Design of a Wheelchair

Project -2

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Product design

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Need for wheelchair design

-50-60 million physically disabled people in our country.

- When the influx of Chinese companies entering the market with their consumer products in different sectors they would not be focusing on the disability sector as it comprises of a relatively less user population there fore less marketability. There for it is the time for the entrepreneurs and designers to foresee this as a prospective challenge to provide for this user segment.

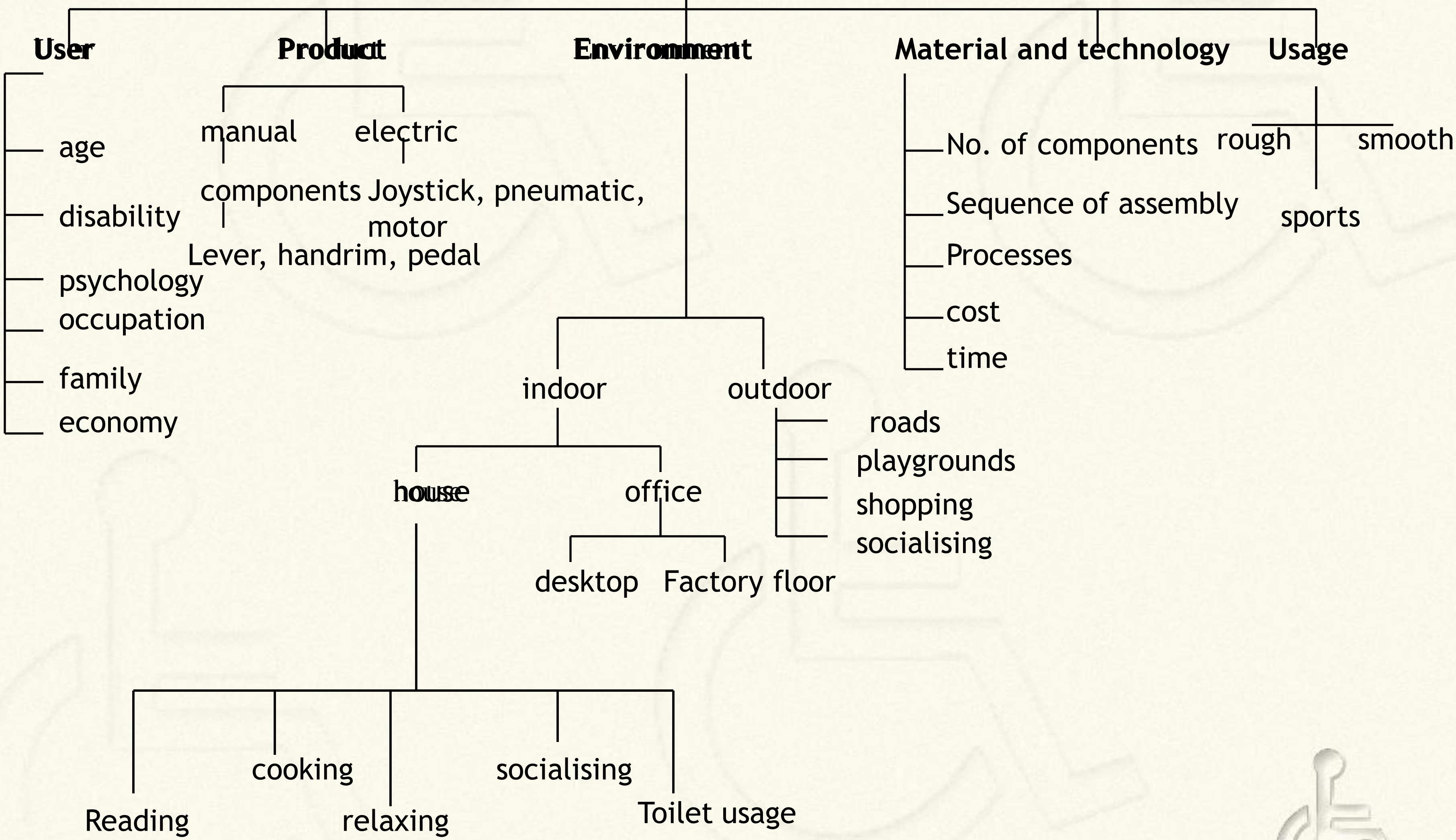
Why wheelchair Design project ?

The wheelchair project is taken because a need was felt for a wheelchair in India which suites the Indian patients and gives them the much needed comfort and motivation to use a wheelchair. It was also to **seek meaningfulness** in my work by contributing my little bit into the disability sector where I personally feel lies immense possibilities and the results generate very significant and obviously comforting change in the lives of the user.

- The design of a suitable wheelchair for developing countries presents several problems :
- Wheel chair design poses as a challenging project due to following reasons:
- 1) Large **variation in Socio- economic** status of user class.
- 2) Various user categories there fore:
- Involves good understanding of **user needs** and psychology.
- Involves understanding of **market and targeting this user segment.**

- 3) Possibility of **exploration and innovation**.
- 4) Involves good **material; and process** understanding.
- 5) Involves understanding and utilising **ergonomics** at different junctures.
- 6) Involves **product detailing** as a very important element.

Aspects of the wheelchair



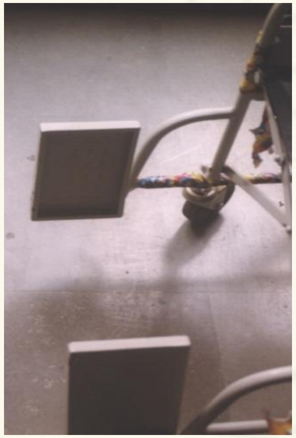
Process of data collection

Stage-1

Wheelchairs available (Indian and international scenario)

-Study of types and components

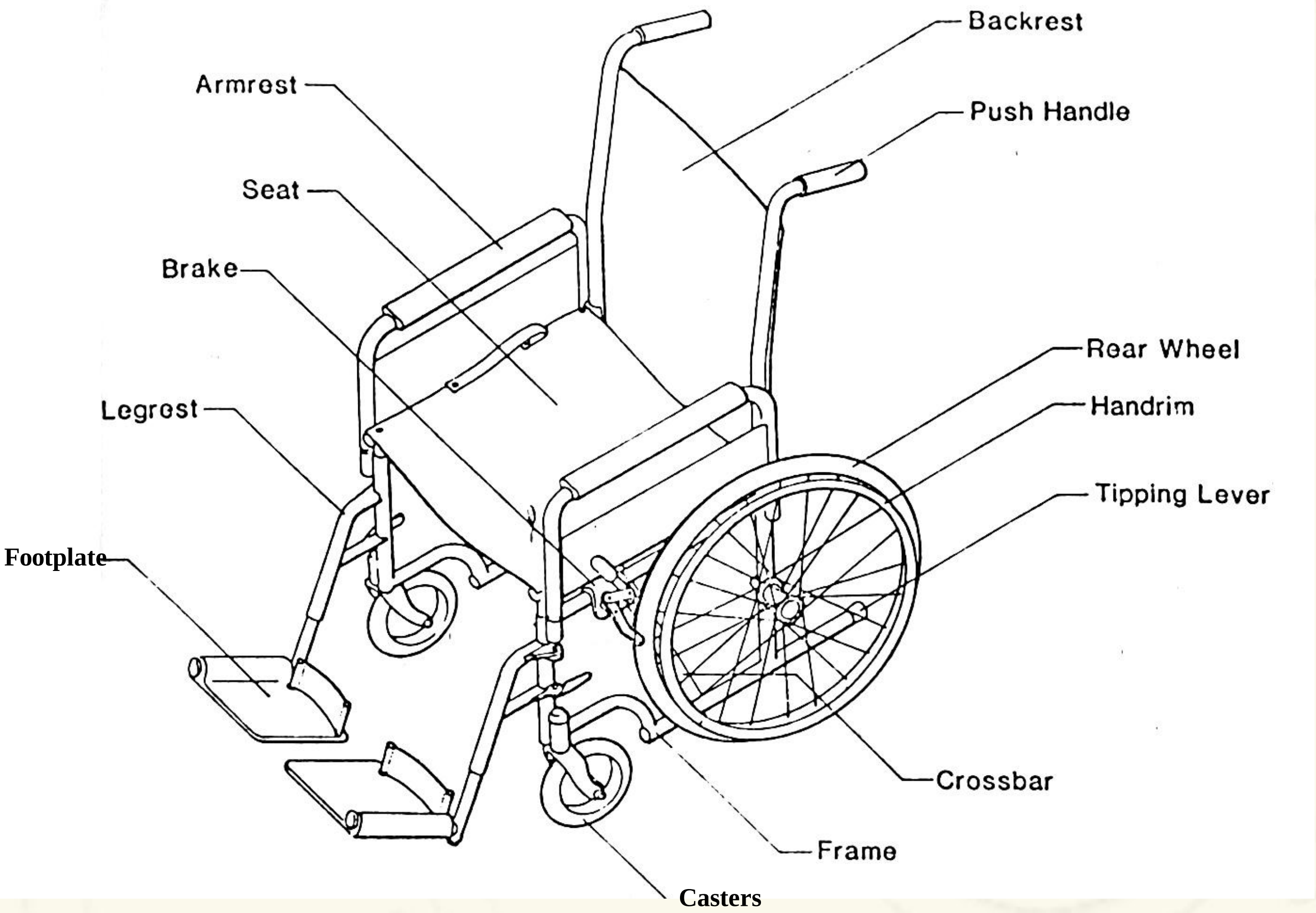




MATCHING GRANT PROJECT
ROTARY CLUB OF BOMBAY MANDV
MUMBAI (DIST.3140)
ROTARY CLUB OF PISA-GALILEI
ITALY (DIST.2070)
26th JANUARY 2002.

Typical wheel chair materials and processes



Frame or basic structure
-Tubular sections - aluminum alloys, titanium and carbon fibers
-Plastics used more in frame design . Reinforced plastics - carbon epoxy tubes, composites foams or honeycomb cores, are light and strong.
-Tubular m.s. sections - bending and welding is used.

Seats
canvas, Rexene, and nylon

Footrests
. aluminum or m.s or P.V.C depending upon the user and needs.

Wheels
wire spoke wheels with metal frame , molded poly propylene

Tyres
pneumatic tyres - rubber with a tubing inside. Non pneumatic tyres - urethane or other synthetics

Casters
Different kinds of casters p.v.c. injection molded in different sizes

Drive systems
p.p or chrome plated m/s

tubular sections •

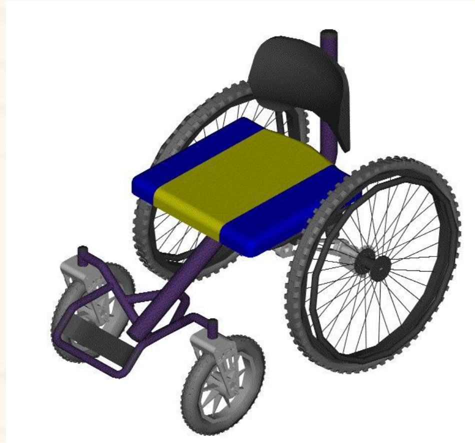
National job development center, kiwanis








Types




Wildernet Phoenix 2 Off-Road Wheelchair
ADJUSTABLE STEERING DAMPER
INDEPENDENT TRAILING-ARM SUSPENSION
FULLY ADJUSTABLE SADDLE
ADJUSTABLE-RATIO STEERING
MODULAR FRAME
MAGURA HYDRAULIC BRAKE LEVERS
INDEPENDENT DUAL-WISHBONE SUSPENSION UNITS
COIL SPRINGS SHOCKS
ADJUSTABLE GRAVEL GUARD FOOTREST
PROSTOP HYDRAULIC DISC BRAKES
CASTERED FRONT WHEELS


independence

independence 3000





Other vehicles designed for similar user group

Outcome of stage-1 study

The study resulted in a better understanding of –

1. Types of wheelchairs available in India and abroad.
2. Component design.
3. Materials and technologies at the disposal.
4. Fabrication methods and tools and space requirement.
5. Time taken and sequence of assembly.
6. Existing details.
7. Provisions for customization and adjustability.

Stage-2 Understanding and defining Disability

User group and Indian scenario

- A mobility impairing disorders causes a person to use the wheel chair. A survey was conducted at the All India Institute of Physical and Medical Rehabilitation to classify the percentage of wheel chair users according to their disabilities.

CONDITION OF DISABILITY	EXPLAINATION
*- Paraplegic	Both lower limbs are paralysed. Injury/infection to the Spinal Cord Caused by Infection/accidents
*-Poliomyelitis	Polio virus damage nerve cells paralysing muscles
-Quadriplegic	All four limbs are paralysed. Injury at a higher position of the spinal cord
-Muscular Distropy	Hereditary disability , gene distrophin absent a progressive disability
-Congenital Diseases	By birth , fragile bone or deformaty
*-Amputees	Caused by accidents absence of lower limbs
-Hemiplegic	Half side paralysed
-Rheumatoid arthritis	Auto immune disorder, inflammatory disorder, younger ladies and girls
-Muscle diseases	Weakening of the muscles leading to a subsequent disability of the limb,
-Oesto-artherithis	Progressive disability prevalent in old people, caused due to wear and tear.
-Ankylosing spondilitis	Progressive disability , joints gets stiffer, restriction of the movement
-Spinal Muscular Atropy	Hereditary disability , muscles weaken.
*-Cerebral Palsy	Damage to a developing brain , no control over motor movements.
-Multiple Soierosis	Eating away of ceils of the spinal cord resulting in paralysis.

Target Segment

User category

Poliomyelitis

Amputees

Paraplegic

Spinal injury

Users whose lower limbs are immobile due to any disease or accident like the above . Therefore the user should be able to propel the wheelchair independently by himself have considerable upper body strength.

Environment

The wheelchair is predominantly an indoor vehicle which is used to move around inside homes. But this does not negate its possibility to be transported and taken to another location and moved around in public spaces like shopping malls , local bazaar or cinema halls

The wheel chair user is a middle or upper economic class urban resident

Focus of the project and defining the deliverables

1.To design a wheel chair which would aid in :
Climbing up and coming down staircase.
Human power driven
2. Ease of transferability.
3. Integration of parts, components.

Aspects to Climbing staircase

Climbing up one kerb or step.
Climbing down one kerb or step.
Climbing up staircase
Climbing down staircase

Transferability

Self transfer of user from wheel chair to pot (western)
Self transfer of user from wheelchair to chair or car.

Integration of parts

Weight reduction.
Ease of assembly
- time
- convenience

Lesser joints- increase in stability, strength

Aesthetics

To derive a new aesthetic language from new and existing materials and processes

Stage-3 Activity analysis

Strong upper body – well built fore arms and chest .
Strong neck, less lower body weight.

Good gripping power.

User capability study

- Transfer and getting in and out of the wheel chair

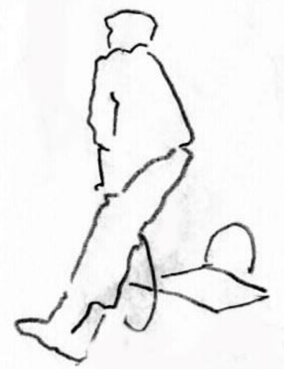
Sitting to standing

2 hand support

Skew lower body

With hand grips shifts upper body

Hands behind one foot on the floor



Turning the body grip on the vehicle footrest as fulcrum

Bending forward to put weight and take support from vehicle

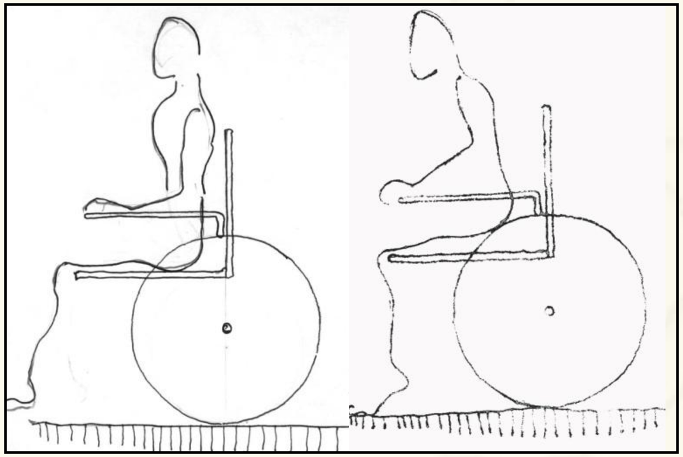
Sitting to shifting

External support with one hand other behind the body shifting the upper body

Lifting the body with two supports one external one internal

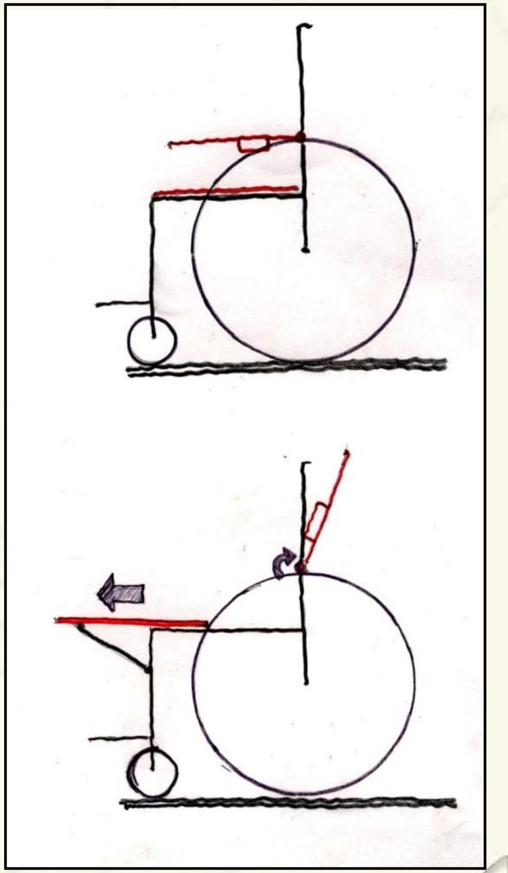
Taking support of the vehicle and placing the upper body on the other seat.

Inferences drawn -



clearance required for front facing
standing up

Breaking grounding stability
The vehicle needs to provode a steady and rigid support, it should not move while in user is transfering.
Enough clearance space for side transfer.
Removable side wheel and arm rest



Objectives

Concerns

Climbing up and own staircase

Transferability

Balance

-Angle – distribution

-of weight and C.G

Maneuverability

-mechanism ,

-ergonomics

Force

-weight of the wheelchair

-transfer of power

Safety

-breaking mechanism

Stage-4

Concept generation

Concept generation

Concept for mechanism

-Climbing steps

-Transferability

-Maneuverability

-Retractability

(physics numericals and consulting mechanical department faculty)

Form generation

-Exploration in materials

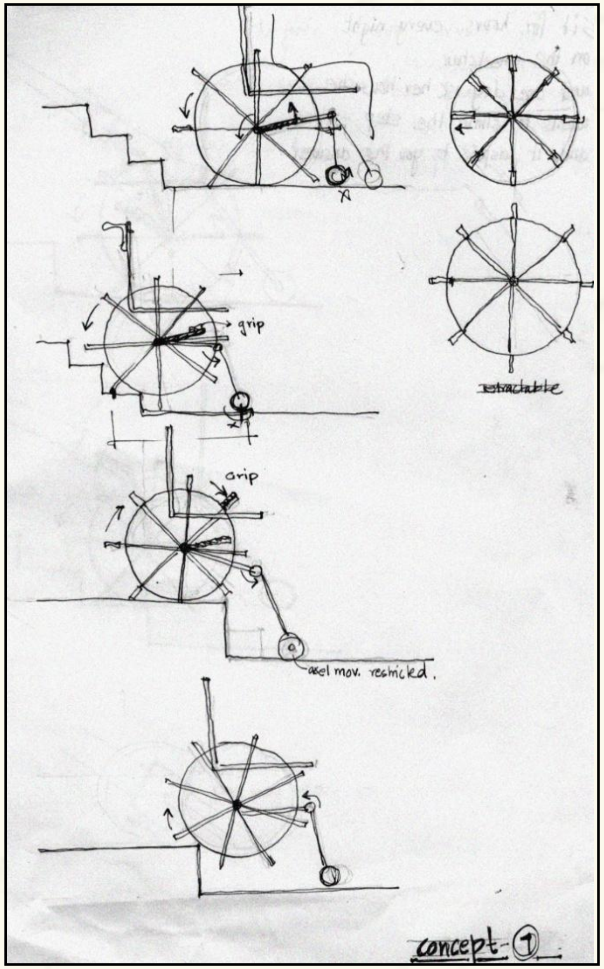
(through renderings and models)

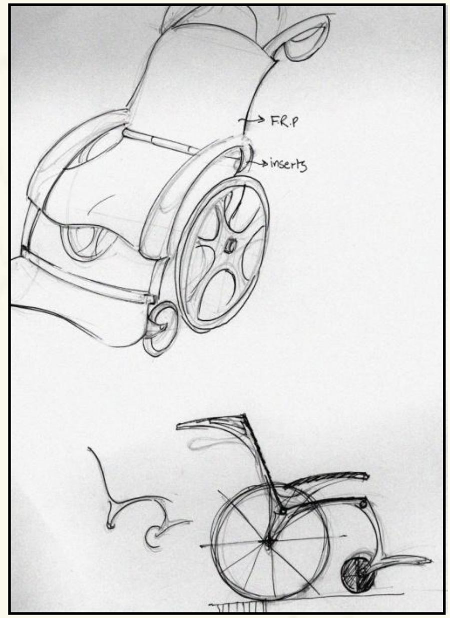
Construction

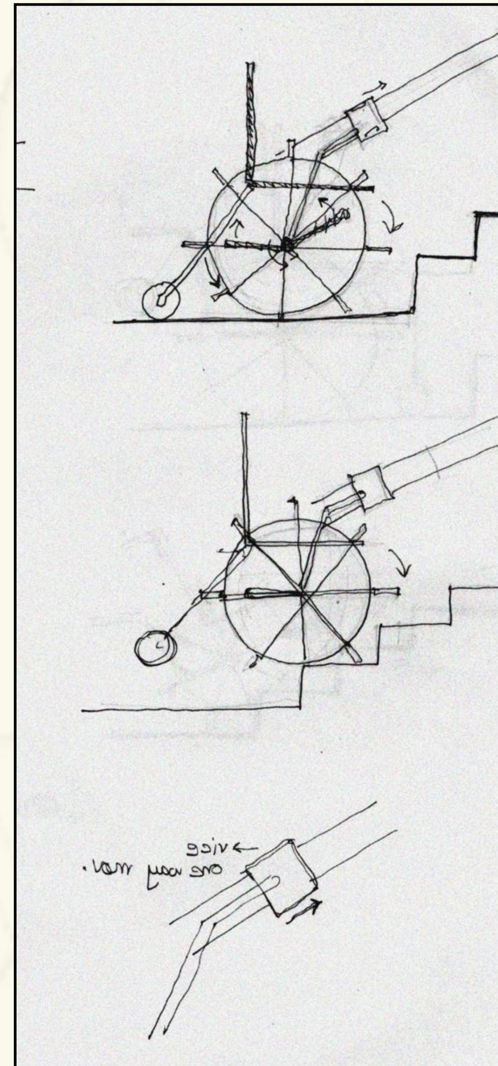
-Components and details (joints and junctions, finishes)

(consulting fabricators, lookin for paralles in furniture and automoble industry)

Concept generation







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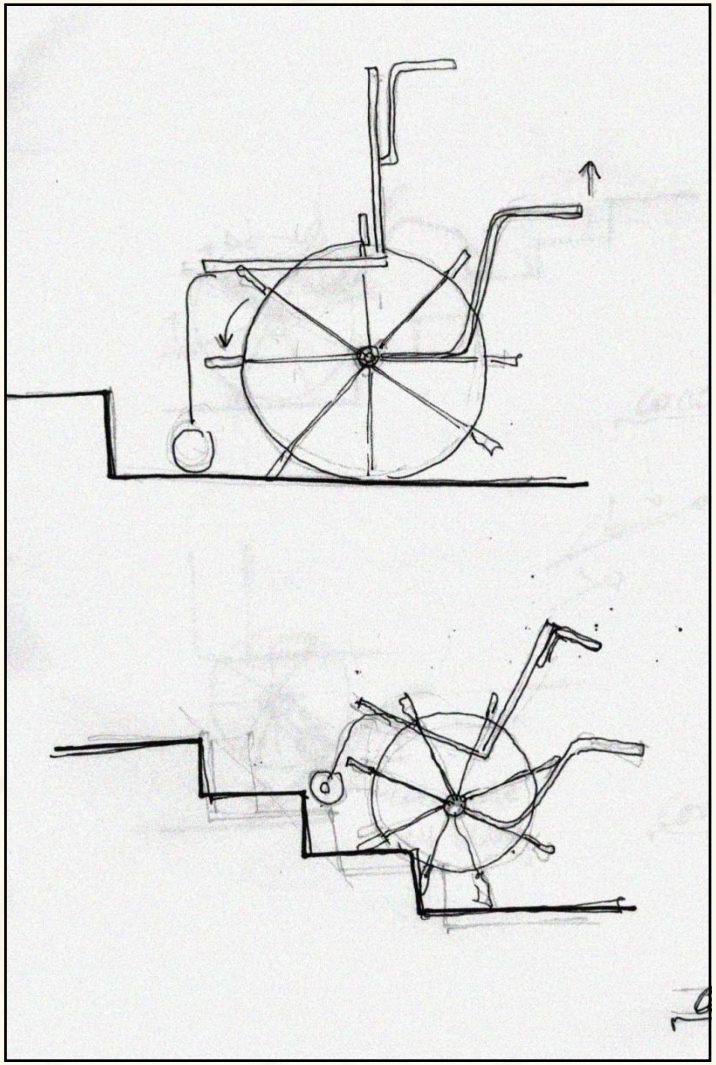

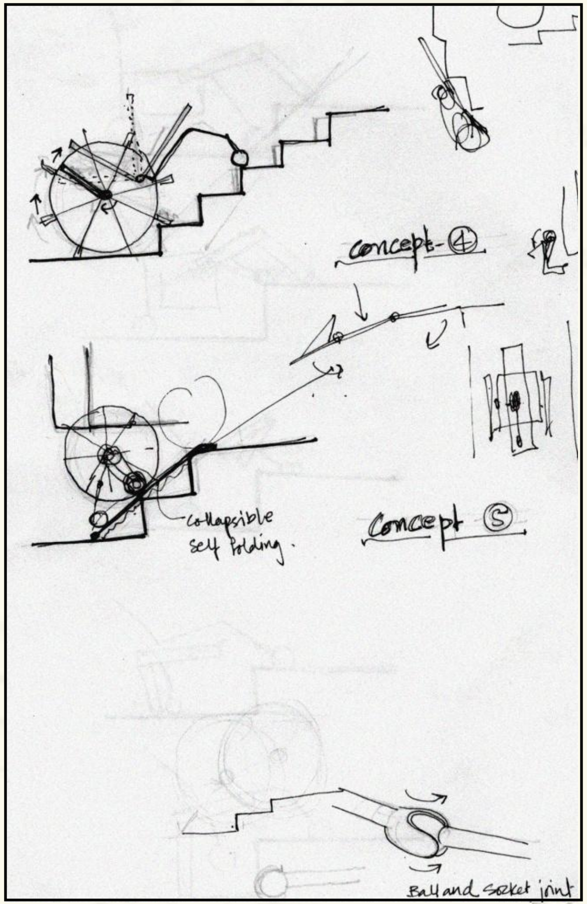

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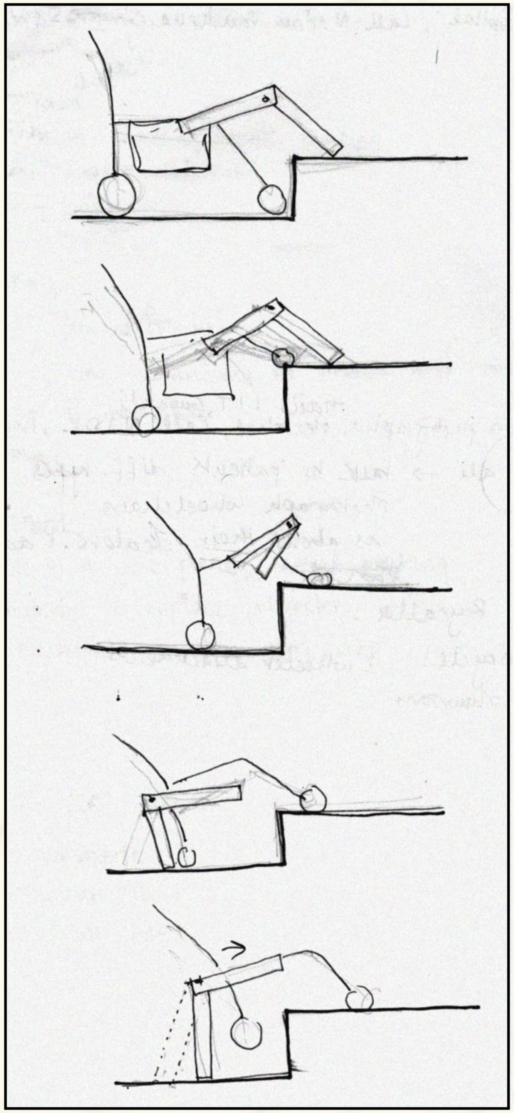

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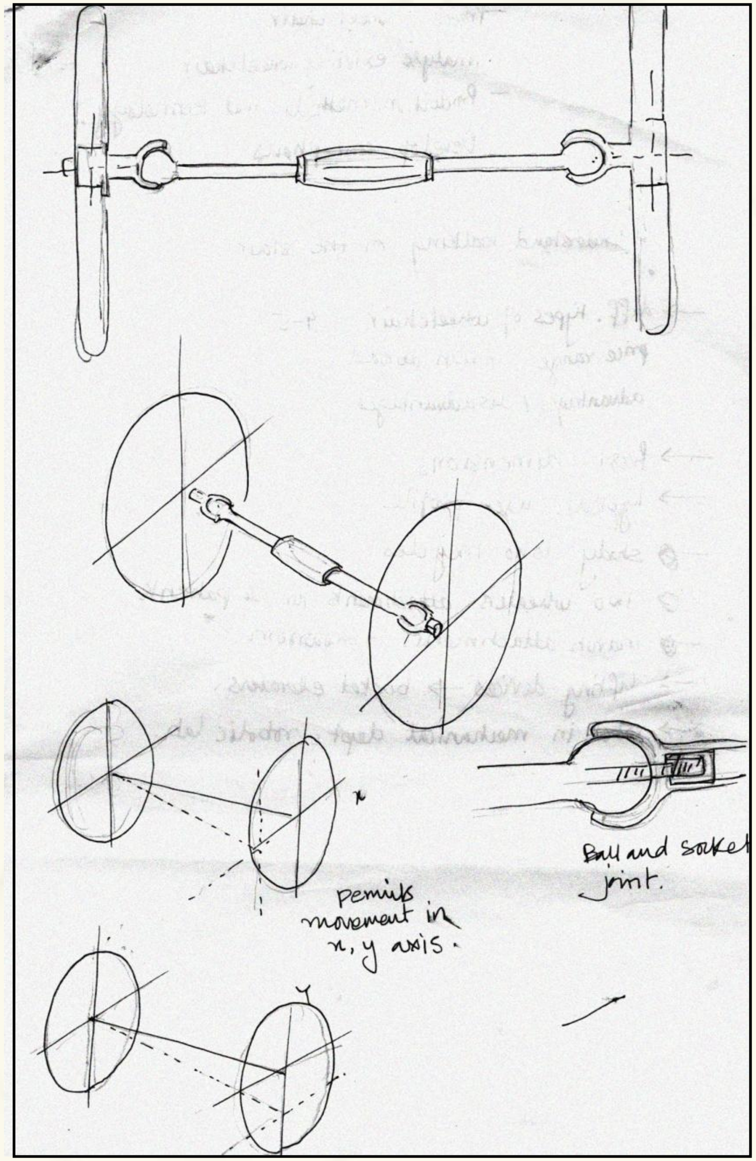

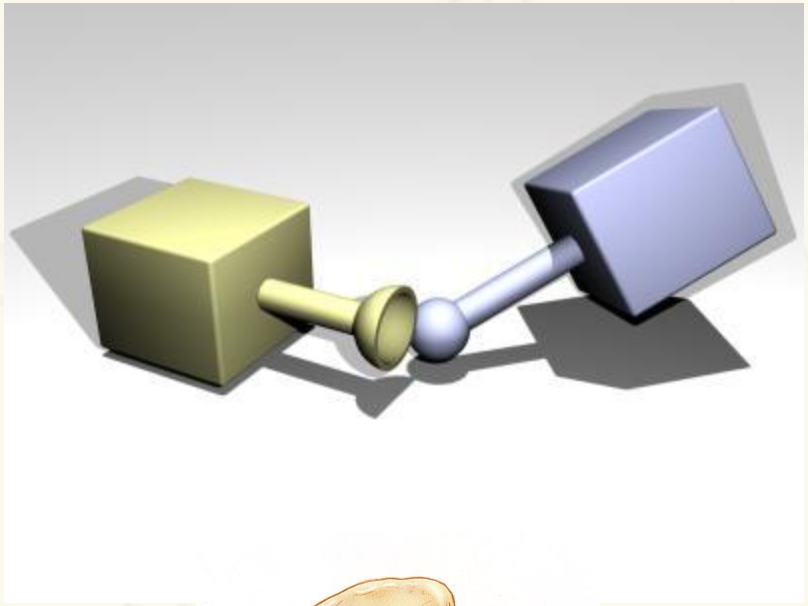

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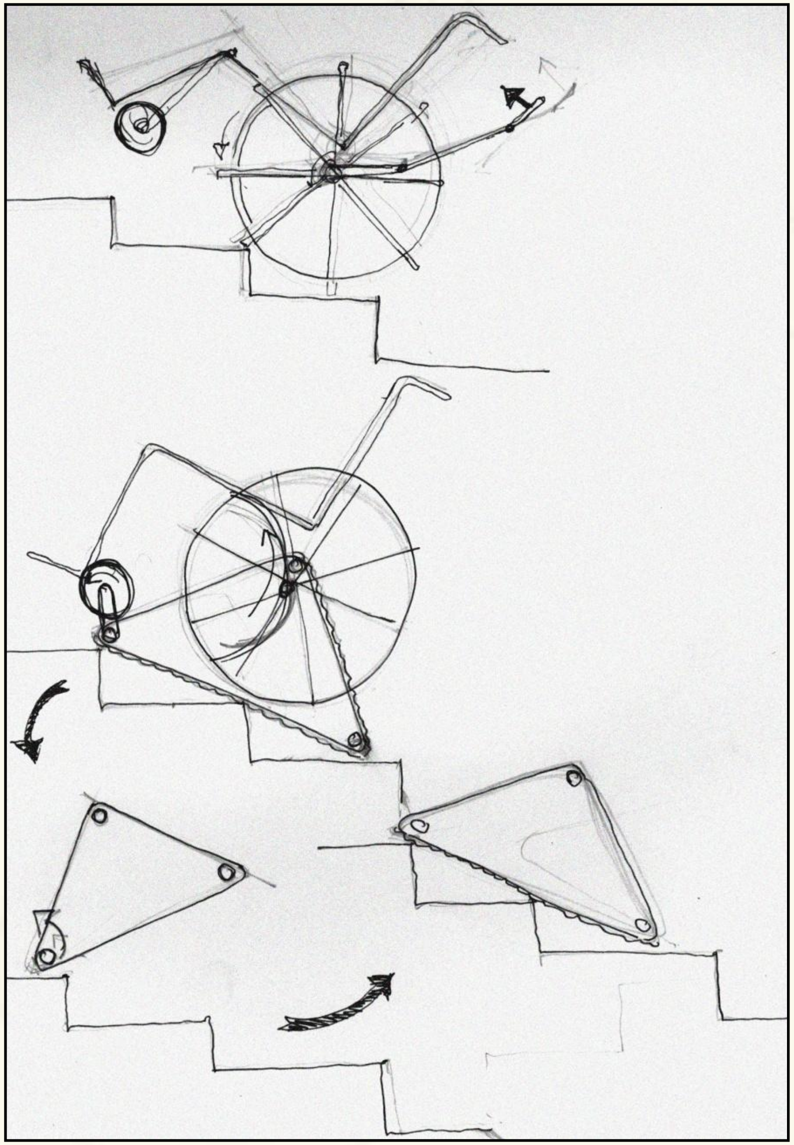

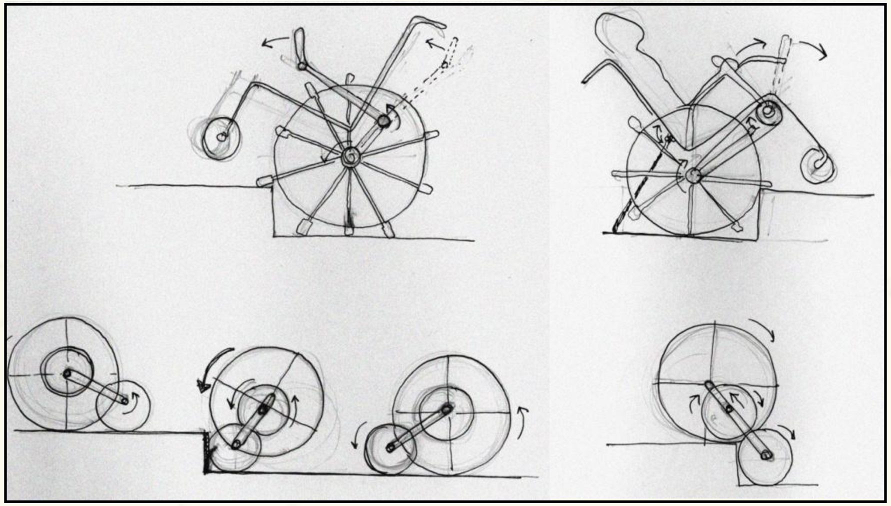

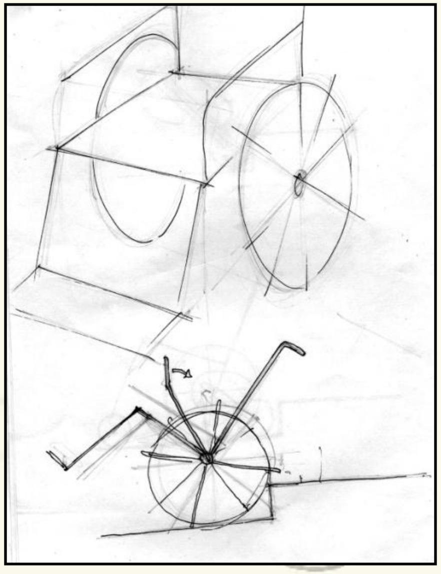

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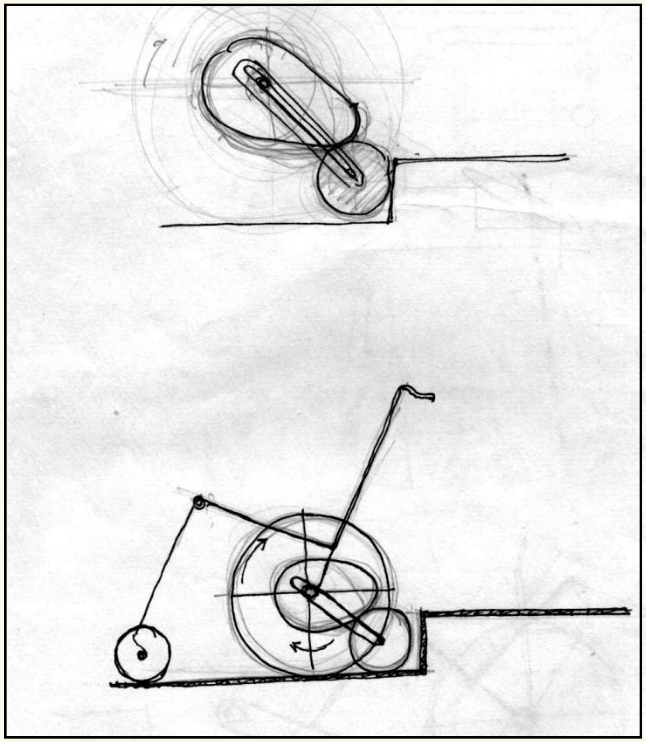

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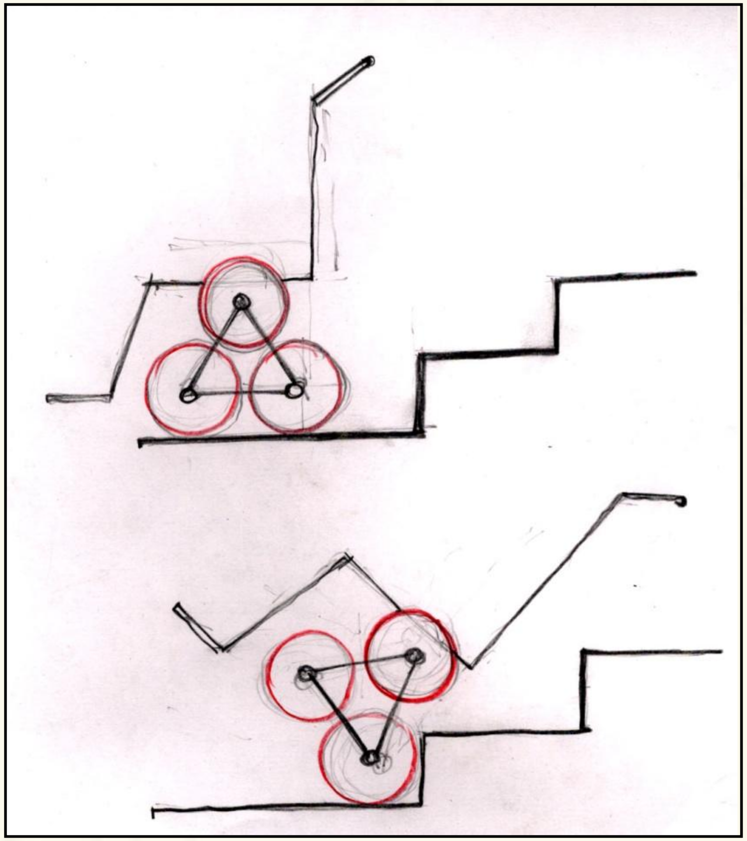

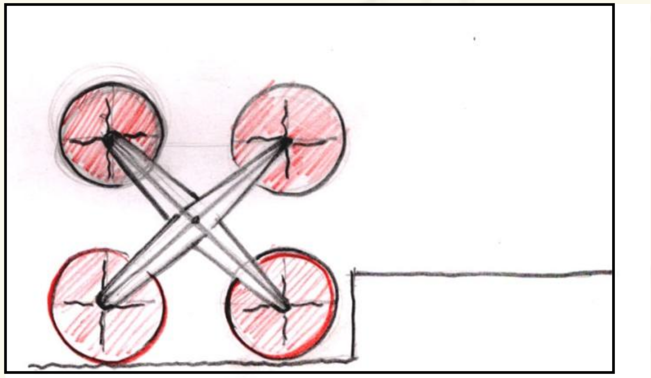

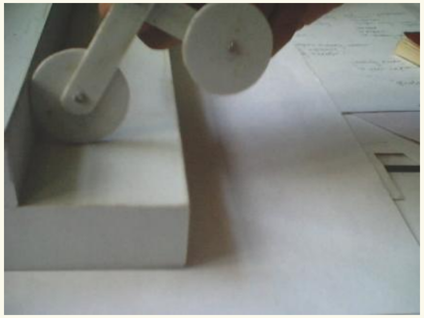

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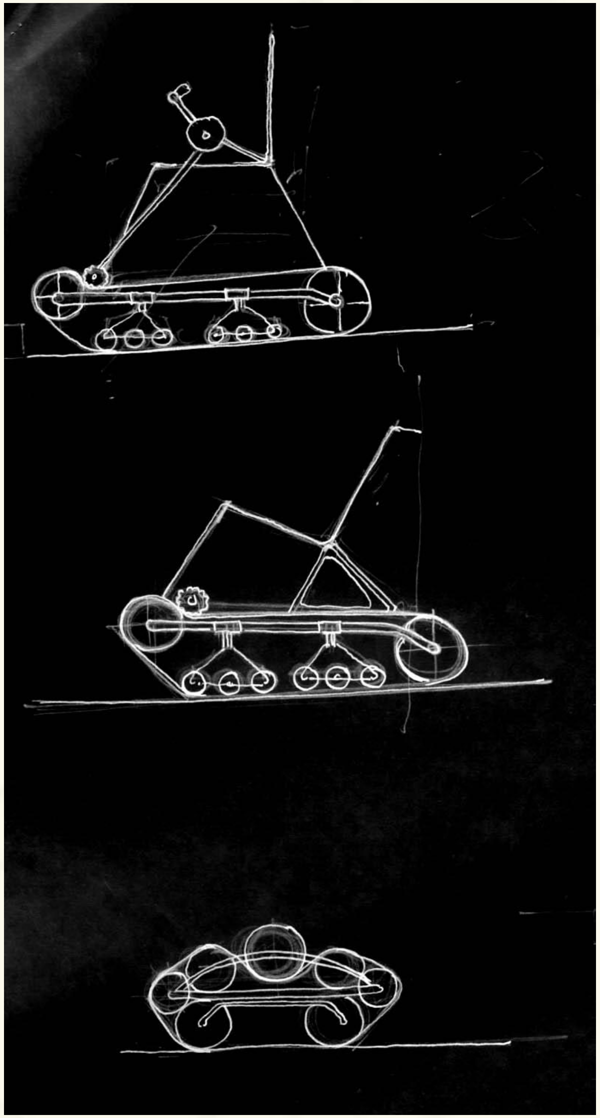

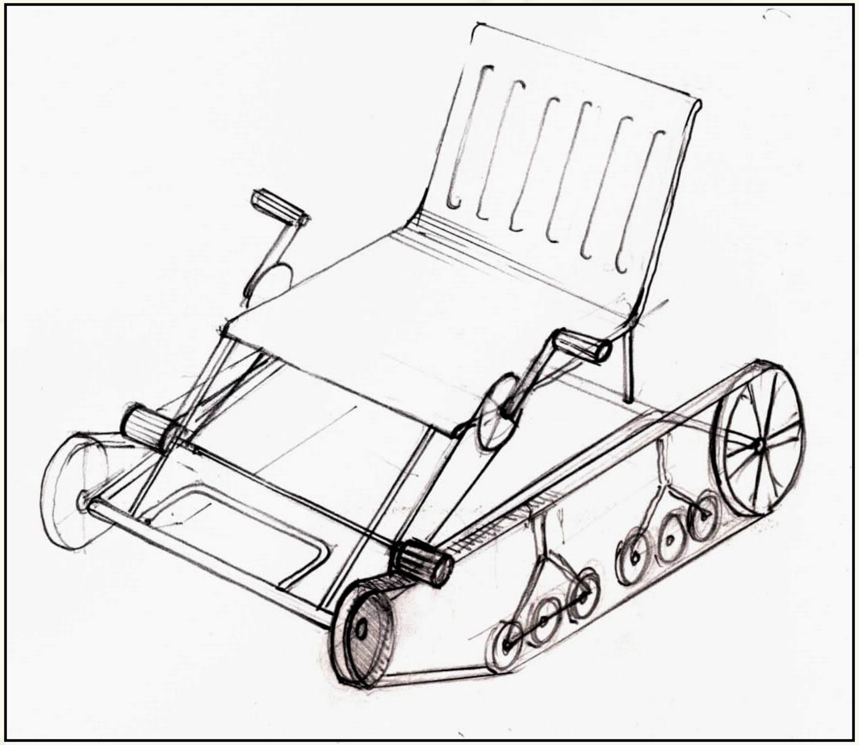

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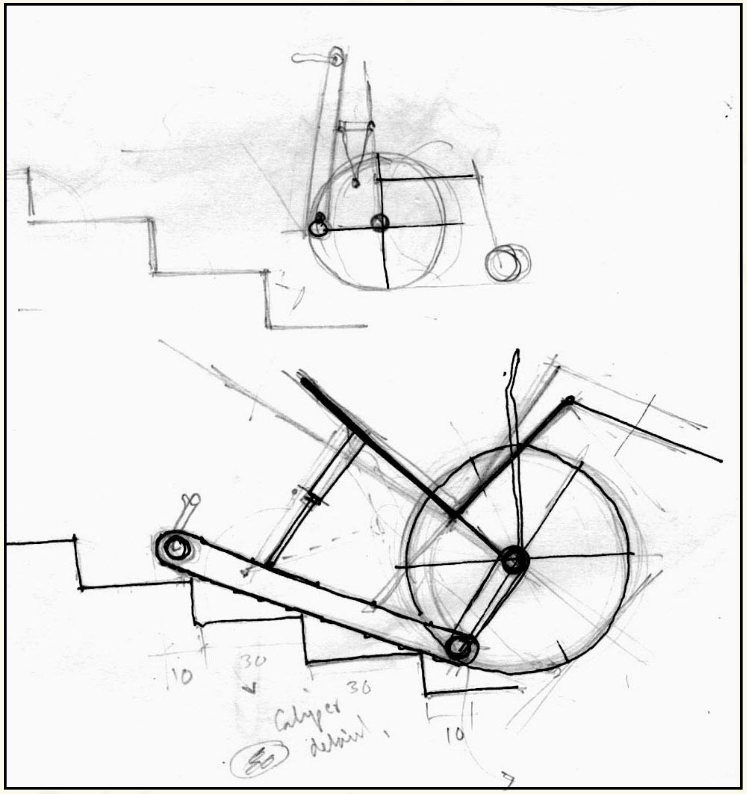

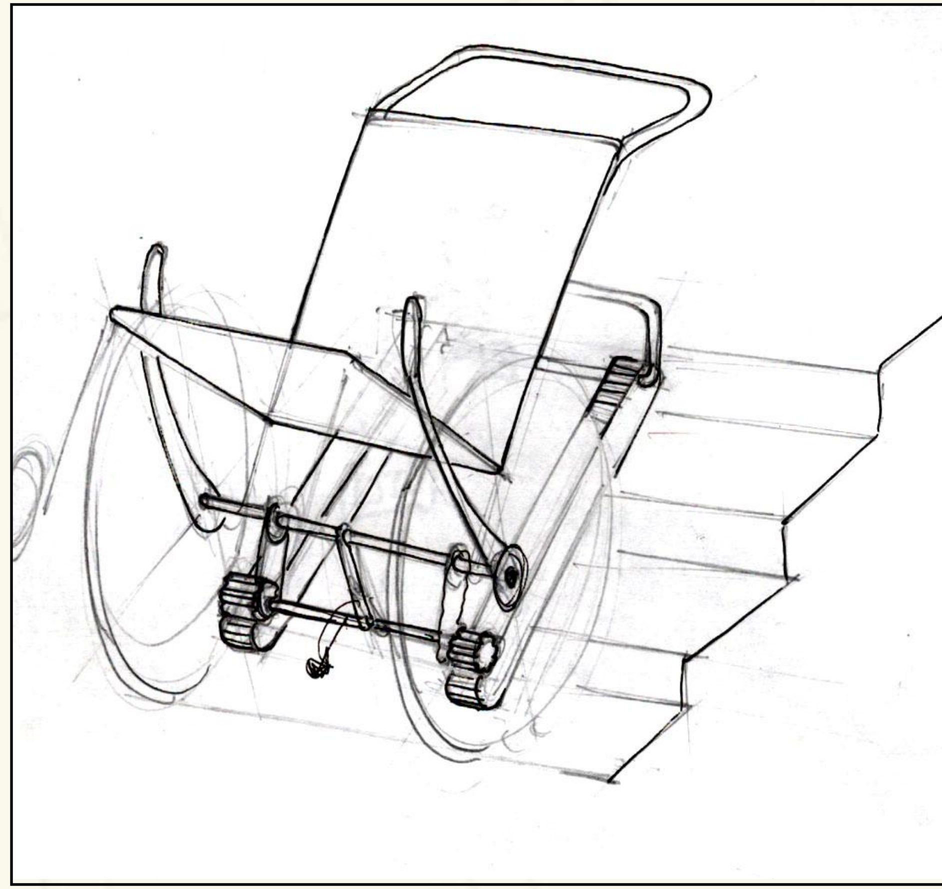

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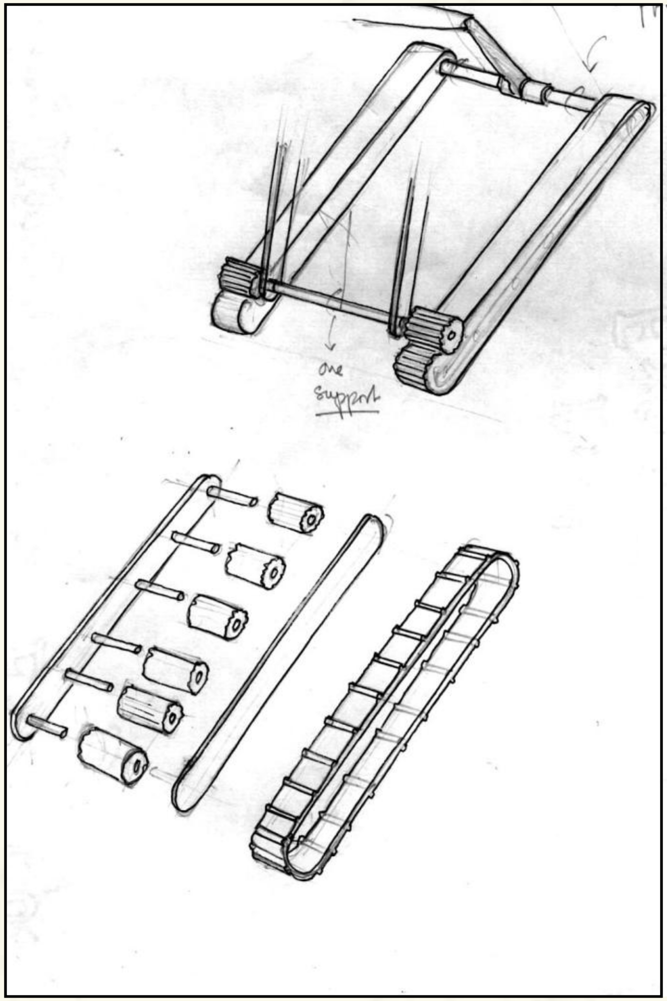
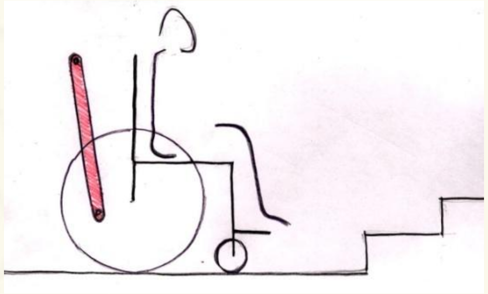
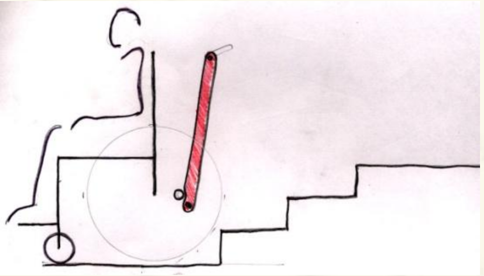
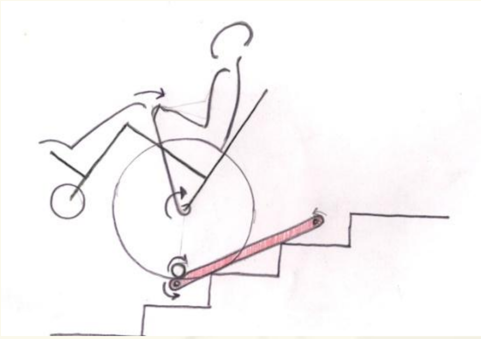
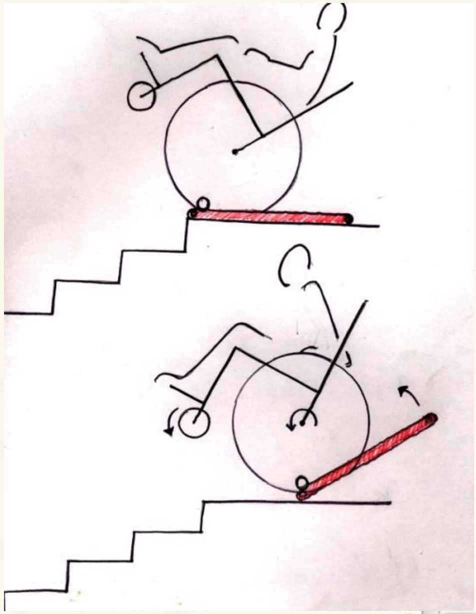




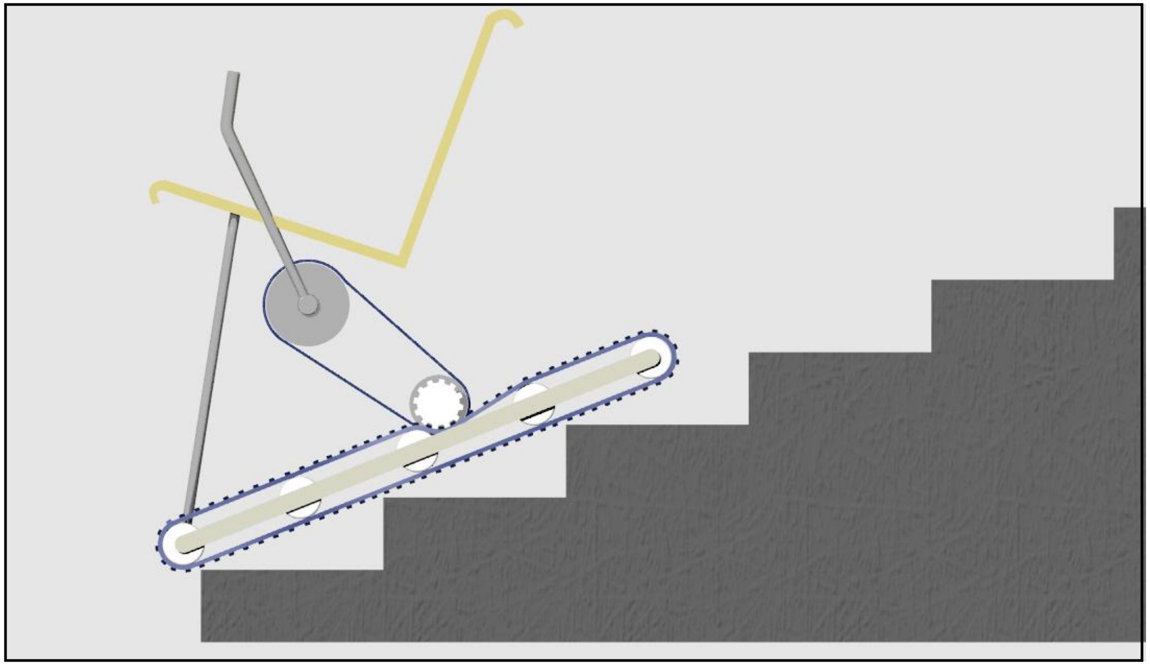


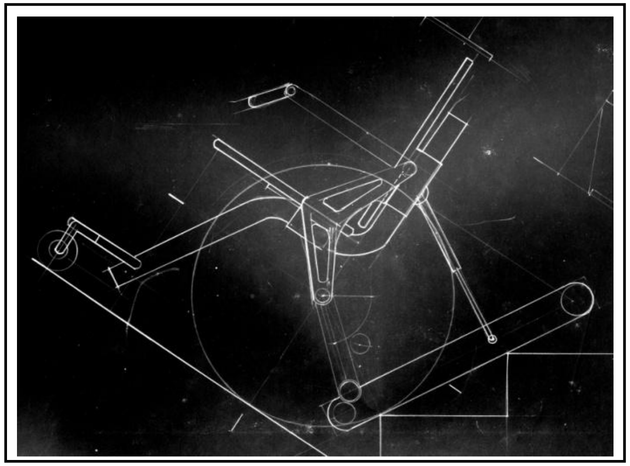




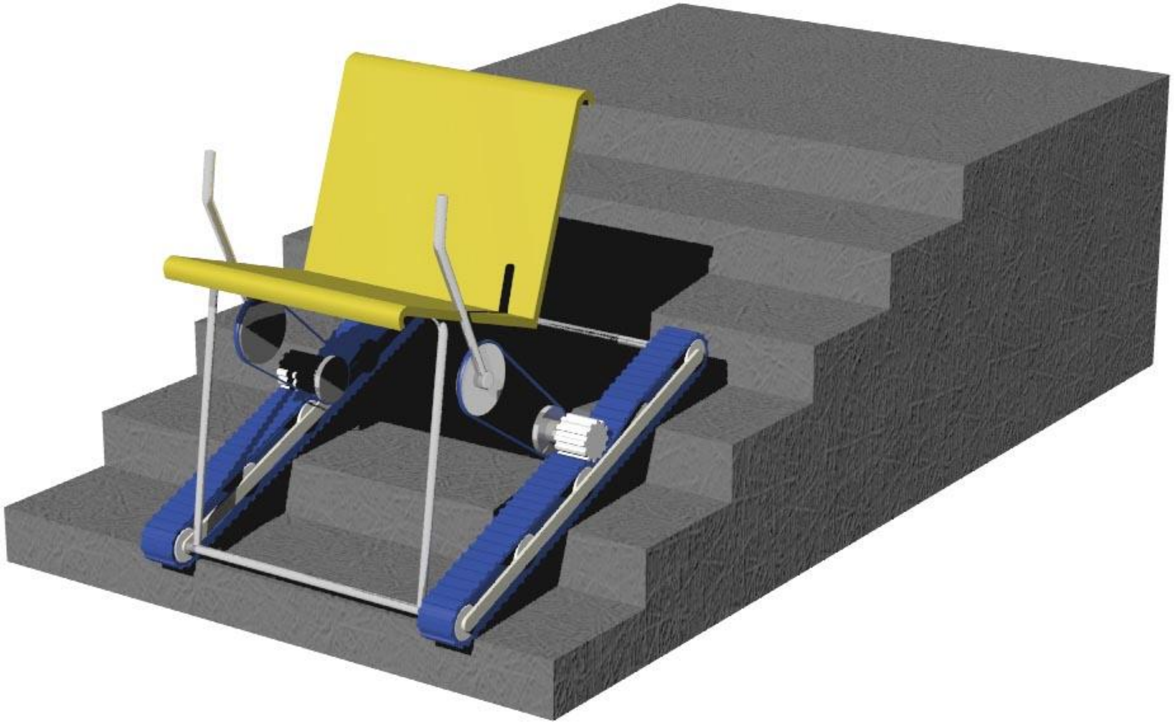
Stage-5

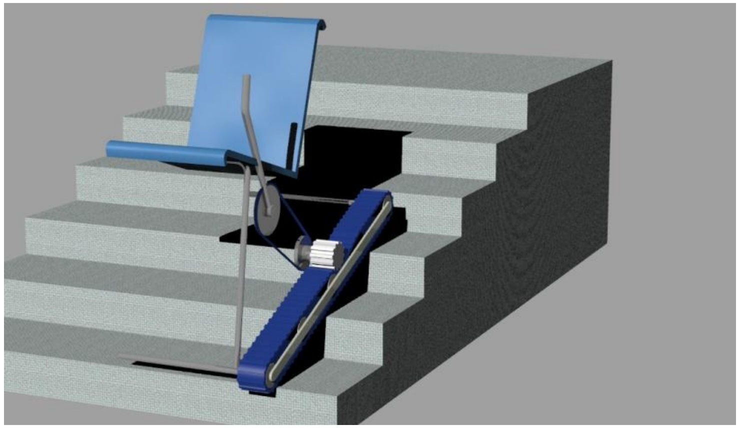
Final Concept selection and evaluation



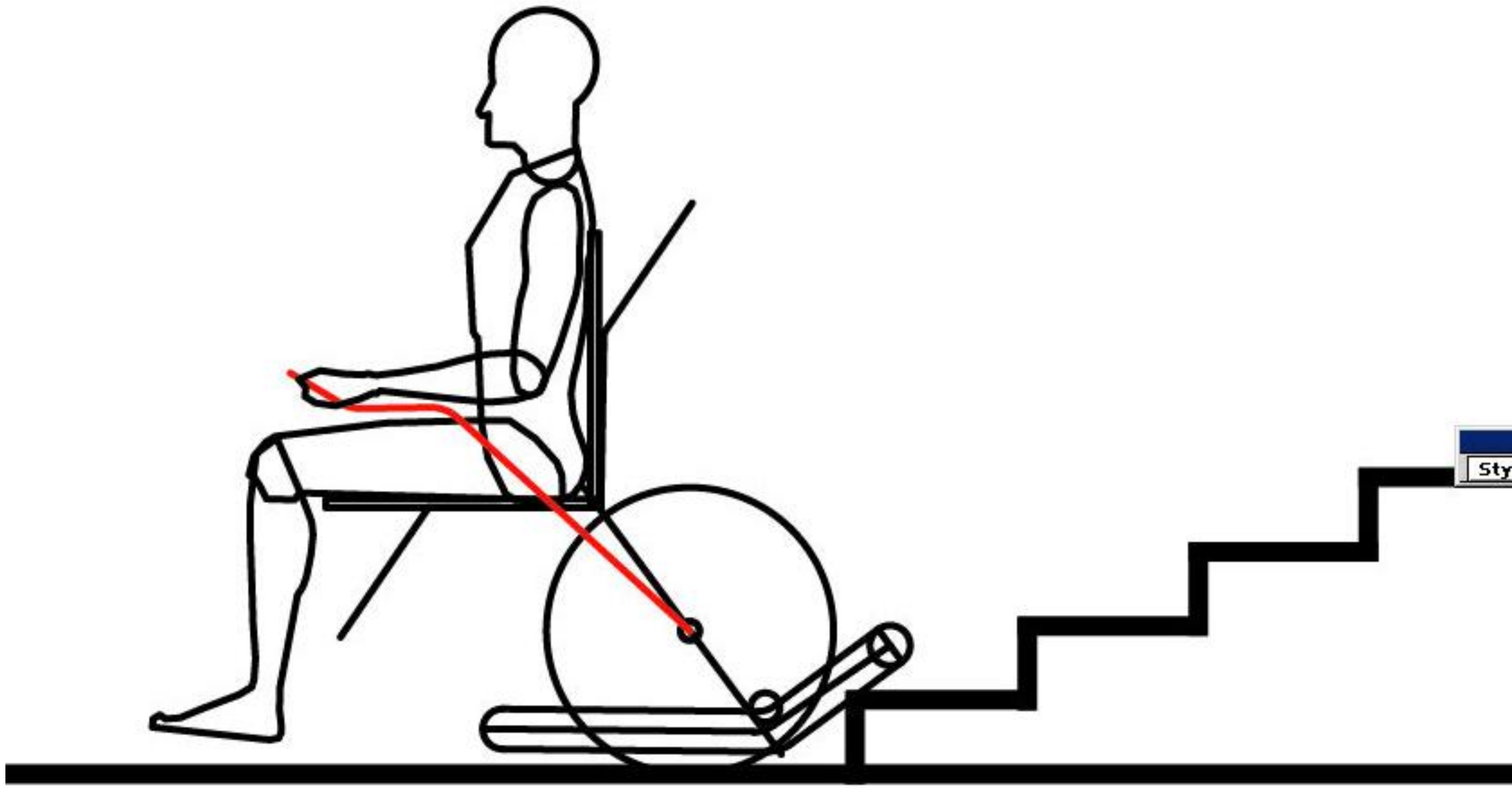


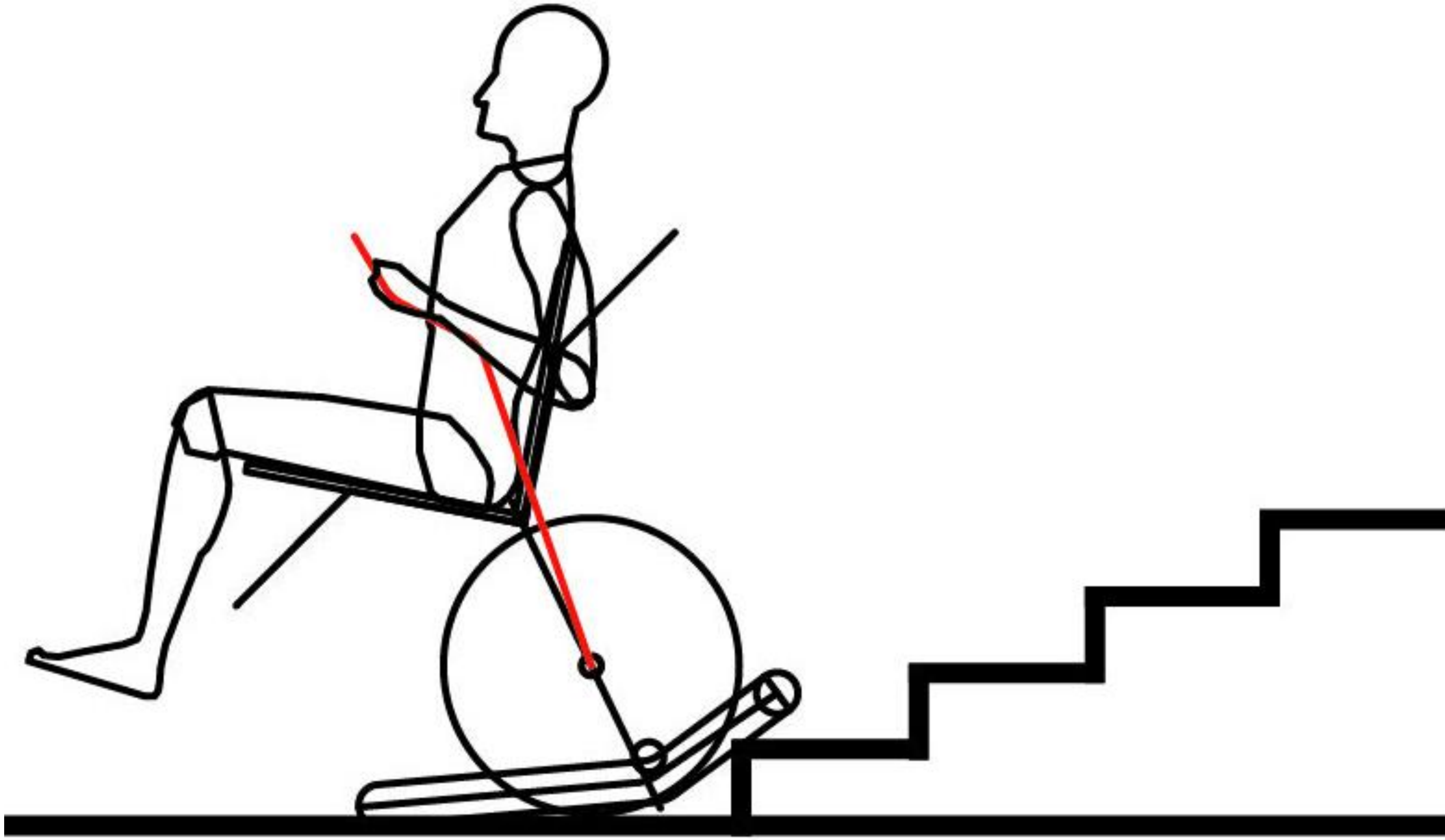
Final Concept selection and evaluation

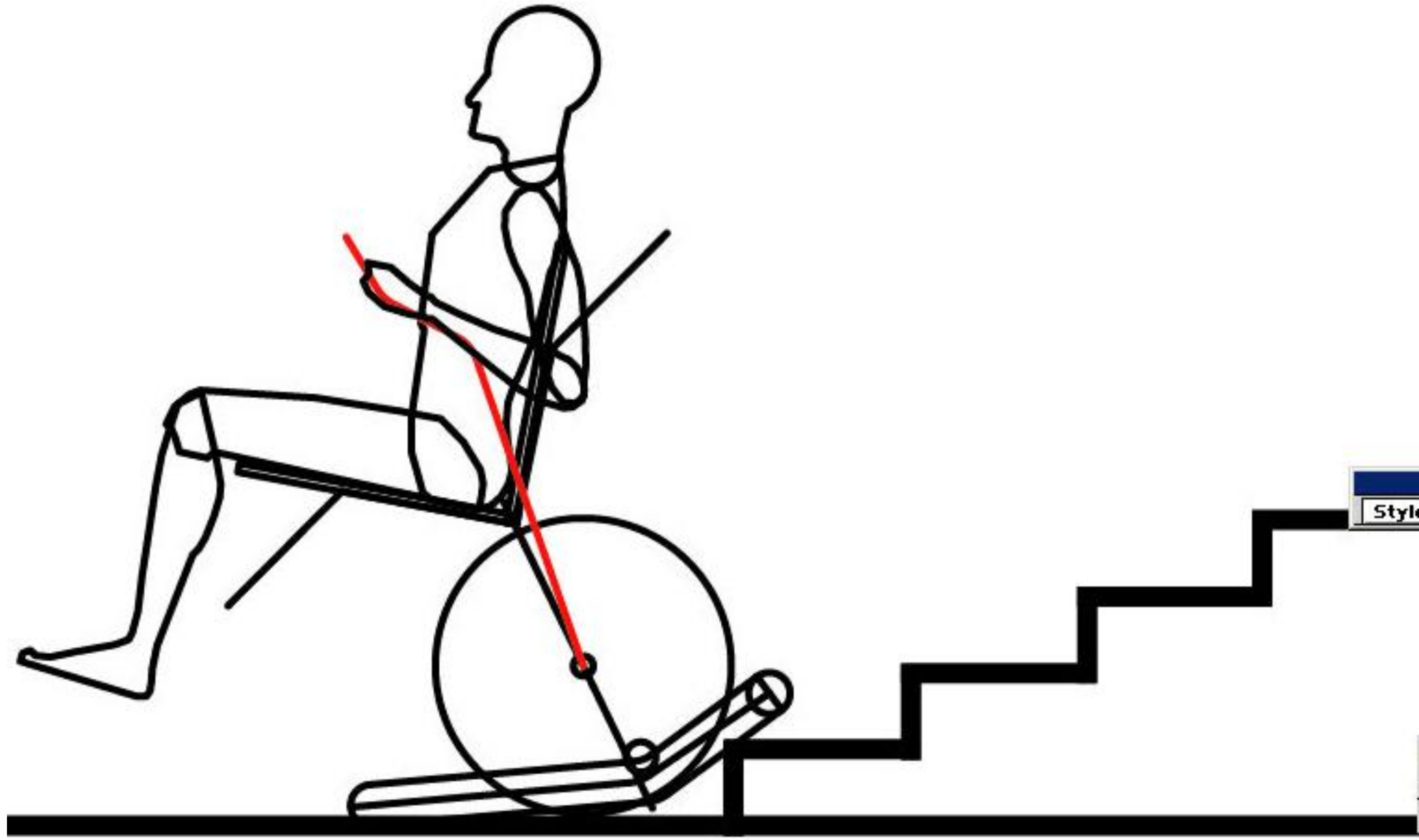


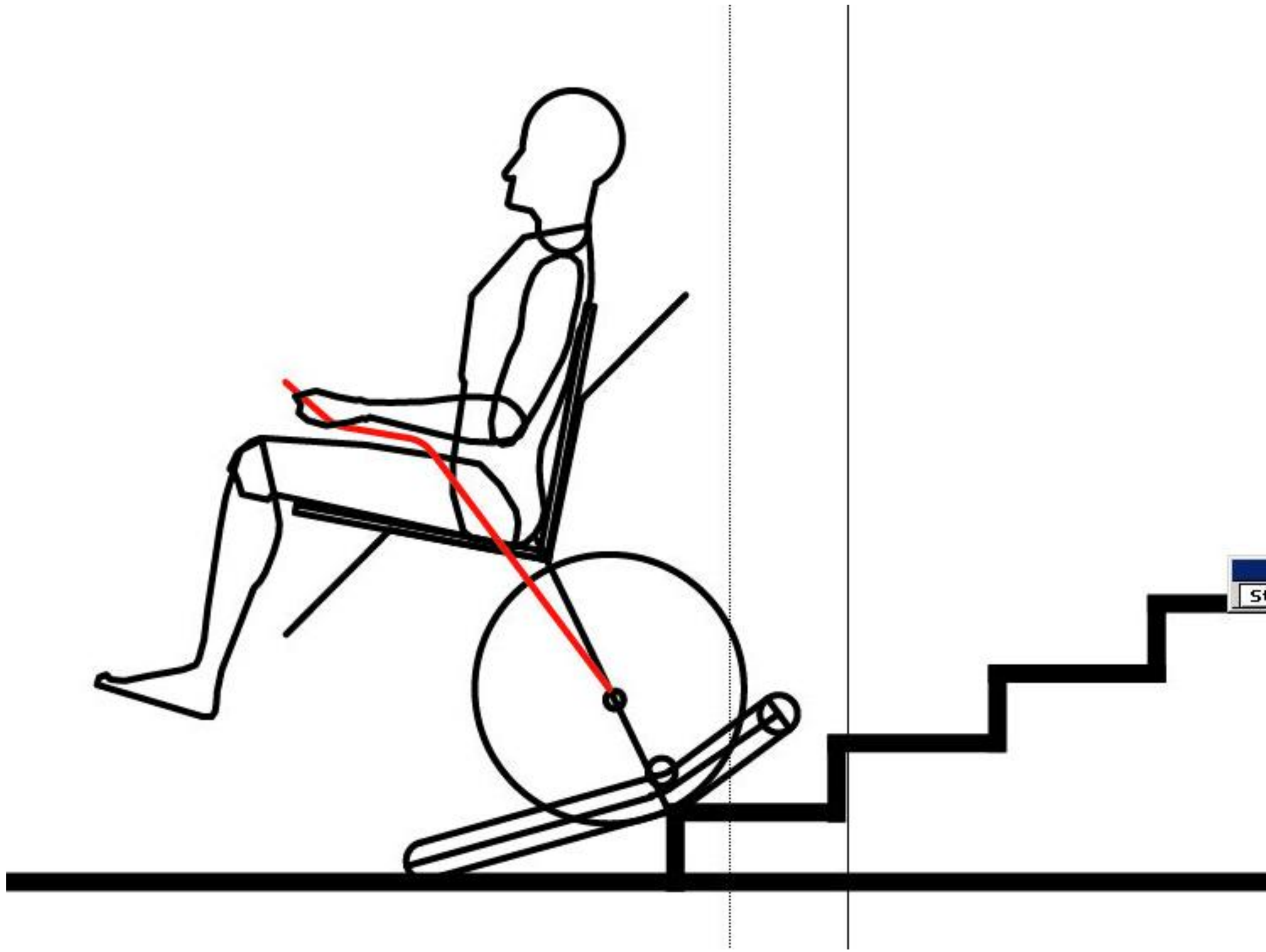


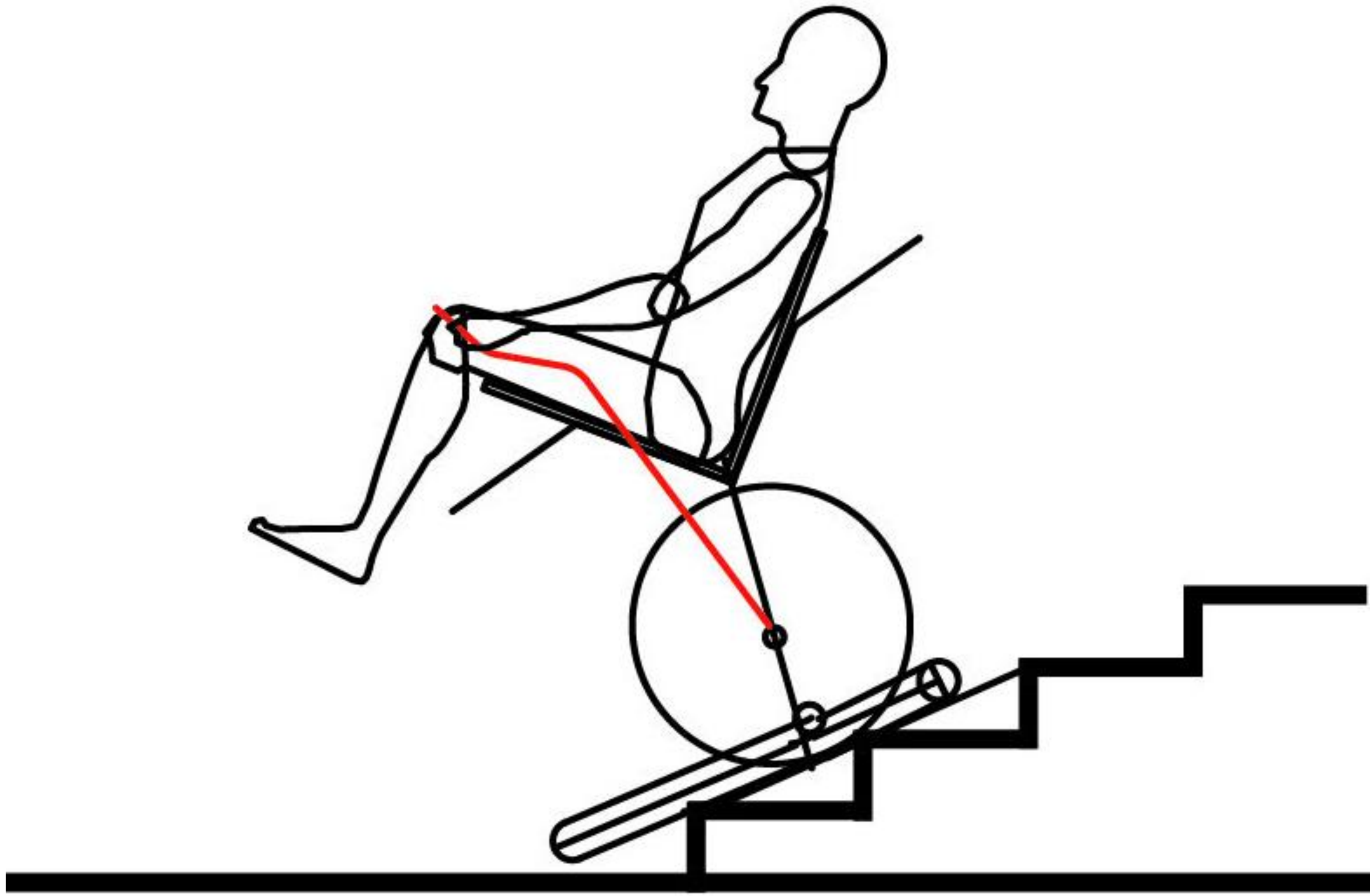
Staircase

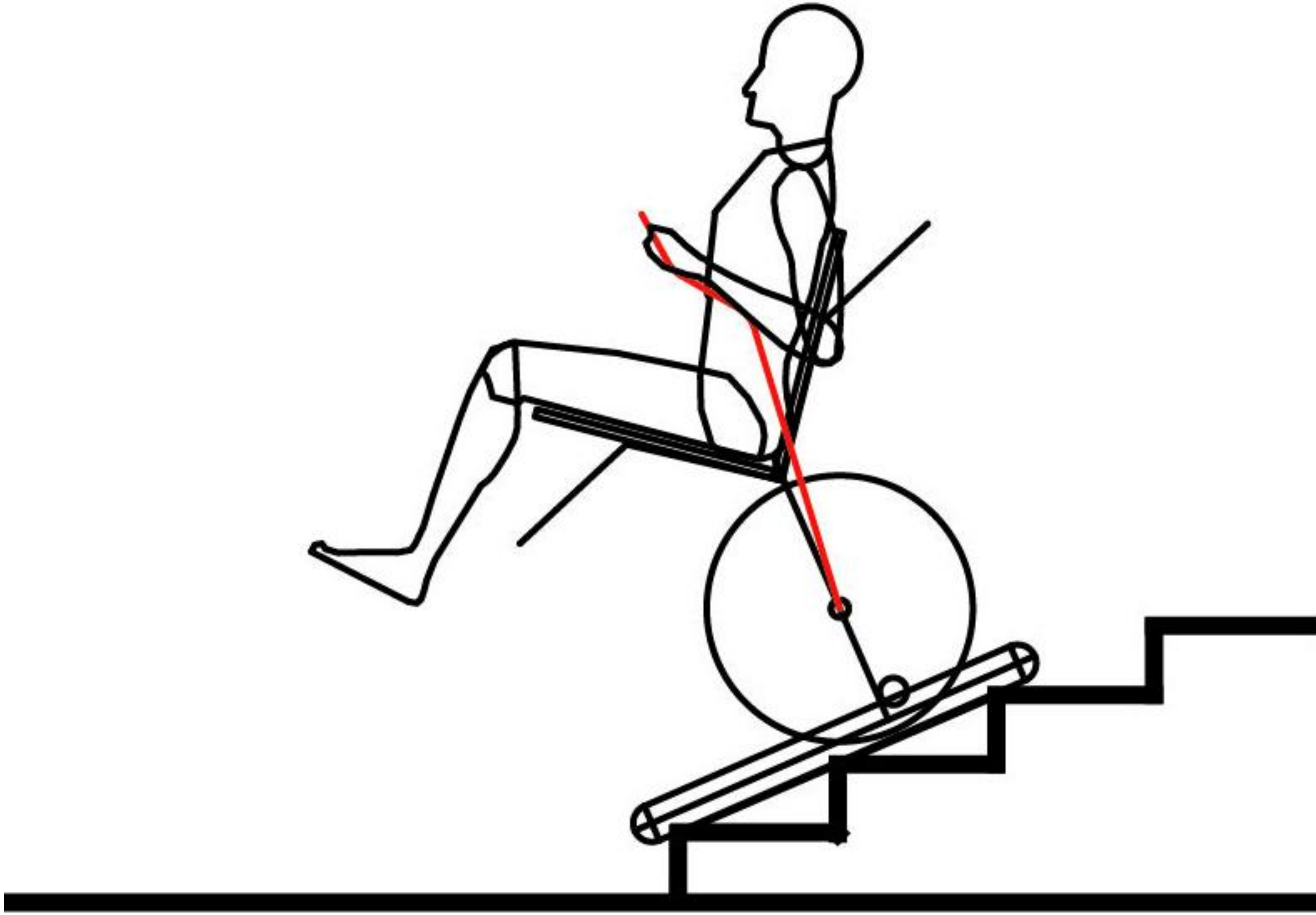


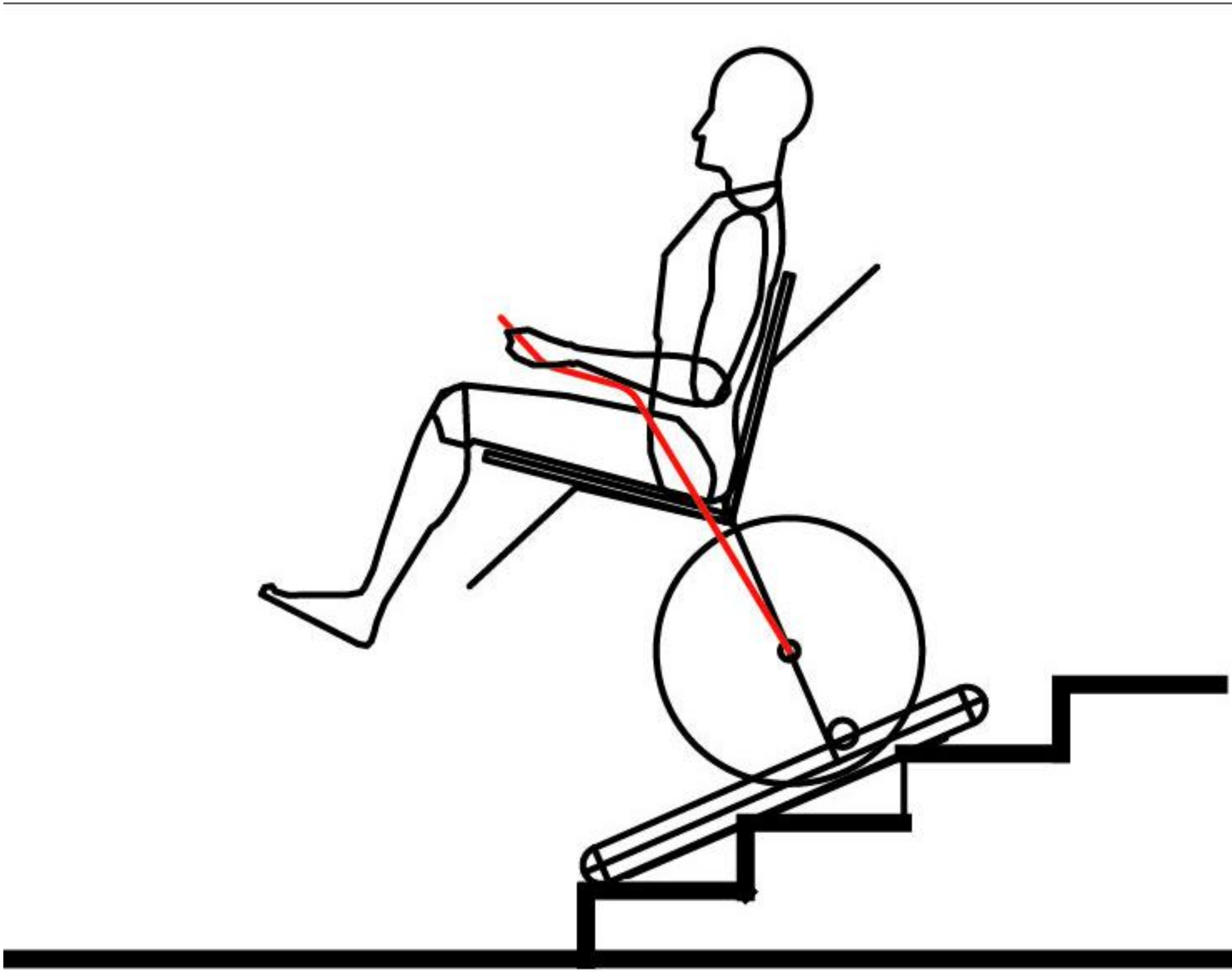


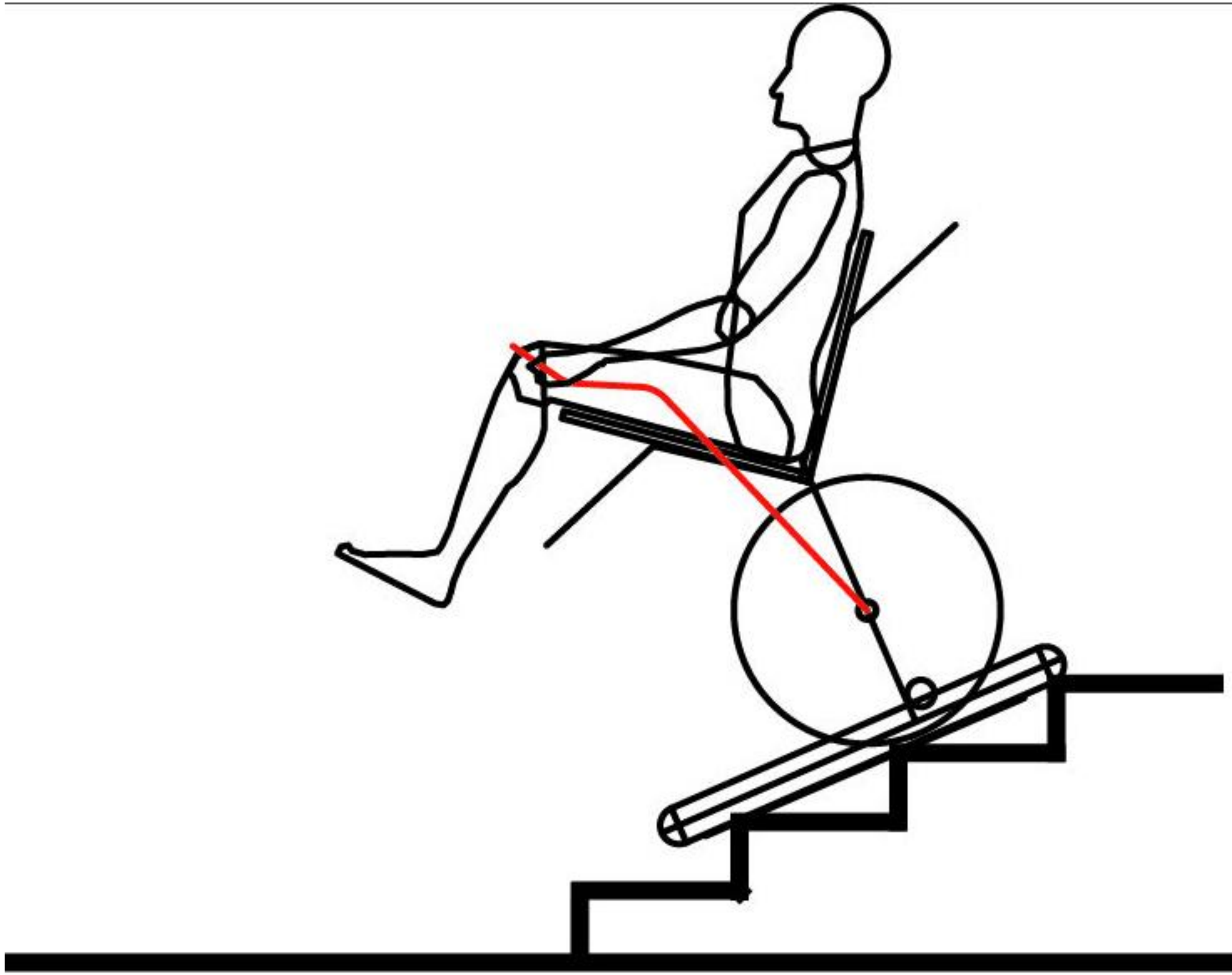






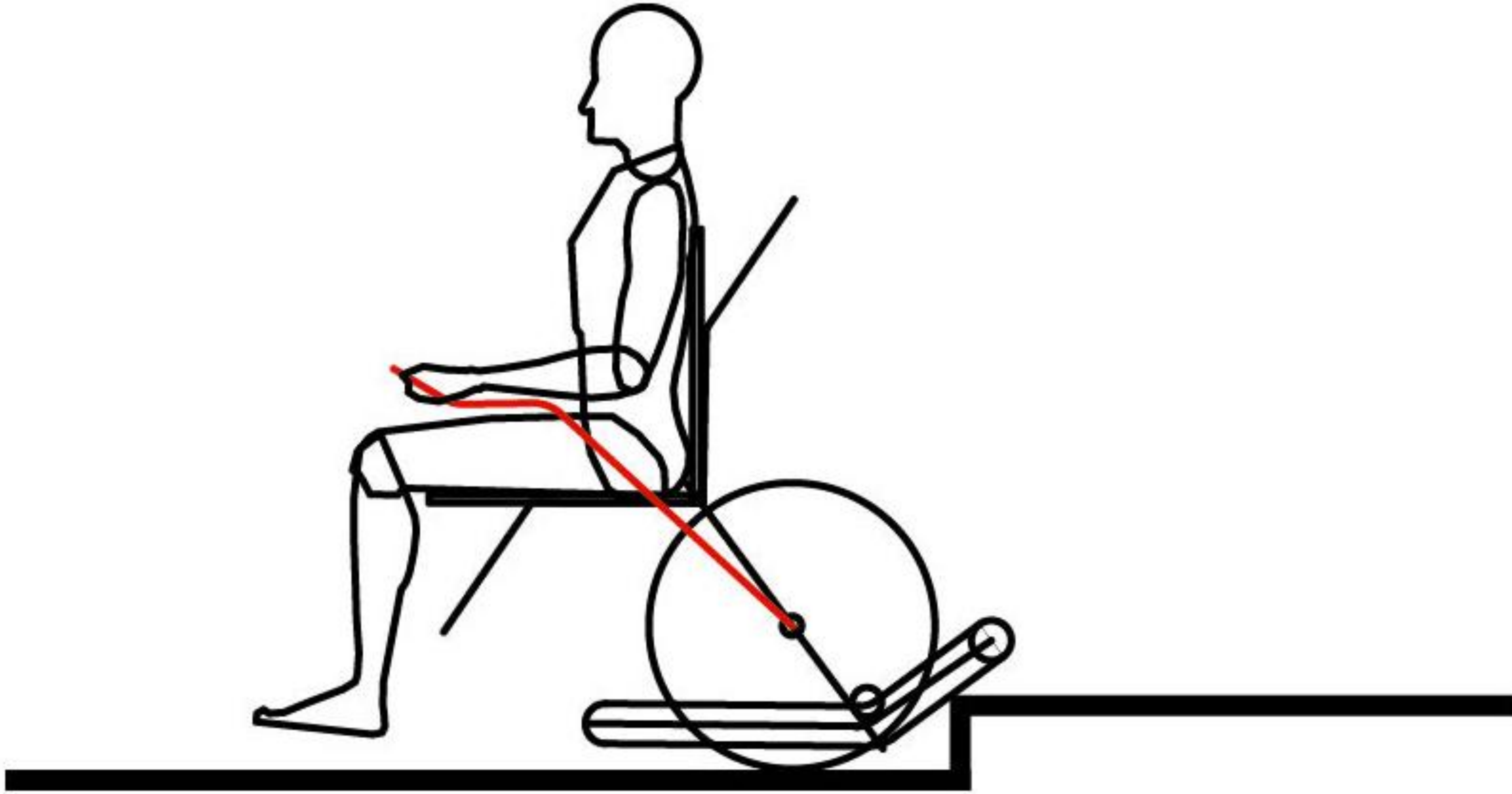


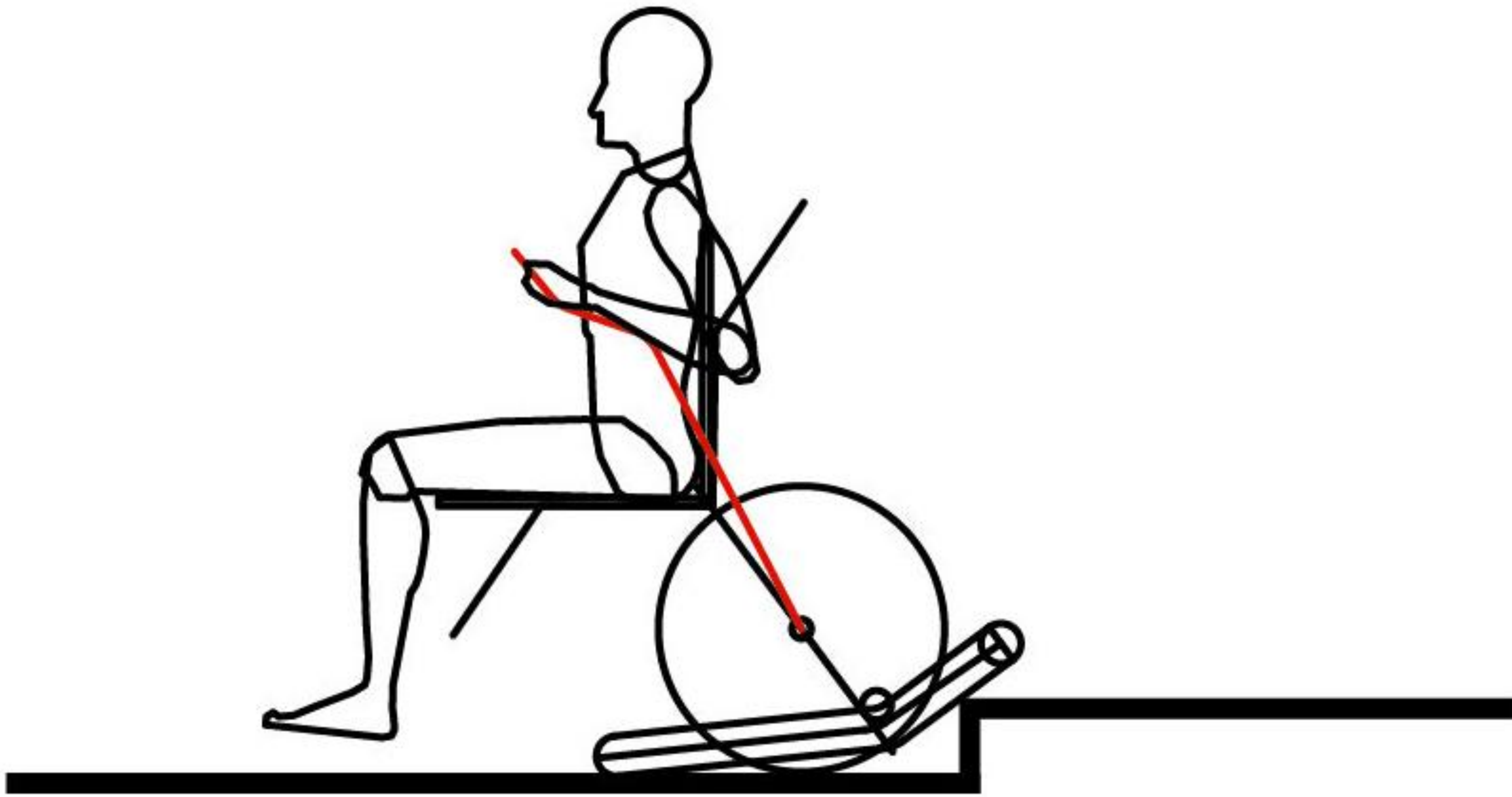


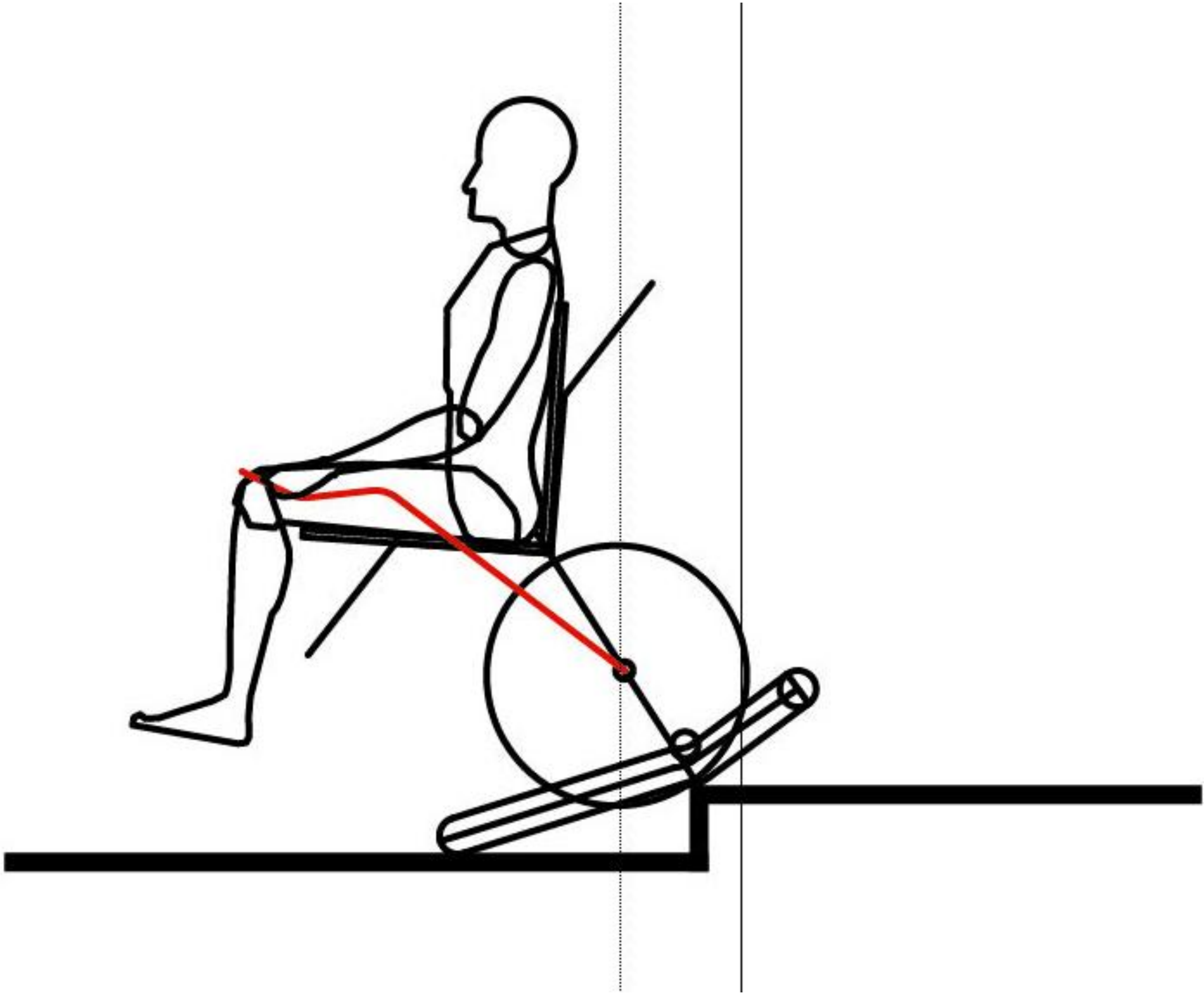


Single step or kerb

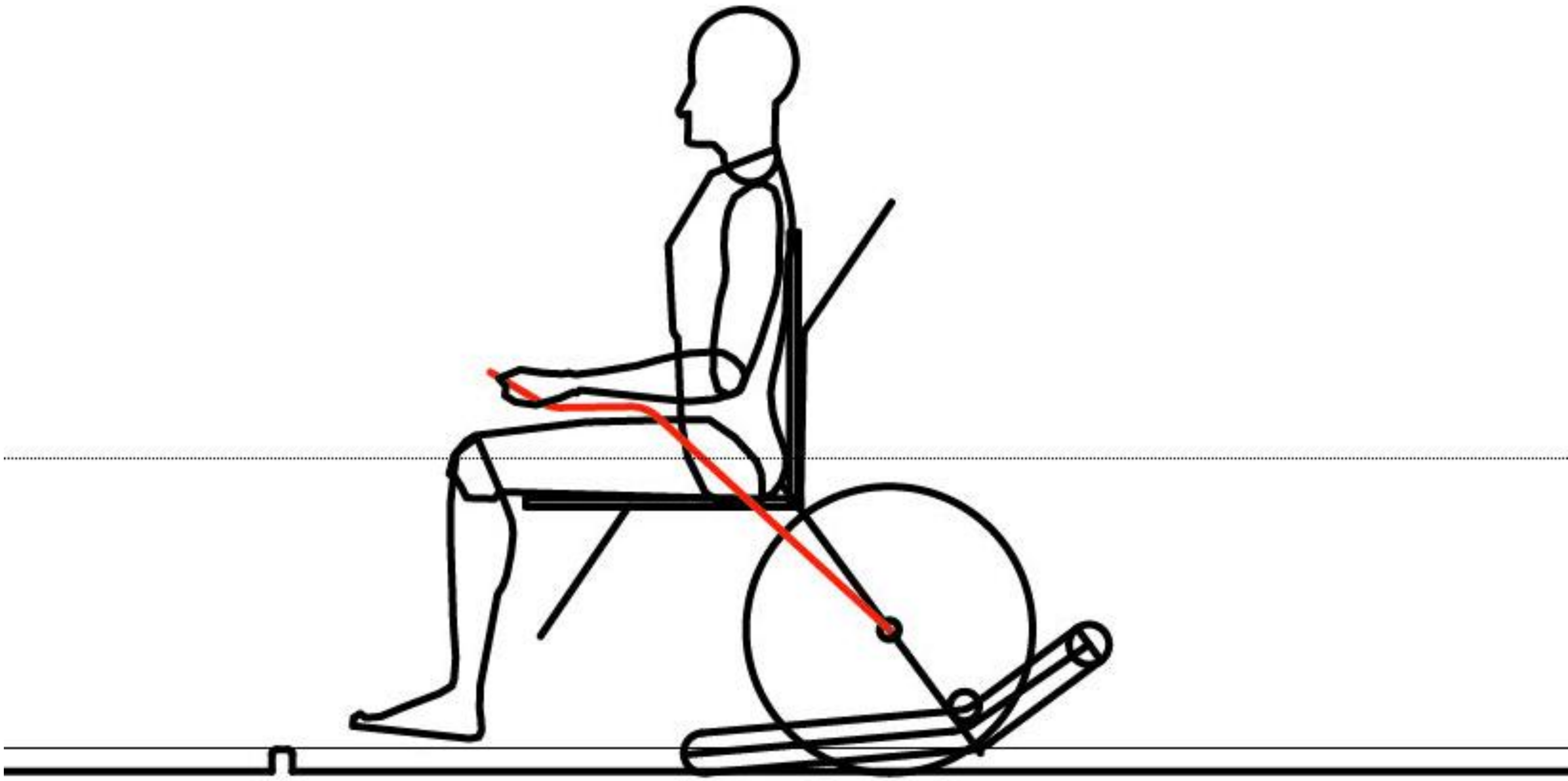
Single step or kerb







Small level change



Two point contact the
traction can be used to
overcome the level change

Final Concept selection and evaluation

Why a need for a “Test model” ?

-To check **traction**

-**Force** required for climbing as well as the amount of resistance force or breaking required.

-To check **placement** and center of gravity in order to achieve balance, while climbing.

-To estimate how much needs to be added and reduced in terms of dimensions and weight of different components.

-To place different parts and their co-ordination between each other.

-Adjustment of **center of gravity** and managing a balance between the theoretical and the psychological.

Final Concept selection and evaluation



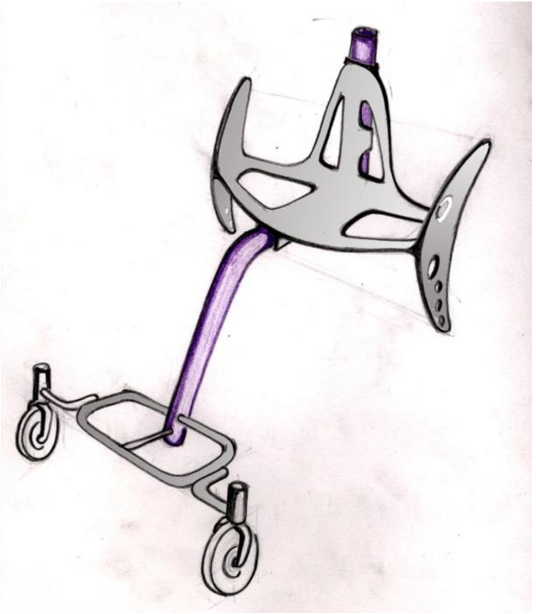


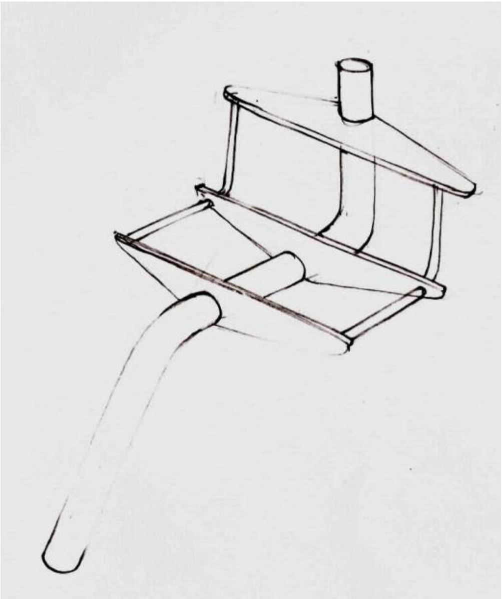


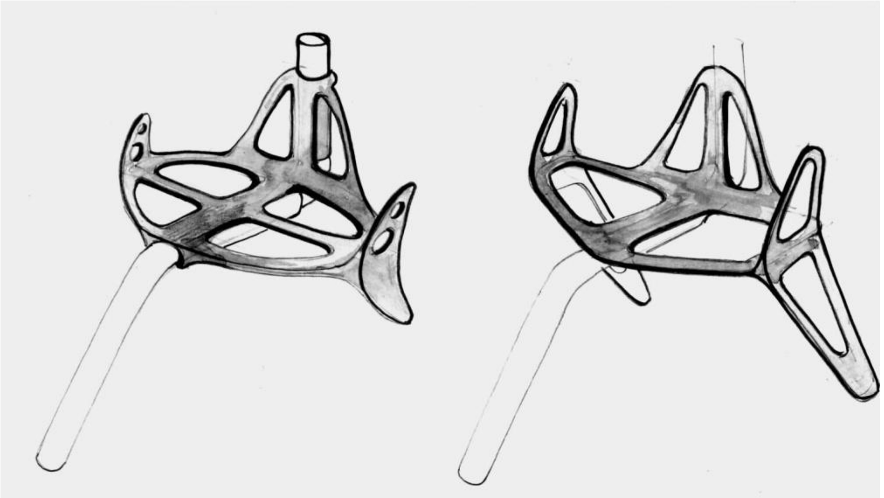
conclusions drawn test model at this stage

1. Gears and treads to be made deeper.
2. decrease pitch between two treads.
3. Detail aligning the chain wheels.
4. Weight reduction.
5. More possibility of increasing transmission ratio.

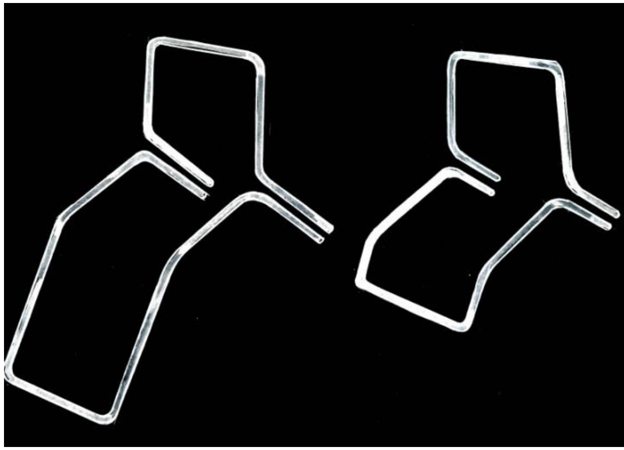
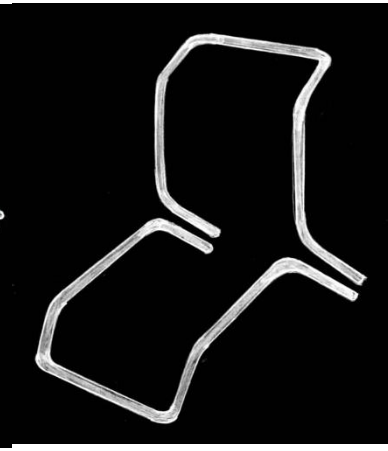
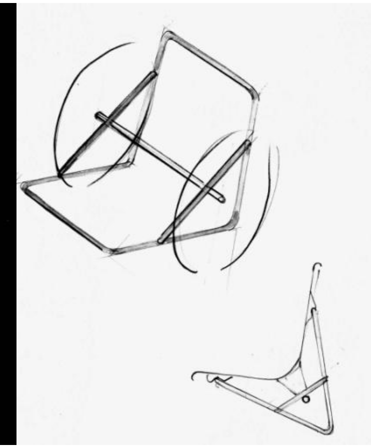
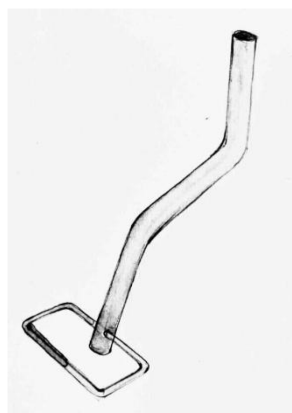
Concept generation (form and construction)

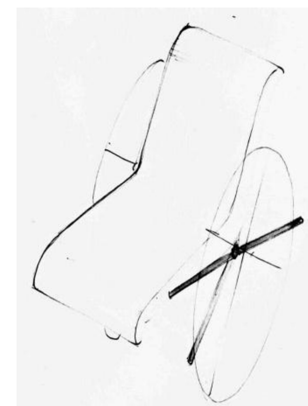




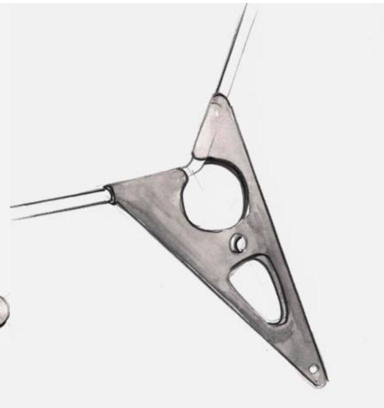


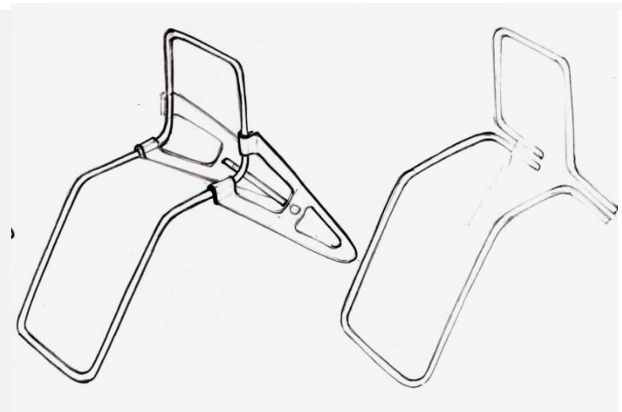
Concept generation (form and construction)

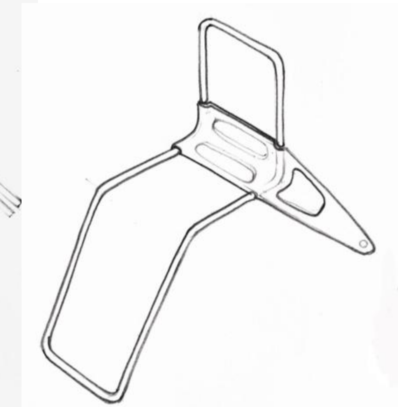





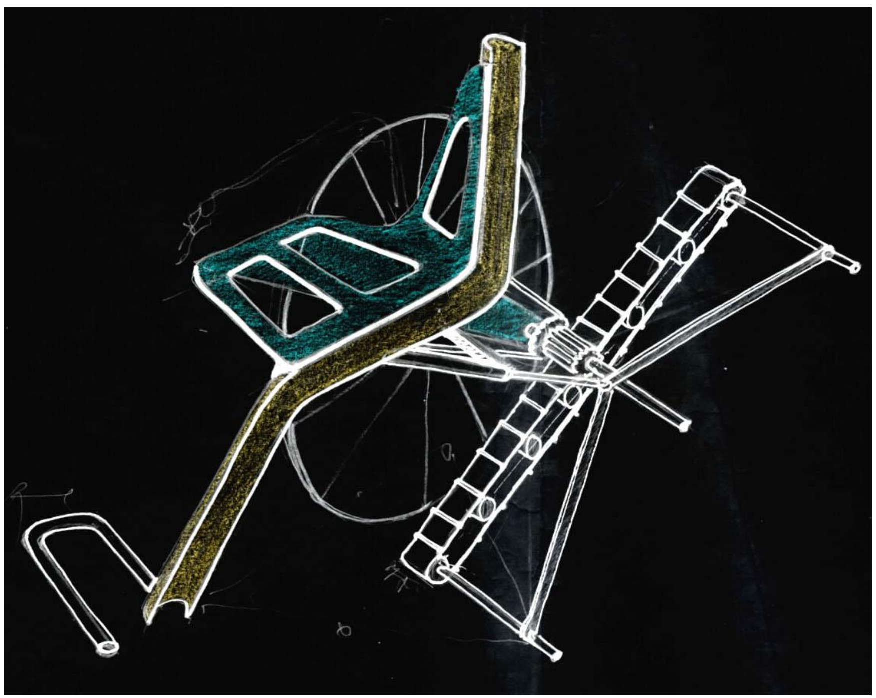


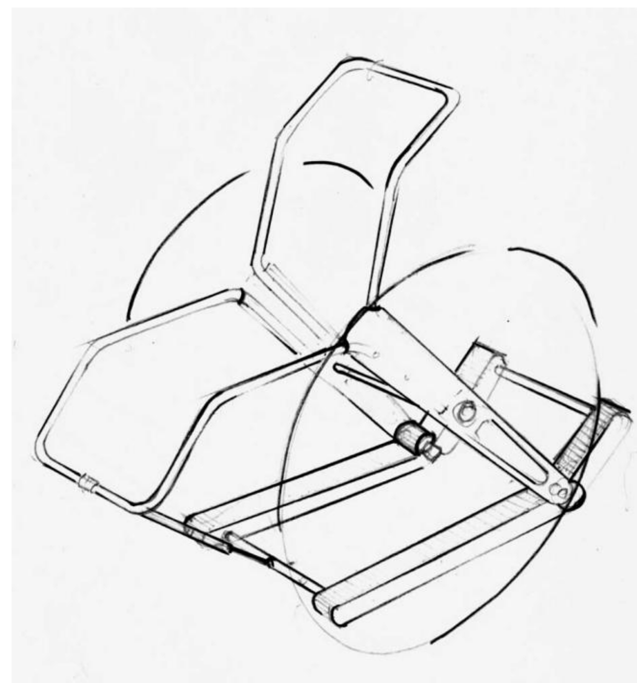
Concept generation (form and construction)



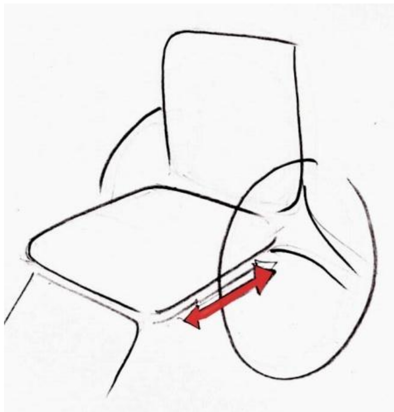
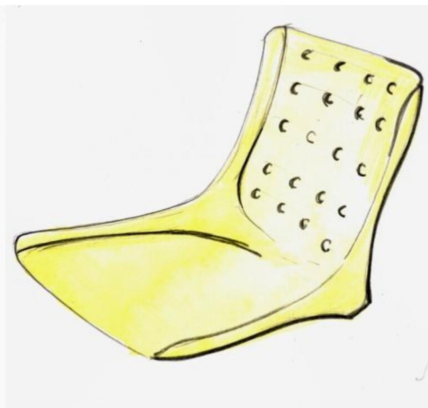
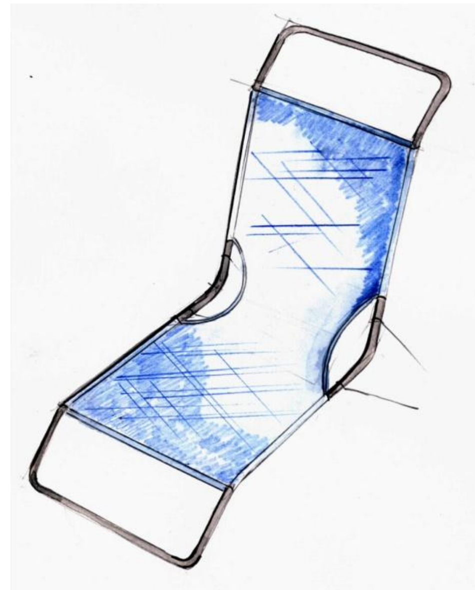
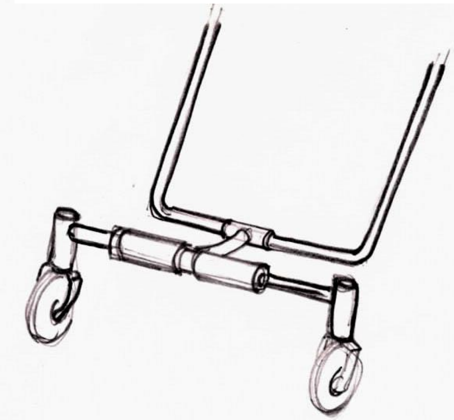


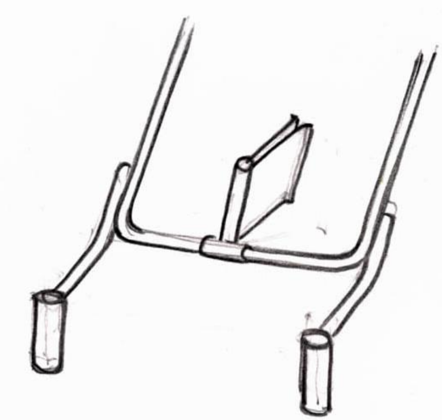






Concept generation (form and construction)

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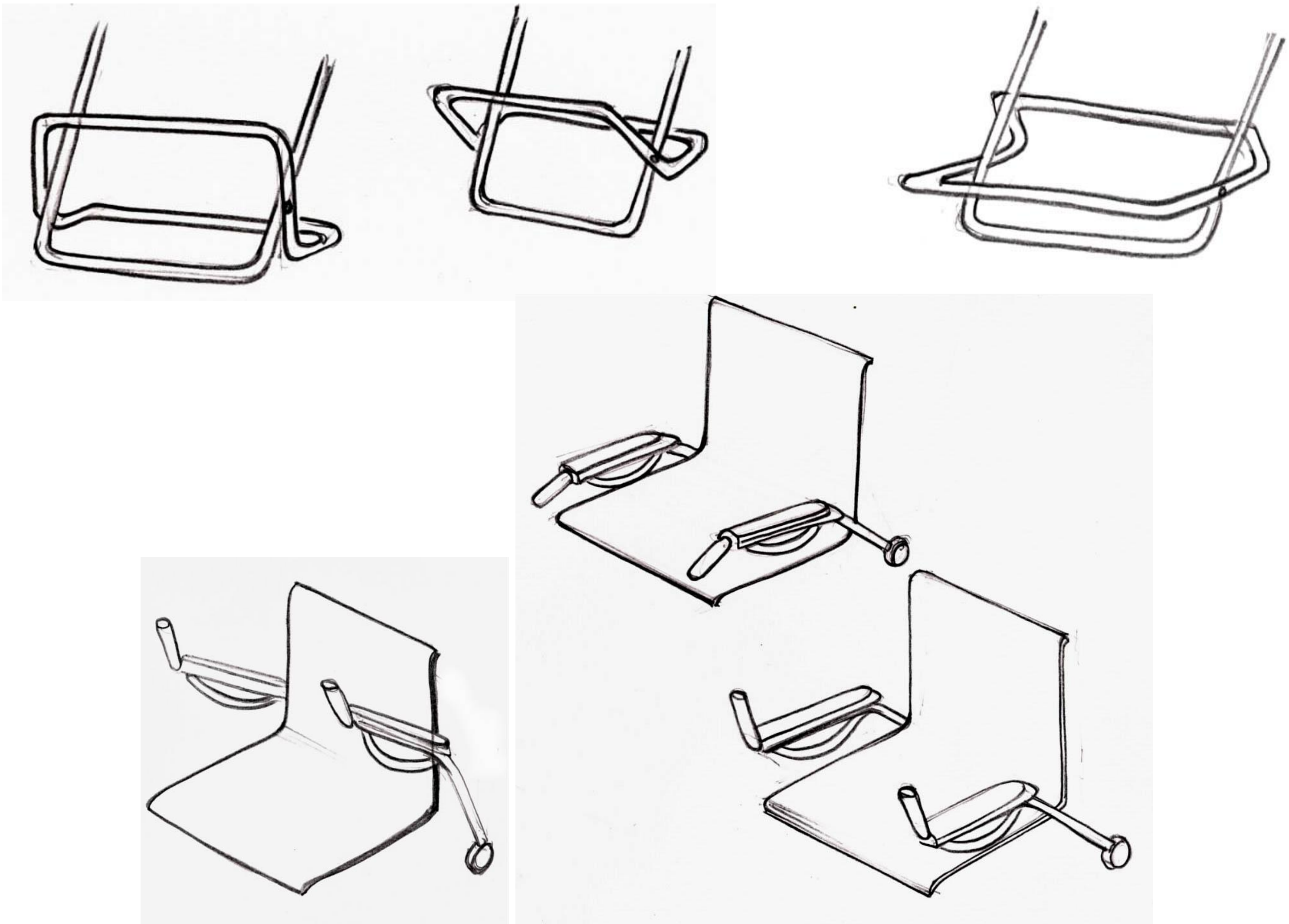

Concept generation (form and construction)

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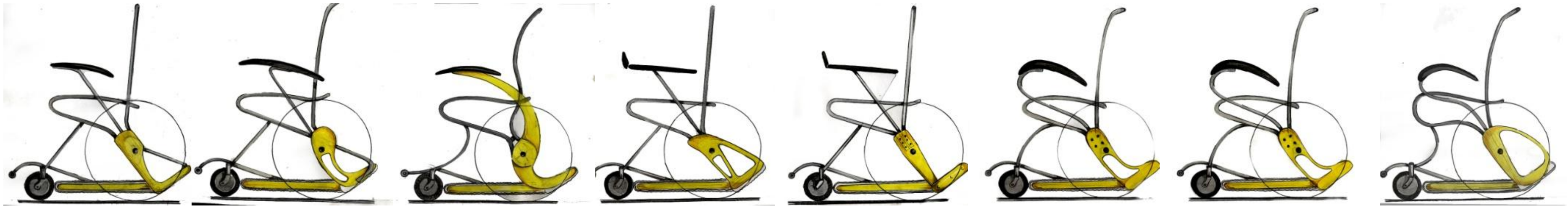


Selection criteria-

1.Maneuverability

Force transmission, turning radius , ease of breaking and turning

2. Ease of assembly

Number of parts and joints, nature of combining different materials and their behavior

3. Ease of construction

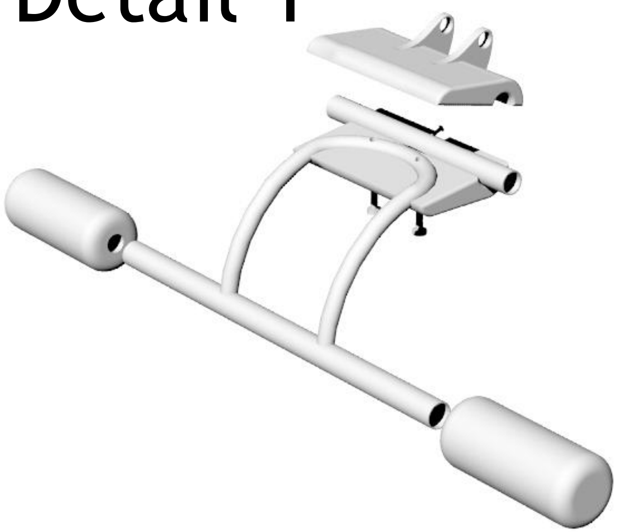
4. Visual Appeal

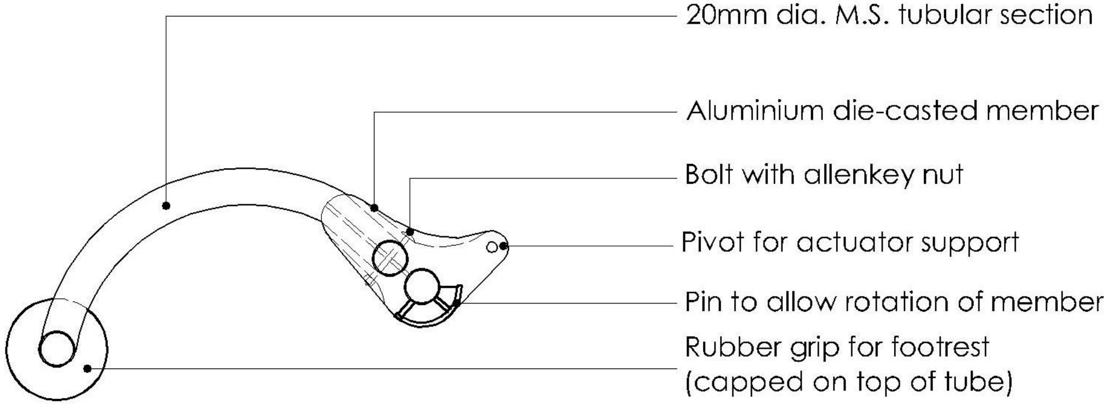
5. Weight to strength ratio

Minimise on weight and maximise on strength

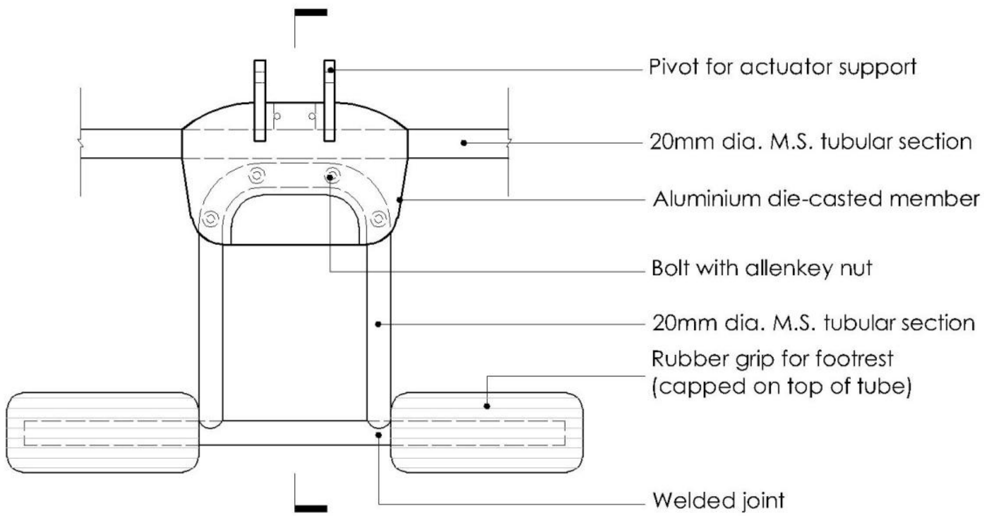
a s c e n d e r

Detail 1



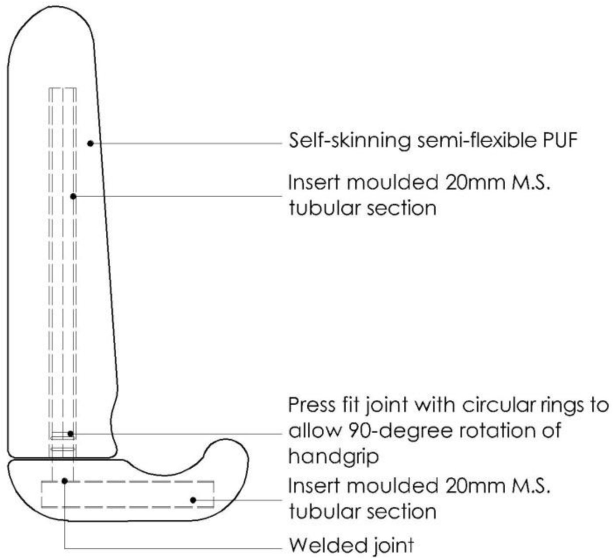


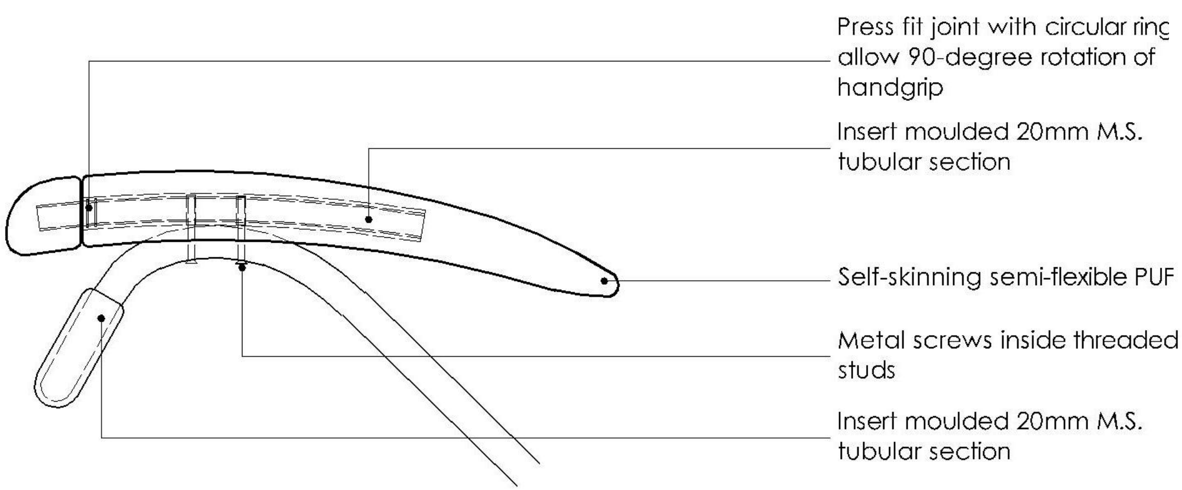
20mm dia. M.S. tubular section
Aluminium die-casted member
Bolt with allenkey nut
Pivot for actuator support
Pin to allow rotation of member
Rubber grip for footrest
(capped on top of tube)



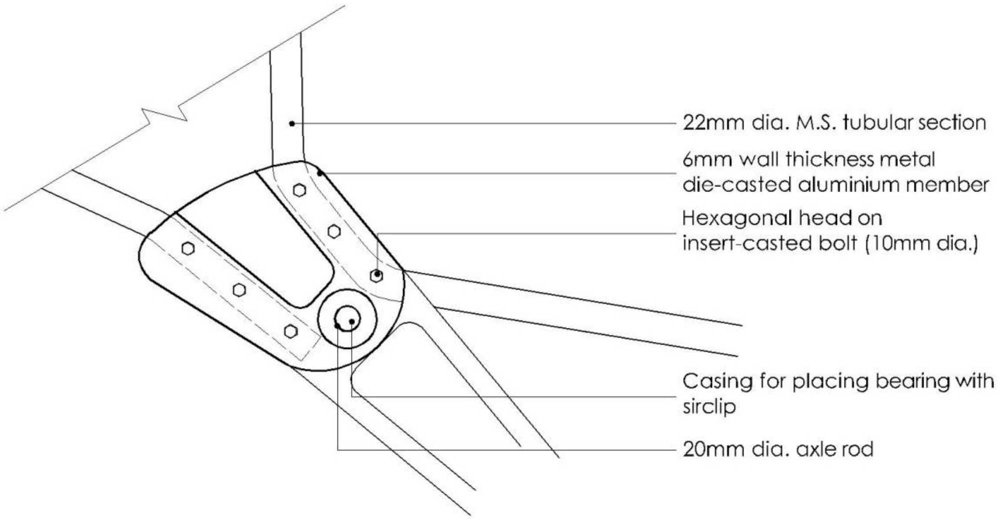
Pivot for actuator support
20mm dia. M.S. tubular section
Aluminium die-casted member
Bolt with allenkey nut
20mm dia. M.S. tubular section
Rubber grip for footrest
(capped on top of tube)
Welded joint

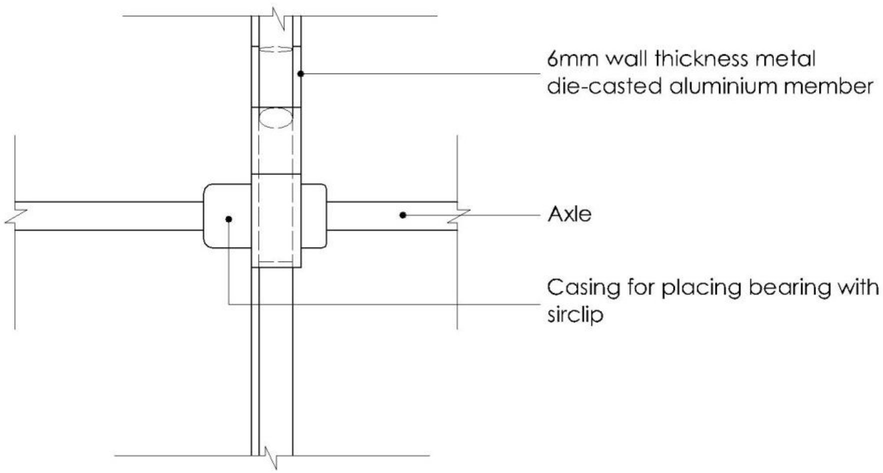
Detail 2


Self-skinning semi-flexible PUF
Insert moulded 20mm M.S. tubular section
Press fit joint with circular rings to allow 90-degree rotation of handgrip
Insert moulded 20mm M.S. tubular section
Welded joint

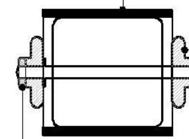

Press fit joint with circular ring
allow 90-degree rotation of handgrip
Insert moulded 20mm M.S. tubular section
Self-skinning semi-flexible PUF
Metal screws inside threaded studs
Insert moulded 20mm M.S. tubular section

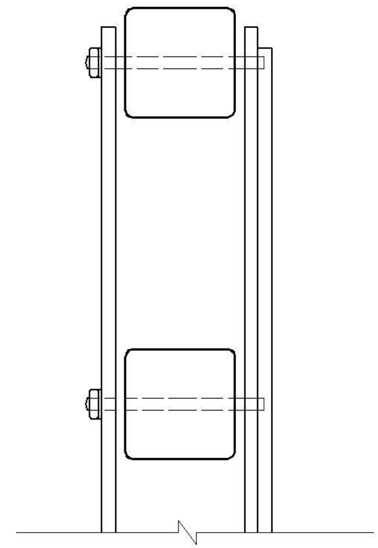
Detail 3

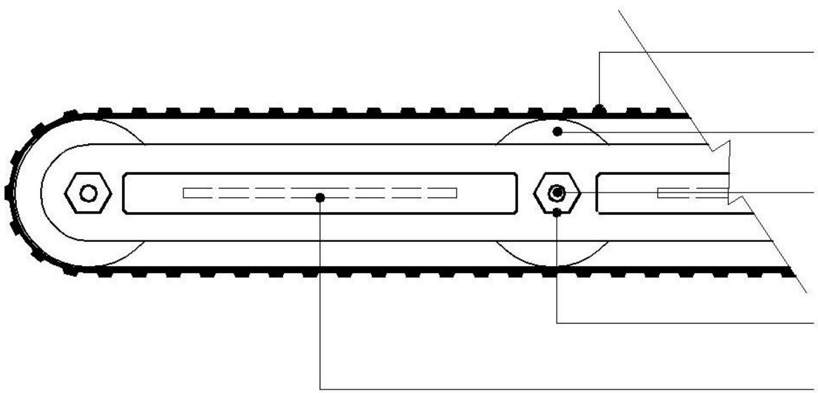

22mm dia. M.S. tubular section
6mm wall thickness metal die-casted aluminium member
Hexagonal head on insert-casted bolt (10mm dia.)
Casing for placing bearing with sirclip
20mm dia. axle rod


6mm wall thickness metal die-casted aluminium member
Axle
Casing for placing bearing with sirclip

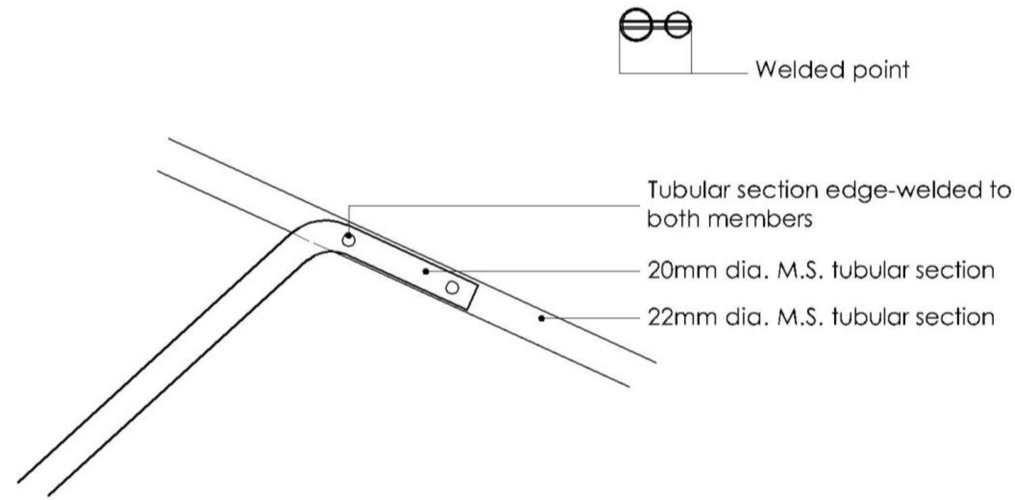
Detail 4


Fibre-reinforced rubber belt
(pitch > 1/2"), 4mm thk.
6mm wall thickness metal
die-casted aluminium member
Hexagonal head on
insert-casted bolt (10mm dia.)



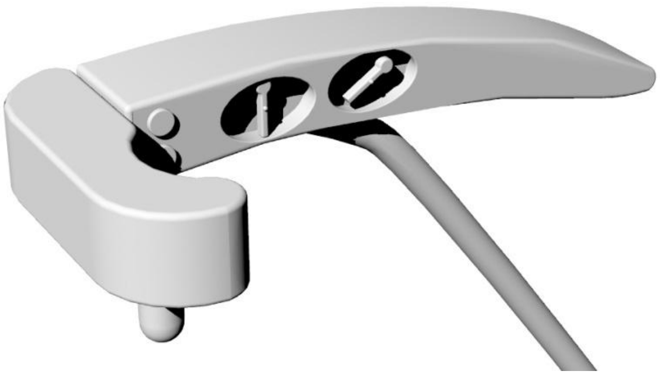

Fibre-reinforced rubber belt
(pitch > 1/2"), 4mm thk.
65mm dia. nylon wheel
6mm wall thickness metal
die-casted aluminium member
Hexagonal head on
insert-casted bolt (10mm dia.)
Cross-bracing

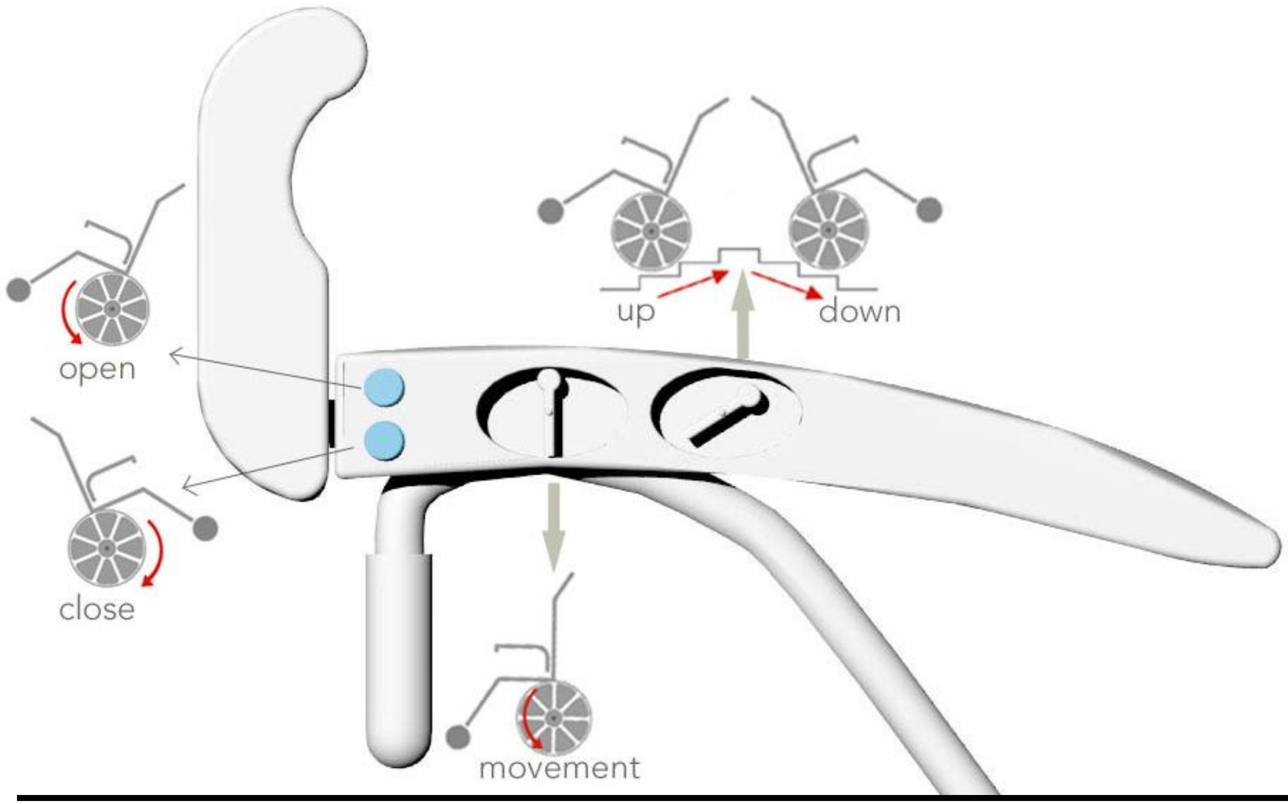
Detail 5



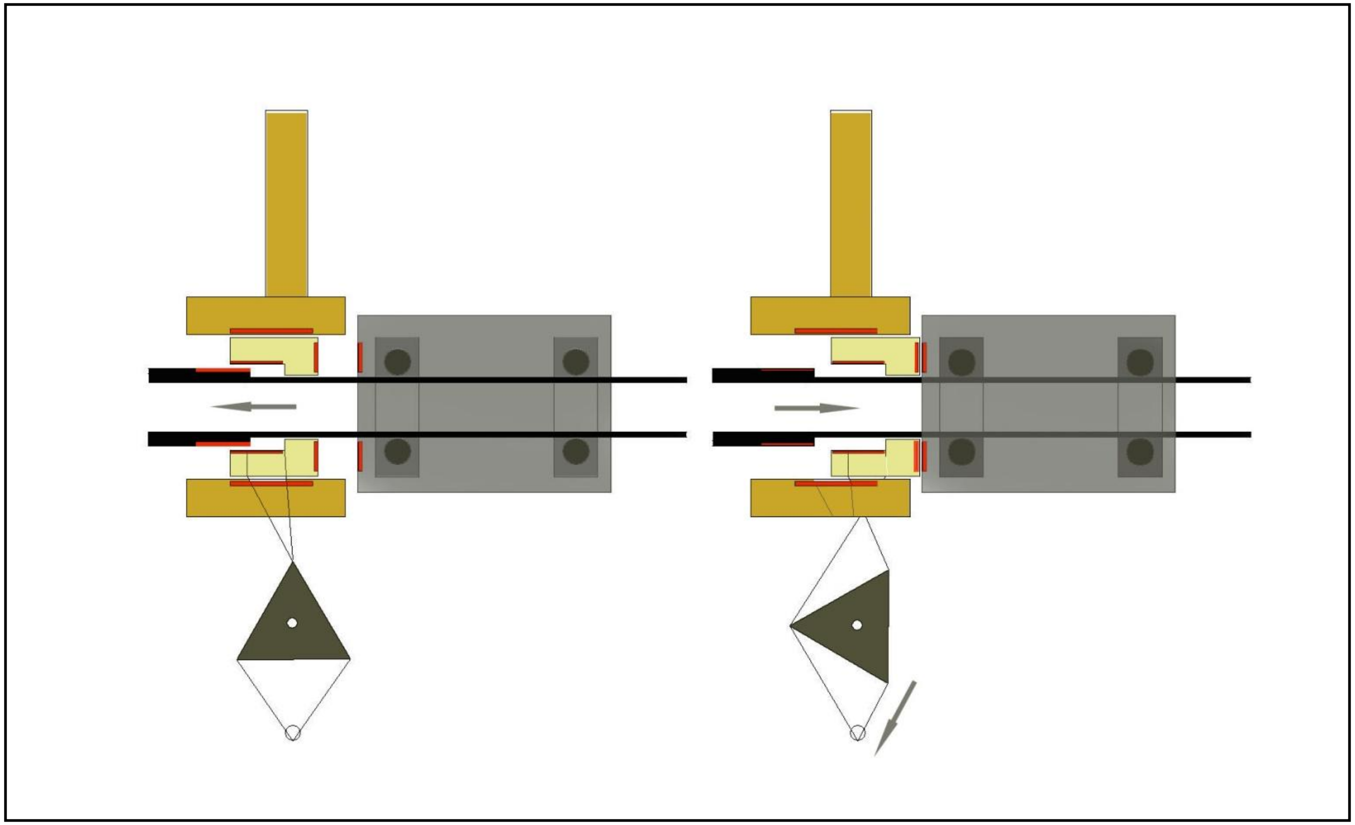
Welded point
Tubular section edge-welded to both members
20mm dia. M.S. tubular section
22mm dia. M.S. tubular section

interface





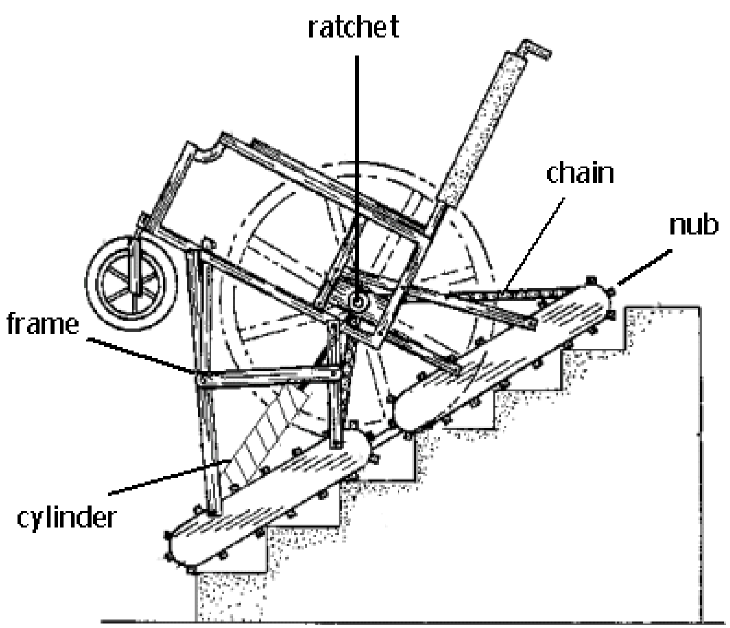
detail



costing

part	component	Length/volume/area	no. of pieces	rate	Total cost
BACKREST	FRAME(22mmdia)	2.7meters		Rs 66/ mt	170
	FABRIC	1meters		Rs 711per mt	710
	GRIP(RUBBER				50
SEAT	FRAME(22mmdia)	1.4meters		Rs 66/ mt	90
	FABRIC			Rs 711per mt	Used from previous
WHEELS	WHEELFRAM		2		
	E(POLYPROP ELENE)				
	TYRES(PNEUMAT IC RUBBER)				600
ARMREST	P.U.		2		200
	TUBULAR SEC.(20dia)	.6meters		Rs 60/ mt	35
	RUBBER GRIP		2		40
FOOTREST	TUBULAR SEC.(20dia)	1.7meters	2	Rs 60/ mt	100
	ALLUMIN. DIE CAST	1.8 kg	2	Rs180/kg	320
	RUBBER GRIP		2		100
ALUMIN. JOINT	BELT		2		1400
	NYLON WHEELS		10	Rs180/kg	100
	ALL. FRAME	10 kg	2	Rs180/kg	3600
	GEAR		2		100
ACTUATOR					1000
MISC.					500 = 9100

Stair Climber Design



Internal Force Diagram of Stair Climber

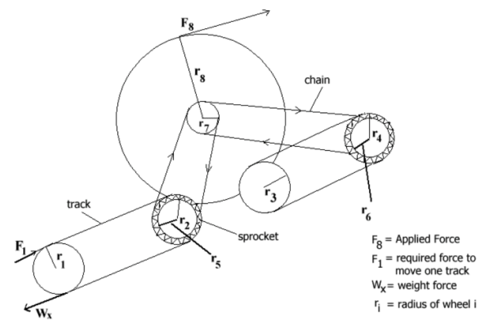


Figure 2

External Forces Applied on Stair Climber

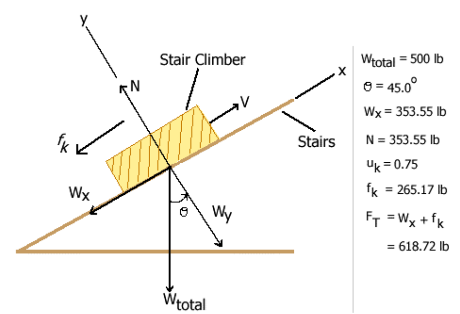


Figure 3