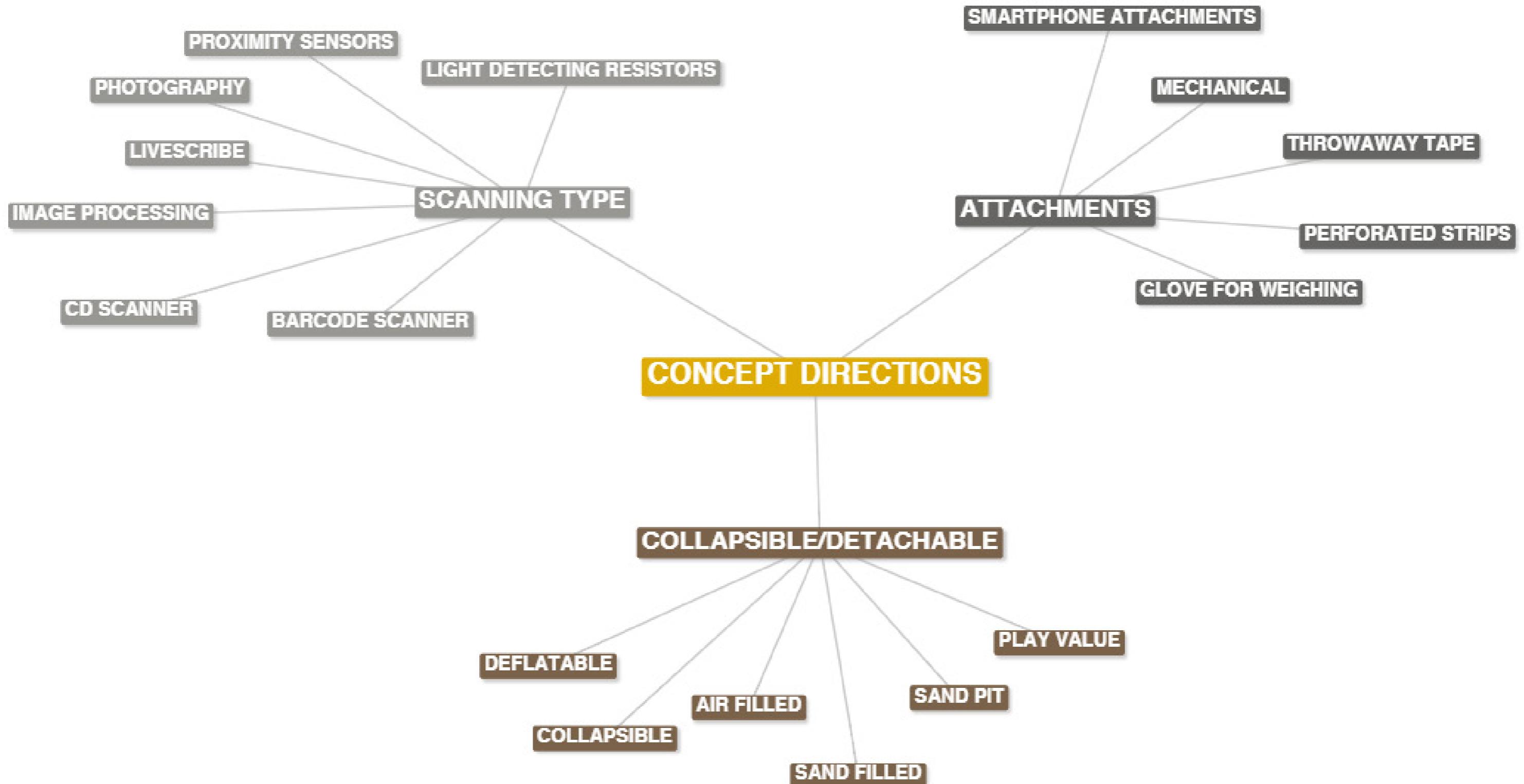
Concept cluster 1:
Portable - Inflatable type

Headboard

Sliding tape.

Inflated Mat.

HEAD

CHEST

ABDOMEN

Pouch. for keeping

Display

Weighing scale.

Button for switching on the light.

Can be secured around the infant's foot.

Beam of polarized light

Small unit [about the size of a pendrive] for length measurement.

Perforation to tear off.

perforation.

paper for placing baby.

Weighing scale

Display

Tissue roll

paper roll.

Contours of the deflatable mattress.

Sliding tape for measuring circumferences.

Pouch for placing small unit with light

Headboard.

Measurements of a baby being taken.

Length

Head circ.

Abdomen circ.

PROS:

- Portable
- Light weight
- One person needed
- All measurements can be taken
- Safe for infant
- Hygienic

CONS:

- Deformation of head support
- Buckling of mattress
- Error in measurement from slider

Concept cluster 2:
Attachments

Types of head supports.

Measuring device

Contours for the head.

Head support

Measuring tape is attached to foot support

Foot support

90° freedom for orienting

Clamp for the surface.

Measuring tape pulled out.

Head support

foldable head support
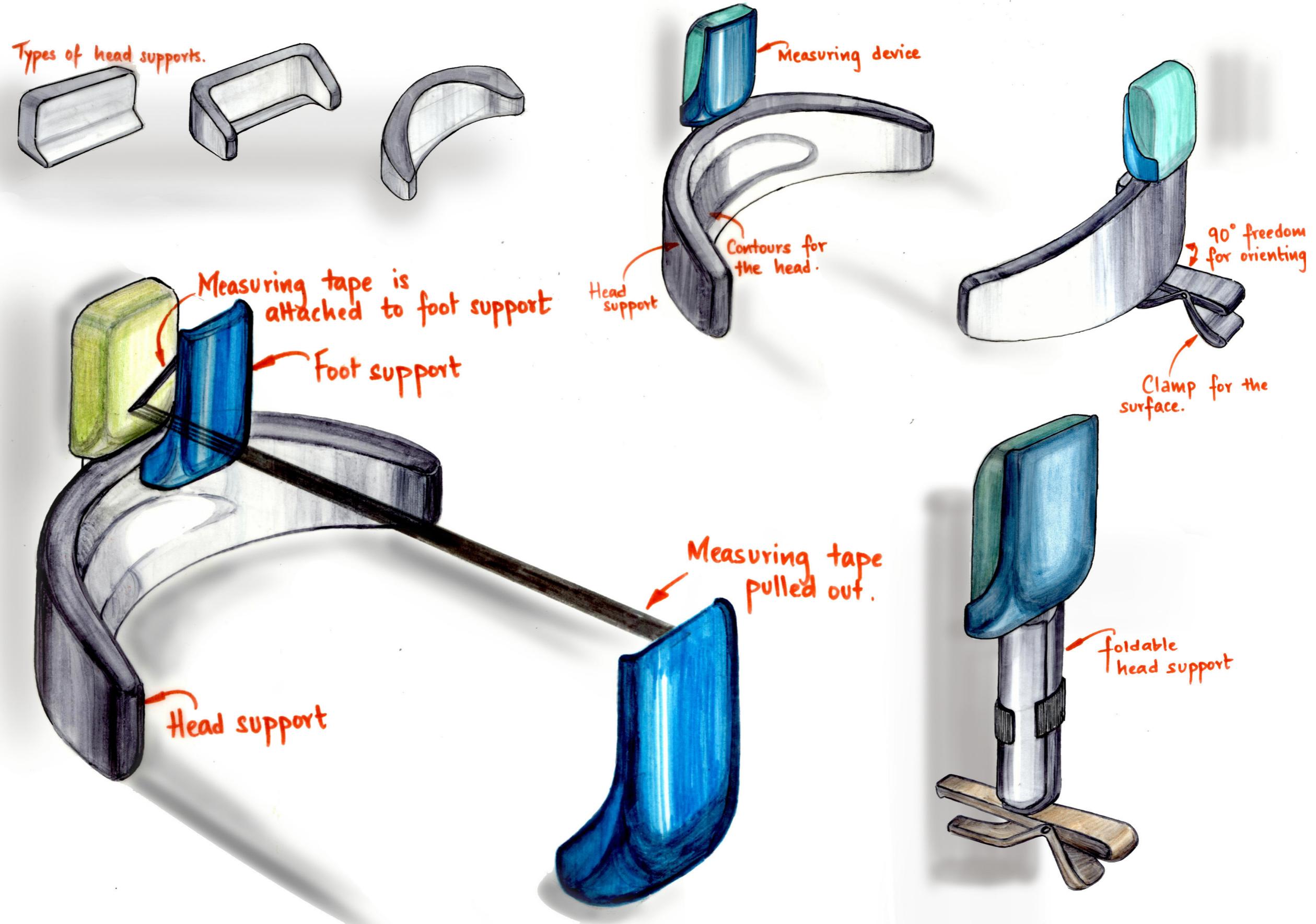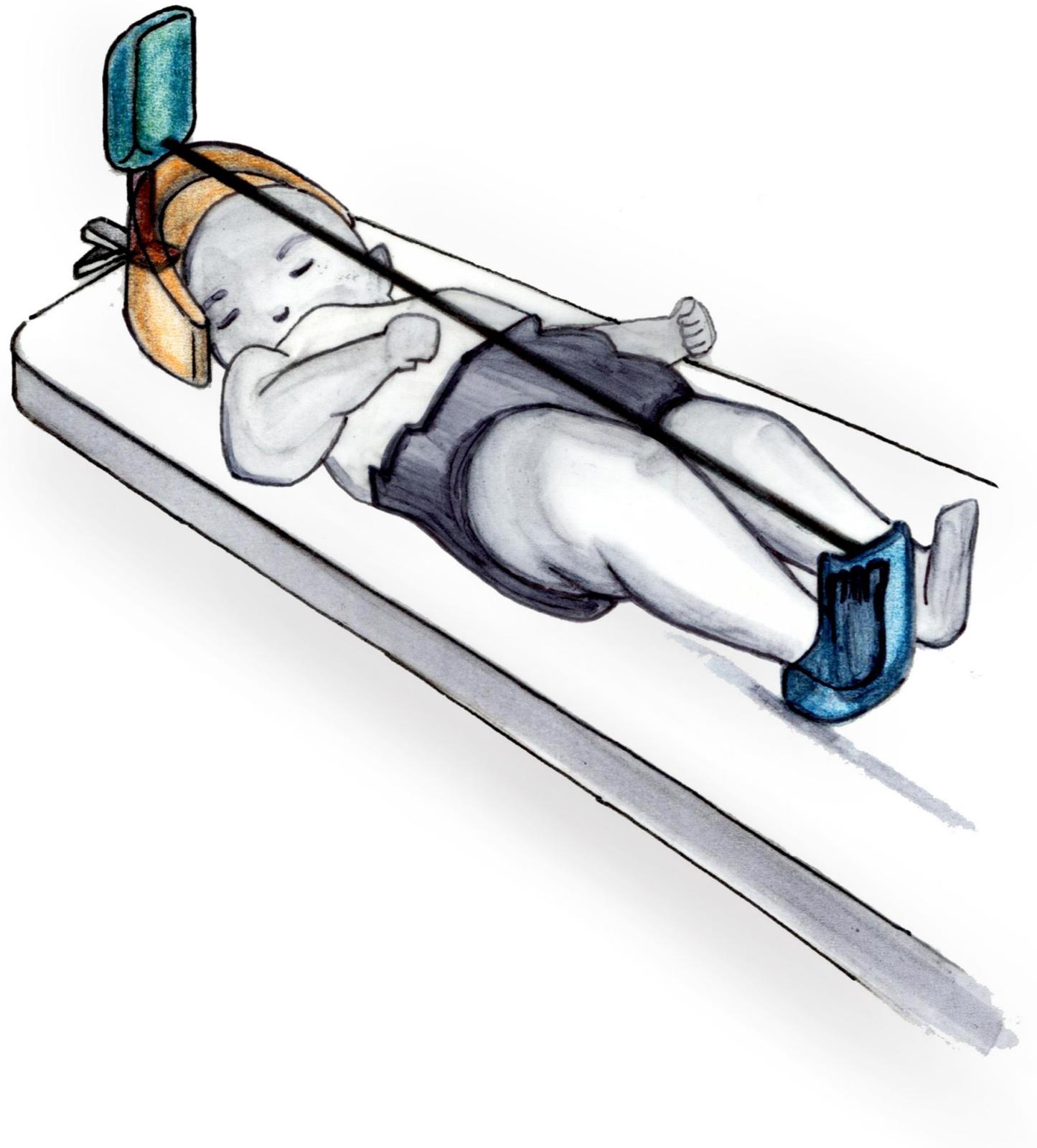
PROS:

- Portable
- Light weight
- One person needed
- Can be attached to any surface
- Easily repairable

CONS:

- Does not cater to weight measurements or circumference measurements.

Concept cluster 2:
Scanners

LDR.

Light source

Handheld device

BED/TABLE/
WEIGHING SCALE
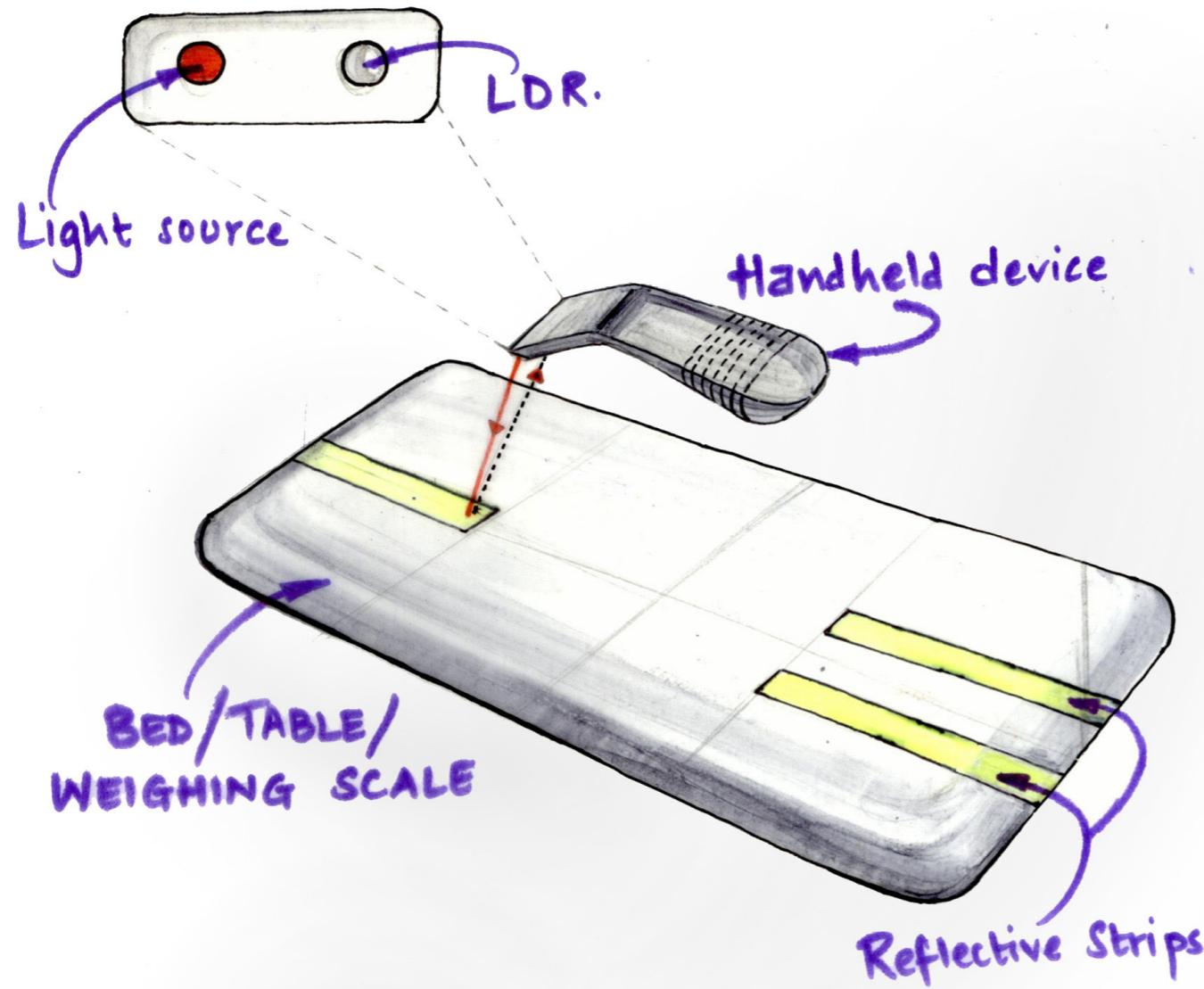
Reflective Strips

ROLL OF
REFLECTIVE STRIP

ORIENTATIONS OF
REFLECTIVE STRIP

Not continuous

Continuous

Battery
slot

BOTTOM VIEW

Push Button

Handle

Light source & LDR.

SIDE VIEW.
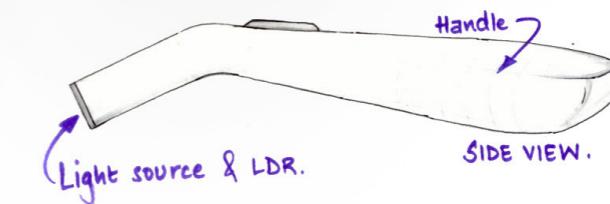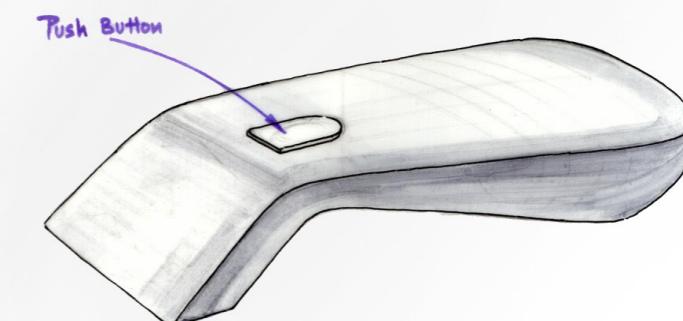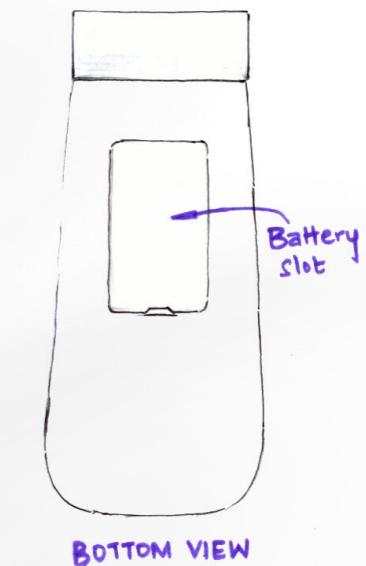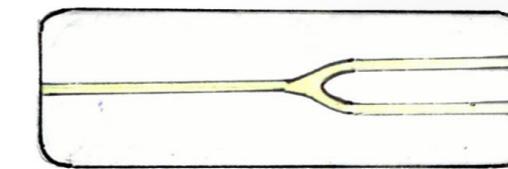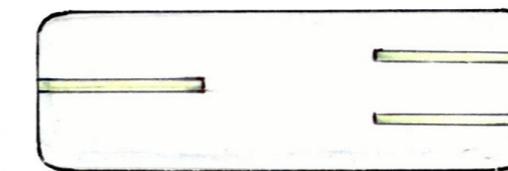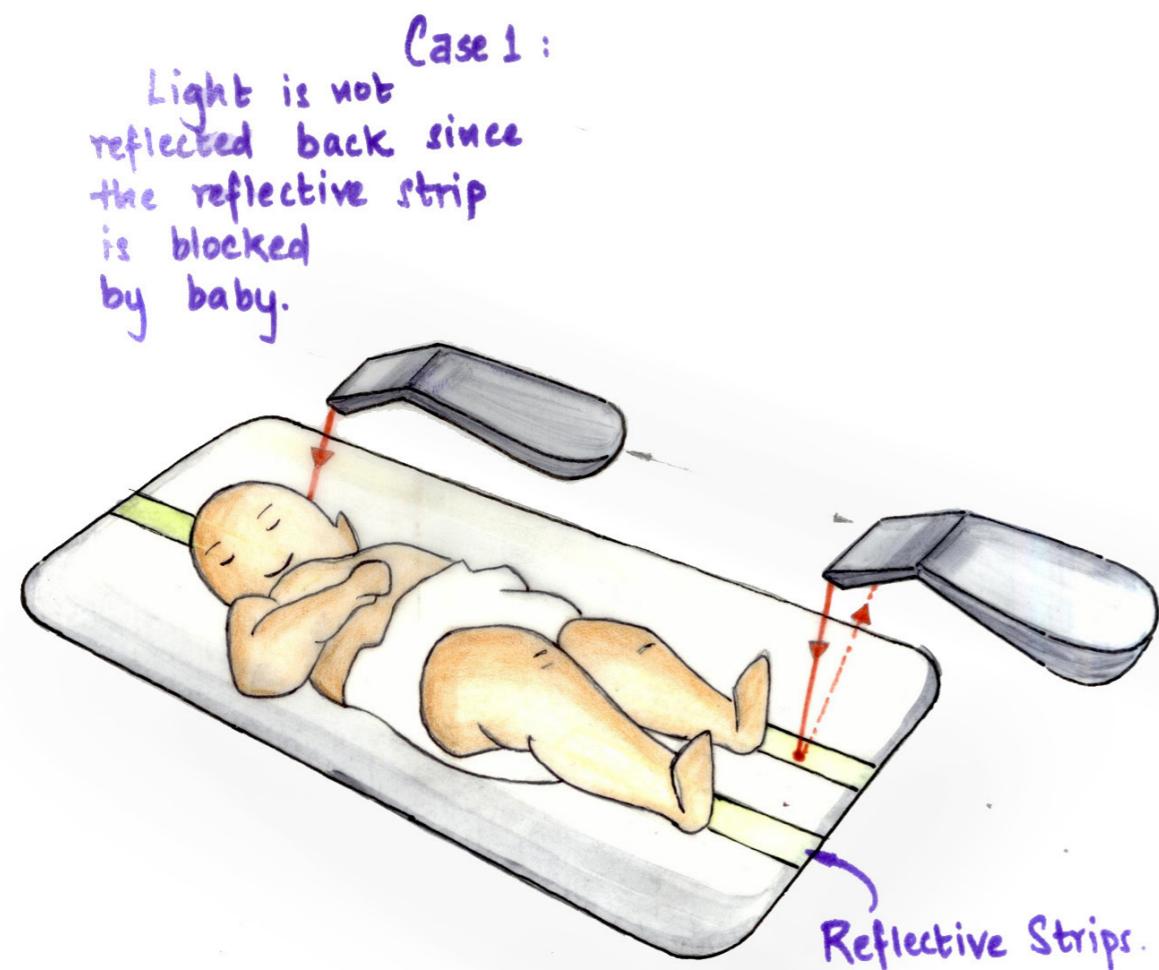
Case 1:
Light is not reflected back since the reflective strip is blocked by baby.

Reflective Strips.

Case 2:
Light is reflected back from the reflective strips. This reading is recorded & length is recorded calculated.

PROS:

- Inexpensive scanning method

- Highly accurate

- Non-contact type

- Easy to manufacture and simple

  to use.

CONS:

- Does not cater to
  weight measurements or
  circumference measurements.

- Lacks the perception of safety.

Evaluation criteria

Based on insights and research, the following evaluation criteria were put in place:

- No. of measurements taken

- Steps involved in all measurements

- No. of people involved in taking a measurement

- Ease of measurement

- Affordability

- Portability

- Safety of the infant

- Perception of safety

Based on the above evaluation criteria, concept 1 and concept 2 were ranked better and thus further explored.

Mockups for concept 1 and concept 2

Concept 1:

Inflatable type

Concept 2:

Attachment type

Mockup: Concept 1
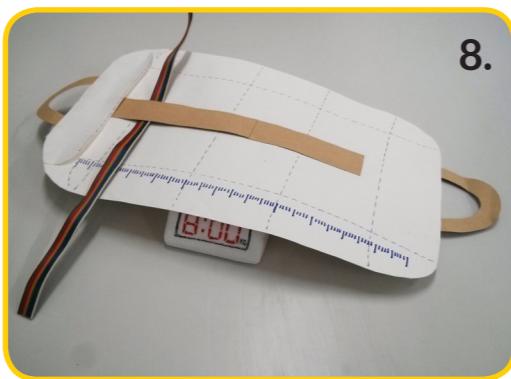
1. The mattress in inflated condition
2. Infant is placed on the contoured mattress against the head support
3. The light unit is wrapped around one foot of the infant
4. The light is switched on
5. With one hand, the person pushes down the knees of the child to make the legs straight. The reading is then taken
6. The sliding tape is then used to measure the head circumference
7. The tape is then slid down to take chest and abdomen circumferences
8. After several uses, the mattress is finally deflated
9. It is then folded up and the handles are used to carry it.

Mockup: Concept 2
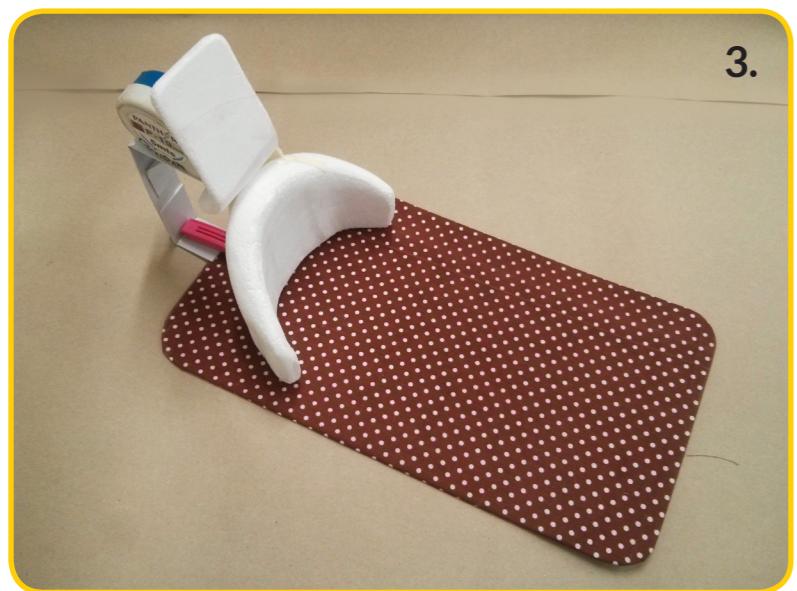
1. The mockup of the Attachment type concept
2. Any surface such as a bed or a table
3. The attachment is clamped onto the side
4. The infant is placed on this surface with reference to the head support
5. Pull the tape out which is attached to the heel support
6. The heel support is placed under the foot to get the correct orientation and measurement.

Inferences from evaluation

- Concept 1 & 2 can allow for measurement of an infant by one person.

- The Attachment type concept cannot be used to measure circumferences.

- The Collapsible type allows for all the desired measurements.

- The perforated tissue can have strips of tape for circumference measurements.
  These can be thrown away along with the tissue after taking the measurement.
  Thus keeping the use of the product hygienic.

- Both concept 1 & 2 provide a head support for the infant which also acts as a reference for the measuring the length.

- All the concepts are light weight and portable

- The Attachment type concept can be made very low cost.

- The Scanning device can also be used in combination with the other concepts. However, the method of scanning does not allow in circumference measurement

Pressure sensitive weighing

Case for spring loaded tape.

Heel reference.

Slot for mattress to fold back in.

Power button

Display

Head reference.

Nozzle for filling air.

Pressure sensing device

Heel reference

Spring loaded tape unit

Clamp.
[Holds the Tape unit, weight sensing unit & surface table together]

Weight sensing unit

Inflatable mattress
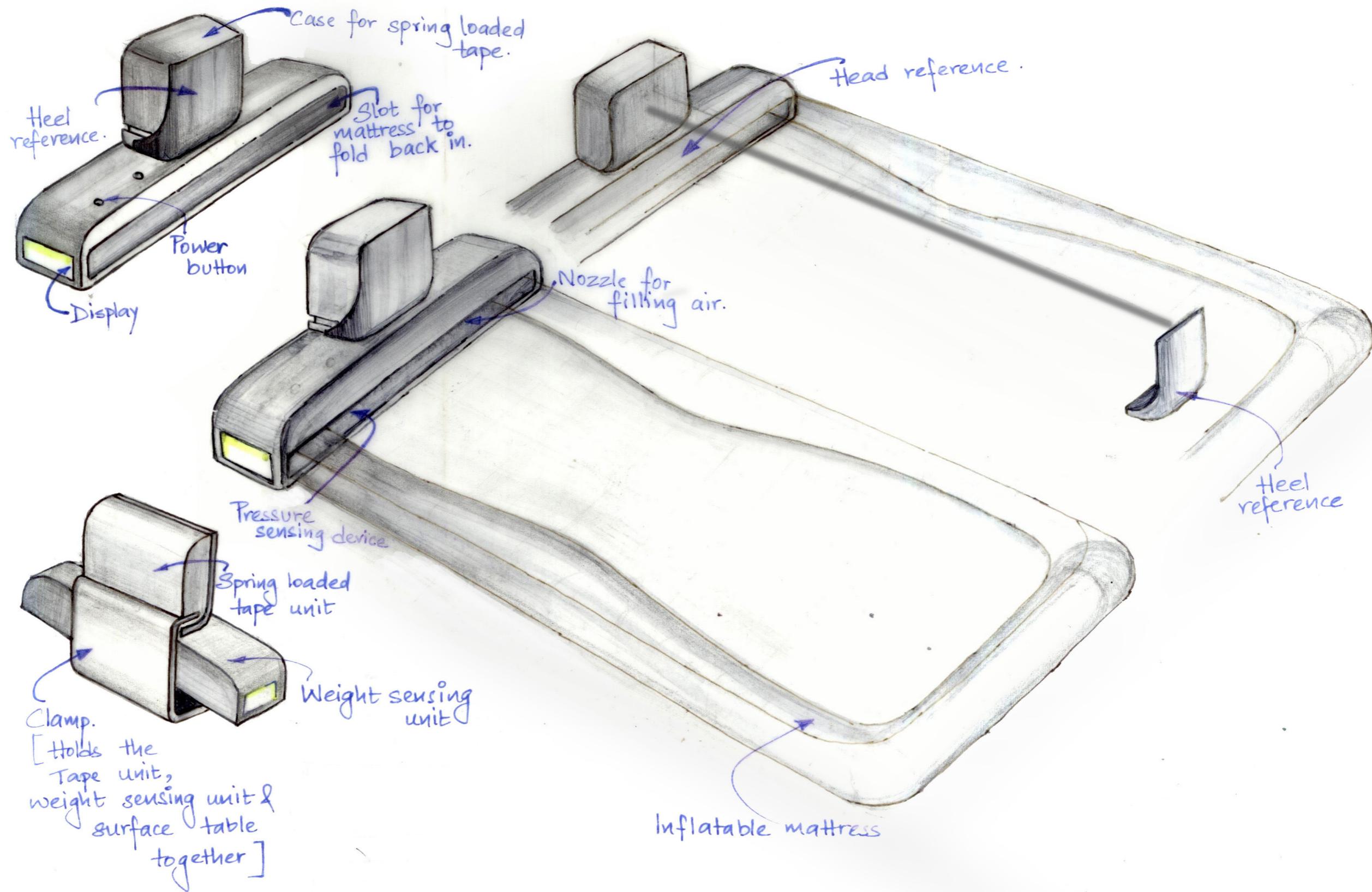
Dismantled weighing scale

Spring loaded tape cased

Heel reference

Head support [Head reference]

Load cell

Red Safety Indicator

Suction pad.

Screw

Clamp

Clamp

Housing electronics

Display.

function buttons

Wire coiled around the load cell!

Connecting wires.

Load cell attached to surface using suction pad.

Board to hold child placed over 4 load cells

Connecting wire stretched out.

Load cells coiled up.

Connecting wire to display

Load cells stretched out.

Spring loaded tape case

Head support [reference]

Clamp

Heel support [Reference]

Board to hold infant [It is placed on the 4 load cells for proper distribution]

Load cells attached using suction pads. [Red Indicator not visible since it is correctly attached.]

Display unit

Base surface available [Eg. Table]

Changes that needed to be incorporated

Final design must allow for all measurements

It must reduce dependency on locals to the minimum

Must be accurate when used in different ways

Must provide all the parts required for assembly

Final concept direction

INFANT BEING MEASURED

Heel reference being pulled out?

Attachment clipped onto the plank

Head reference

Infant's knees need to be held down

Thin rod hooked to side planks

Plank

Hinge

Middle plank

Weighing scale

To allow for weighing scale to fit in correctly
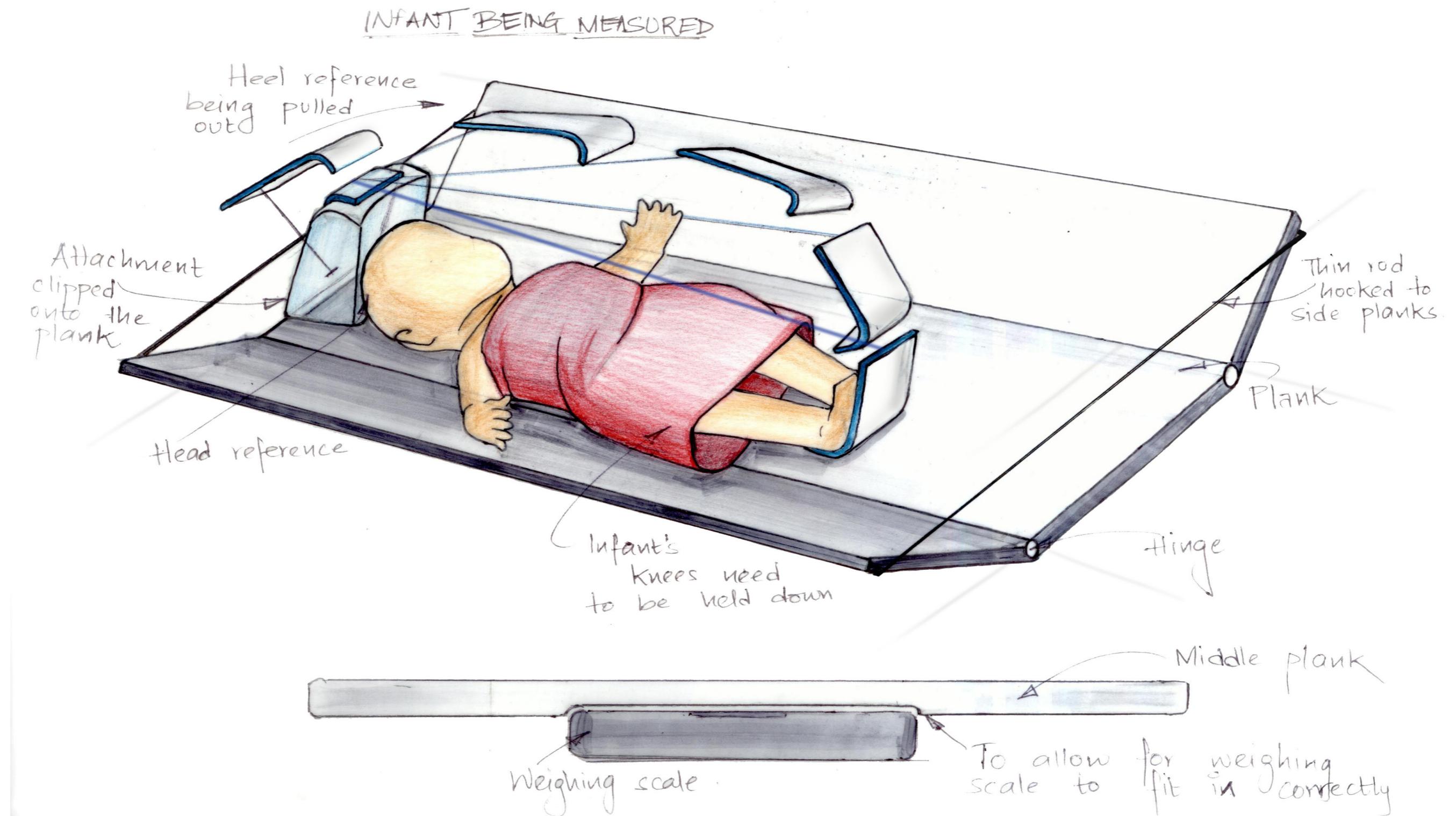
Form exploration of the attachment

LENGTH MEASURING ATTACHMENT

Heel reference

Head support

Heel reference

Head support

Heel reference

Heel reference being pulled out.

Heel reference being pulled out

Allows user to hold easily.
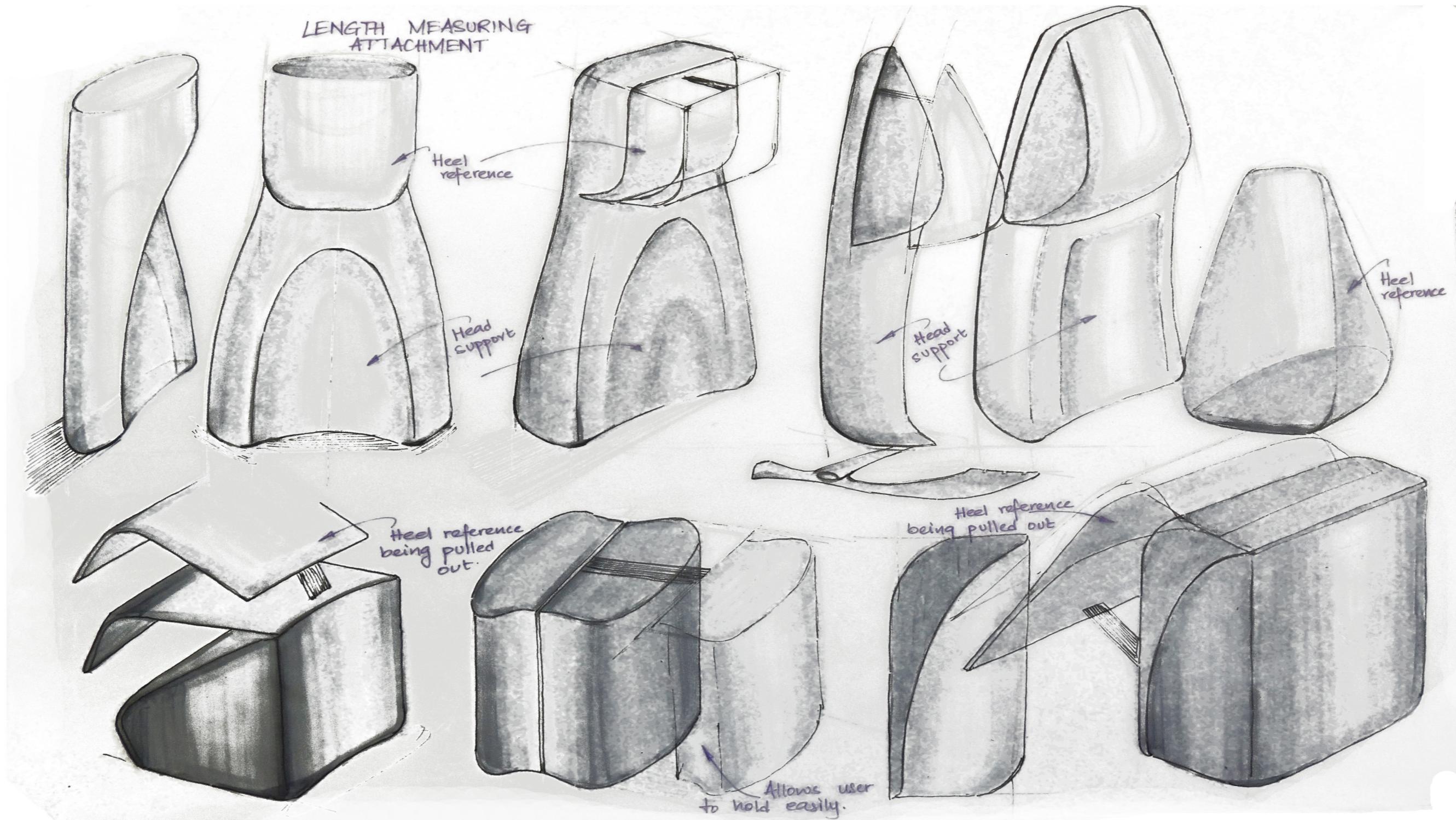
Attachment for length measurement

LENGTH MEASUREMENT

PULL OUT

HEAD REFERENCE

CLIPPED ON
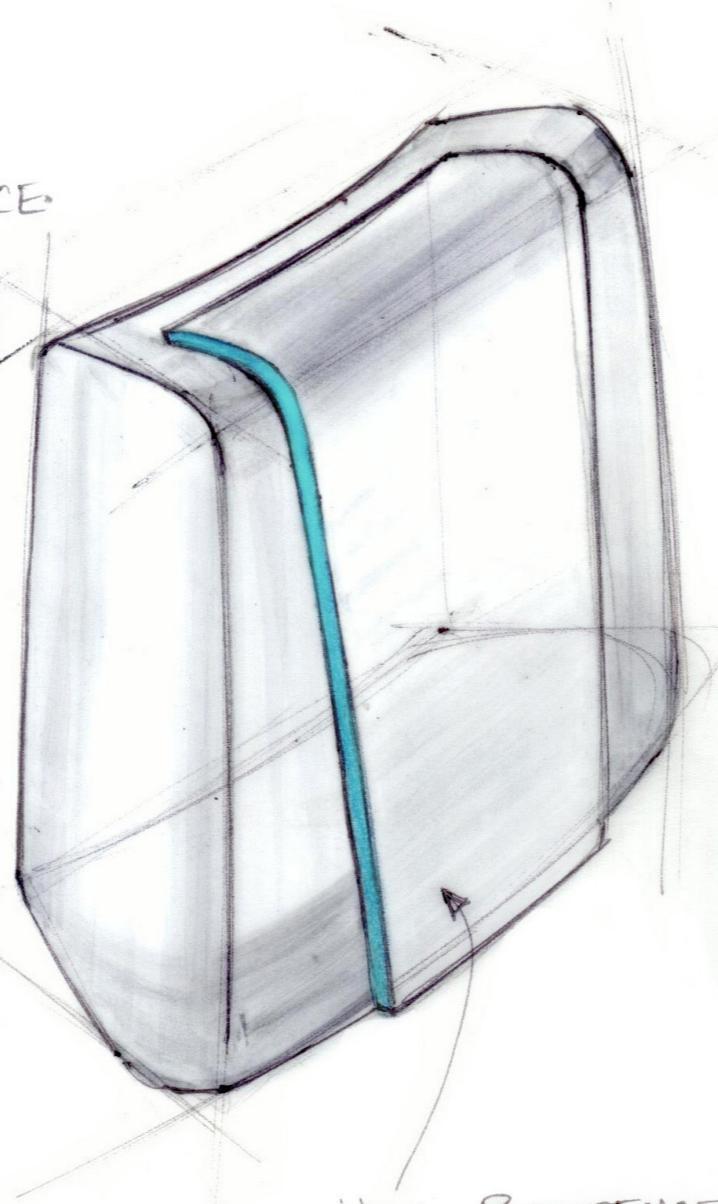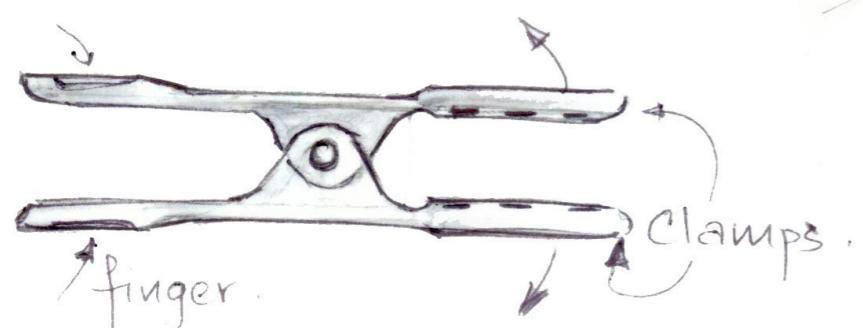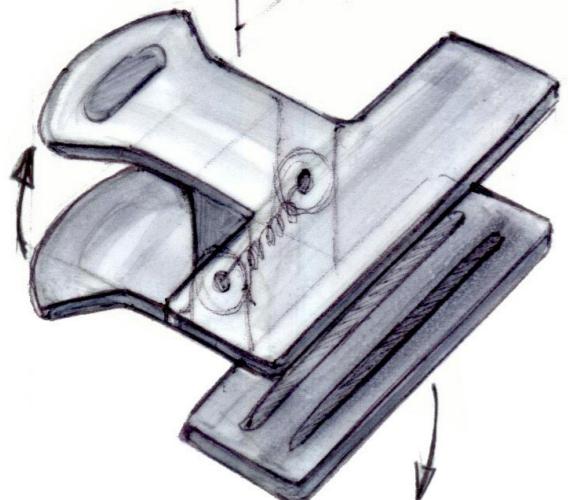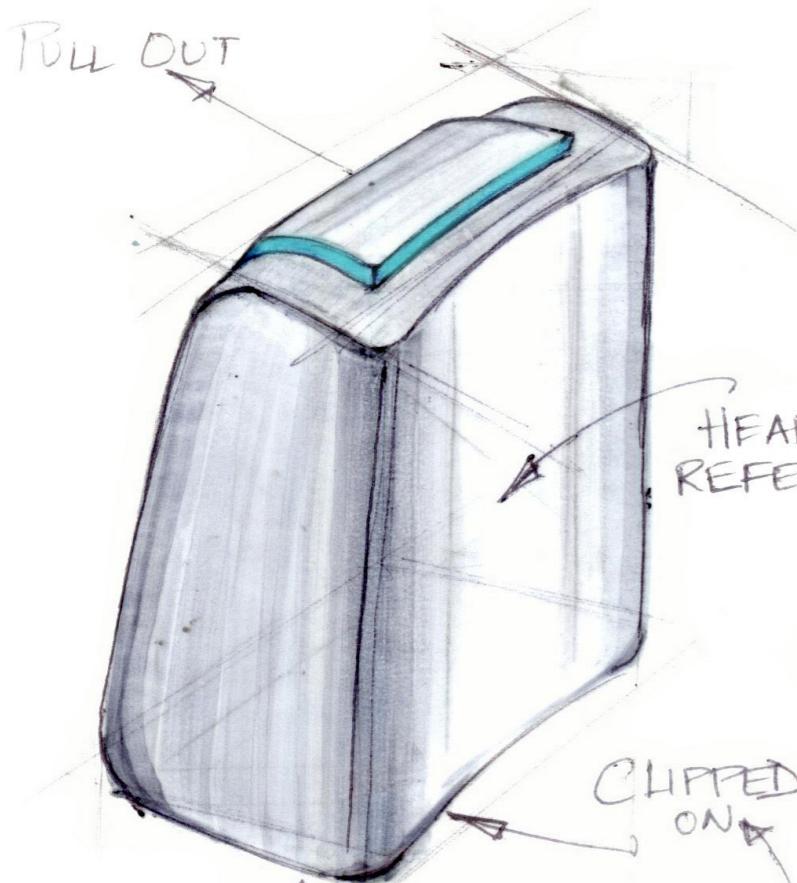
HEEL REFERENCE
[Can be pulled out]

Clamps.

finger.

TOP VIEW

BACK VIEW

SIDE VIDEO
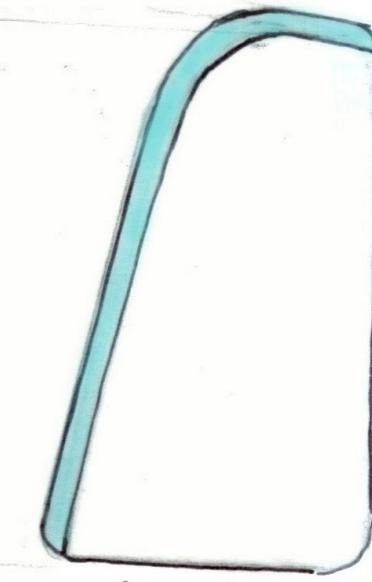
BOTTOM VIEW

Exploration of the base structure

PLANK DESIGN :

Slider

Tape

Slider

Tape

Attachment

Slider
ERROR in reading

Plank

Attachment

Clamp

SLIDER: Slippery fabric such as nylon

Tape

Plank

Attach tape separately from the top to remove error

Make the slider go from below.

Attachment clipped on.

The relief for the attachment depicts the top (head) side.

Instead of using plastic or any other rigid material for the slider, fabric can be used.
Fabric will reduce error to almost negligible and also take the shape of the infant's body contours.

Center plank

Rolled up fabric

Side planks can be stretched out fabric like canvas

3 piece plank

Plank folding

Pre-stressed members.

Hinges

Collapsible metal frame

Side planks can attach to the center

U shaped.

Fabric

3 planks. The two on either side can attach to the center.

2 piece plank

Bend for more rigidity

A thin metal rod hinged

The rod helps the plank hold shape Hooked

Collapsed metal frame

Foldability of base

3 piece plank held by two rods & hinges

Slider made of nylon fabric

Thin rods

folding up

folding down

Planks folded completely

Folding

Shoulder strap

Zip

Case for plank

Stationery

Attachment for measuring

Weighing scale

Packaging

Data storage and transmission

Transmitting to Smartphone

Display

USB port

Weighing scale.

USB port
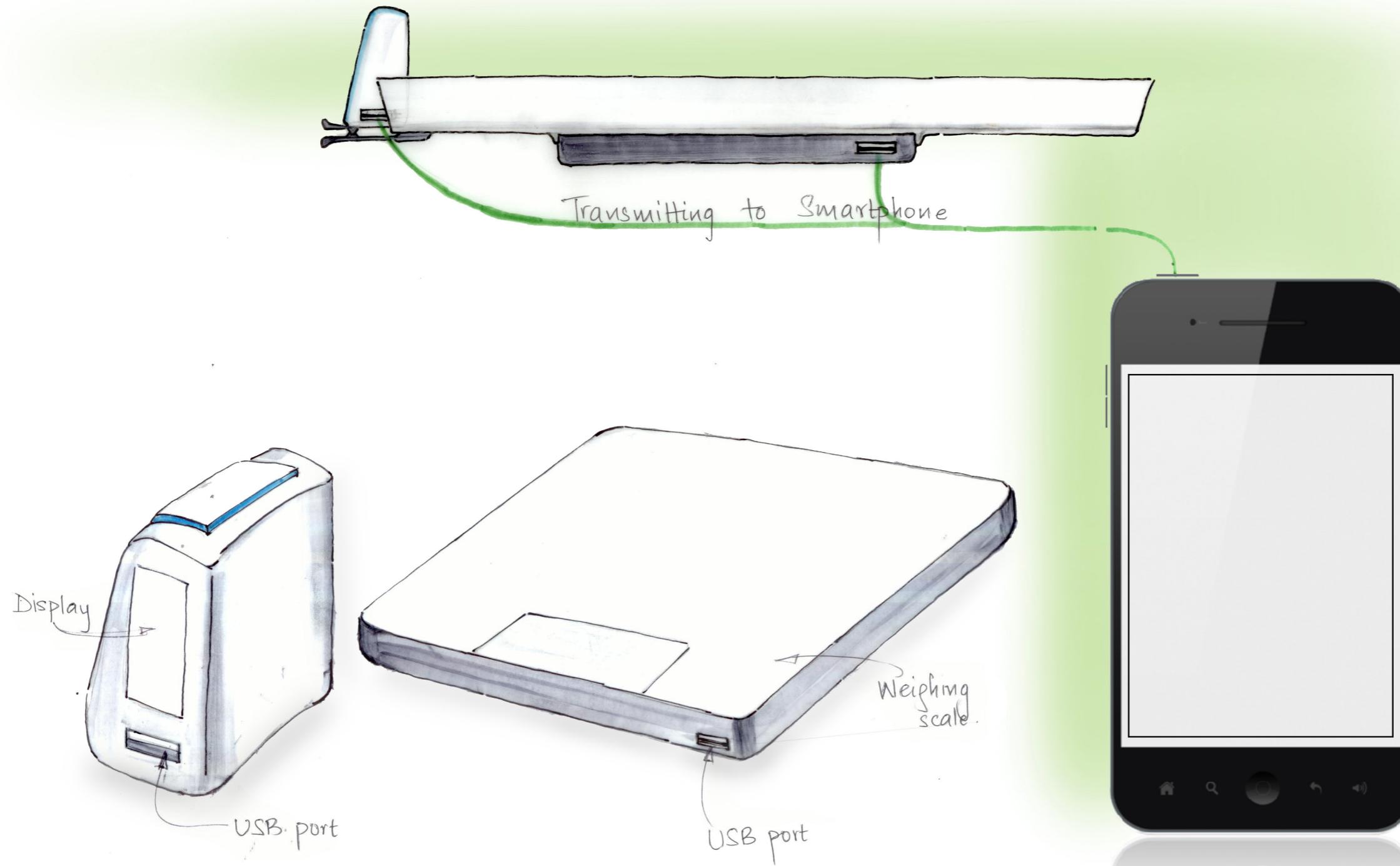
Transferring data via usb to smartphone

Allows for immediate recording

Can also be used to check what action must be taken

Further changes that need to be incorporated

Correct weight distribution in case of small babies

Better foldability for the base structure

Final Concept

The final concept consists of an electronic weighing scale, a length measuring attachment and a folding base which can be used to examine and measure the baby.

Folded base

Opening the base
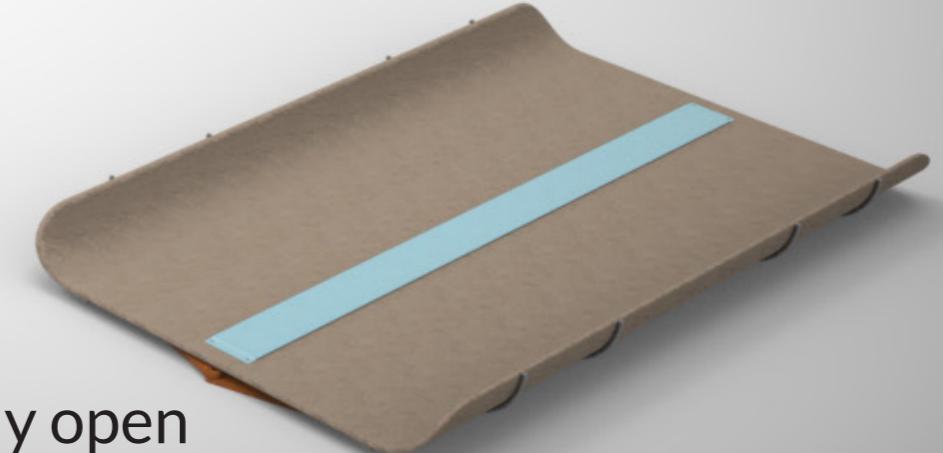
Completely open

Base design

Nylon cloth strip

Soft foam mat

Gooseneck wires

Rigid plates

Collapsible structure made from ciderwood

Exploded view

Use of the attachment

Measuring tape

Head support

Heel reference

Curved base structure

Attachment for length measurement consists of
a recoiling tape in an HDPE casing
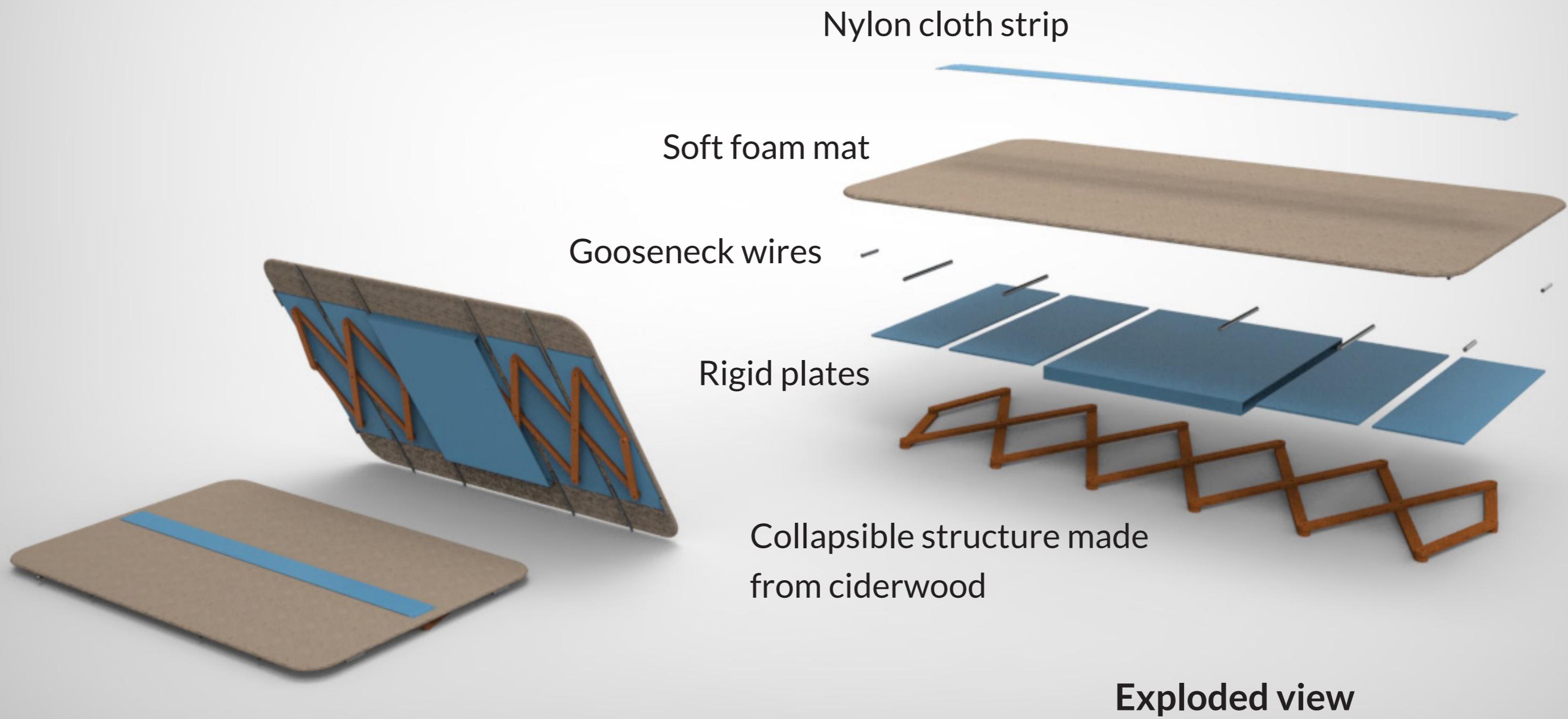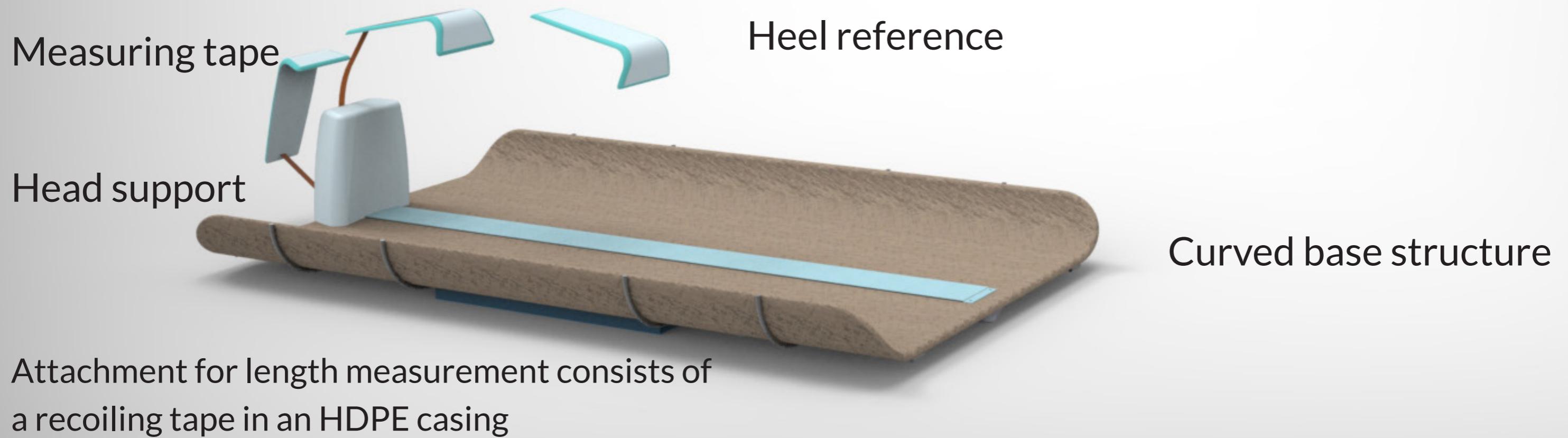
Anthropometric data

The dimensional details of the product were based on anthropometric data provided by ICMR.

Length and weight of infants upto the age of 1.5 was taken from these charts
The maximum length: 80.5 cm
The maximum weight: 10.6 Kg

Several existing folding mats and changing mats for infants were studied and the width of the base was derived from that
Dimensions of the base: 85 x 45 cm

The height of the attachment was kept 16 cm in accordance with the body of the infant.

Mockups and prototyping
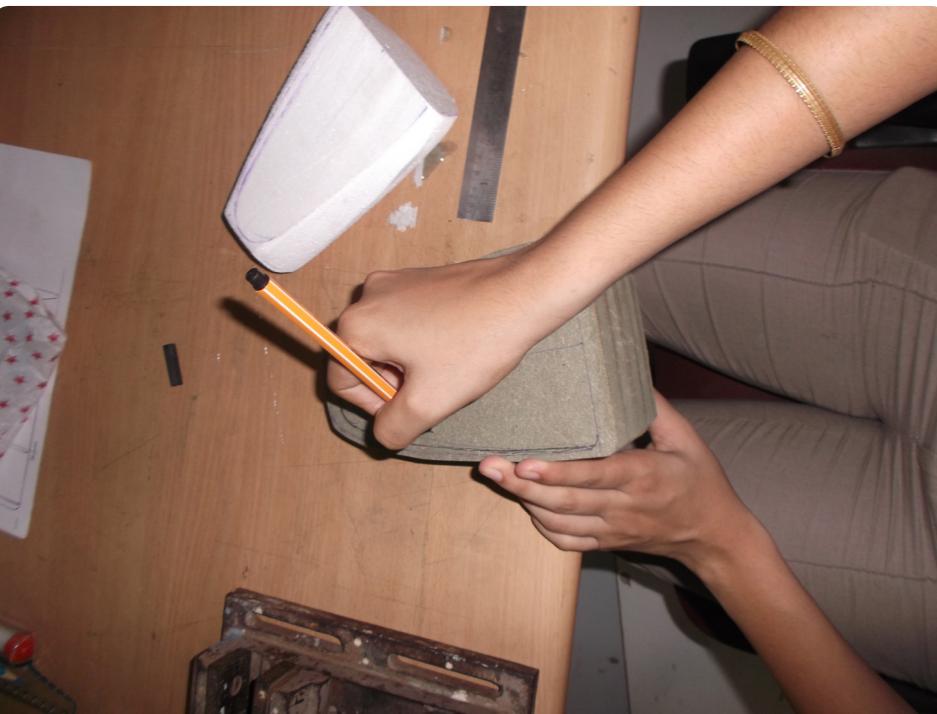
Testing the product

Set up time
First time user: 4-5 minutes
Experienced user: Under 1 minute

Weight of the base structure:
Less than 2 Kg

Results and add-ons

Buckling force:

More strength of the collapsible structure is necessary so thatthe base does not buckle.

In case of infants over 6 months of age, they can be weighed in the seated position. By doing so, the weight is more concentrated in the center and thus there will be no buckling force.

Weight reduction:

The base structure can be made lighter by using lighter wood.

Hanging toys:

In order to maintain the attention of the infant and orient the infant's head correctly, there can be hangings above the infant's head. These can have light, sound and colour.

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Thank you