



IDC SCHOOL OF DESIGN

Redesigning Of Wheelchair For Indian Context

A Lightweight Mobility For Physically Challenged Person

MOBILITY & VEHICLE DESIGN PROJECT II

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APPROVAL SHEET

This Mobility & Vehicle Design project report titled **"Redesigning Of Wheelchair For Indian Context"** by **Lavendra Kumar Shukla** is approved in partial fulfilment of the requirements for Master of Design degree in **Mobility and Vehicle Design**.

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Date : 02-12-2016

Place : IIT, MUMBAI

DECLARATION

I declare that this project report submission represents my thoughts in my own way, and where other's ideas or words have been included, I have adequately cited and referenced the original source. This project is all my own work and has not been copied in part or in whole from any other source except where duly acknowledged. As such all use of previously published work (from books ,journals, internet sites etc.) has been cited within the main report and fully referenced as an item in the list of References/Bibliography .I understand that any violation of the above will be cause for disciplinary action by the institute.

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Place :Mumbai.....

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CONTENTS

ABSTRACT :	1
1. INTRODUCTION :	2
A.Scope of Project:	3
B.Defining Indian Context:	4
2. PRELIMINARY RESEARCH :	05
A. Internet Study :	06
i Evolution:	07
ii Wheelchair:	08
iii Type of users:	10
B. Type of disabilities:	11
i Cerebral palsy:	12
ii Paraplegia:	13
iii Muscular dystrophy:	14
iv Poliomyelitis :	15
v Amputation :	16
C. Manufacturers:	17
i Existing product category:	18
3. USER RESEARCH :	19
A. Problem Identification:	21
B. Voice of users:	26
C. Product Exploration:	27
i Anatomy of product:	28
ii Disassembling of product:	29
iii Product Comparison :	30
D. Study Of Materials :	31

4. ERGONOMIC CONSIDERATION :	34
A. Body dimensions:	35
B. Seat dimensions:	36
C. Necessary supports:	37
D. Sitting posture and reclining angle:	38
E. Dimension benchmarking :	39
5. DESIGN BRIEF :	40
6. DESIGN DEVELOPMENT :	41
A. Inspiration:	42
B. Keywords:	45
C. Exploration sketches:	46
D. Ideations:	47
E. Concepts:	49
F. Mockups:	55
7. FINALIZING THE CONCEPT:	57
8. CONCEPT REFINEMENT AND PRODUCT PACKAGING :	58
A. Drawings:	59
B. Details:	60
C. Final Product:	63
9. PHYSICAL MODEL:	64
10. BIBLIOGRAPHY:	65
Image References	
Book References	
Internet References	

ABSTRACT

India is not a physically disabled friendly country as compared to other countries. According to the 2011 census ,2.1% of the Indian population is physically disabled . According to the 2011 census, 75% of persons with disabilities live in rural areas, 49% of disabled population is literate and only 34% are employed.

If we think of mobility aid for the disabled person, public transportation system seems very discriminatory to disabled people. Most common modes of public transport don't keep in mind disabled people, especially people using a wheelchair. Even if ramps are provided somewhere, a major complaint is that those ramps are not properly built according to the regulations, which makes going up and coming down the ramp a challenge.

The design of wheel chair started by means of Internet study to know the current scenario of wheelchair. Market study was carried out to know the present manufacturers available in India.

For better understanding of products available in market I have done comparison in between the existing products. Ethnography study was done by myself as a user to observe the problems of the existing product and to address the design gap in the existing product to the user need. The feed back which was taken from actual users and attendees also considered for concept generation and design execution. The final output is a wheel chair that must have ease of manoeuvre to the user by providing better transportability and transferability.

1.INTRODUCTION

Wheelchair is a mobility aid designed for shifting patients, moving physically challenged person from one place to another with the help of attendee or by means of self-propelling. This project is to redesign the wheelchair for Indian context for better and comfortable use of the product.



IR-1

1.A SCOPE OF PROJECT

The design of wheelchair should be light in weight for better manoeuvrability. The modes of public transport in India are not friendly towards person on wheelchairs so the transportability of a wheelchair is a major issue. The design of back rest and seat pan in the existing wheelchair creates repetitive stress injury if the patient is sitting for a long time. All the components of Wheelchair must be designed ergonomically. Current design of wheel lock needs to be redesigned that can solved both the issues braking and locking. Arm rests create obstruction while shifting the patient from wheelchair to vehicles.

1.B DEFINING INDIAN CONTEXT

India is one of the most diverse country in the world. Before buying any product people usually think of the purchasing cost and also think parallel of the maintenance cost of product. Even they become ready to compromise with comfort and many other issues related to ergonomics. So the product should be designed in very low-cost with all the ergonomic consideration.

Affordability : We must think of correlation between disability and poverty.

Maintenance free product: The wheelchair must fulfil all the aspects of its durability and ruggedness.

Portability: India is not a physically disabled friendly country as compared to other developed countries. So the wheelchair should be portable and easy to transport from one place to another place.

2.PRELIMINARY RESEARCH

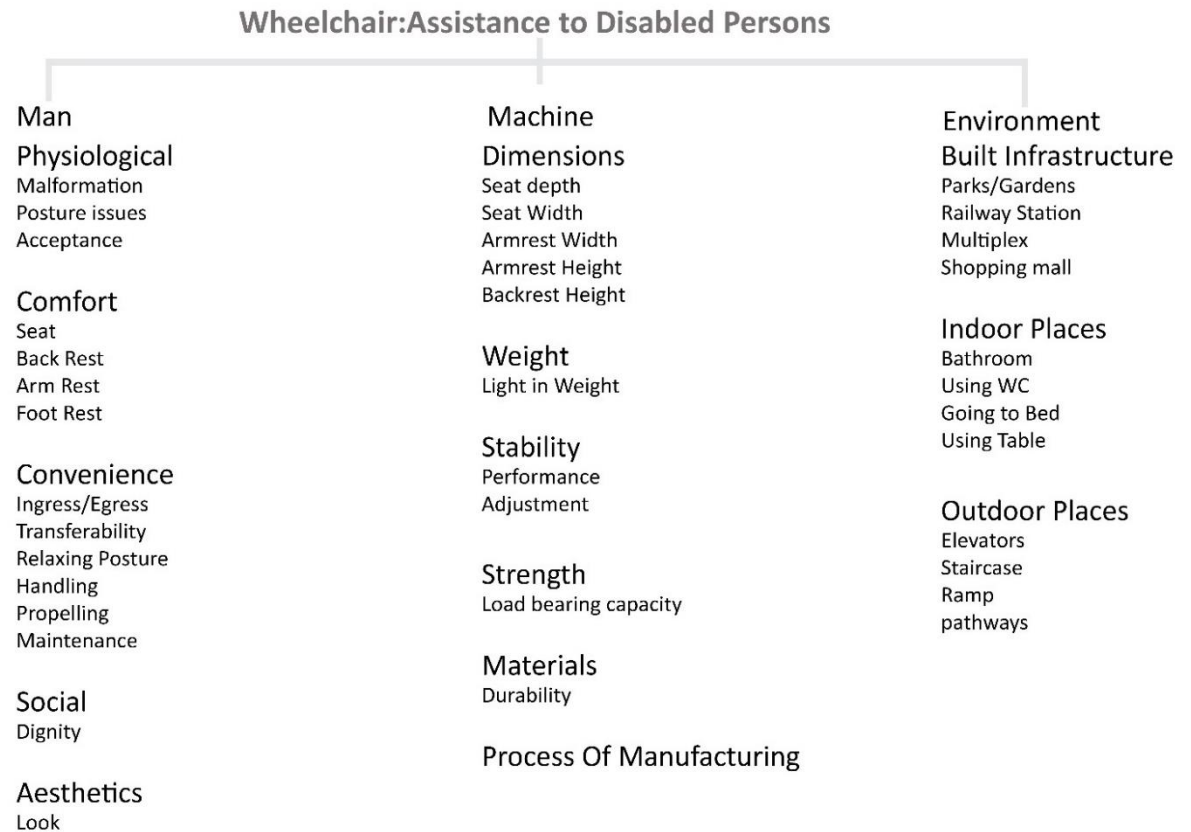
Before arriving at the research, a preliminary research was done which includes study of Indian context, study of existing wheelchairs and the manufacturers and understanding of scope of this project in the field Mobility Design.



IR-2

2.A INTERNET STUDY

Internet study is a important tool for collecting information about any product. The design of wheel chair started by means of Internet study to know the current scenario of wheelchair. Internet study was carried out to know the present manufacturers available in India and to know how is it evolved.



2.A i EVOLUTION



Wheelchair
15th century

IR-7



Wooden wheelchair
20th century



self-propelled three wheeled wheelchair
by Stephan Farfler 16th century

IR-8



Bath Chair
17th century

IR-9



Modern wheelchair
21st century

Earlier wheelchairs are called as "rolling chairs"

In 1933 **Harry Jennings** and his disabled friend **Herbert Everest**, both mechanical engineers, invented the first lightweight, steel, collapsible wheelchair.

In earlier wheelchair there are some restrictions to the physically disabled person which are gradually changed according to the accessibility to anywhere. In the current situation, accessible transportation services for physically disabled person would not be possible without some key innovations in history of wheelchair. These shifts in the evolution of wheelchair will definitely help me to improve the technology and design of product to provide a better quality of their life.

2.A ii WHEELCHAIR

Wheel Chair is a mobility device designed for shifting patients, moving physically challenged people from one place to another with the help of attendee or by means of self-propelling.

The wheel chair is divided into two categories-

i-Battery powered wheelchairs

ii-Human powered wheelchairs

Human powered or manual wheelchair are further divided into two categories according to their function and utility.

i-foldable

ii-Rigid or non-foldable

IR-15



IR-16



IR-17



Internet study of wheelchair is carried out to understand the following aspects:

Need of the product:

Wheelchair is used for the fulfilment of following requirements which are listed as follows:

Mobility-related activities

Transferring from wheelchair to bed

Transferring to bed from wheelchair

Bathing and Dressing

Functionality:

It must allow freedom of movement and for this it needs to be lightweight, durable and easy to manoeuvre. It must offer comfortable seating posture.

To whom:

Physically challenged person

Physically challenged children - Paraplegic, Poliomyelitis

Elderly Person

Where used:

In Hospitals

In Houses

In Malls/Multiplexes

In Pilgrim places(for old aged people)

In Travelling

In Sports (sport injured persons)

When Used :

During Emergency like Road Accidents, Maternity emergency, Physical disorders Muscular Dystrophy

Why Used :

To shift the patients from one place to another in hospitals

To shift the patients from one room to another at home

As a mobility for the people who are unable to walk

As a aid to elderly people

2.A iii TYPE OF USERS

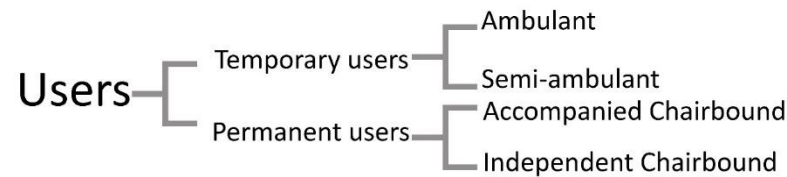
IR-4



IR-5



IR-6



According to their disabilities, deformities and capabilities users are divided into two parts which are as below:

1. Temporary Users

Ambulant: A person able to walk, with or without aid, who use building or facilities without his wheelchair.

Semi-ambulant: A person who always or sometimes used his wheelchair to use building or facilities and who was able to walk for example, to access lavatory.

2. Permanent Users

Accompanied chairbound: A chairbound person who was always Accompanied by someone else when he used building or facilities and who was unable to walk.

Independent chairbound : A chairbound person who always or sometimes used building or facilities Independently ,who was able to propel his own wheelchair over level ground,and was unable to walk.

2.B TYPES OF DISABILITIES

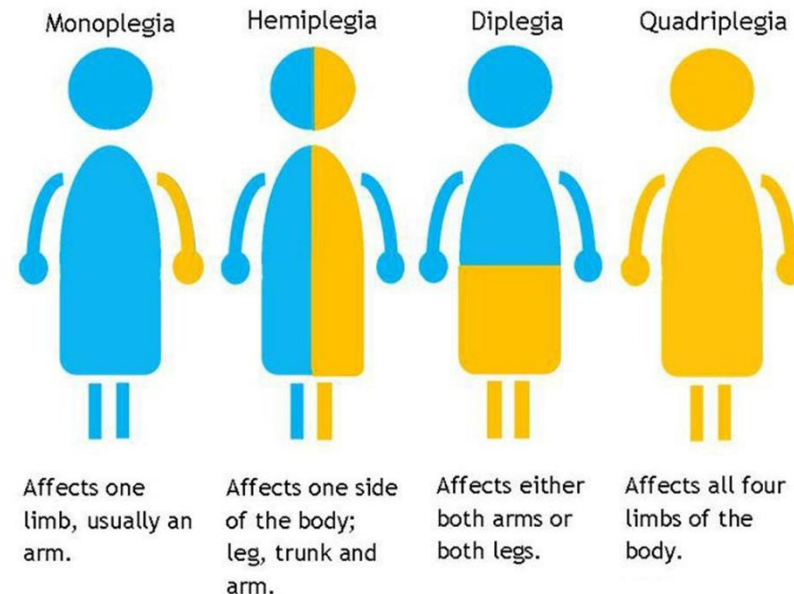
Each Wheelchair Service has its own criteria. The utility of wheelchair is rely on the cause, deformities and type of disabilities. which is divided according to their disabilities and deformities which are as below:

1. Paralytic persons
2. Those who crawl
3. Those who are able to walk with the help of aid
4. Have acute and permanent problems of joints/muscles
5. Have stiffness or tightness in movement or have loose, involuntary movements or tremours of the body or have fragile bones
6. Have difficulty balancing and coordinating body movement
7. Have loss of sensation in body due to paralysis, Leprosy etc.
8. Have deformity of body like hunch back or are dwarf.



2.B i CEREBRAL PALSY

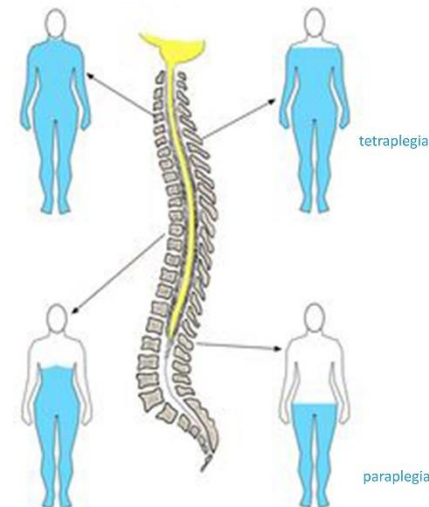
Cerebral palsy (CP) is a group of permanent movement disorders that appear in early childhood. Signs and symptoms vary among people. Often, symptoms include poor coordination, stiff muscles, weak muscles, and tremors. There may be problems with sensation, vision, hearing, swallowing, and speaking. Often babies with cerebral palsy do not roll over, sit, crawl, or walk as early as other children of their age. Difficulty with the ability to think or reason and seizures each occurs in about one third of people with CP. While the symptoms may get more noticeable over the first few years of life, the underlying problems do not worsen over time. Cerebral palsy is caused by abnormal development or damage to the parts of the brain that control movement, balance, and posture. Most often the problems occur during pregnancy; however, they may also occur during childbirth, or shortly after birth. Often the cause is unknown.



IR-14

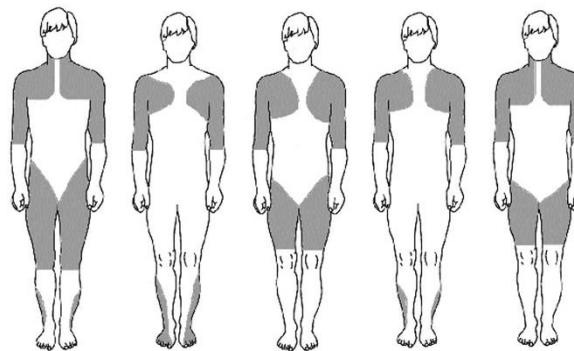
2.B ii PARAPLEGIA

Paraplegia is an impairment in motor or sensory function of the lower extremities. The word comes from Ionic Greek: "half-striking". It is usually caused by spinal cord injury or a congenital condition such as spina bifida that affects the neural elements of the spinal canal. The area of the spinal canal that is affected in paraplegia is either the thoracic, lumbar, or sacral regions. Common victims of this impairment are veterans or members of the armed forces. If four limbs are affected by paralysis, tetraplegia or quadriplegia is the correct term. If only one limb is affected, the correct term is monoplegia. Spastic paraplegia is a form of paraplegia defined by spasticity of the affected muscles, rather than flaccid paralysis.

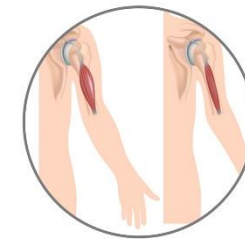


2.B iii MUSCULAR DYSTROPHY

Muscular dystrophy (MD) is a group of muscle diseases that results in increasing weakening and breakdown of skeletal muscles over time. The disorders differ in which muscles are primarily affected, the degree of weakness, how fast they worsen, and when symptoms begin. Many people eventually become unable to walk. Some types are also associated with problems in other organs. There are nine main categories of muscular dystrophy that contain more than thirty specific types. The most common type is Duchenne muscular dystrophy (DMD) which typically affects males beginning around the age of four. Other types include Becker muscular dystrophy, facioscapulohumeral muscular dystrophy, and myotonic dystrophy. They are due to mutations in genes that are involved in making muscle proteins. This can occur due to either inheriting the defect from one's parents or the mutation occurring during early development. Disorders may be X-linked recessive, autosomal recessive, or autosomal dominant. Diagnosis often involves blood tests and genetic testing. There is no cure for muscular dystrophy. Physical therapy, braces, and corrective surgery may help with some symptoms. Assisted ventilation may be required in those with weakness of breathing muscles. Medications used include steroids to slow muscle degeneration, anticonvulsants to control seizures and some muscle activity, and immunosuppressant to delay damage to dying muscle cells. Outcomes depend on the specific type of disorder.



main areas of muscle weakness in different types of dystrophy



normal biceps

muscular dystrophy

2.B iv POLIOMYELITIS

Poliomyelitis, often called **polio** or **infantile paralysis**, is an infectious disease caused by the poliovirus. In about 0.5% of cases there is muscle weakness resulting in an inability to move. This can occur over a few hours to few days. The weakness most often involves the legs but may less commonly involve the muscles of the head, neck and diaphragm. Many but not all people fully recover. In those with muscle weakness about 2% to 5% of children and 15% to 30% of adults die. Another 25% of people have minor symptoms such as fever and a sore throat and up to 5% have headache, neck stiffness and pains in the arms and legs. These people are usually back to normal within one or two weeks. In up to 70% of infections there are no symptoms. Years after recovery post-polio syndrome may occur, with a slow development of muscle weakness similar to that which the person had during the initial infection. Poliovirus is usually spread from person to person through infected fecal matter entering the mouth. It may also be spread by food or water containing human feces and less commonly from infected saliva. Those who are infected may spread the disease for up to six weeks even if no symptoms are present. The disease may be diagnosed by finding the virus in the feces or detecting antibodies against it in the blood. The disease only occurs naturally in humans.



bulbo-spinal polio-19%



spinal polio-79%
scoliosis



bulbar polio-2%

2.B v AMPUTATION

Amputation is the removal of a limb by trauma, medical illness, or surgery. As a surgical measure, it is used to control pain or a disease process in the affected limb, such as malignancy or gangrene. In some cases, it is carried out on individuals as a preventative surgery for such problems. A special case is that of congenital amputation, a congenital disorder, where fetal limbs have been cut off by constrictive bands. In some countries, amputation of the hands, feet or other body parts is or was used as a form of punishment for people who committed crimes. Amputation has also been used as a tactic in war and acts of terrorism; it may also occur as a war injury. In some cultures and religions, minor amputations or mutilations are considered a ritual accomplishment. Unlike some non-mammalian animals (such as lizards that shed their tails, salamanders that can regrow many missing body parts, and hydras, flatworms, and starfish that can regrow entire bodies from small fragments), once removed, human extremities do not grow back, unlike portions of some organs, such as the liver. A transplant or a prosthesis are the only options for recovering the loss.

Lower limb amputation (bilateral)



2.C MANUFACTURERS

ALIMCO: Artificial Limbs Manufacturing Corporation of India

VISSCO: Vijay Scientific and Surgical Company

PARAMOUNT SURGIMED LTD.

M. TECHNOLOGIES

ANAND MEDICAL

SAYANI SURGICALS

MANISH STEEL INDUSTRIES

MAHAVIR SURGICAL LTD.



2.C i EXISTING PRODUCT CATEGORY

There are many different types of wheelchair categories currently available in market. Every category has different models suited for different users. Some of the wheelchair of different categories are shown below:



Paramount Wheel chair PWc 902Gc
Reclining High Back Moveable Armrest



VISSCO Wheelchair with commode



ALIMCO Wheelchair Folding Child size
MAMTA (TD 2 A 06)



Sayani Surgical Wheelchair 100MM



Sayani Wheel Chair - Recliner



VISSCO Wheelchair 200MM

3. USER RESEARCH

I had conducted two weeks user study within the IIT campus by myself as a user.

:For better learning and experience I have used wheelchair in my day to day life.

:To get a hands on feelings it was a great idea.

:By this I could understand the problems very well.

H14-IDC --- H14-Mess --- H14-IIT Hospital --- IDC-SJM SOM --- H14-H15 --- SOM-IIT Hospital --- H15-Central library

3.A PROBLEM IDENTIFICATION



:hectic in holding push rims (due to distributed force applied by hands)



:width of wheelchair create trouble while accessing elevator

3.A PROBLEM IDENTIFICATION



::Stress in hand while steering the wheelchair due to this kind of handle



:problem in reaching the table and non adjustable height of table for ease of work which increases repetitive stress injuries like wrist, back and shoulder injuries.

3.A PROBLEM IDENTIFICATION



Foot rest

It is too low in the current wheelchair, it hits door thresholds when traversing. (Image 1)

Footrest contact occurs most often during starting to go up a ramp or when transitioning between the ramp and flat ground when descending. (Image 2) (Image 3)

The danger lies in the fact that a moving wheelchair can tip forward if the footrests suddenly hit an obstacle.

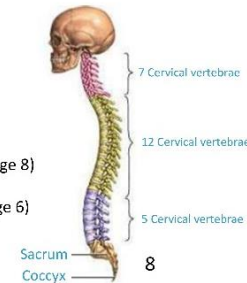
Seat Pan

One of the most common problems with wheelchairs can be attributed to sling seat upholstery. (Figure 7)

Backrest

The height of the backrest does not fulfill the lumbar support. Due to the long use of wheelchair this creates the pain near the sacrum. (Image 8)

Sitting with a backrest with short height can lead to postural instability. (Image 6)



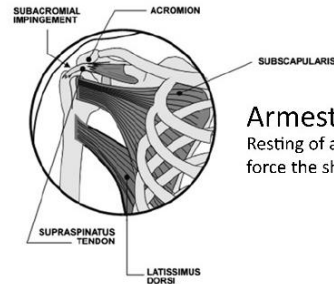
Arm rest

Armrests serve a valuable postural support role for users. They have different body structure.

The armrests are too high so it forces the user to elevate his/her shoulders, leading to discomfort. (Image 4, 5)

Due to the lack of adjustability armrest does not allow the user to go underneath the table or desk. (Image 6)

3.A PROBLEM IDENTIFICATION



Armrest Height

Resting of arm is obstructed by a armrest This will result in postural instability. Due to this the armrest force the shoulder towards up that generates the stress to shoulders.(Image 1)



Backrest Inclination

Wheelchair users tend to do a lot of functional activity from a seated position. After a long time sitting This will result in postural instability, and the user will respond by leaning forward on the seat into a slouched posture. It causes the back pain.(Image 2)

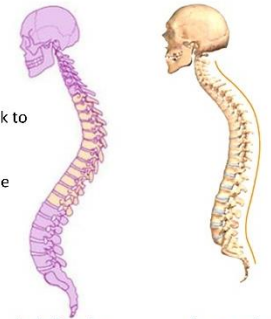
3.A PROBLEM IDENTIFICATION



Vibrations and jerks

When the foot rest hits door thresholds when traversing ,It gives a sudden jerk to the whole body.(Image 1)

The vibrations which are generated While using ramp creates unstability to the whole body posture.It happens on the rough terrain.(Image2)



stretching of muscles is caused by the sudden jerks and vibrations which creates stress to the users having the kyphotic posture and C curve posture.



3.B VOICE OF USERS

:Light in Weight

:Cost effective

:Highly visible frame colour

:Correlation between disability and poverty

:Facing problem while defecating

:No ramp for wheelchair in Best Buses

:Unfortunately, India is not disabled friendly Country

:There is difficulty in shifting the patient from wheel chair to auto rickshaw and other vehicles

:Dignity of the user-Aesthetically it should not look like hospital equipment

:NGO and Govt. distributed wheelchairs are not up to standards

:many of them don't know-is it a good or bad design



3.C PRODUCT EXPLORATION

This step was taken to understand the anatomy of product so that I could know the correct terminology of wheelchair parts.

Areas of exploration

Existing product disassembling to know the utility of each parts.

comparison between other two existing products to know the following factors:

cost

affordability

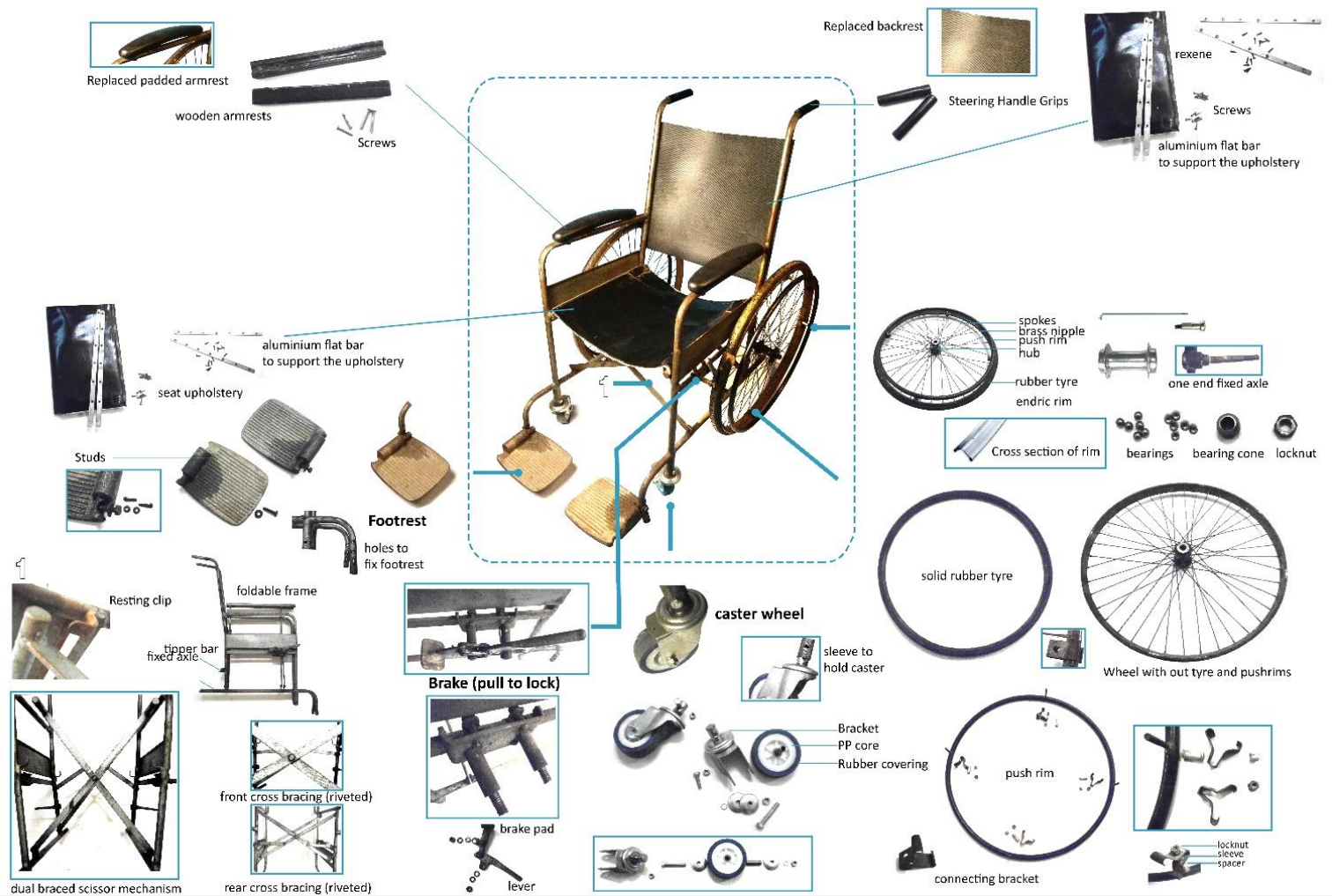
weight of available /existing wheelchairs

use of material

3.C i PRODUCT ANATOMY



3.C ii DISASSEMBLING OF PRODUCT



3.C iii PRODUCT COMPARISON

Components & Specifications

IDC department



Meet Importers



M.R.P.=5800 Rs.

Carbon steel grade -304
:good resistance to corrosion
:good malleability and weldability

Mahavir Surgicals



M.R.P.=6800 Rs.

Castor wheels		3" Bracket type With PP core		8" Bracket type solid rubber With PP core		8" Bracket type solid rubber With PP core
Pushrims/Handrims		painted tubular section		Plastic coated solid bar		Chrome plated Carbon steel tubular section
Footplates		Foldable aluminium stud		Swingaway PP Footrests		Swingaway Aluminium studs
Upholstery		Black Rexene		Padded Black nylon		Tartan pattern padded fabrics
Wheel locks Side panels		Pull to lock MS assembly Powder coated MS plate		Pull to lock Chrome finish assembly Moulded PP panel		Pull to lock Chrome finish assembly Riveted SS panel
Folding Assembly Frame		Dual Crossbraced Flat Bars (Riveted) MS Powder coated		Crossbraced Powder coated Steel tube (Bolted) Chrome-plated carbon steel		Crossbraced SS tube (Bolted) Chrome-plated carbon steel
Armrests Steering Grip		Padded arms Wrap-around Nylon strap		Full-length Padded arms PP Grips		Full-length Padded arms PP Grips
Safety Features		N/A		Safety belt (Nylon) Carry pocket on back		Safety belt(Fabric) Carry pocket on back
Wheels Tippers Tyres		Endric Type Bicycle Rims MS tube without grip 24" Molded solid Rubber		Endric Type Bicycle Rims Chrome plated tube with grip 24" Molded urethane Rubber		Endric Type Bicycle Rims Chrome plated tube with grip 24" Molded urethane Rubber

3.D STUDY OF LIGHTWEIGHT MATERIALS



IR-11

Coconut Husks and Fibre Reinforced Polymers:
coconut fibre is a natural fibre extracted from the husk of coconut and used in making of various kind of products. With the application of epoxy with this we can fabricate any desirable shape. This is relatively new category of composite materials that combine stiffness and strength with weight reduction and corrosion resistance.

3.D ALUMINIUM EXTRUDED SECTIONS



3.D POLYPROPYLENE

Polypropylene (PP), also known as polypropene, is a thermoplastic polymer used in a wide variety of applications including furnitures, plastic parts and reusable containers of various types, automotive components. An addition polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids. It can be moulded. It is very light in weight



IR-12



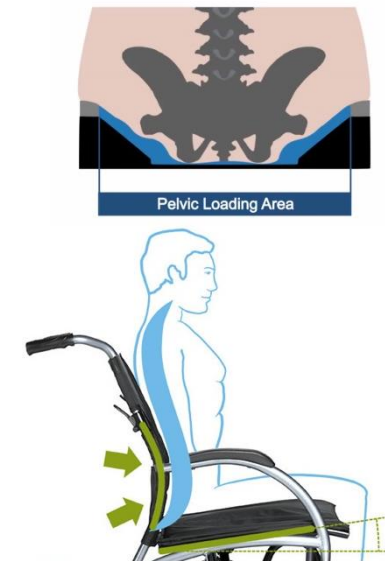
IR-13

4. ERGONOMIC CONSIDERATION

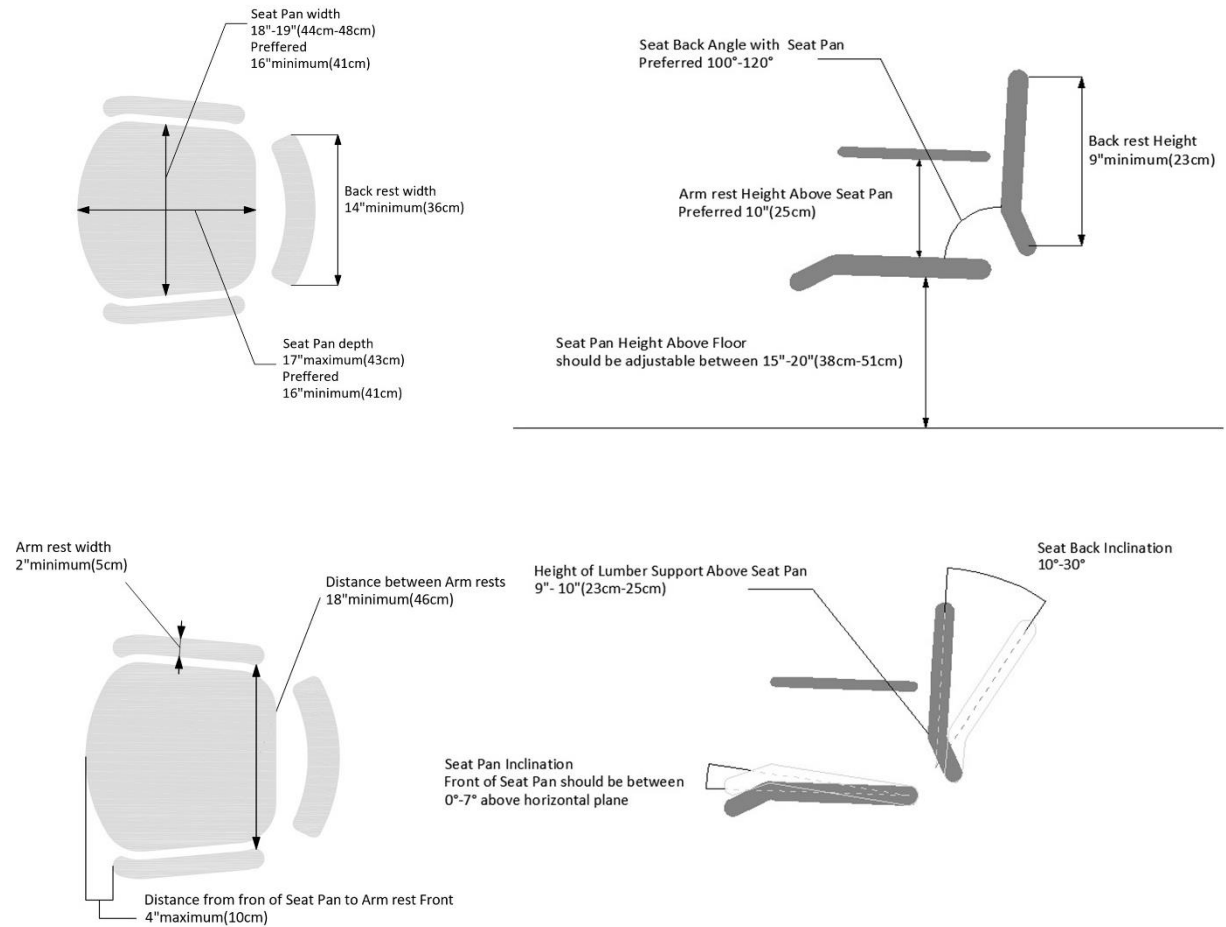
Polypropylene (PP), also known as polypropene, is a thermoplastic polymer used in a wide variety of applications including furnitures, plastic parts and reusable containers of various types, automotive components. An addition polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids. It can be moulded. It is very light in weight

4. A BODY DIMENSIONS

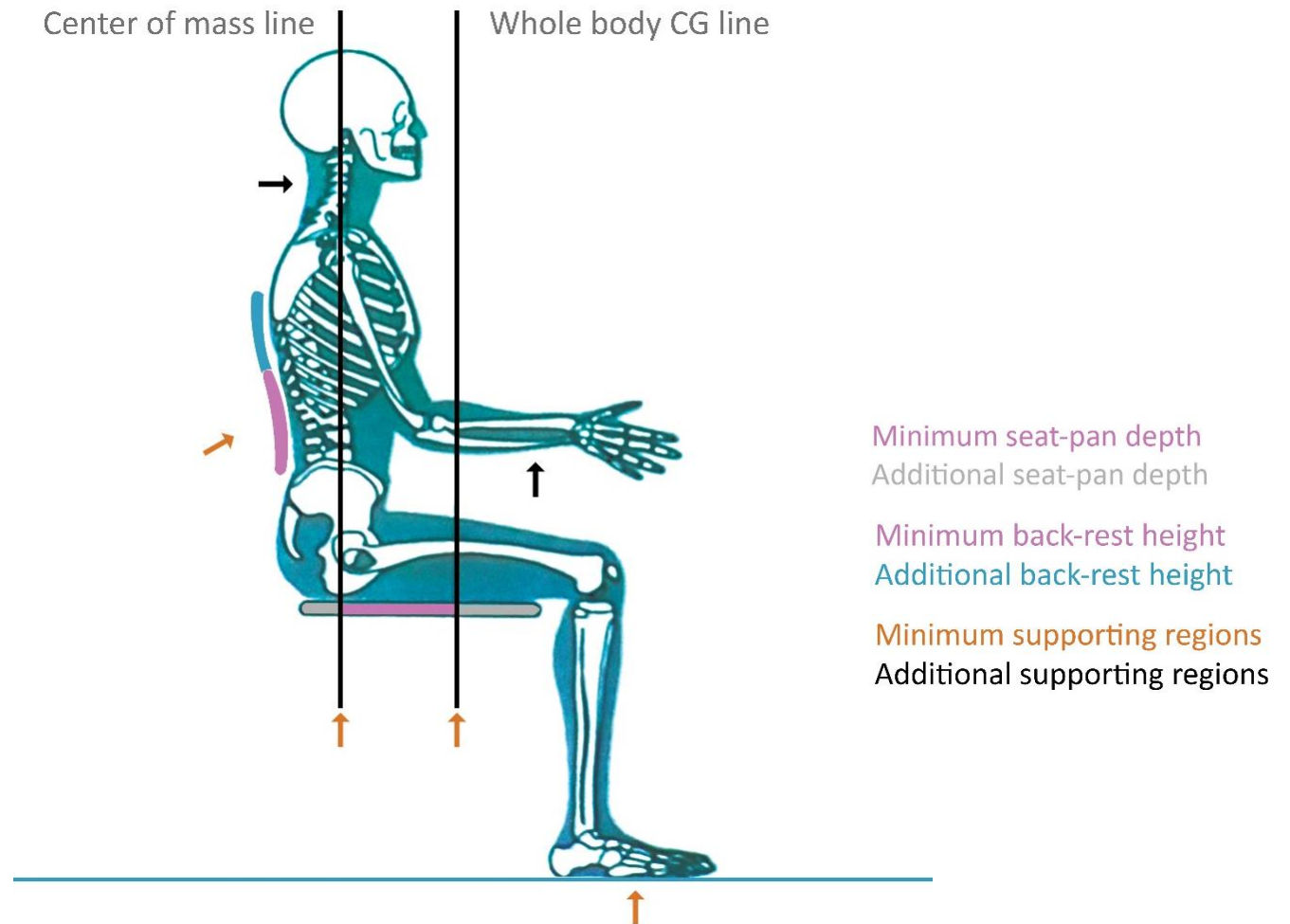
Selected Structural Body Dimensions (cm)		
Body Features	95 Percentile Male	5 Percentile Female
Height	185	150
Sitting Height, erect	97	79
Sitting Height, normal	93	75
Knee Height	59	46
Elbow-Rest Height	49	36
Thigh-Clearance Height	30	18
Buttock-Knee Length	18	10
Buttock-Knee Length	64	52
Buttock-Popliteal Length	55	43
Elbow to Elbow Width	51	31
Seat Width	40	31



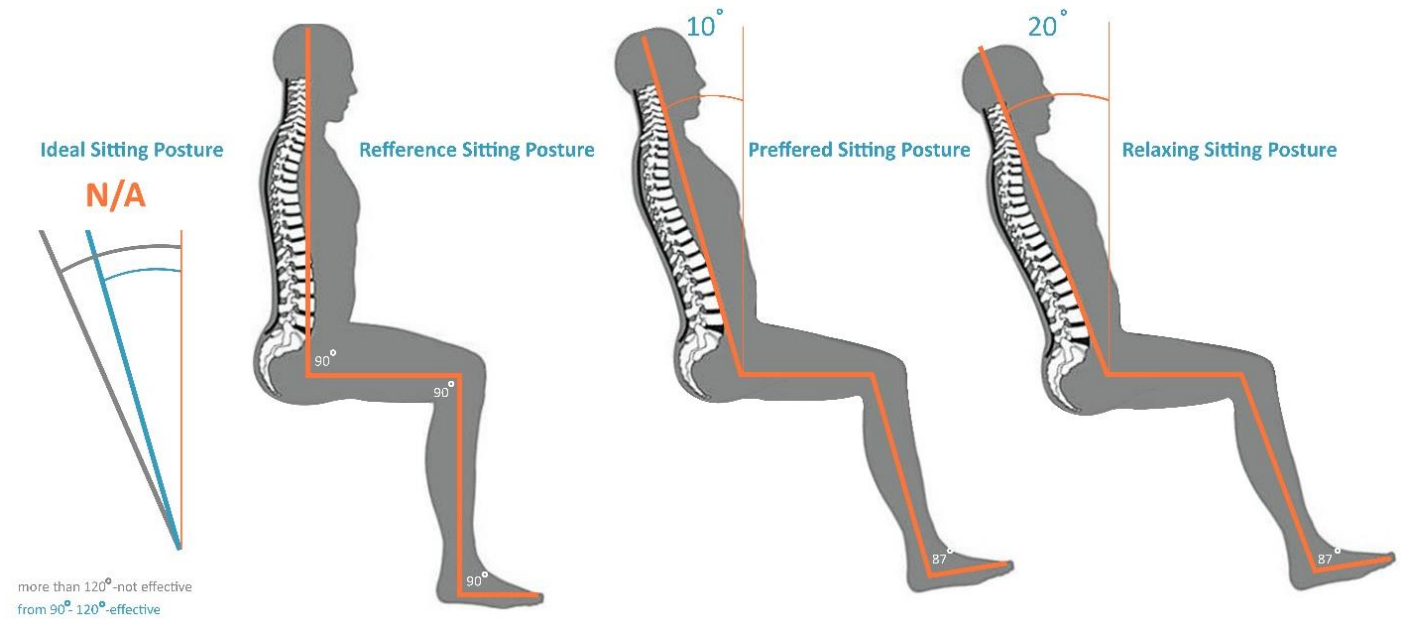
4.B SEAT DIMENSIONS



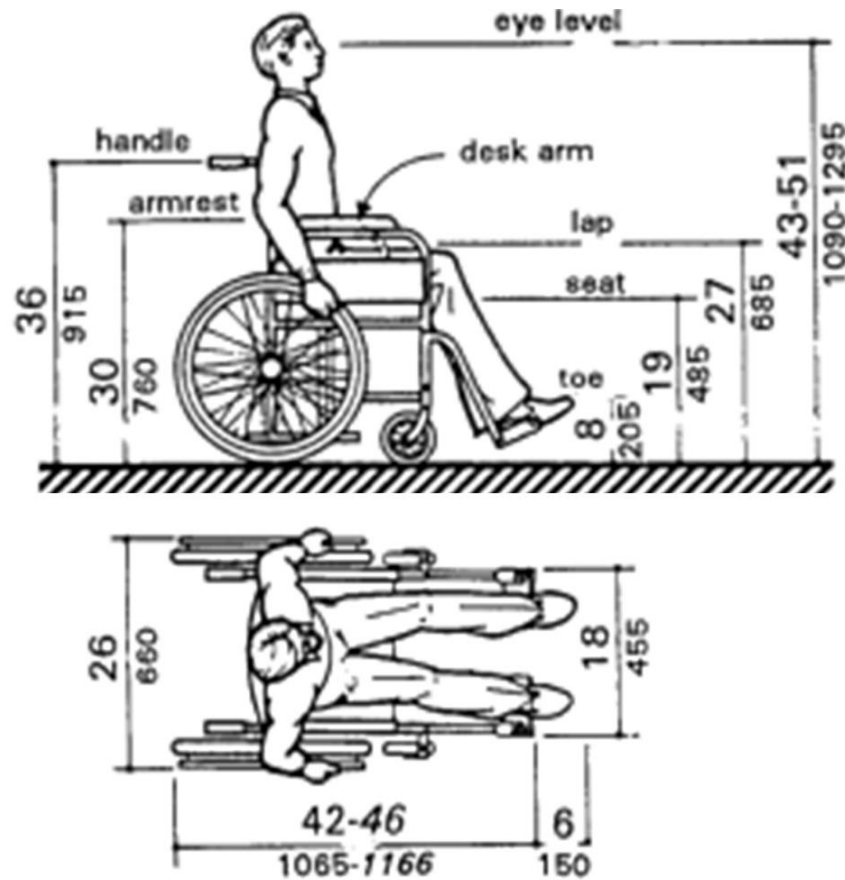
4.C NECESSARY SUPPORTS



4.D SITTING POSTURE AND RECLINING ANGLE



4.E DIMENSION BENCHMARKING



IR-3

5.DESIGN BRIEF



IR-10

To redesign a lightweight wheelchair (Weight reduced by 30%) so that it can enhance the comfort level of users in day to day life activity with the ease in manoeuvrability.

Following points are also taken forward for the user-cantered design:

Foldability-Reducing volume after folding
Portability

The challenge lies in making the innovation scalable on a mass manufacturing level. This is because of the increase in NGOs requirement of low production cost of wheelchairs for their strategic CSR initiatives.

6.DESIGN DEVELOPMENT

Following steps are taken forward for the ideations and concepts generation:

Implementation of user study which has been conducted by me as a user.

Study of the natural and manmade objects which are capable of carrying much more than their own weight.

Taking inspiration forward for the concept generation.

6.A INSPIRATIONS

Which Are Capable of Carrying Much More than Their Own Weight.

1 Bicycles

:diamond shape frame
frame divides rider's weight between
front and back wheels.



:Bicycle are used for transportation of peoples.
:The entire assembly of Bicycle weighs 18 kg -20kg.
:It is suitable for 1-2 persons (average weight -65kg).

3 Jhoola

:tension and compression
compressive strength due to
flexibility of twisted rope.
compressive strength of wood.



2 Cobweb

:clustering and radial connectivity
tensile strength of segmented silk



:One weave of Cobweb silk can hold the Weight of One
House Spider. (weight 2 to 3 grams)
:It is up to 6 times stronger than high-grade steel per weight.

4 Skateboard

:plywood has omnidirectional strength due to its layered structure
plywood divides rider's weight
between front and rear wheels.



:A Skateboard is a type of sports equipment used primarily
for the activity of skateboarding.
:Skateboard weighs 1.8 kg

:A Jhoola is a type of swing often seen in the month of
Shrawan in India.The entire assembly of Jhoola weighs
2 kg -3kg. It is suitable for 1-2 persons.(average weight -65kg)

5 Mushroom

:cantilevered UDL of cap
concentrated at free end.



:The weight of the cap of a mushroom is 2-3 times
heavier than the stem or stalk.

: tensile strength
due to flexible webbing strap-cords.



:A hammock is a sling made of fabric, rope, or netting,
suspended between two points, used for swinging or resting.
:The entire assembly of One hammock weighs 400-600 grams.

7

:principle of 'air resistance'
zero-porosity fabrics that are meant
to slow down the fall of people.
(linen, canvas, or nylon)



:The entire assembly of One Parachute weighs 14 kg-20 kg.
:It can carry one person (average weight -65kg).

9 Cup Nest of Sparrow (Gauraiya)

: interlocking in straws
nest weave density
shape of the nest

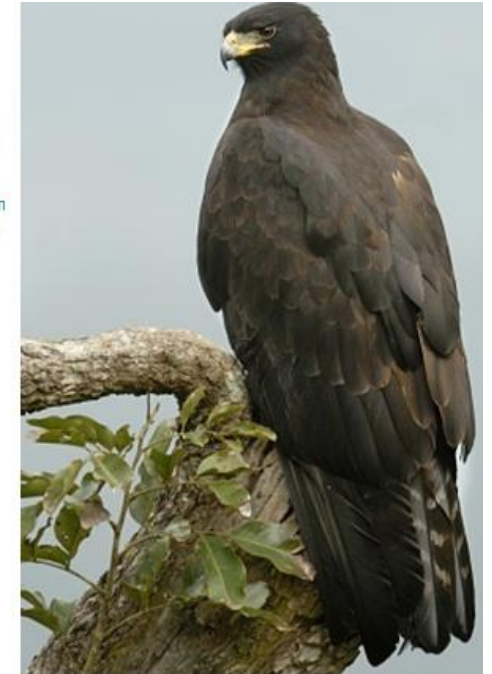


:House sparrow (weight -30-40 grams)
:Sparrow's egg (weight -3-4 grams).

8 Black Eagle

: aerodynamics
momentum and speed gives eagle
the ability to carry more weight.

eagles 'have spicules' structures on
their toes that allow them to hold .



:An eagle is the strongest bird, able to lift something four
times its own body weight during flight.

:Weight- 1.2 kg-1.8kg

10 Dung beetles (also known as gubrella in India)

: Rolling
due to continuous rolling the
dung reforms into spherical shape.



:Dung beetles (also known as gubrella in India)

:A dung beetle can bury dung 250 times heavier than itself in
one night

11 Dynastinae or rhinoceros beetles

:pincer horns
easy grappling



:Rhinoceros Beetles can lift something 850 times their own weight.

13 Tiger



:strong physical characteristics
the bones of the tiger's front legs are strong and dense to support the large musculature.

the bones in each of the tiger's feet are tightly connected by ligaments enabling them to buffer the impact of landing from running, pouncing and leaping.

:A tiger can carry something 550kg, twice its own body weight.

12 Gorilla

:stronger upper body movements
physical power



14 Ox

:Castration process makes them stronger.
stronger neck and shoulder anatomy



:An ox can pull and carry something 900kg, 1.5 times its body weight across rugged terrain.

15 Director's chair

:scissors action (foldability)
braced frame gives more strength to it



:A director's chair is a lightweight chair, weighs 4-5 kg. It is sufficient for 100-120 kg live load

16 Seesaw swing

:A lever that hinges on a pivot point called a fulcrum.
equilibrium mechanics



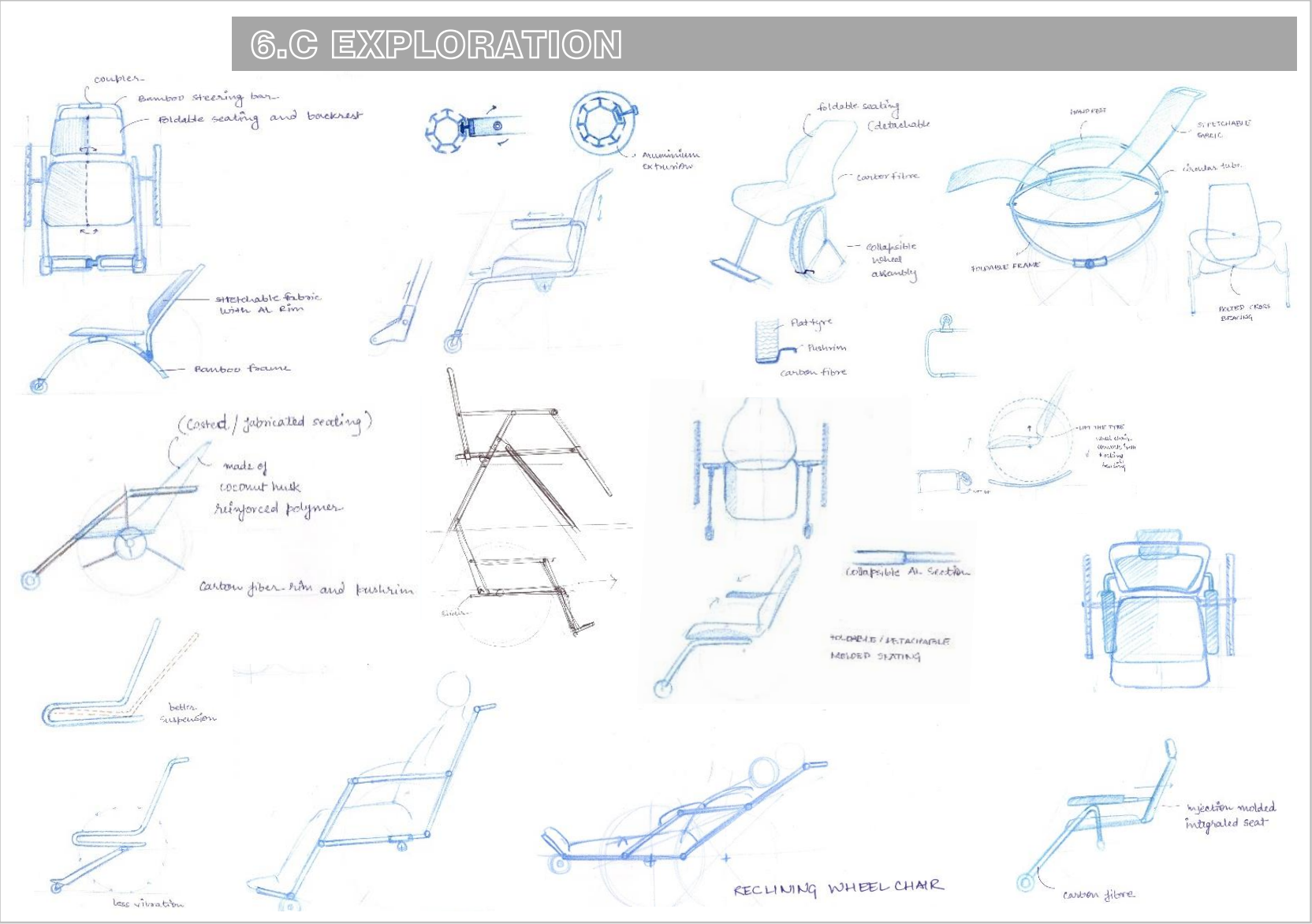
:A seesaw is a kind of swing, weighs 40-60kg. It can hold 100-150 kg live load.

6.B KEYWORDS

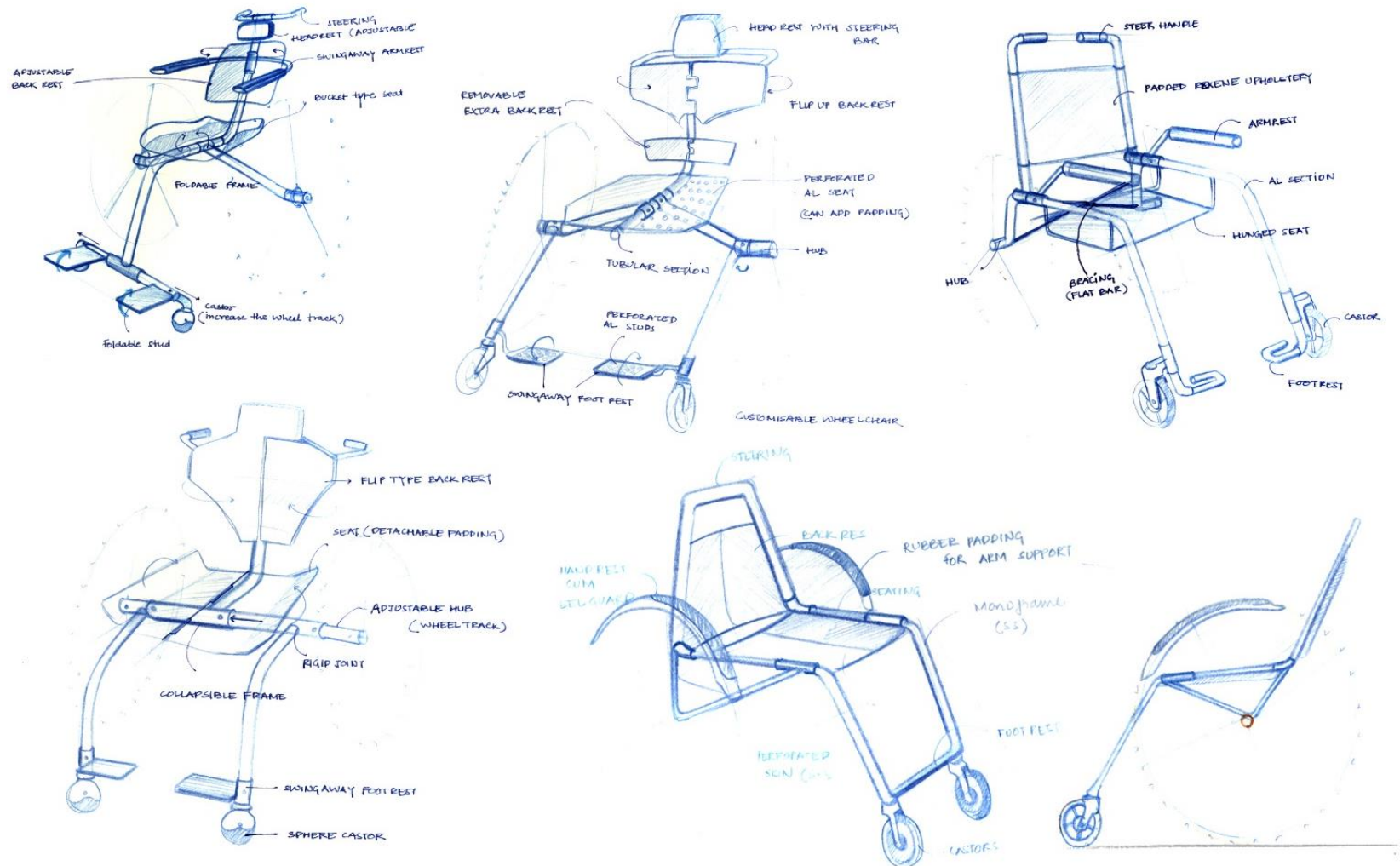
Following are the keywords for explorations for the best user-centered design of wheelchair

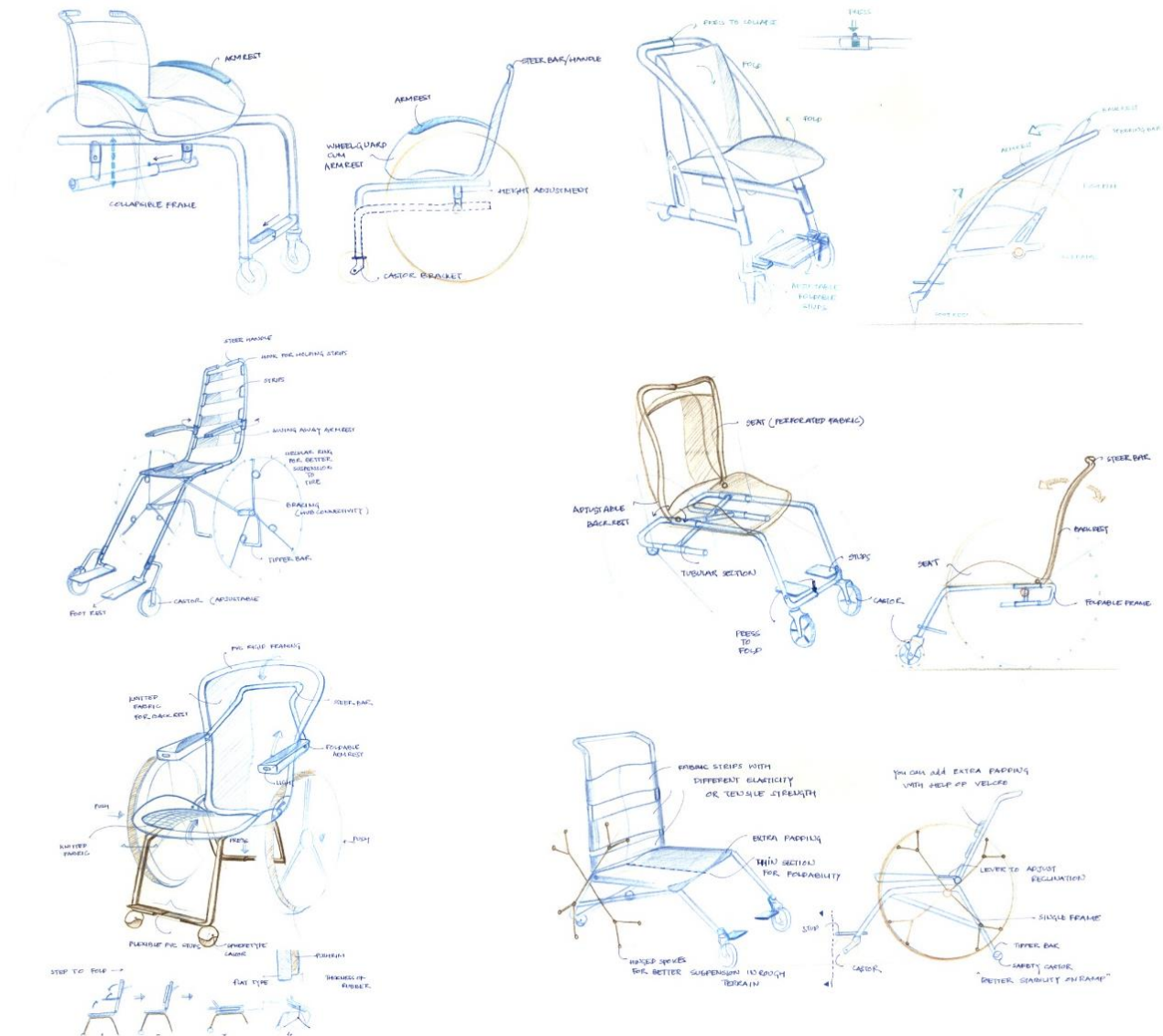
TOUGH
PORTABLE
RESILIENT

6.C EXPLORATION



6.D IDEATIONS

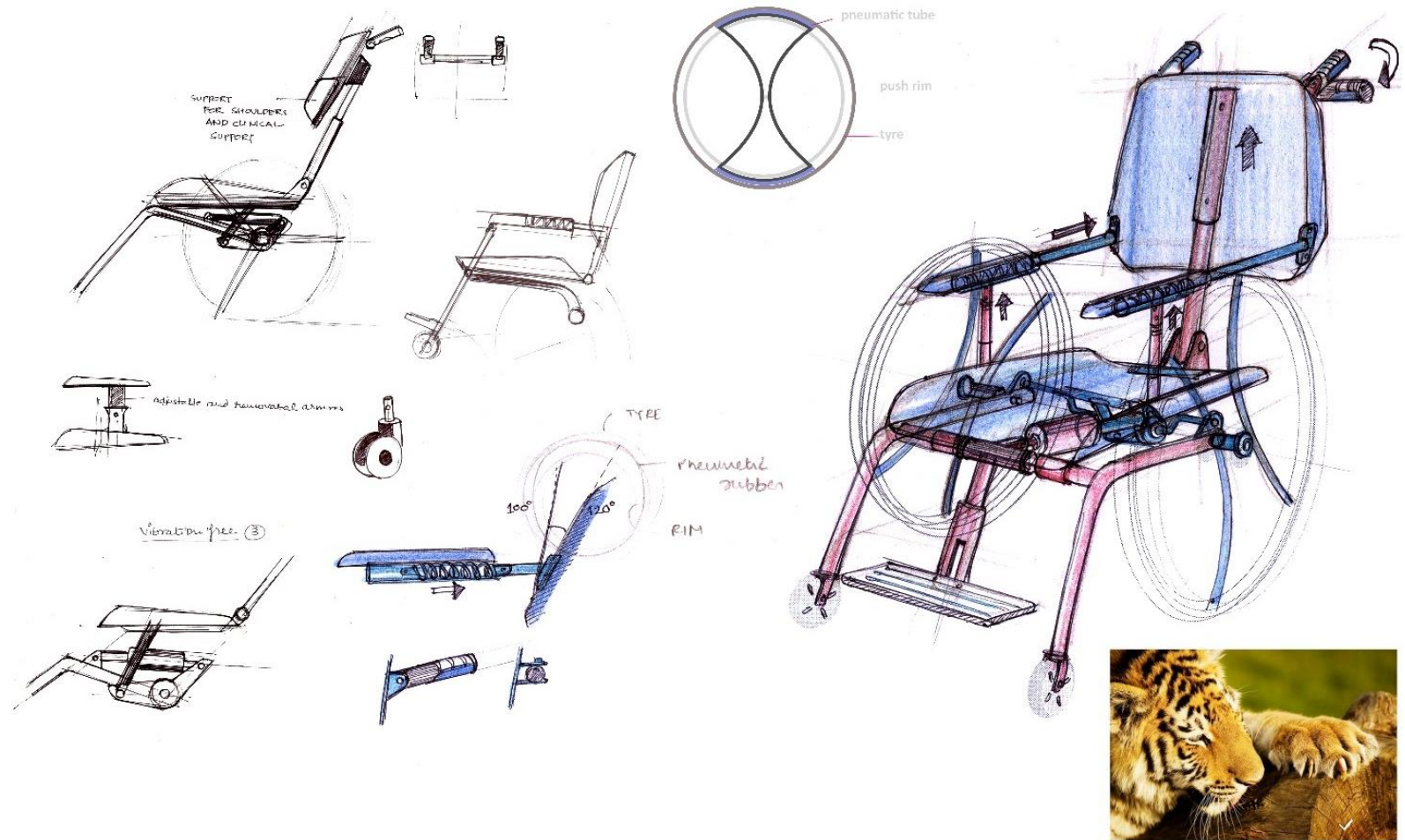




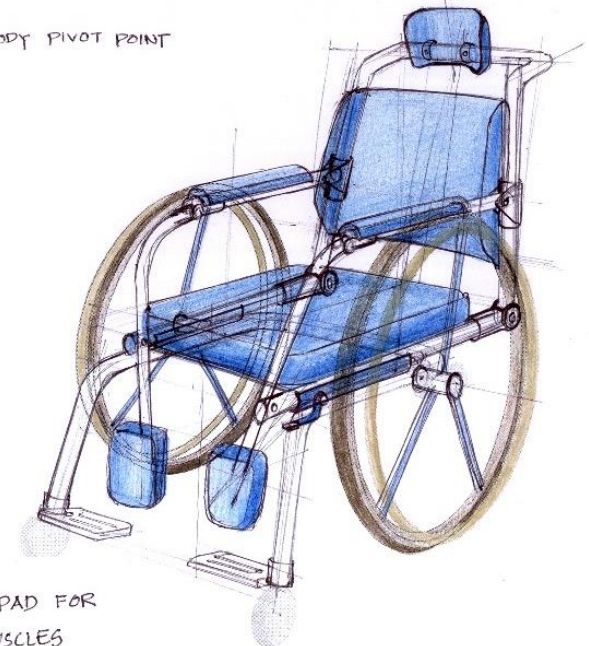
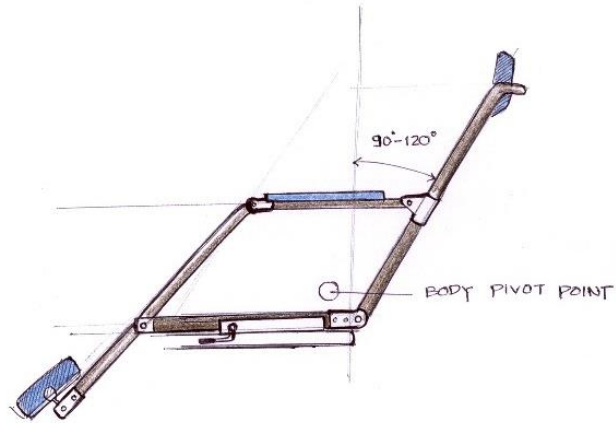
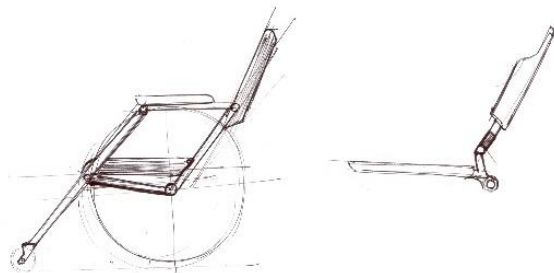
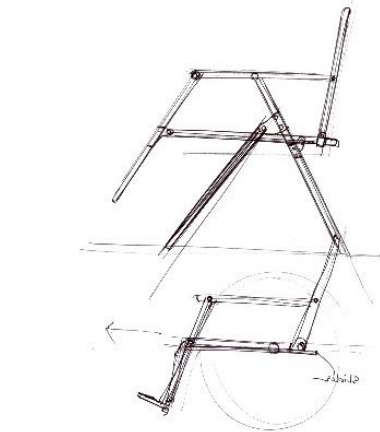
6.E CONCEPTS

I have implemented the outcomes from the user study which has been conducted by me as a user. Inspirations are taken forward for every concept generation.

CONCEPT 1



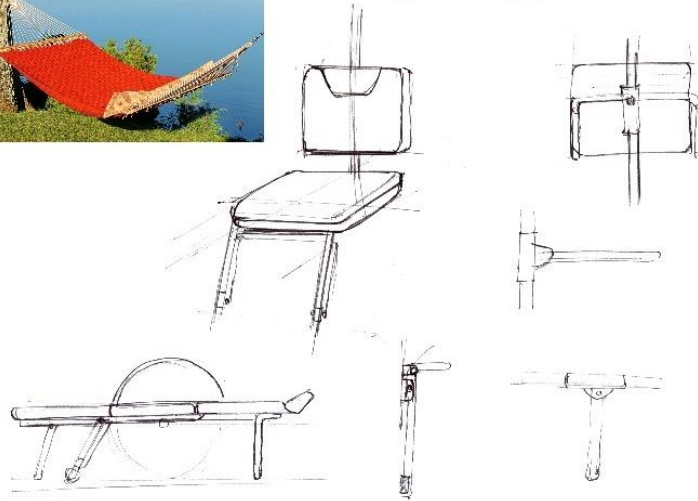
CONCEPT 2



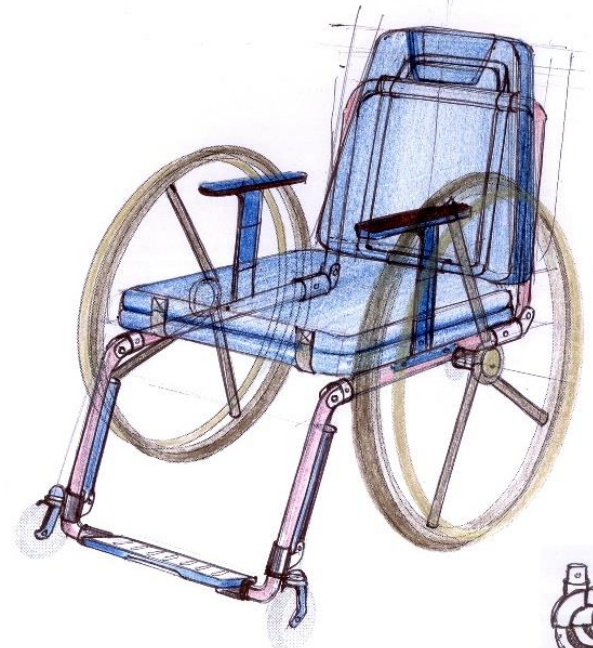
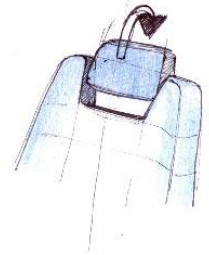
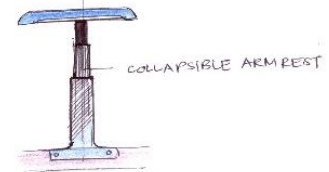
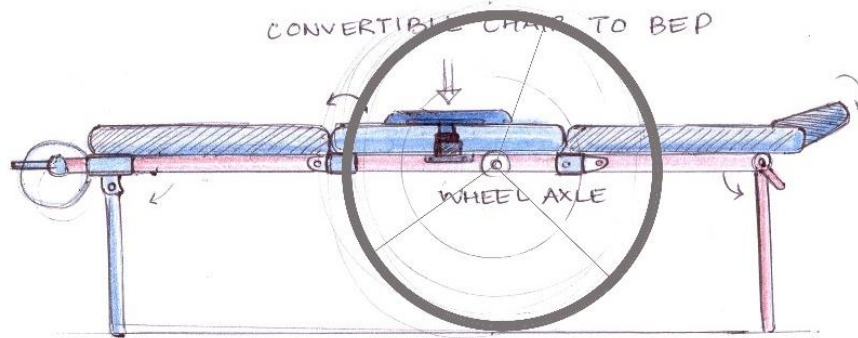
CONCEPT 3



convertible bed



CONVERTIBLE CHAIR TO BED

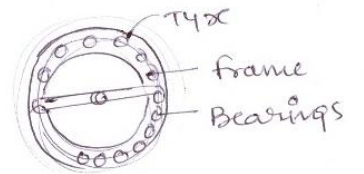
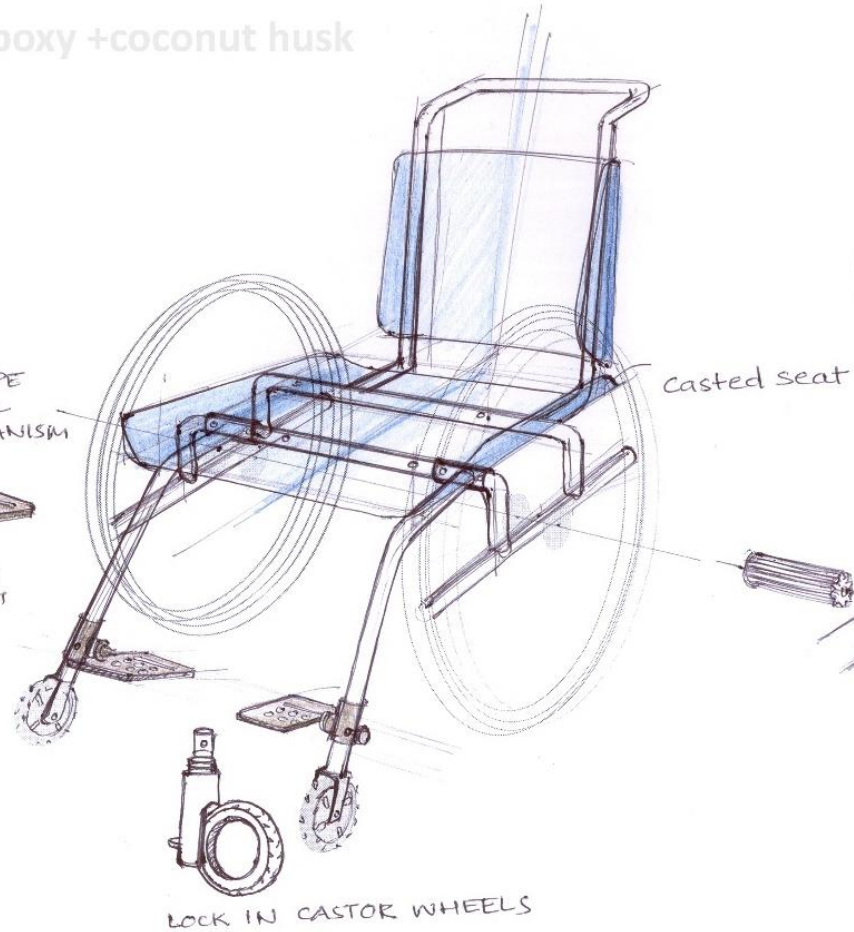
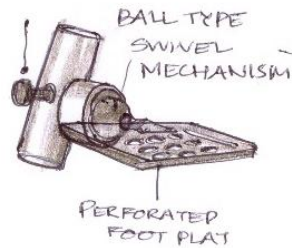


CONCEPT 4

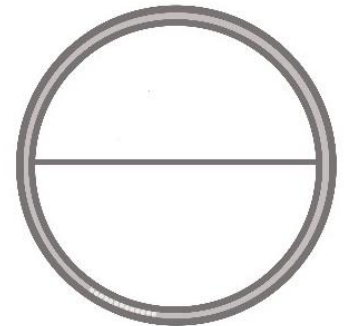


epoxy + coconut husk

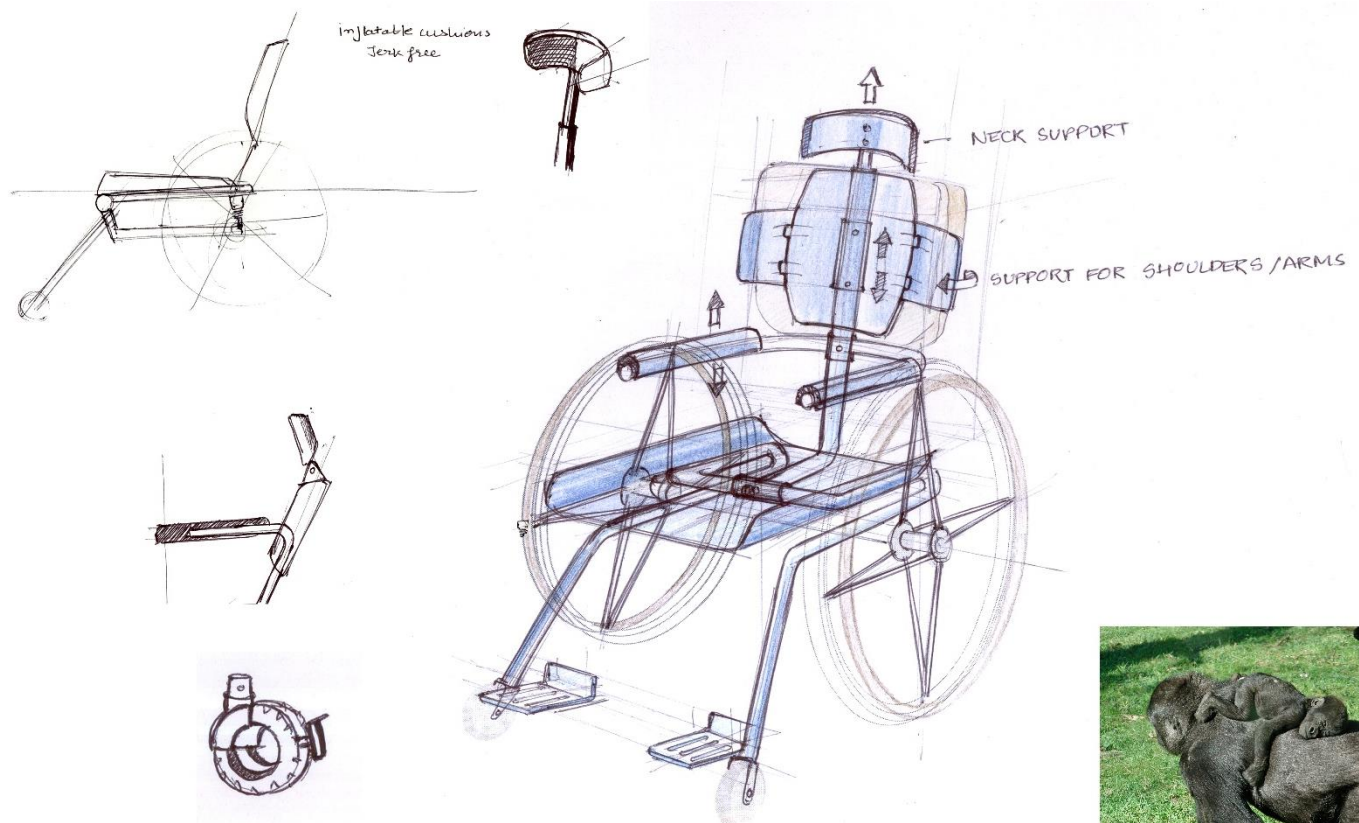
ADJUSTABLE



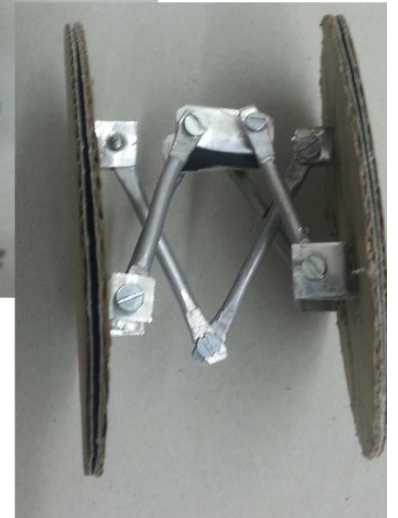
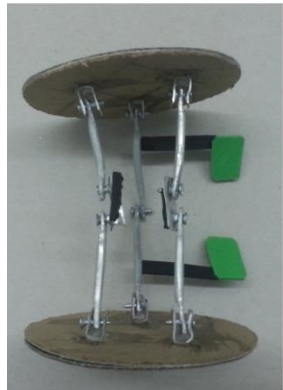
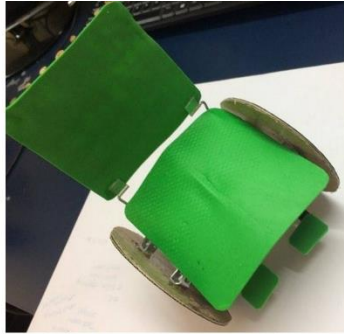
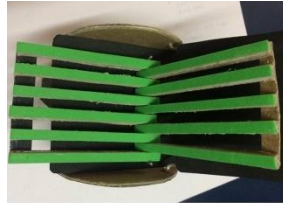
For front hinging
Adjustability of Angle

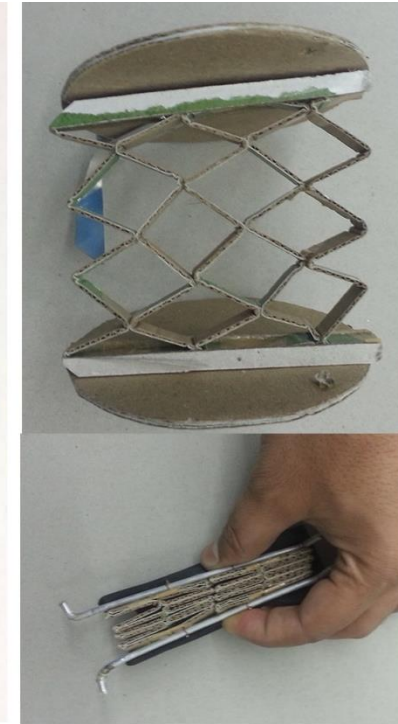


CONCEPT 5

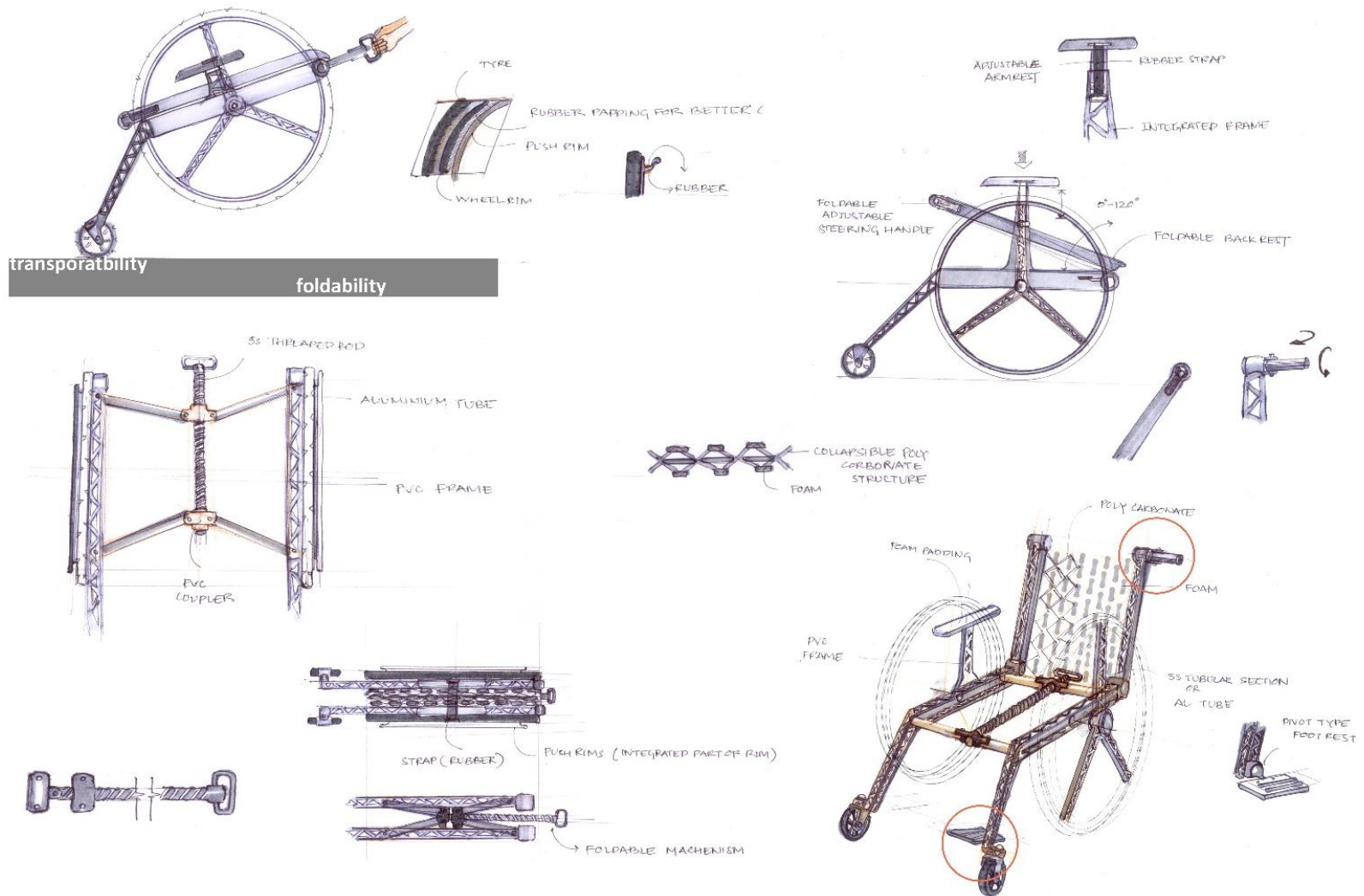


6.F MOCKUPS



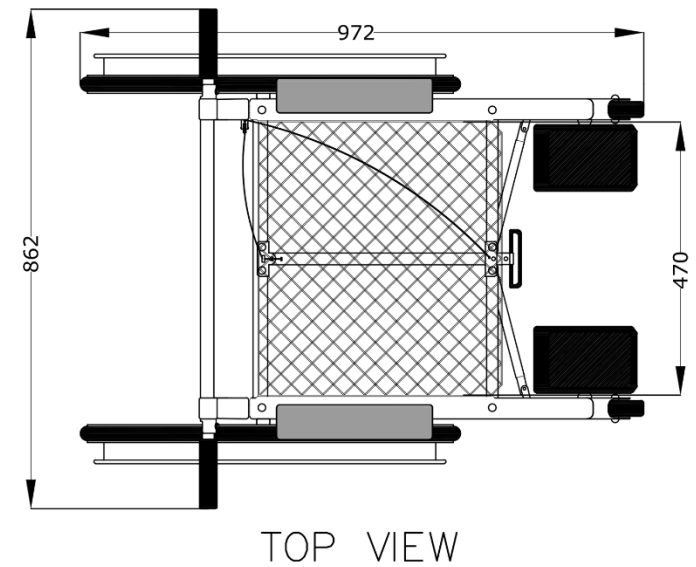
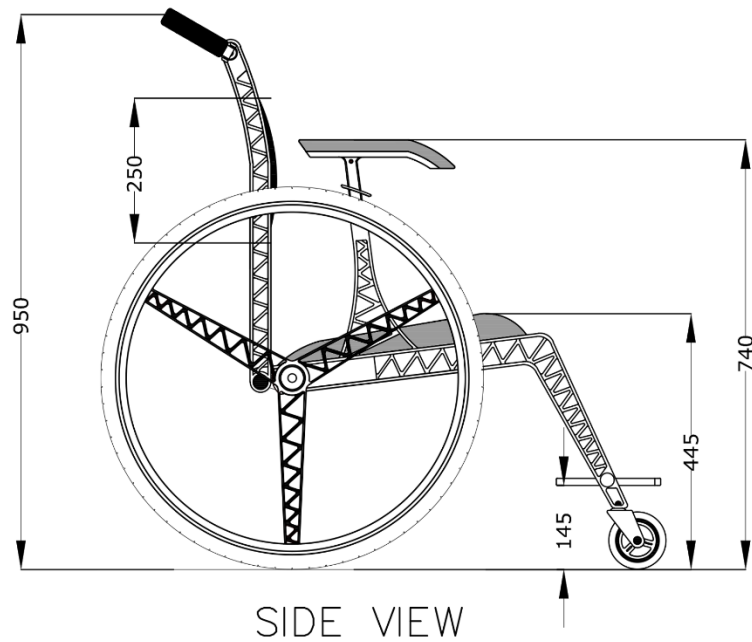


7. FINALIZING THE CONCEPT

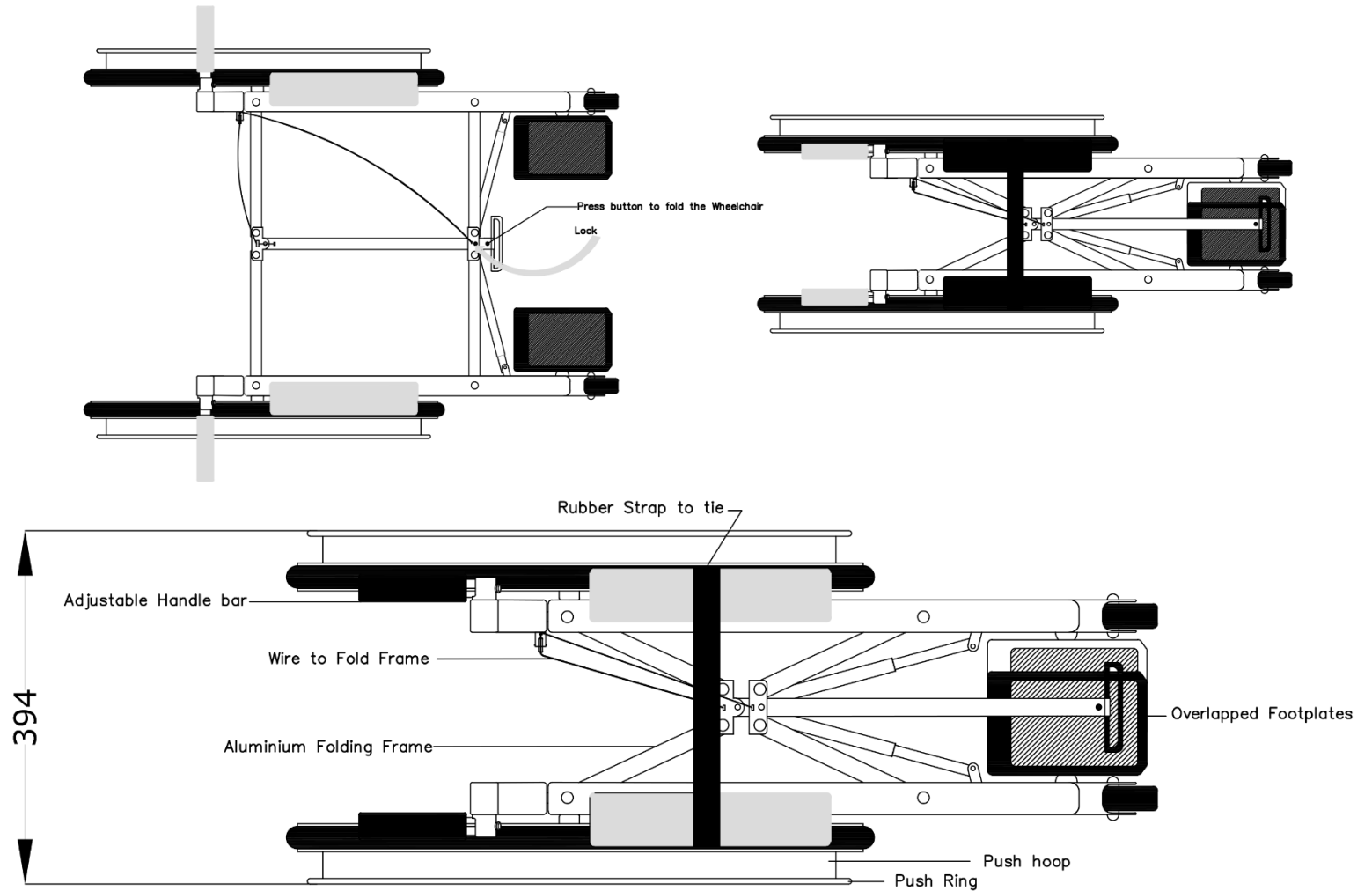


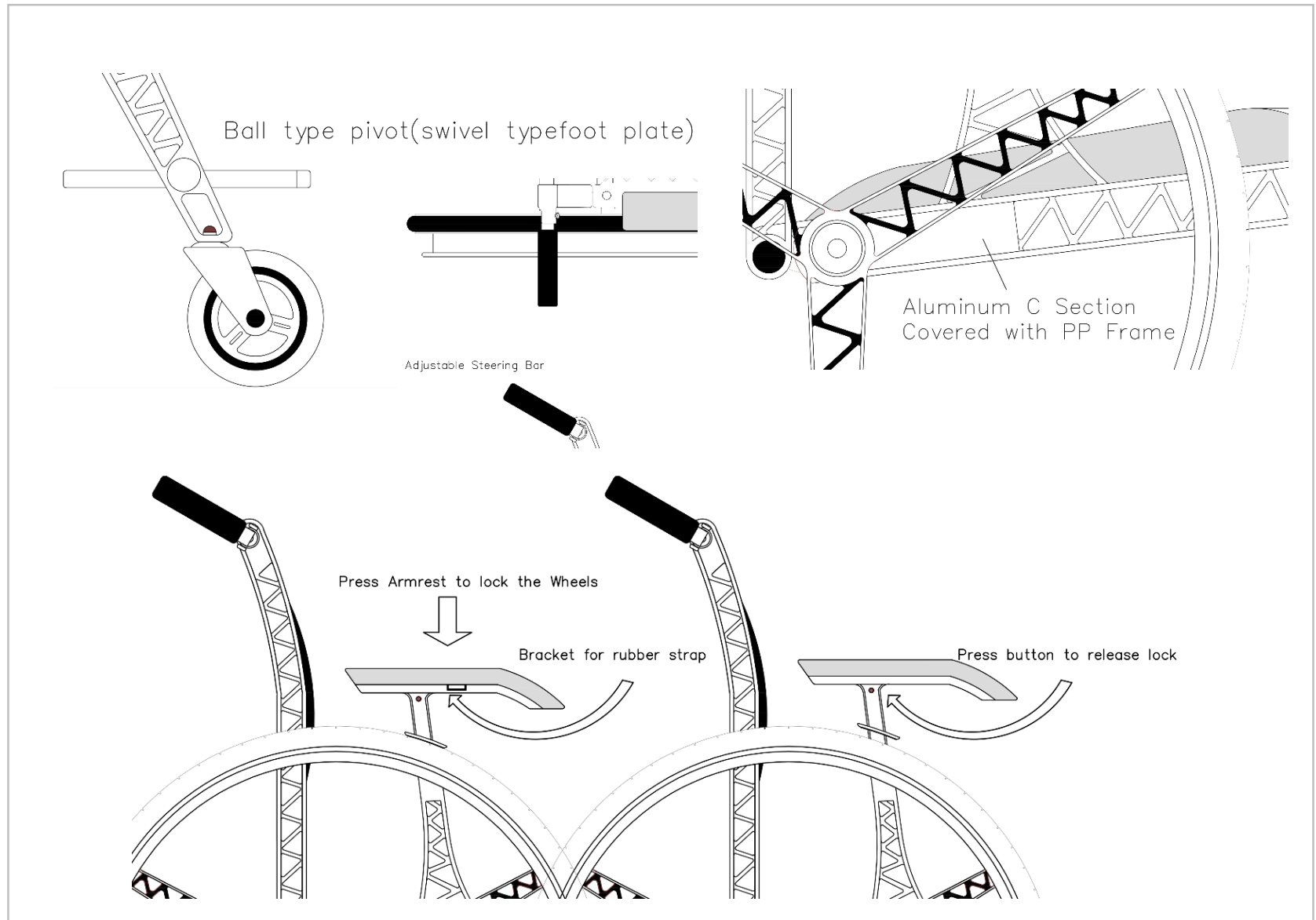
8 CONCEPT REFINEMENT AND PRODUCT PACKAGING

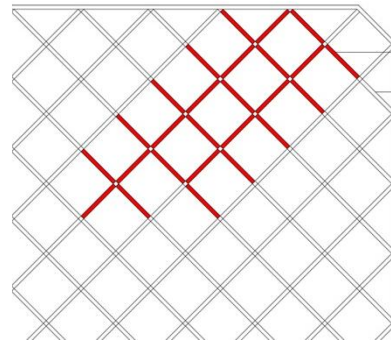
8.A DRAWINGS



8.B DETAILS

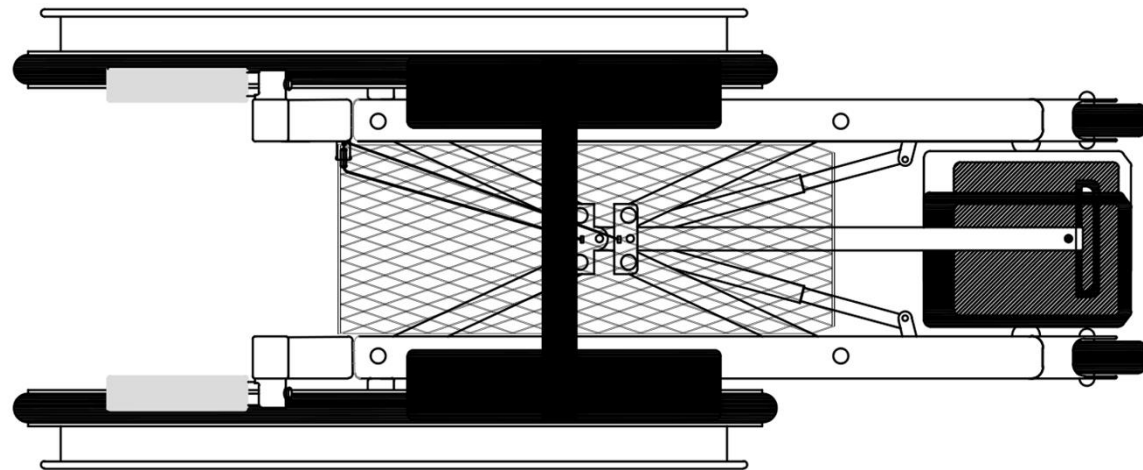






Foam Lining

Polycarbonate foldable structure



8.C FINAL PRODUCT



8.C PHYSICAL MODEL



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<https://en.wikipedia.org/wiki/Polypropylene>