Project 2

Design of thermal suits

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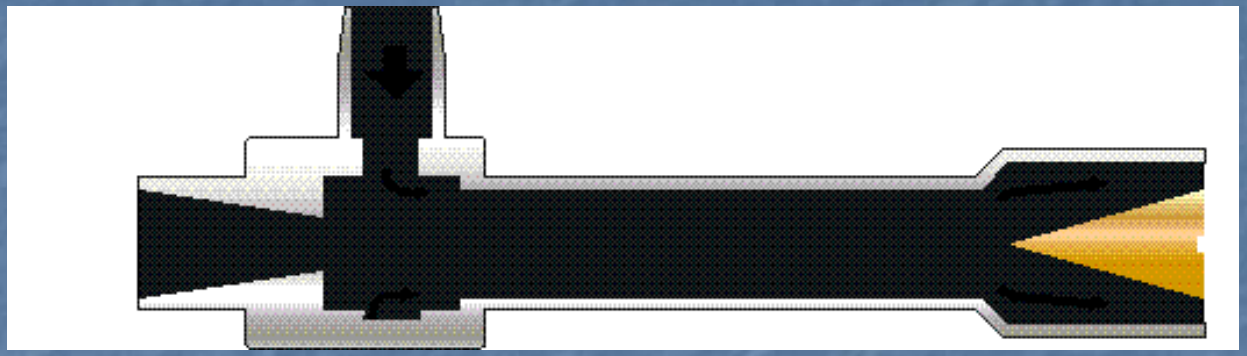
Ashish Chandel
IDC

Vortex tube , how does it work ……

how can you get hot and cold air from just one compressed stream of air ??



How cold ??

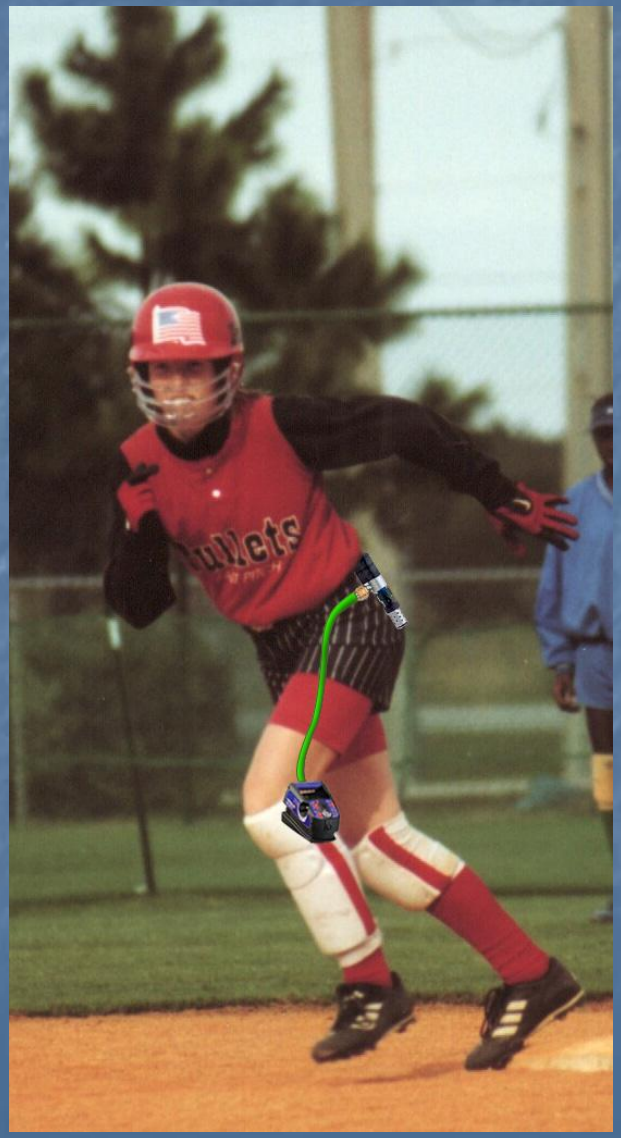
With high cold fraction (20-50 deg) below compressed air temp

With low cold fraction -40 deg C can be achieved .

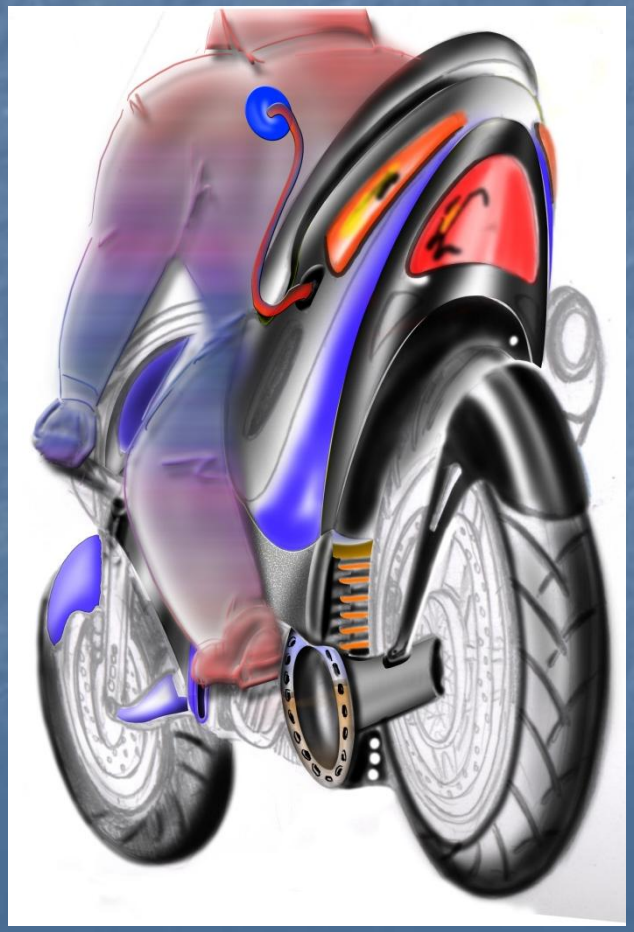
heat removal
2000-4000 BTU/hr ..

Compressor requirements
min 20 PSI max 80 PSI
min 15 CFM is required ……

Prospects ……..



Prospects ……..



Prospects ……..

How human body does reacts to heat?

Why vortex tube?

Where can it be used ?

How do workers work in their respective environment?

How do workers use their existing protective wear?

How and where workers wear their things?

What kind of workers am I targeting?

What are the conditions at the workplace …how hot, how humid ?

The design process

physiological studies

Find subjects
Working conditions
Understanding the technology
Compare the options
Assess the feasibility
setting up test rig
existing product analysis.
user analysis
ergonomic studies
material analysis
usability studies
aesthetics
value addition
detailing
test models
prototyping

What is thermal comfort ……

That state of mind which expresses satisfaction with the thermal environment.

#Temperature of air
#Temperature of surrounding air / surfaces
#The humidity of air
#Air velocity

How to achieve thermal regulation in a clothed worker

*** modification of the internal heat generation**
*** modification of the rate of body heat loss**

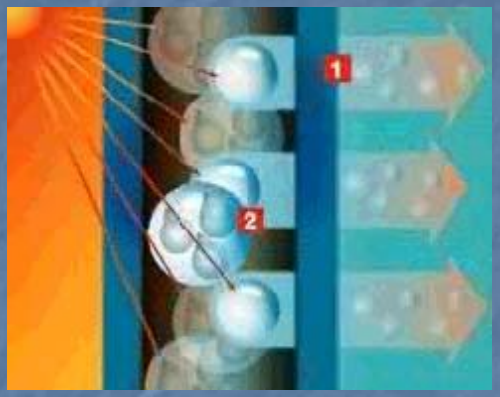
*** modification of the thermal environment**

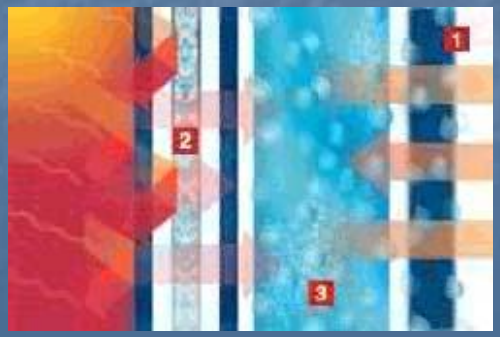
*** selecting a different environment**

Increase convective evaporative losses

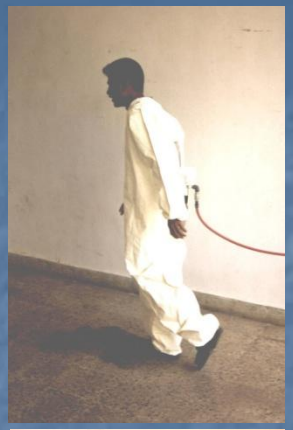
Reduce radiation load

Existing products and technologies ……





Existing products and technologies .....



The Brief ……..

Design of thermal jackets suitable for Indian industrial worker in high temperature conditions keeping in mind ….

#Their special thermal comfort criterion. The suit should be provide 28 deg CET

#Their usability issues based on work analysis .

special requirement like fire, chemical retardance

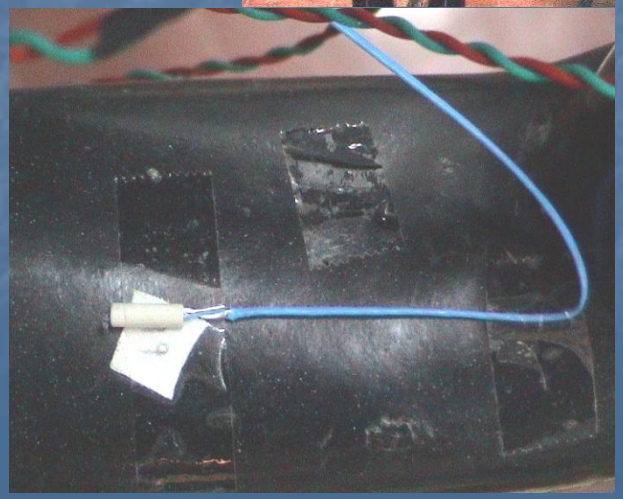
provision of an effective control mechanism for thermal environment inside

cost effectiveness .

In all ,

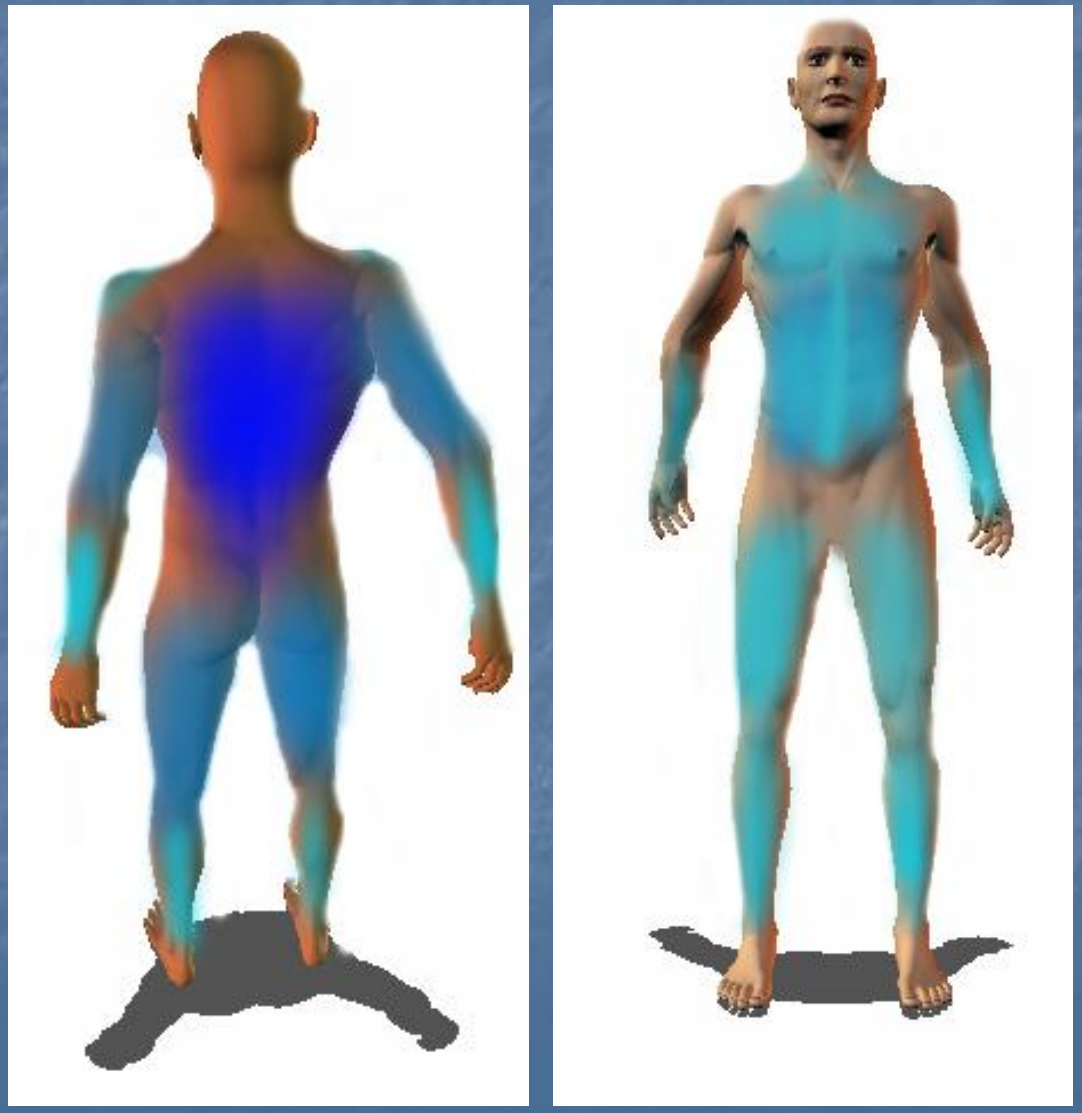
To come up with a value for money package for thermal comfort

What is wrong with the existing designs



What is wrong with the existing designs

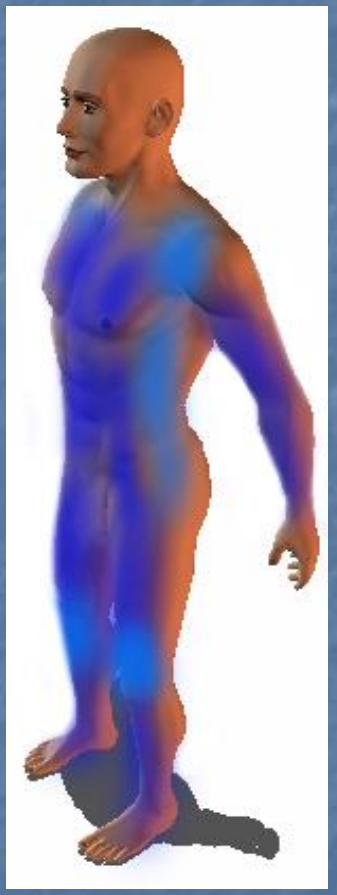
 # Improper cooling



What is wrong with the existing designs

 # required cooling

requirements



What is wrong with the existing designs

 # Improper cooling

requirements

DUCTINGS HAVE TO BE GIVEN INSIDE OR OUTSIDE SO THAT AIR CAN BE PASSED TO REQUIRED AREAS

KEEPING IN MIND

MINIMUM INTERFERENCE IN OPERATIONS

MINIMUM BODY CONTACT

EASY TO WEAR

EASY TO REMOVE SO THAT CLOTHES CAN BE WASHED

BIOSENSITIVE

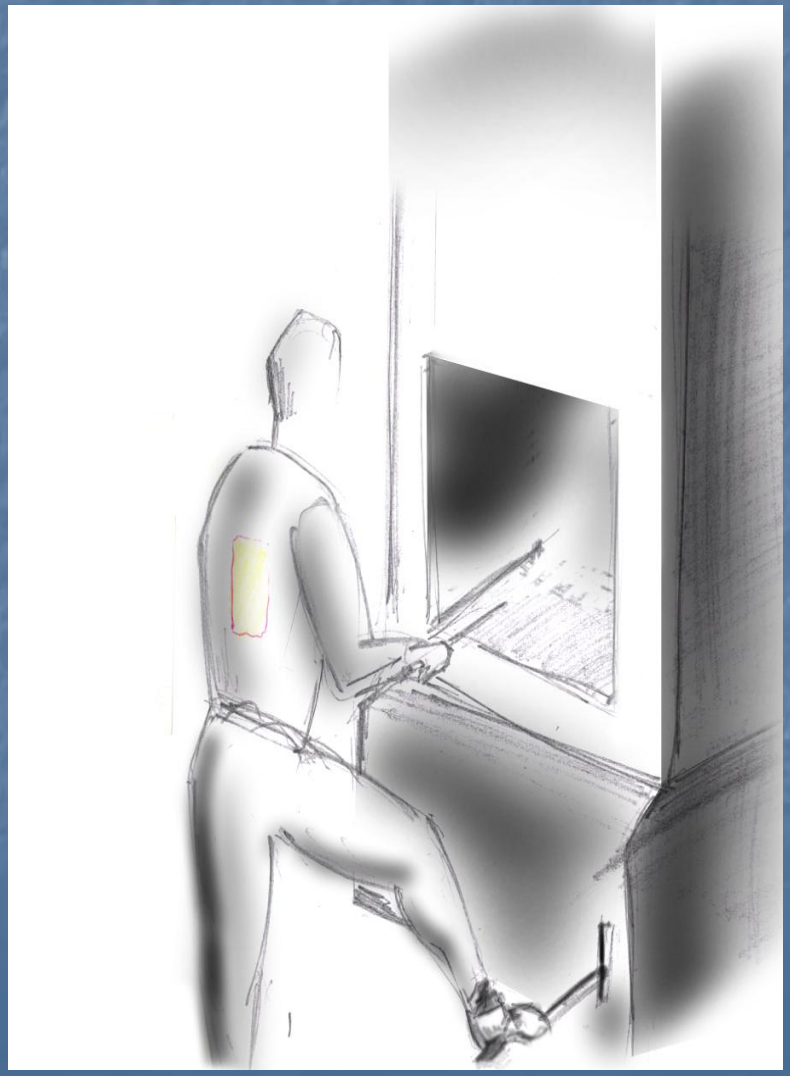
FLEXIBLE

Deciding upon the matrix for the ducting

Work study

Identifying

potential blockage areas/points

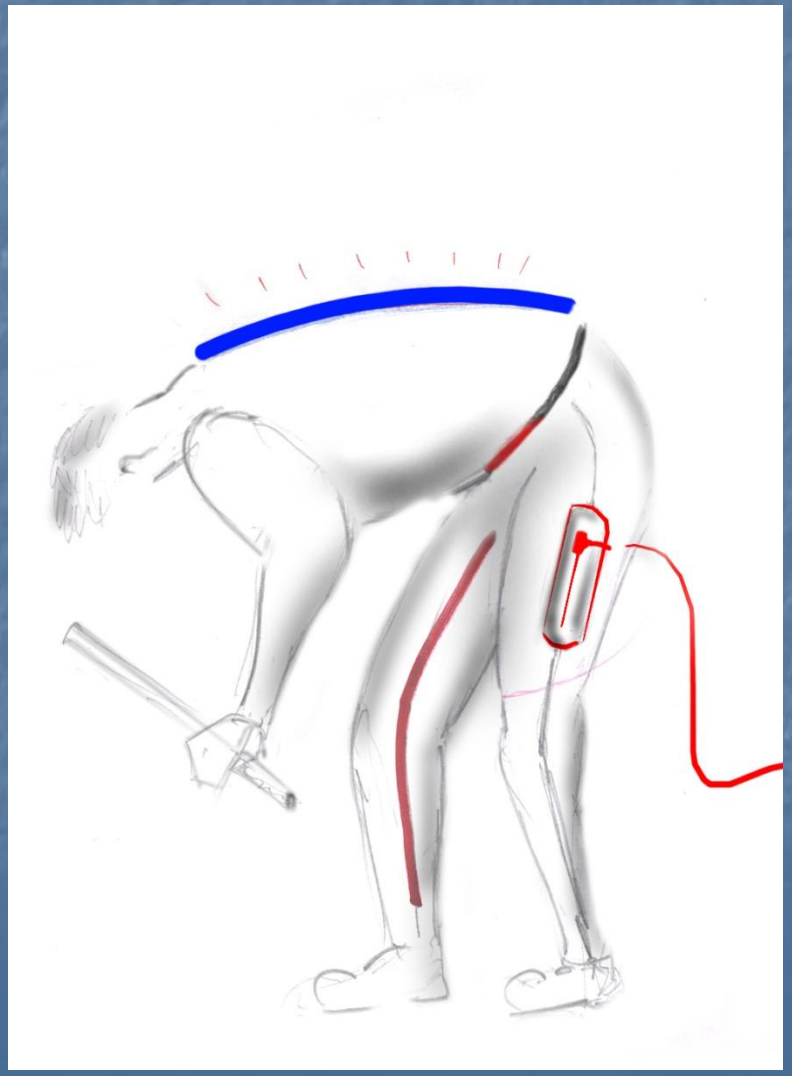


Deciding upon the matrix for the ducting

Work study

Identifying

Identifying stretch lines



Deciding upon the matrix for the ducting

Work study

Identifying

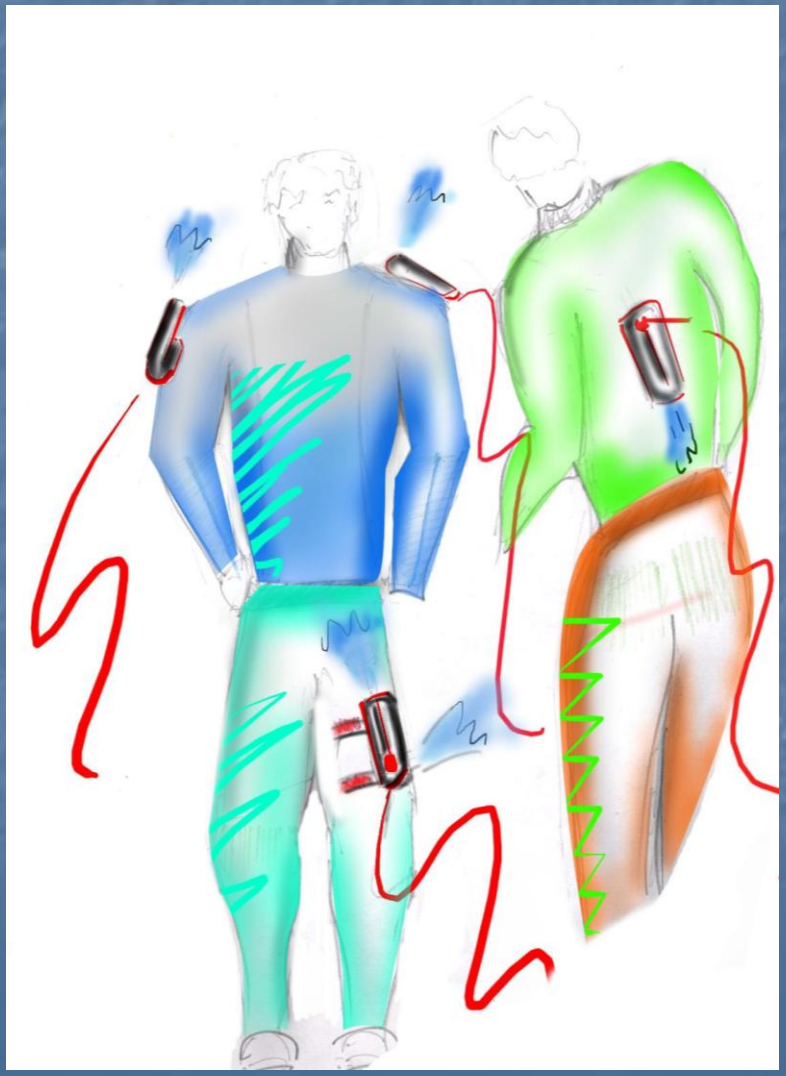
High heat exposure areas

Deciding upon the matrix for the ducting

Work study

Identifying

Identifying potential locations for vortex tube housing and Other details



The ducting layout

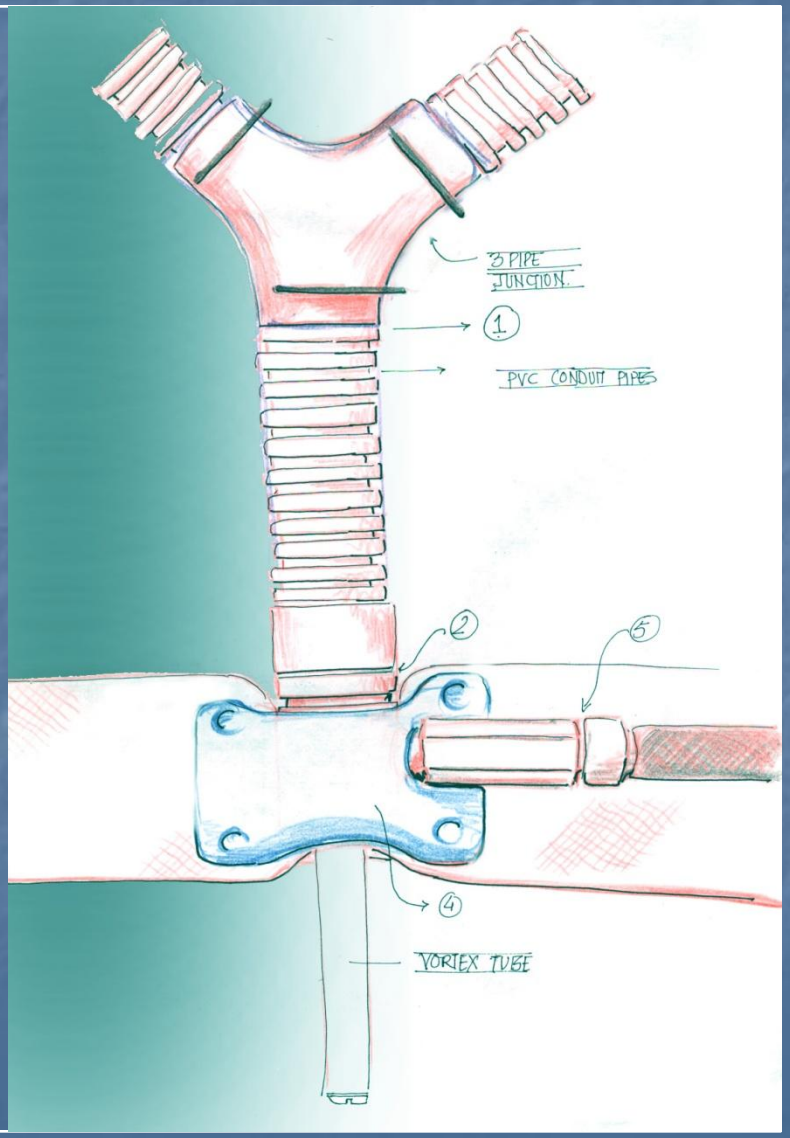
Features

Does not interfere with body movements

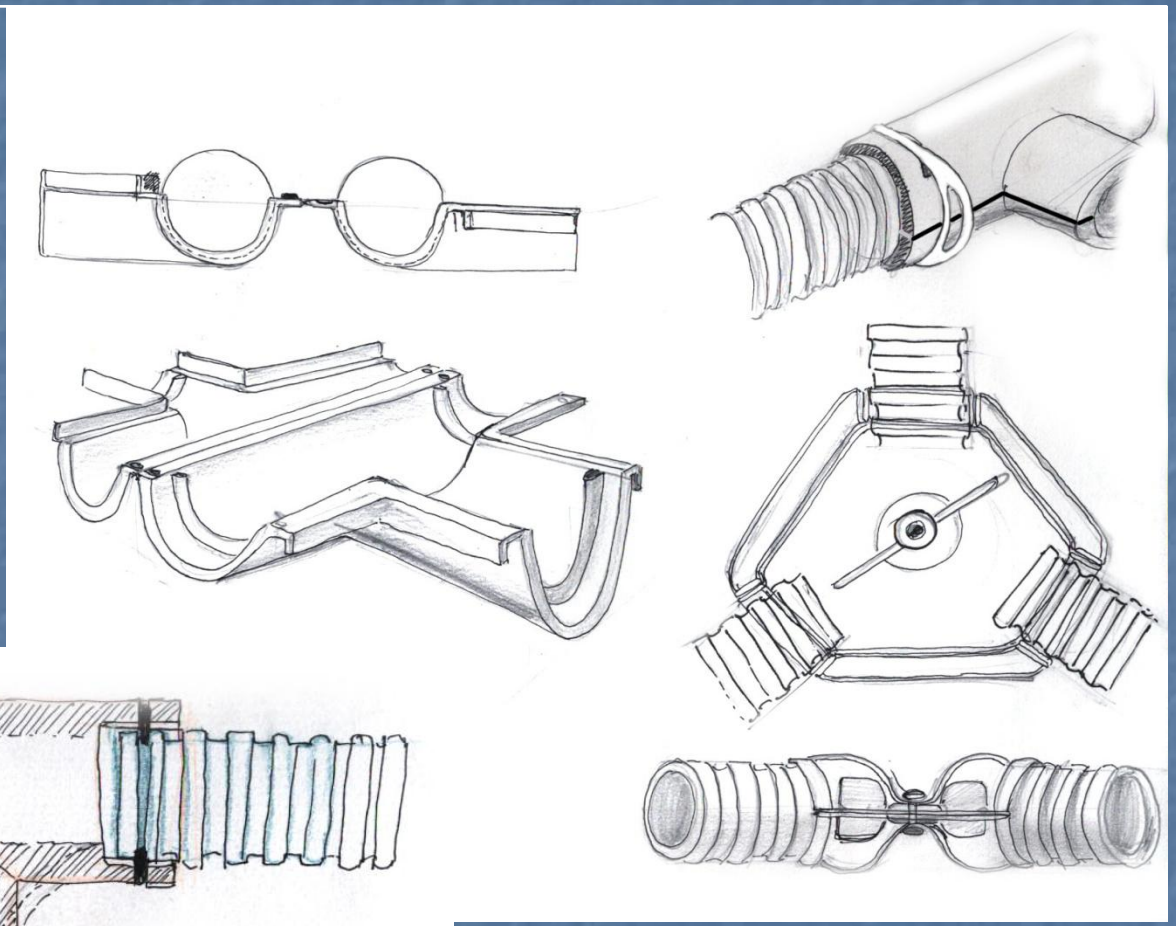
Capable of accommodating wide range of percentiles

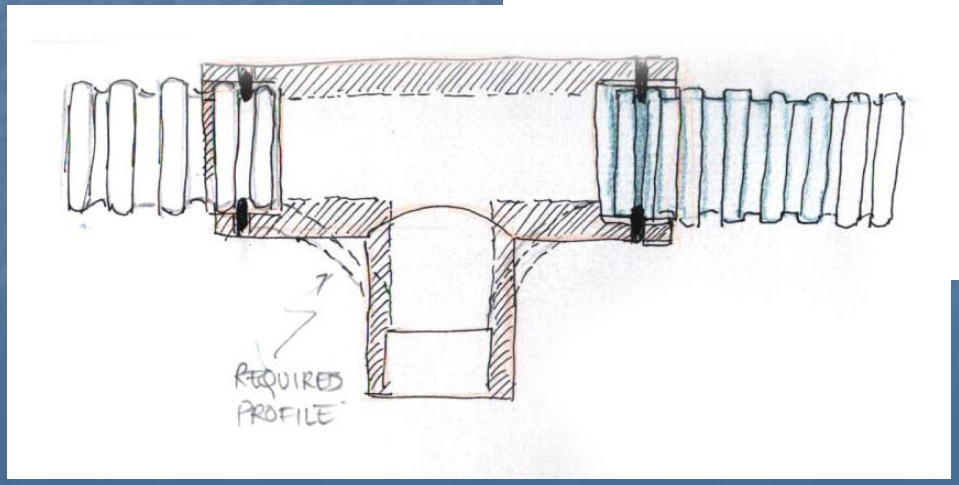
Allows even distribution of air

Joineries



Joineries





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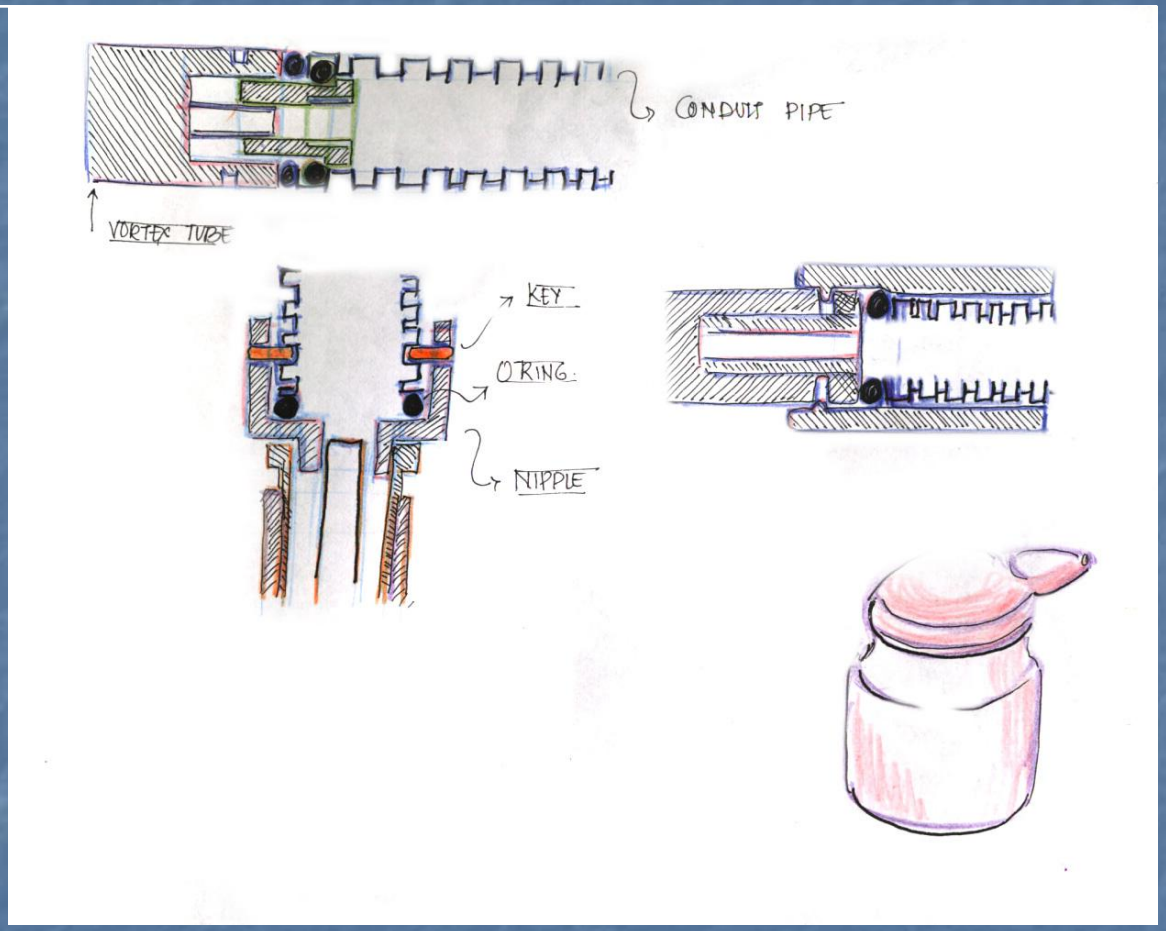


Joineries

Quick Release PY - DIFFERENCE UNION
'Y' coupling PW 0804

PC-MALE CONNECTOR)
for joining the pipes with vortex tubes

Flexible PU pipes

How to make ingress egress more convenient

Problems with the existing concept

Negotiating the upper half

How to make ingress egress more convenient

Problems with the existing concept

Balance

Locating the elements

Concepts

Minimum body twisting

Minimum awkward positions

Minimum time to get in out

Minimum number of steps

Materials for suit

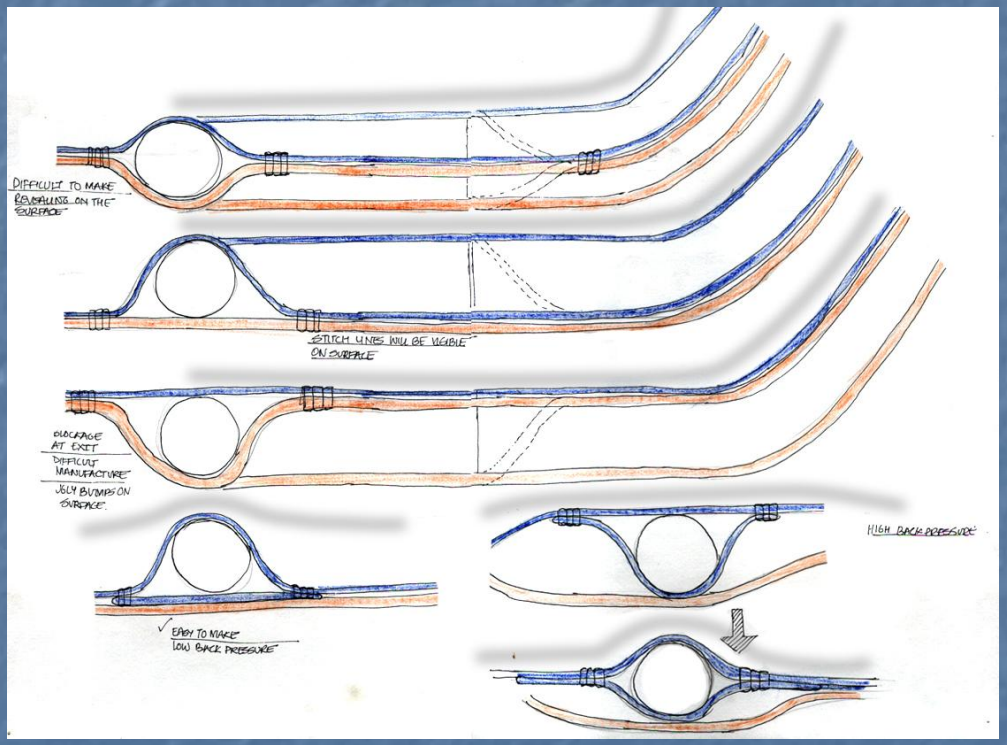
outer material which

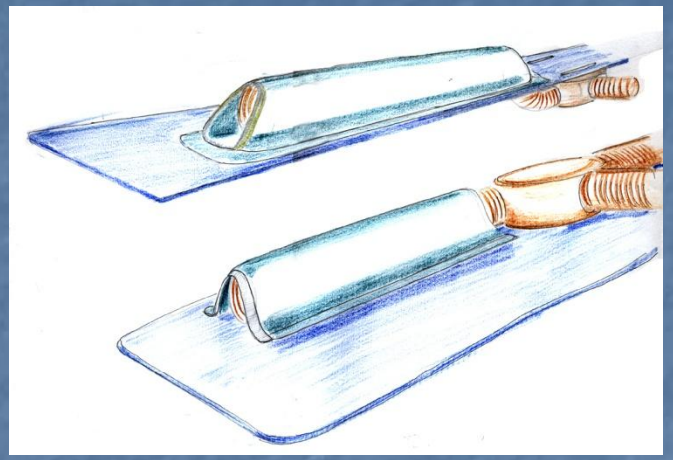
1) can sustain outer temperatures close to 1000 degrees
2) is fairly abrasion resistive
3) has a reflective silvery outer finish
4) is available easily
5) is cost effective

Aluminized Silica fabric (ALUM 84 CH)
SILRUB 84 CH
High Temperature resistive thread

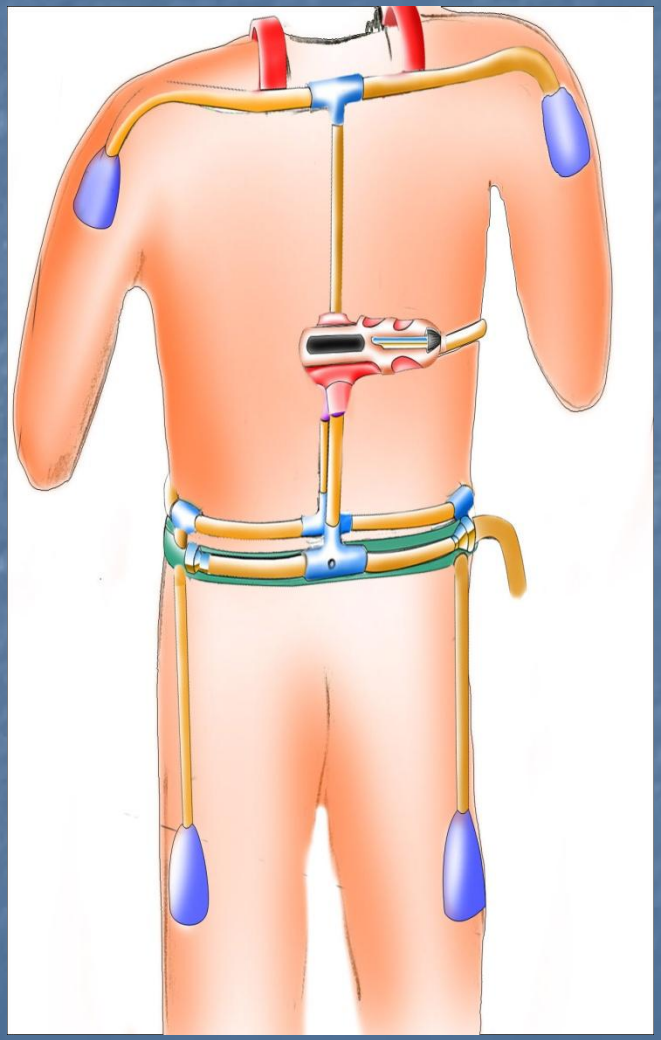
The inner liner for the suit will be 1*1 or 1*2 cotton or voile.

Product integration

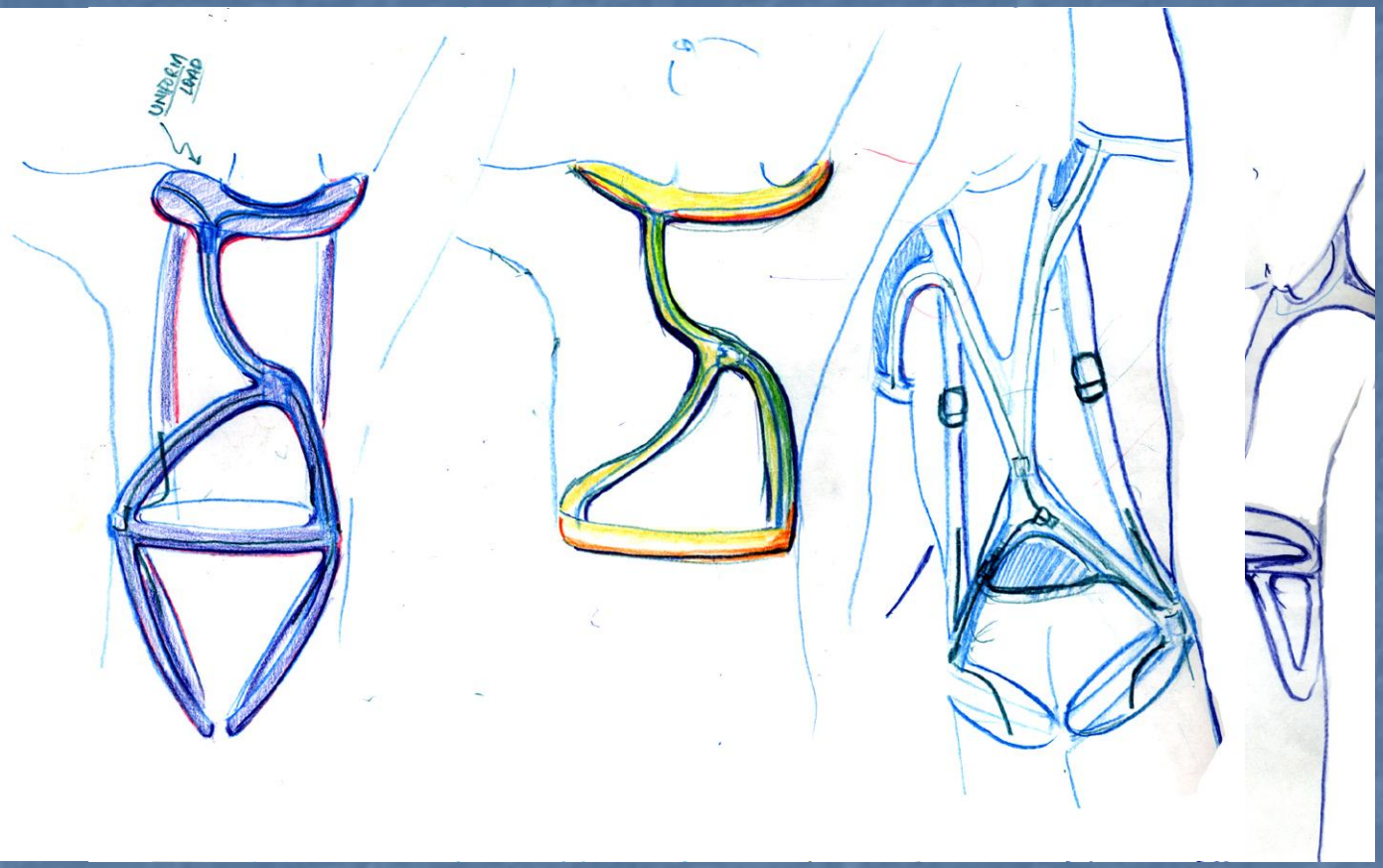




Integral suit
External ducting
Internal ducting

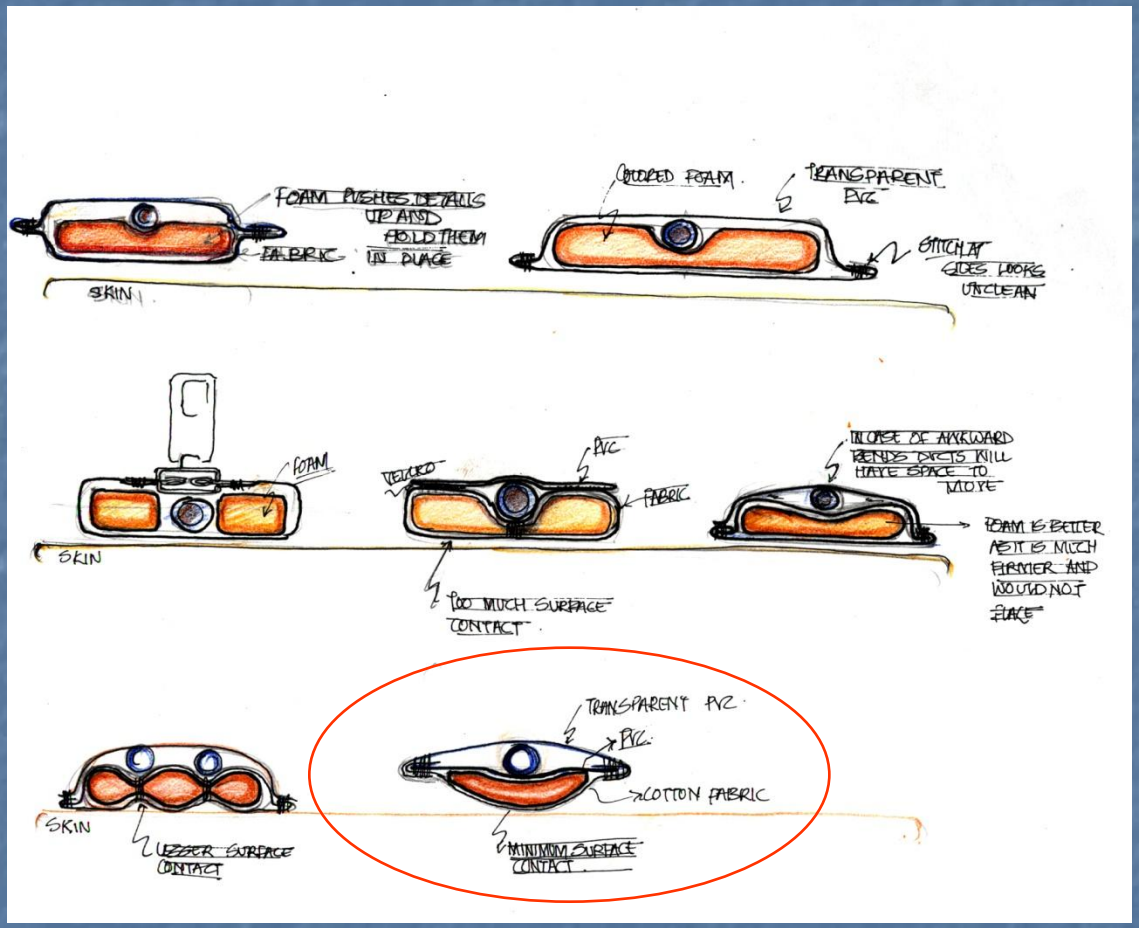


Integral suit
External ducting
Internal ducting



Integral suit
External ducting
Internal ducting

Integral suit
External ducting
Internal ducting



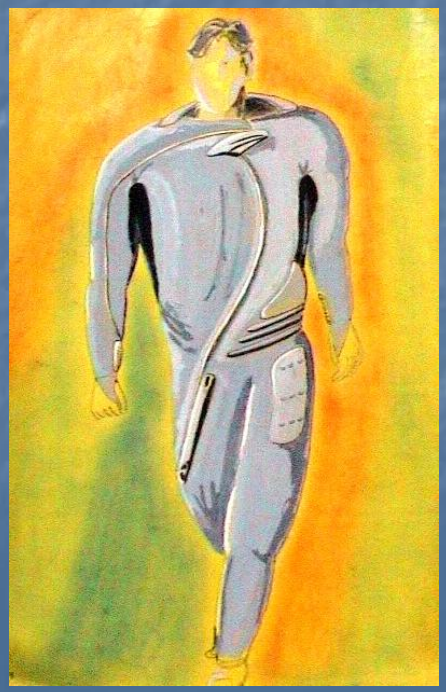
Integral suit
External ducting
Internal ducting

Vayu

Product features

Feature bundles

Basic



capable of withstanding 1000 deg Celsius

Insides of the suit can be cooled unto 10 deg Celsius

Uniform cooling throughout the body with preference over high heat exposure and high sweat rate areas.

Patches of reflective surfaces to reflect radiant heat

arrangement for stress free donning doffing.

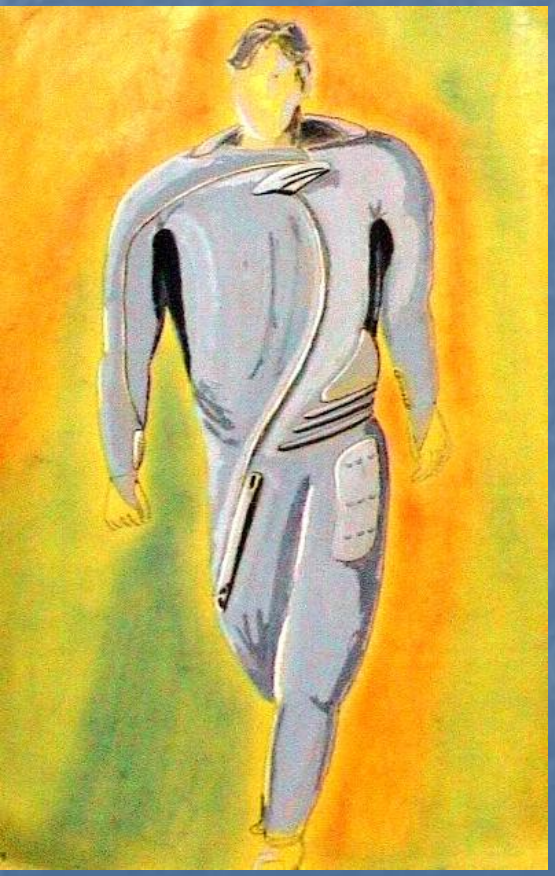
accommodates large range of percentiles

Product features

Feature bundles

Basic

Safety



Chemical resistance

Provision for quick escape in case of hazard

Protection from sparks and splinters

Fluorescent graphics

Metal chains with chain garages

Concealed joineries to avoid cold shock

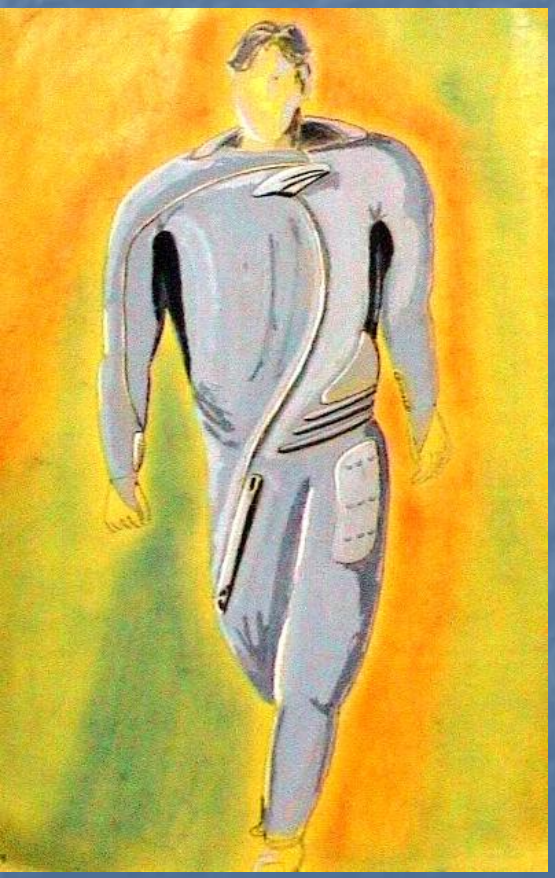
Product features

Feature bundles

Basic

Safety

Usability



Extra port for air tools

Multiple hooking points for compressed air pipe

Temperature regulation

Place to keep/store small tools

Clamp for supporting pipe

Removable ducting for cleaning the suit.

Provision of gussets and bellows over joints to allow easy worker movements.

suit is washable and harness can be disassembled easily for washing

Provision of boot cuts in leg for easy removal of shoes from the suit

Product features

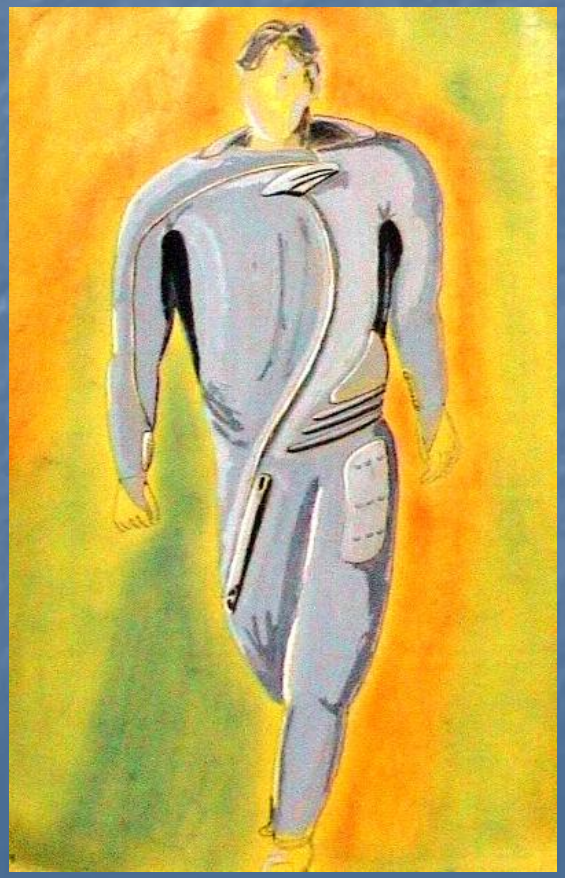
Feature bundles

Basic

Safety

Usability

comfort



Catches and cuts for easier removal with shoes on

Smooth inner liner to absorb sweat and condensate

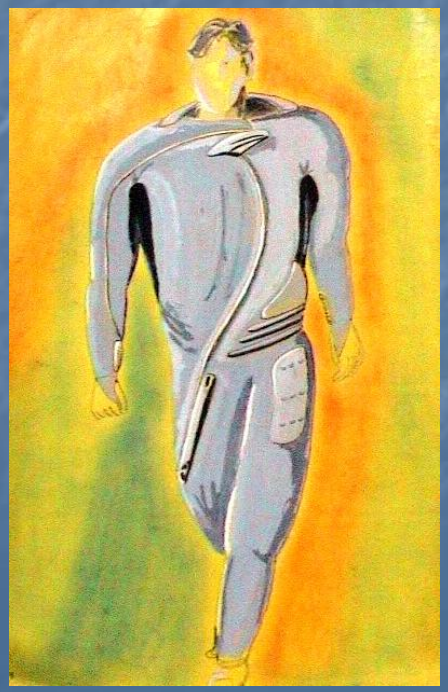
Upright collar which directs air towards face

Predictable folding pattern /easy storage

Product features

Feature bundles

- Basic
- Safety
- Usability
- comfort
- Assembly/construction

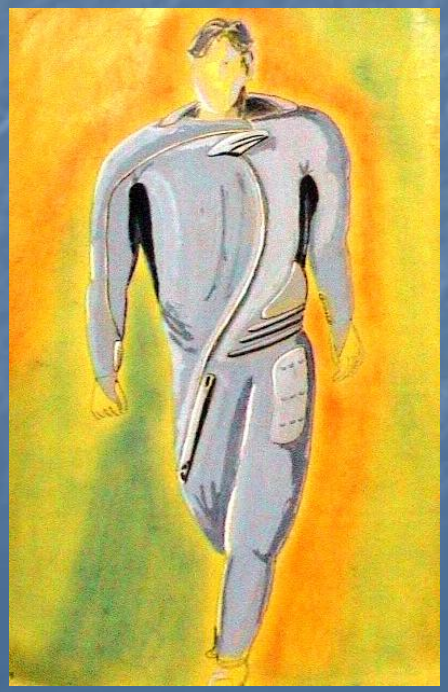


- Smooth nylon surfaces for easy insertion of ducts
- Easily removable joineries
- Suitable access to joints
- Simple and straight cutting pattern and easy assembly of details

Product features

Feature bundles

- Basic
- Safety
- Usability
- comfort
- Assembly/construction
- Aesthetics

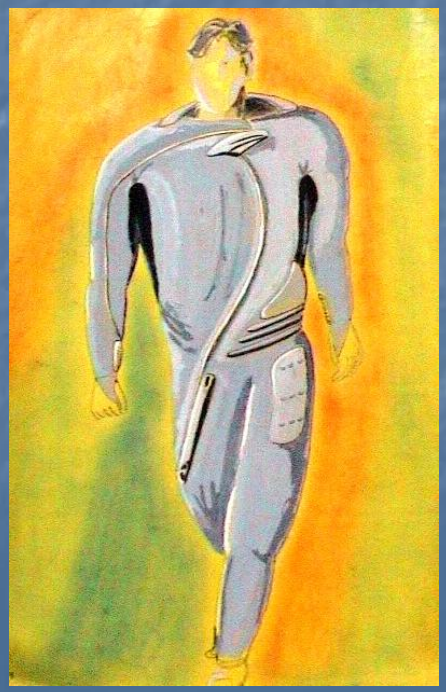


- Smart logical stitch lines
- Concealed joineries and ducts
- Minimum surface stretch lines
- Effective use of glossy fabric surface
- Attractive graphics

Product features

Feature bundles

- Basic
- Safety
- Usability
- comfort
- Assembly
- Aesthetics
- Cost



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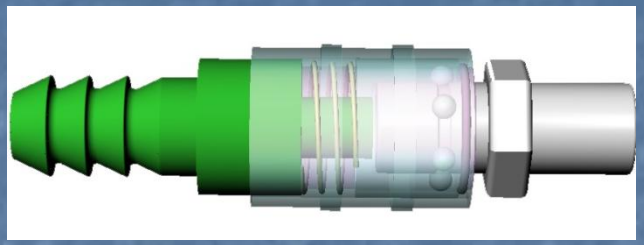

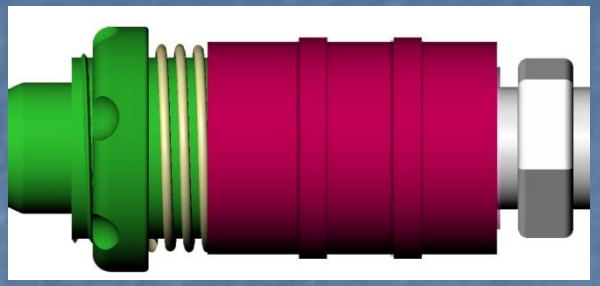

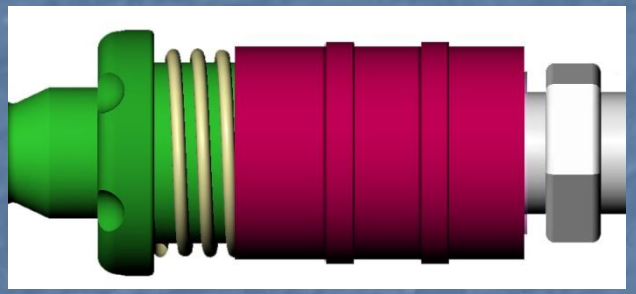

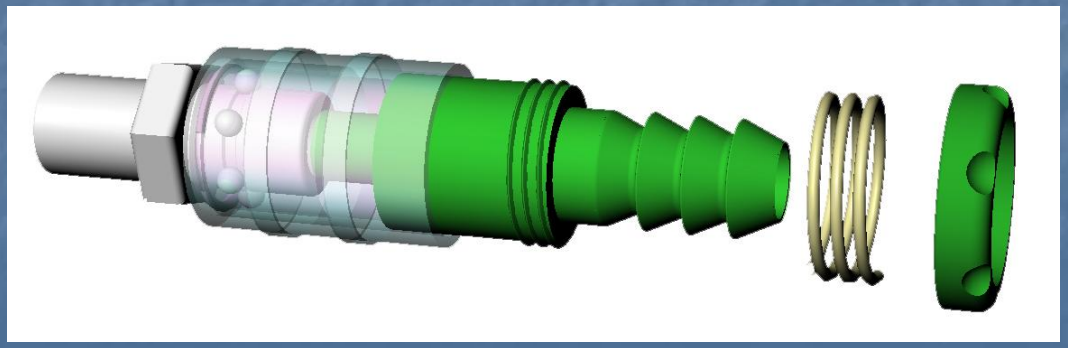

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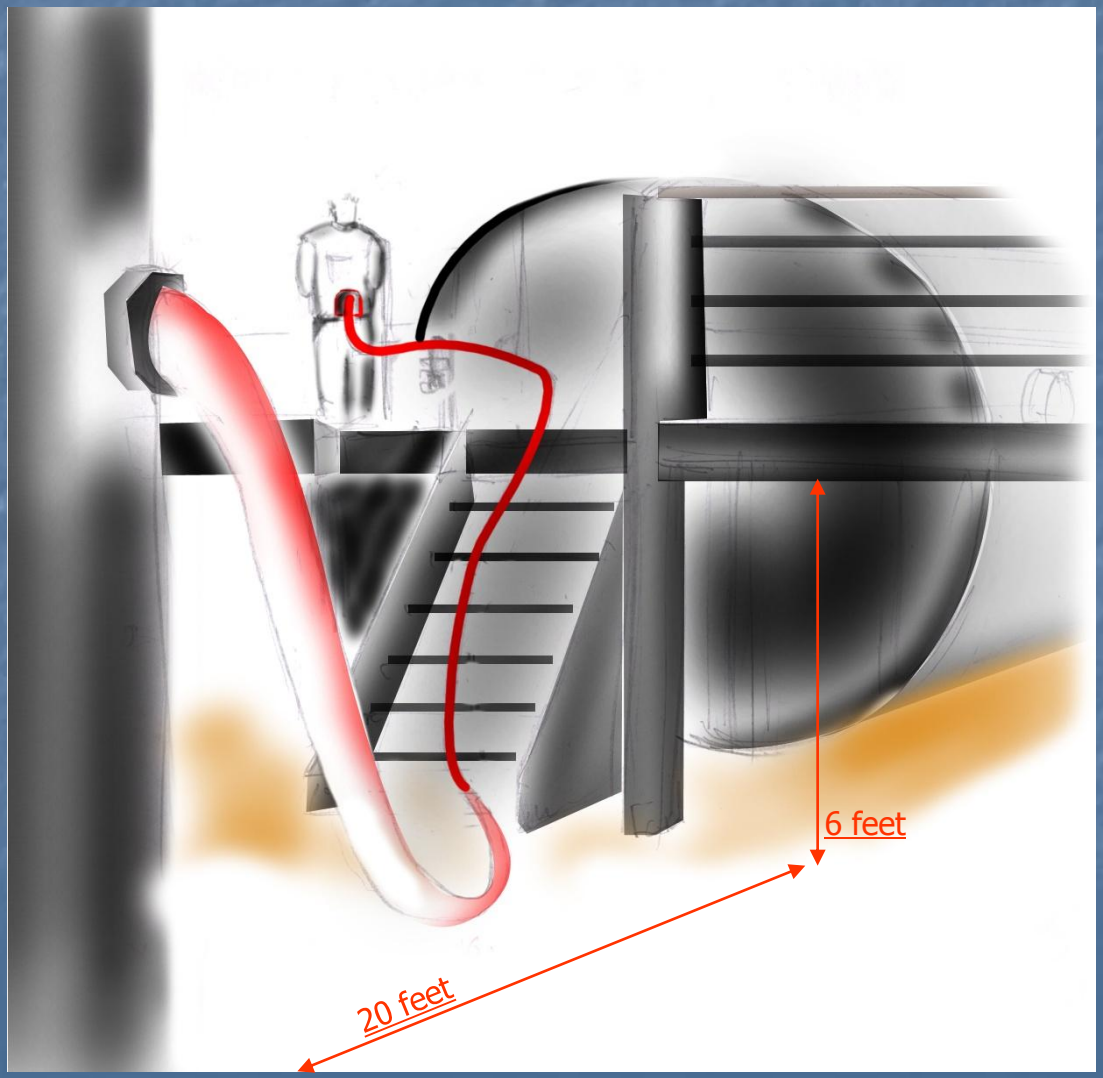
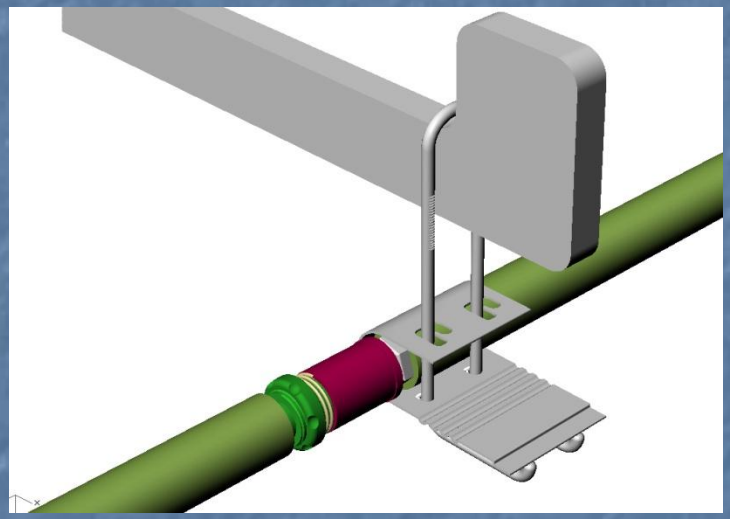
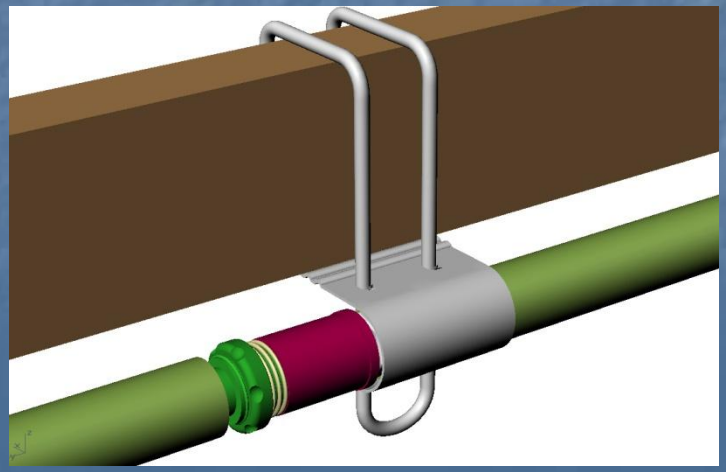
How to carry the pipe ……

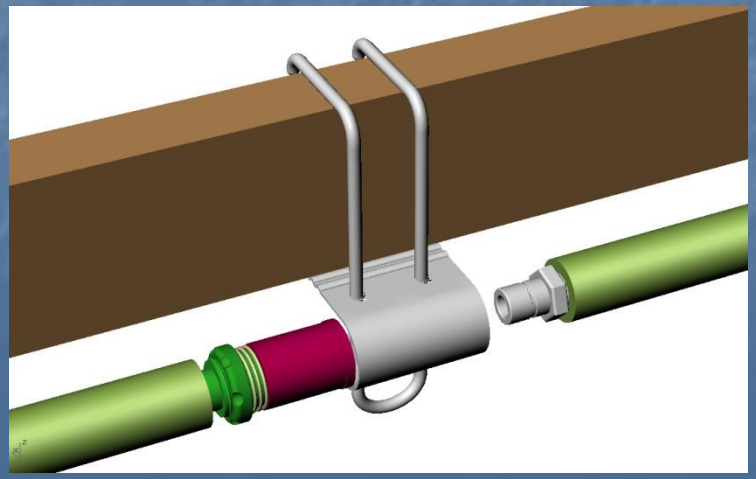
The problem





Double clamps for better grip
Nibbled surface for extra grip
Built in locks
Pipe itself is used as a spring
Knurled rods will help to grip the locking edges





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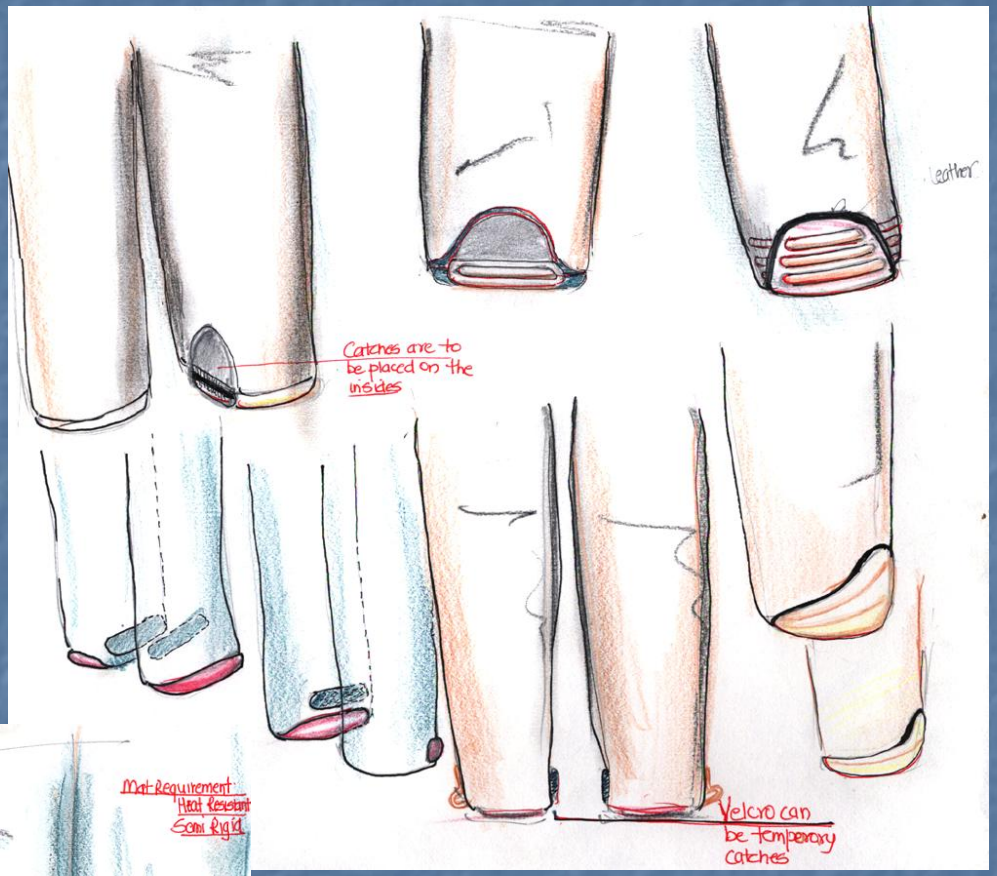
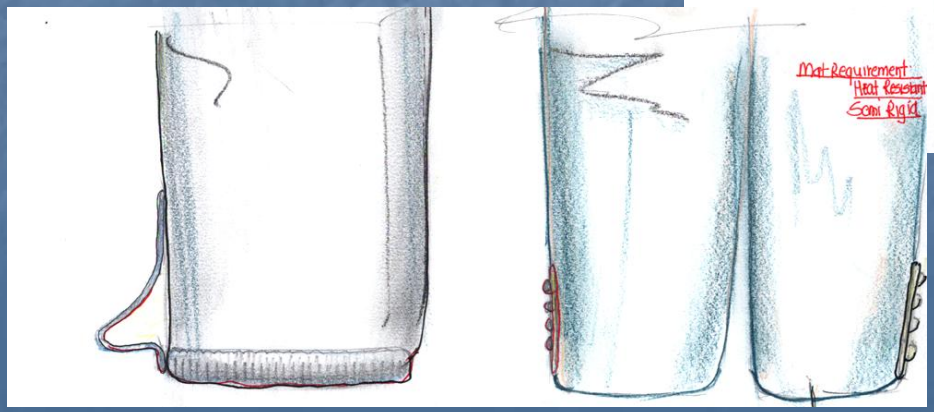
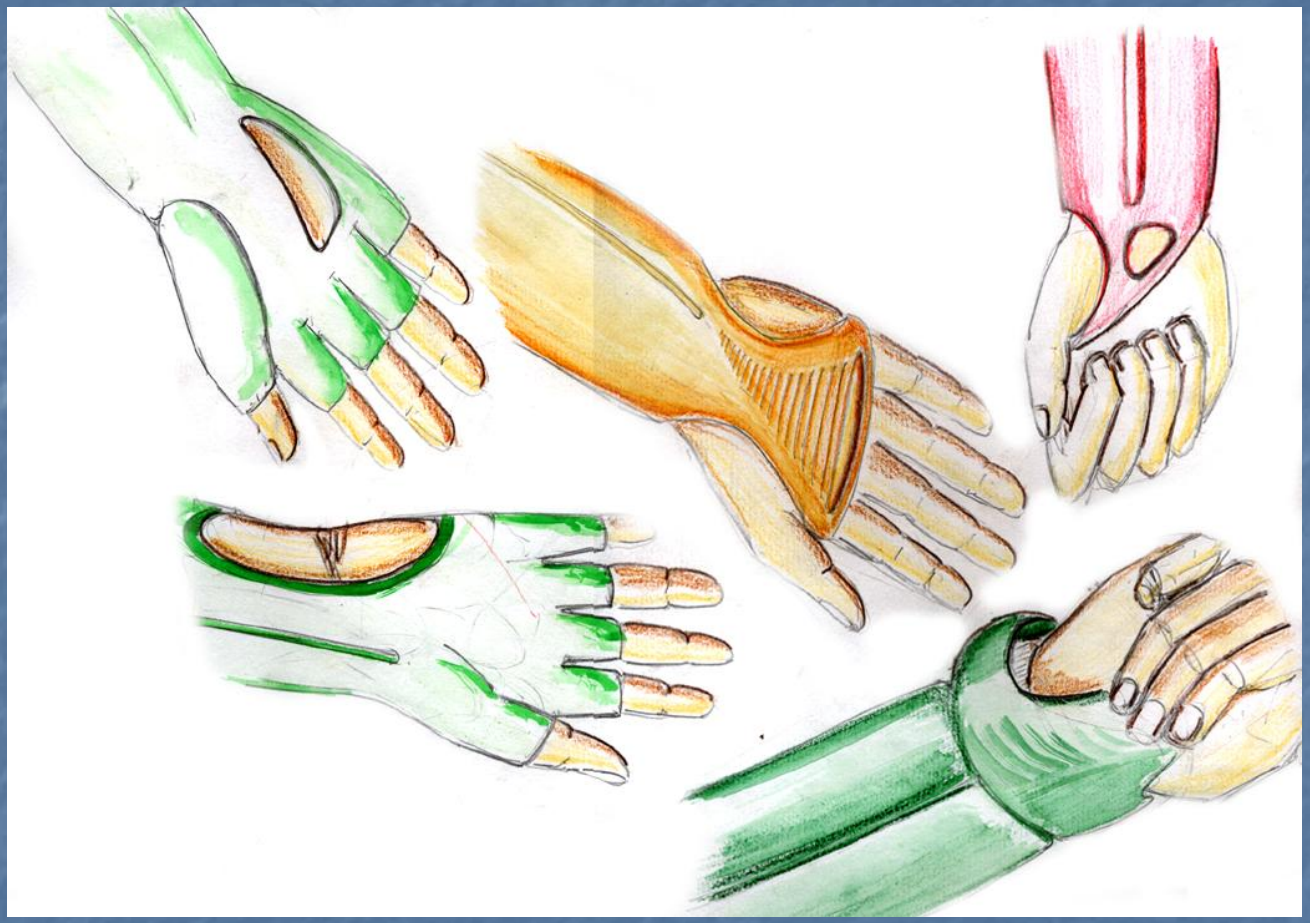

Leather
Catches are to be placed on the insides
Velcro can be temperary catches


Mat Requirement
Heat Resistant
Semi Rigid

Back



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Costing for the harness

S NO	PARTICULARS	QTY	RATE (Rs.)	AMOUNT
1	PUSH FIT MALE COUPLING 3/8"	1	70	70
2	Y COUPLING 6*8	7	74	518
3	VORTEX TUBE	1	8000	8000
4	nylon cloth for harness	2 m	25	50
5	labor cost of stitching the harness		250	250
6	end caps for PU pipe	8	5	40
7	zipper (brass)	0.4	40	160
8	PE foam for cushion	2	20	40
9	INNER COTTON LINER	1 M	75	75
10	nylon straps 3 cm, 6 cm	6	10	60

Costing for the suit

S NO	PARTICULARS	QTY	RATE (Rs.)	AMOUNT
11	High temperature fabric Grade (84 CH)	2M	700	1400
12	High temperature fabric Grade (AL-441-NB)	4M	1000	4000
13	High temperature thread	10M	10	100
14	BRASS ZIPPER	40	2.5	100
15	NYLON Strips	1	10	10
16	1*2 COTTON LINER	4 MTS	45	180
17	ELASTIC	.5 M	50	25
18	LABOR COST OF STITCHING		1000	1000

Total manufacturing cost (in RS .) 16078

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