PROJECT TWO DEFENCE PRESENTATION:

DESIGN OF A MANUAL TEA-LEAF PLUCKING AID

ALLEVIATING OCCUPATIONAL HAZARDS ASSOCIATED WITH TEA-PLANTATION WORKERS IN INDIA

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(Name Withheld) Tea Estate, Darjeeling district, West Bengal

TEA PLUCKER INTERVIEWS


Mrs. Nikita Tamang

WORKER PROFILE:

Name : Mrs. Nikita Tamang (Temporary)
Age : 28 yrs Experience : 1 month

DIFFICULTIES FACED:

- Pain in hands
- Joint pain in the knee
- Abrasion of fingers
- Discomfort in scalp
- Lower back pain

ADDITIONAL INSIGHTS:

Chose this job because :

- Proximity from home
- Allows her to watch her kids
- Company benefits when permanent


Mrs. Indu Rai

WORKER PROFILE:

Name : Indu Rai (Permanent worker)
Age : 33yrs Experience : 4 yrs

DIFFICULTIES FACED:

- Pain on hands
- Pain in the knees, thighs
- Abrasion of fingers
- Burning of Scalp
- Lower & upper back pain

ADDITIONAL INSIGHTS:

- Black deposition on fingers that cannot be washed off.
- Alternate uses of doko include : collecting fire-wood for cooking, grass for goats etc, enclosure for chickens


Mrs. Shashikali Rai

WORKER PROFILE:

Name : Shashikali Rai (Permanent worker)
Age : 45yrs Experience : 13 yrs

DIFFICULTIES FACED:

- Pain & stiffness on hands
- Pain & stiffness in the knees, thighs
- Abrasion of fingers
- Burning of Scalp
- Lower & upper back pain
- Regular Headaches & burning of eyes

ADDITIONAL INSIGHTS:

- difficulties multiplied after the age of 40
- limited load-bearing capacity & mobility
- Stiffness in joints of the limb


Discomfort in scalp


Back pain


Knee joint pain & stiffness


Hand inflammation & abrasion of fingers


Stooped forward posture

Inferences from Field Study

Musculoskeletal Issues

- Hand fatigue , inflammation and stiffness –sustained contraction of muscles.
- Abrasion of fingers repetitive plucking motion.
- Upper and lower back pain -poor working posture.
- Leg Joint pain ,stiffness - long hours of standing & difficult terrain.

Injuries & Ailments

- Injuries from falling.
- Sickle injuries during pruning of tea bushes.
- Costochondritis
- Leeches, insect & snake bites.

Mechanised Tea Harvesting

- Strong opposition by labour union to replacement of workers by machines.
- Existing machines are not manoeuvrable in hilly terrain.
- Existing machines come with their own set of issues-leaf quality etc.

Labourer Housing

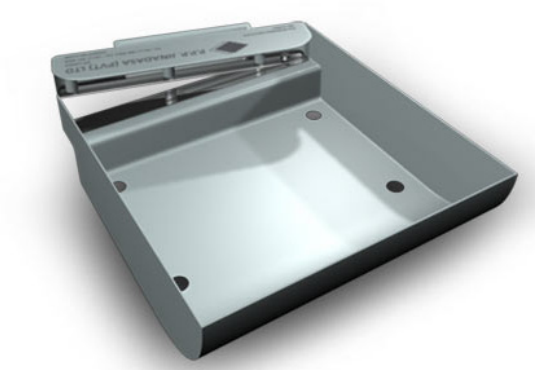
- Discomfort due to cramped spaces.
- Poor utilisation & planning of living spaces.

MARKET STUDY -PARALLEL PRODUCTS

A) Kawasaki (gasoline operated): One man plucking machines
-imgusr.tradekey.com

B) Willames Tea UL750 Selective Tea Harvestor
-www.cmeri.res.in

D) P.P.P. Jinadasa (Pvt) Ltd. ,Sri Lanka
Selective Tea Harvestor
-www.tmachinery.com



C) Falcon Garden Tools, Punjab , India:
Tea Leaf Plucking Shears
-www.teaspares.com

INFERENCES FROM MARKET STUDY

Musculo-Skeletal Issues:

- Static Loading on hands results in fatigue.
- Incorrect load bearing posture such as side bending is not recommended.
- Unbalanced distribution of load on hands and body.

Quality of Plucked Leaves

There is substantial degradation in the standard of leaves harvested (in comparison to hand-plucking) using the machines to accommodate higher production rates.

Problems with Usage:

- Catcher tray/bag gets stuck in the tree bushes.
- Machines & their accessories are heavy , bulky and difficult to carry.
- Machines are difficult manoeuvre in hilly terrain.
- require carefully planned paths.

High Initial Investments

- Apart from the shear-type harvesters ,all other types cost upwards of Rs. 1 lakh.
- Large retail gap between categories.
- Regular maintenance of machines have an incurred cost.

Loss of Jobs

- Hundreds and thousands of house holds are dependant on manual tea plucking for their livelihoods.
- The increased use of tea-harvesting machines are replacing the jobs of upto 20 workers at a time.

DESIGN OBJECTIVE

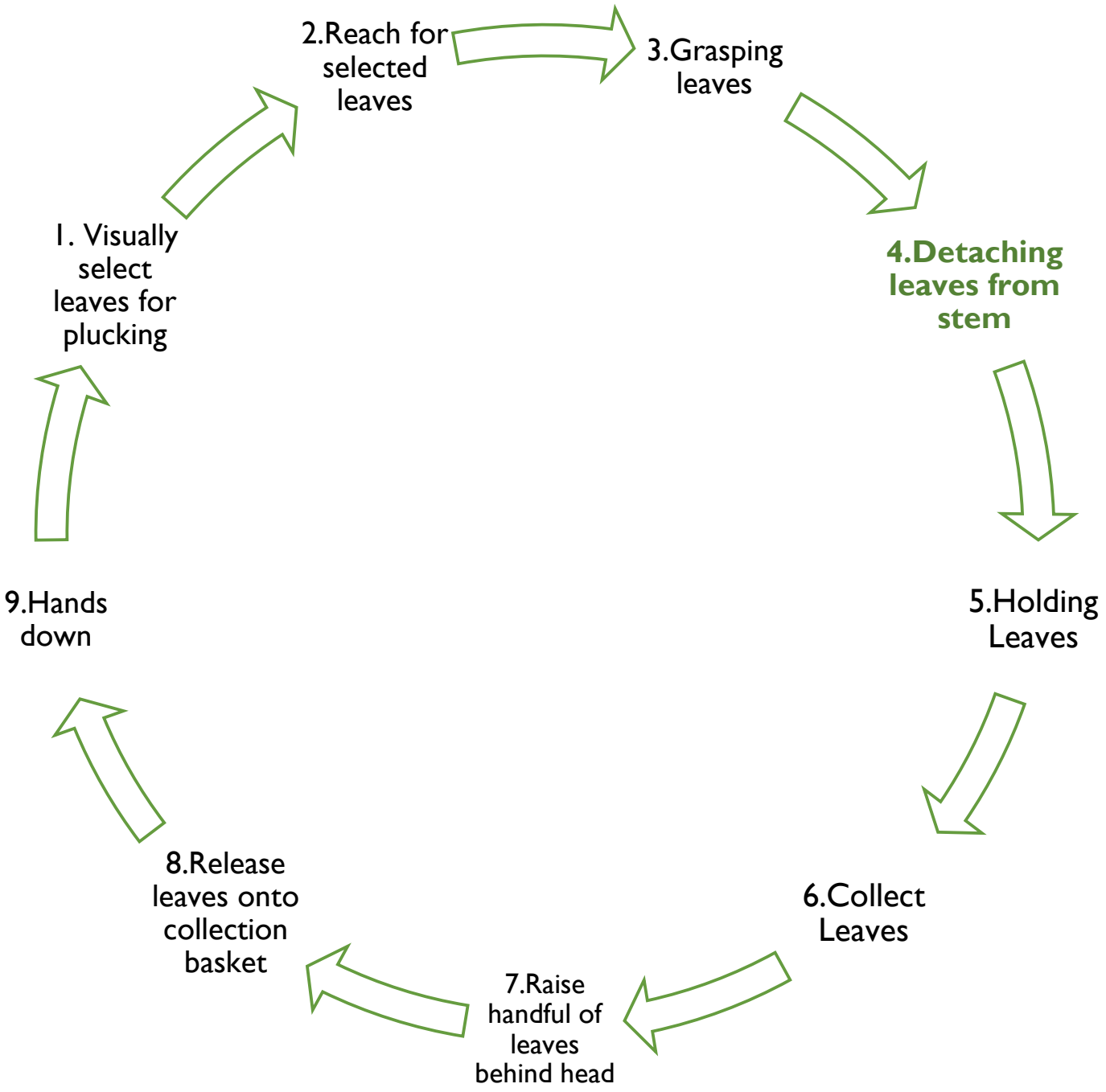
To design a device that is supportive to manual tea plucking. The device must minimise human injury and maintain high leaf standard.

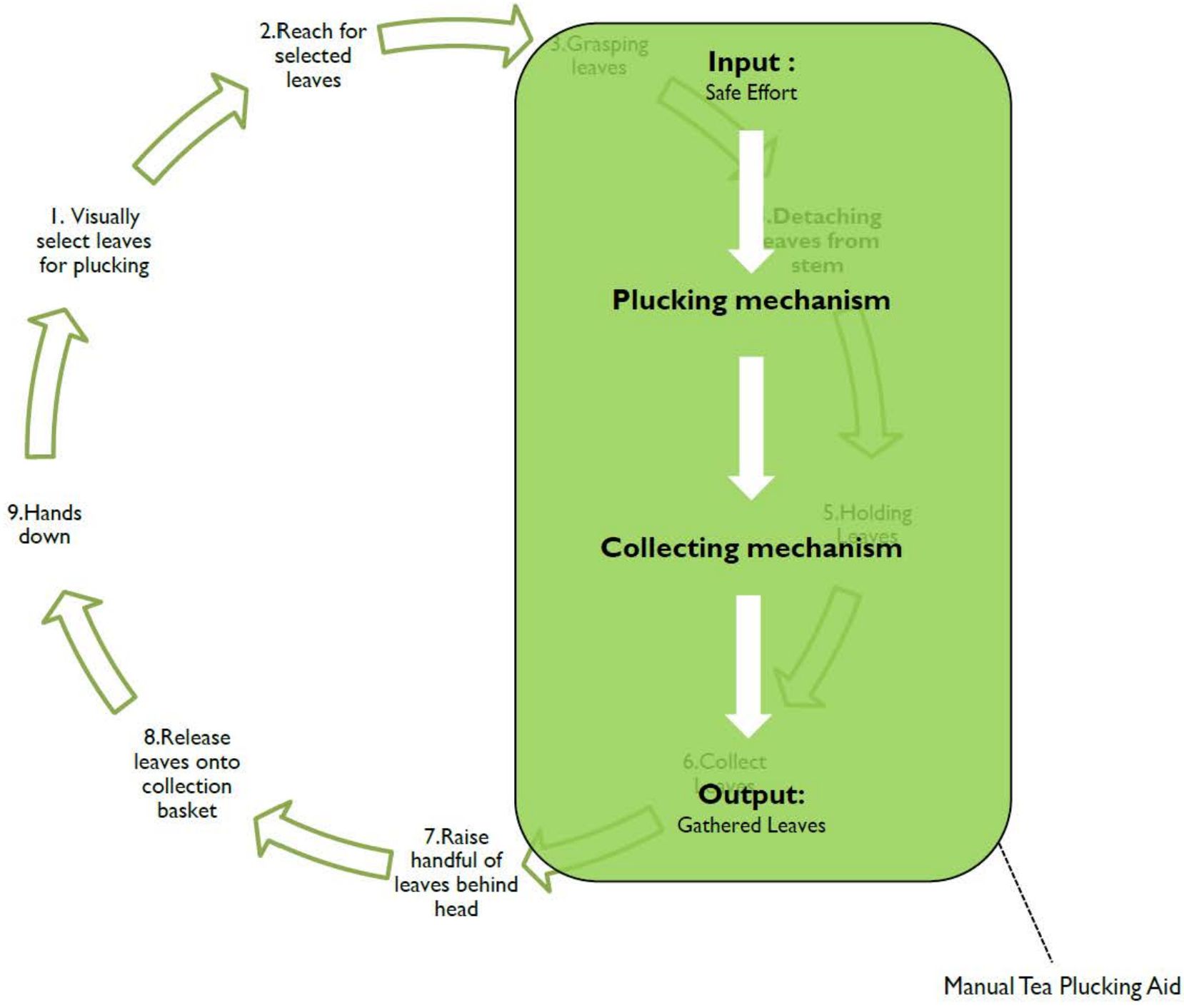
DESIGN BRIEF

The device shall adhere to the following check-points :

1. The device should alleviate musculoskeletal issues associated with manual tea plucking such as muscle & joint pain , inflammation & stiffness.
2. The aid must protect the tea-pluckers hands & fingers from injuries, abrasion , insect bites & deposition of harmful chemicals.
3. Use of the device to pluck tea should not diminish the quality of leaves plucked.
4. The device must be easy to manoeuvre & carry in difficult hilly terrain.
5. The device must be economical to produce.

GATHERING ERGONOMICS INSIGHTS




2.Reach for selected leaves
3.Grasping leaves
Input :
Safe Effort
1. Visually select leaves for plucking
4.Detaching leaves from stem
Plucking mechanism
9.Hands down
5.Holding Leaves
Collecting mechanism
8.Release leaves onto collection basket
6.Collect
Output:
Gathered Leaves
7.Raise handful of leaves behind head
Manual Tea Plucking Aid

ERGONOMIC ISSUES

1.Plucking of Leaves:

a) Repetitive Strain Injury
b) Fatigue
c) Inflammation

2.Collecting Leaves in hand:

- Sustained contraction of muscles

3.Environment:

a) Absorption of Alkaloids & pesticides
b) Insect & snake bites

DESIGN INSIGHTS :

1.Plucking Component

- Effort distributed over more muscles is advisable.
- Dynamic 2 handed plucking motion is recommended.
- Eliminating unnecessary motions will reduce the effort ,time required.

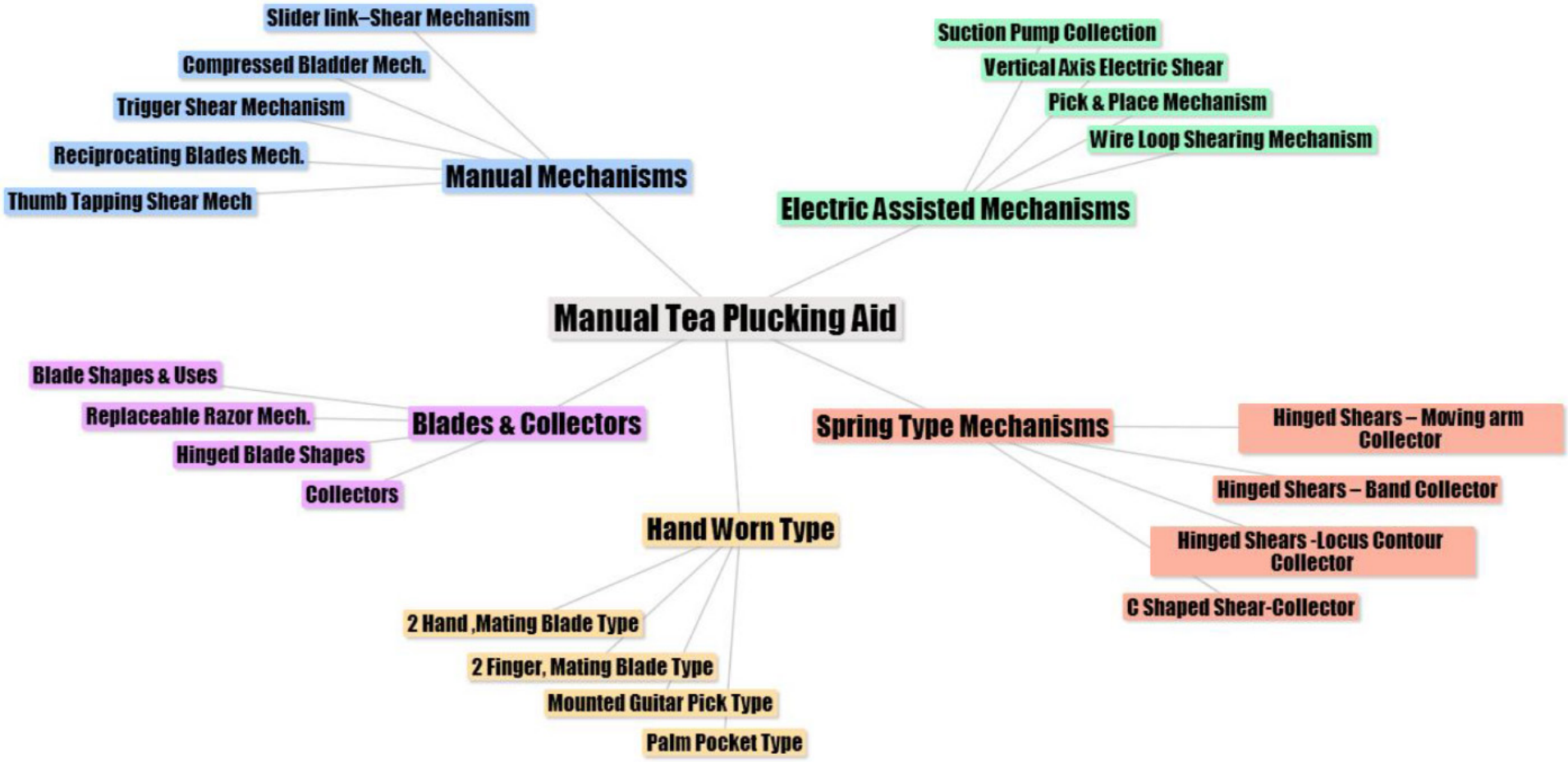
2.Collecting Component

- Should not get caught in the tea bushes
- Should not obstruct device from plucking
- Avoid

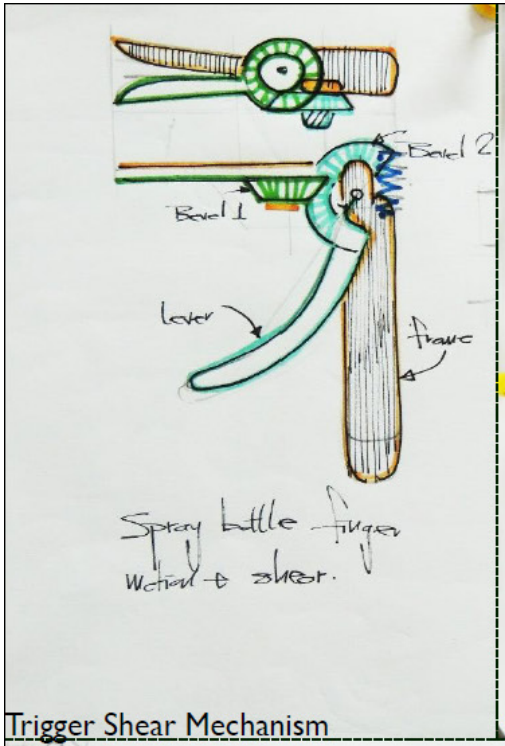
3.Protective Component

- Product weight <1 kg per hand
- Must allow for air circulation.
- Protect fingers to elbow.

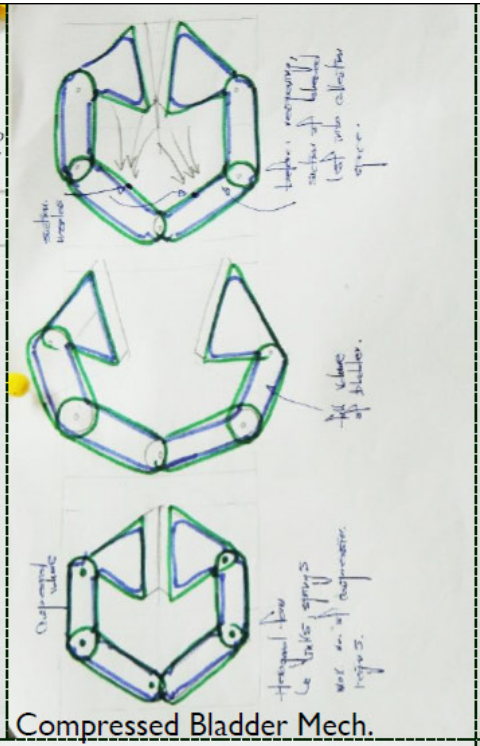
IDEATION & CLUSTERING



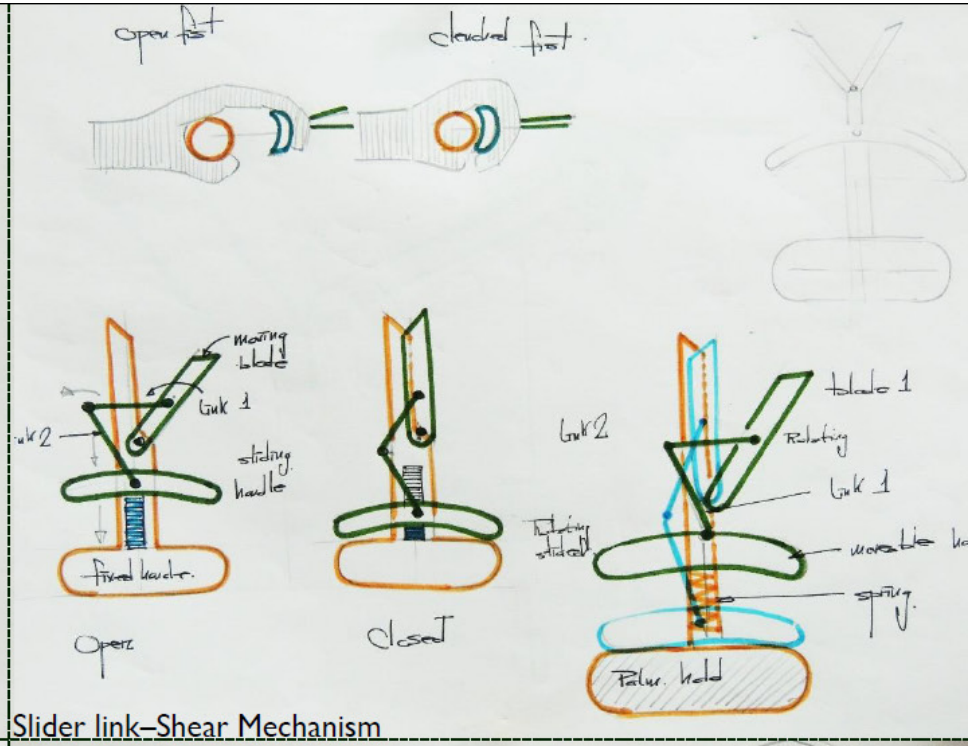
IDEATION :MANUAL MECH.



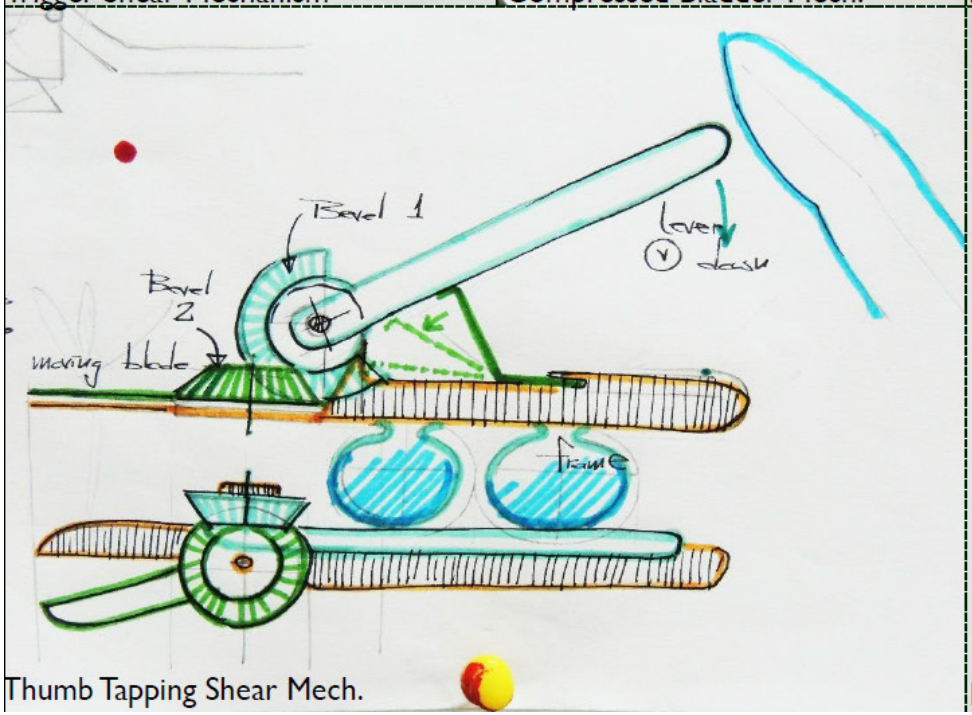
Trigger Shear Mechanism



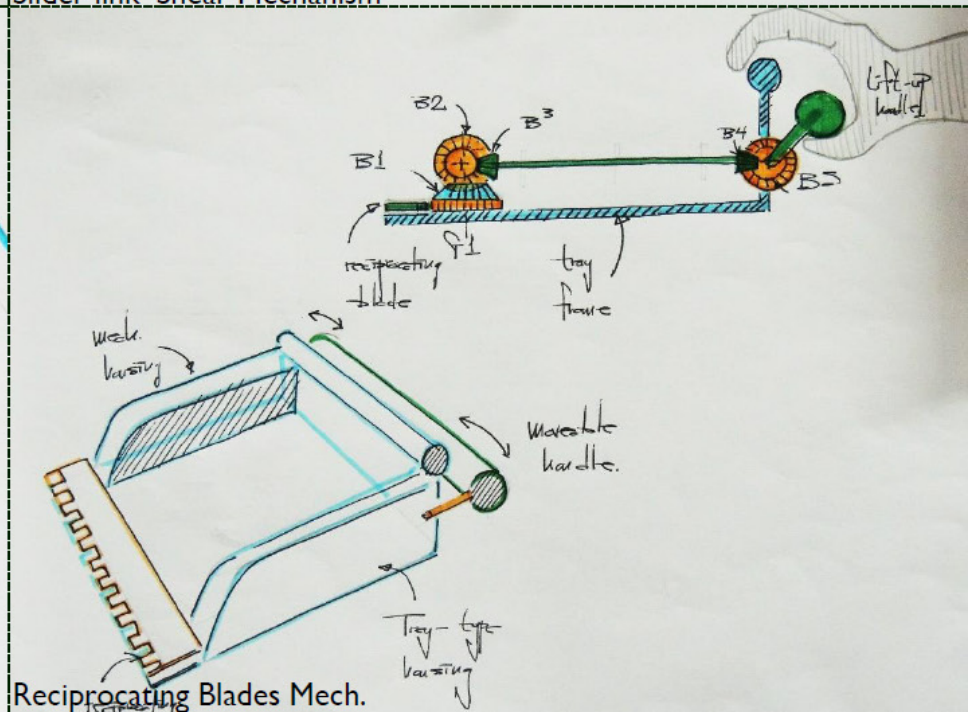
Compressed Bladder Mech.



Slider link–Shear Mechanism

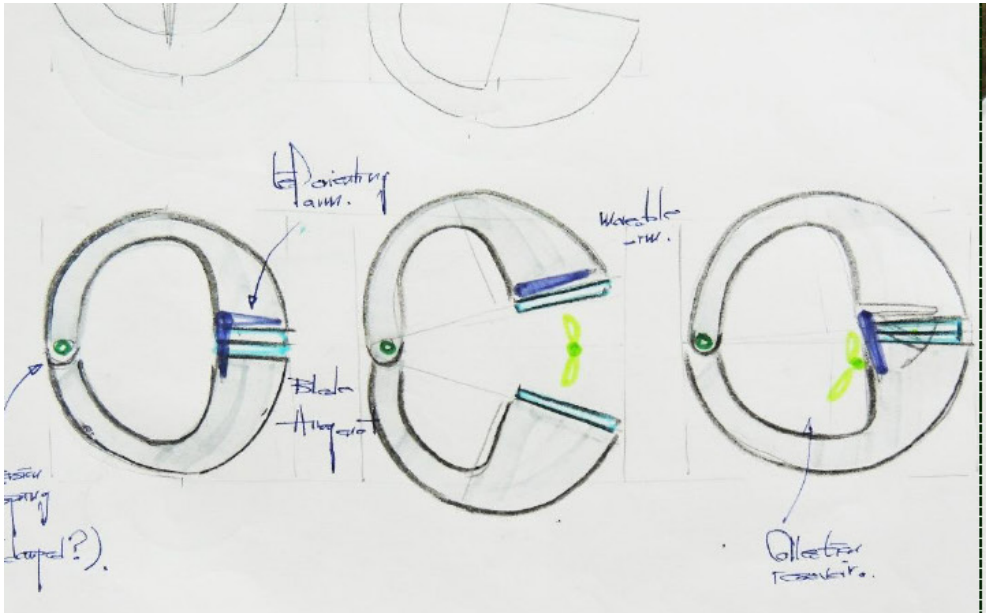


Thumb Tapping Shear Mech.

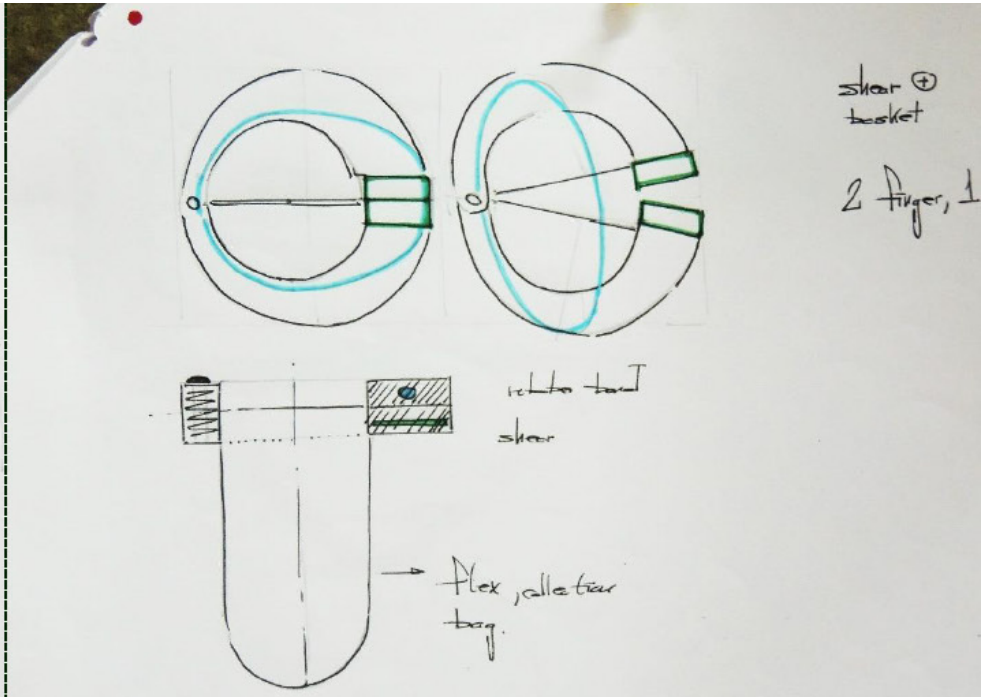


Reciprocating Blades Mech.

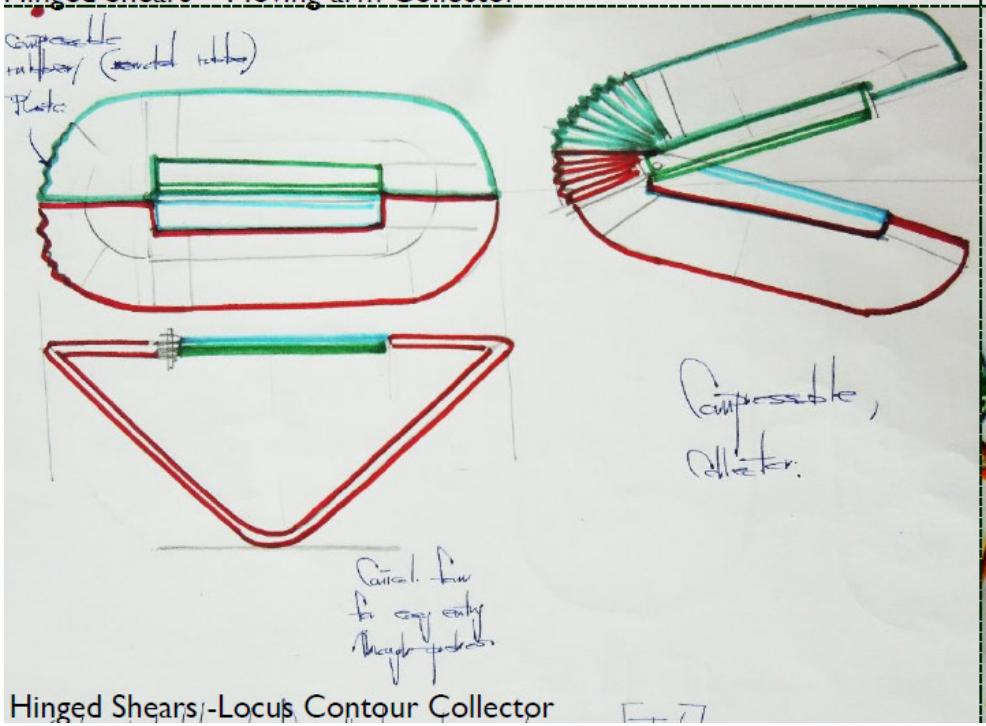
IDEATION :SPRING TYPE



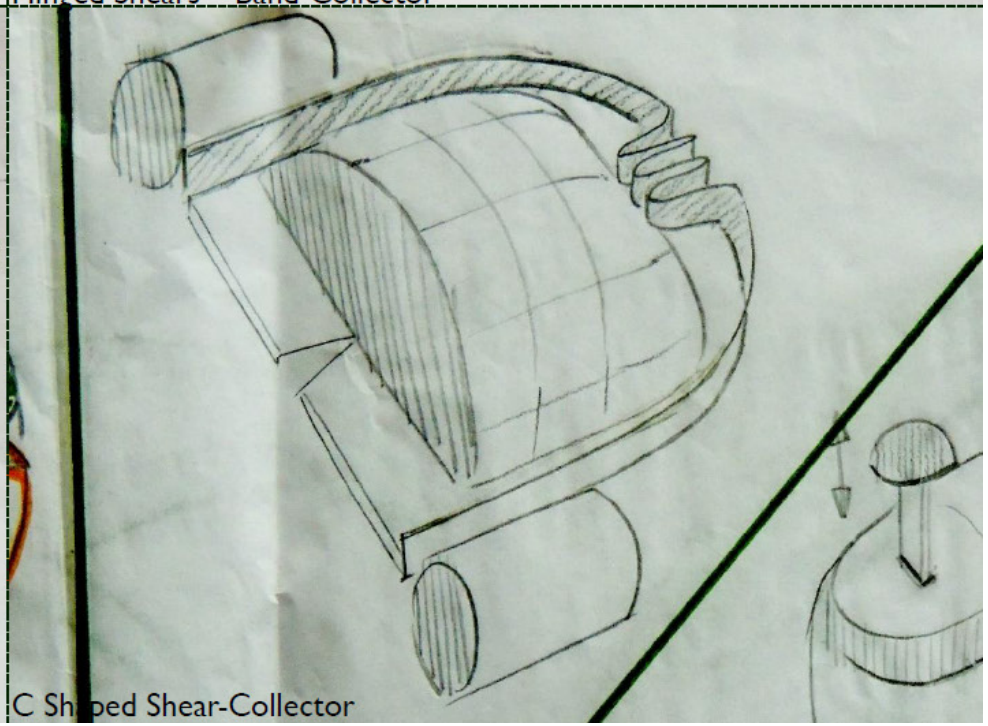
Hinged Shears – Moving arm Collector



Hinged Shears – Band Collector

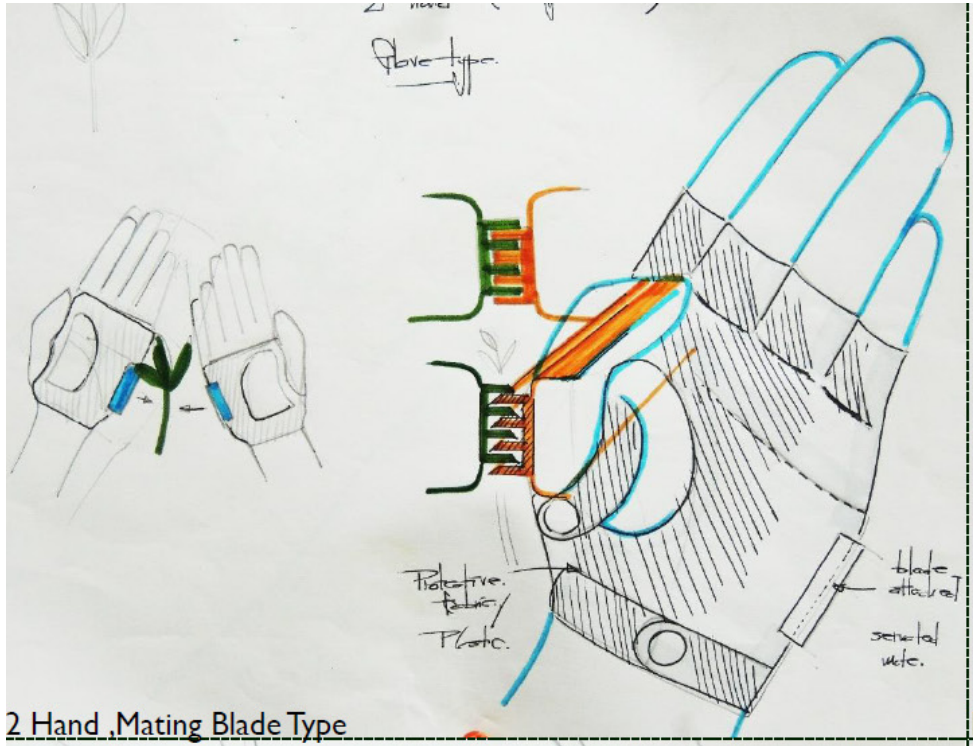


Hinged Shears -Locus Contour Collector

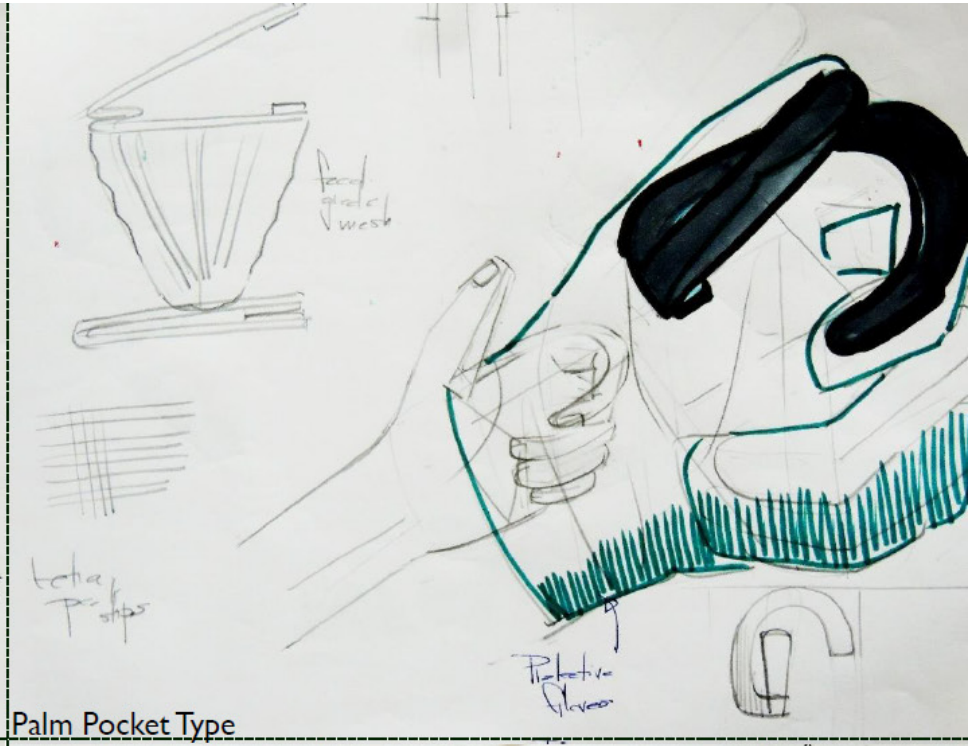


C Shaped Shear-Collector

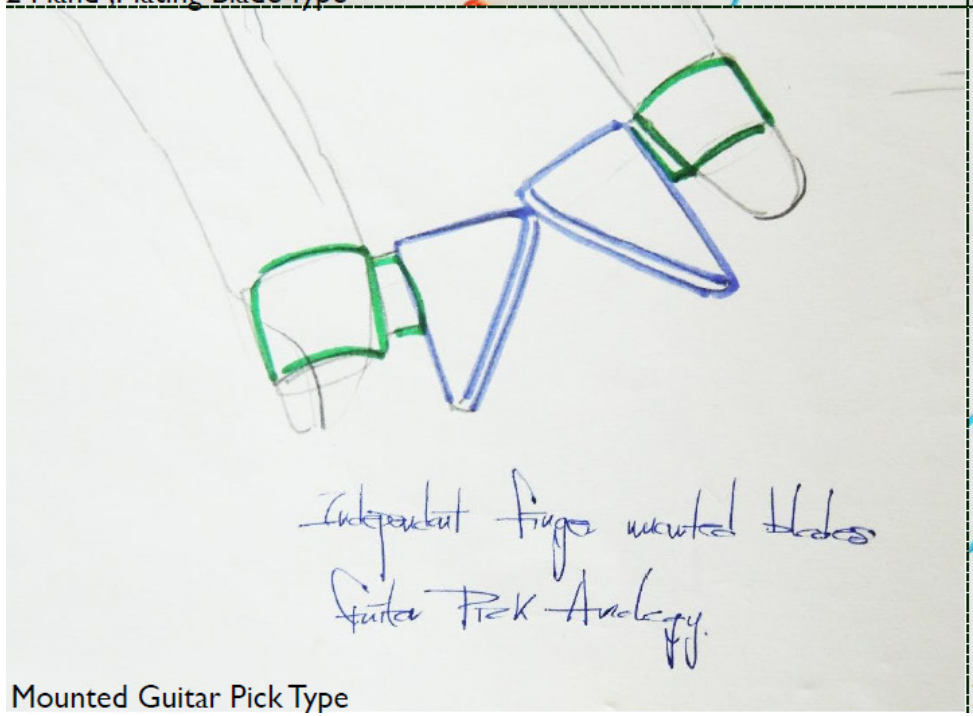
IDEATION :HAND WORN TYPE



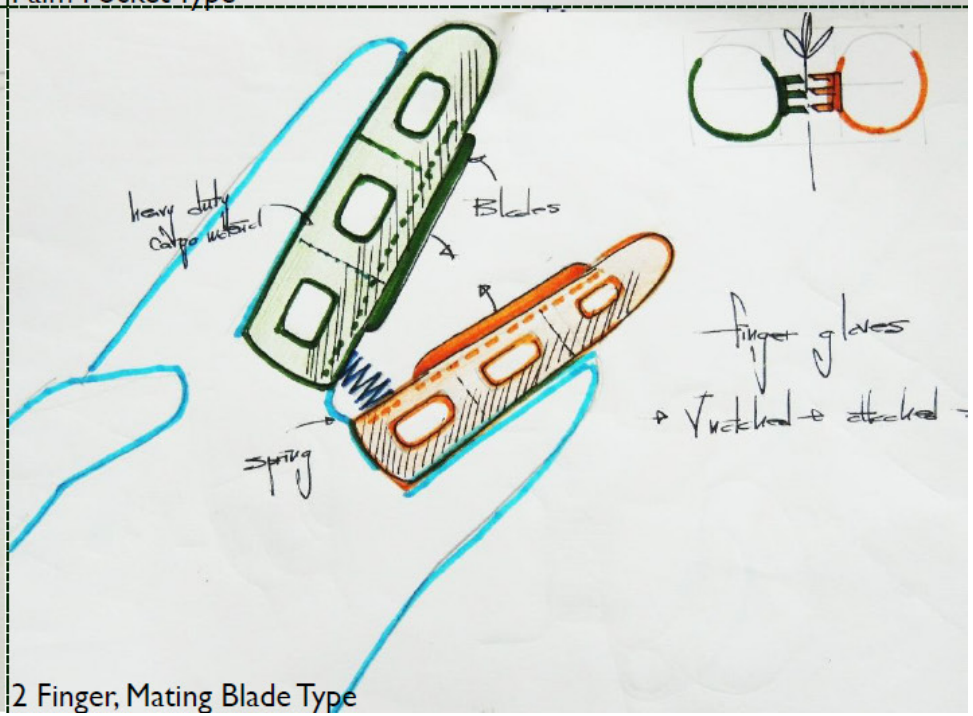
2 Hand ,Mating Blade Type



Palm Pocket Type

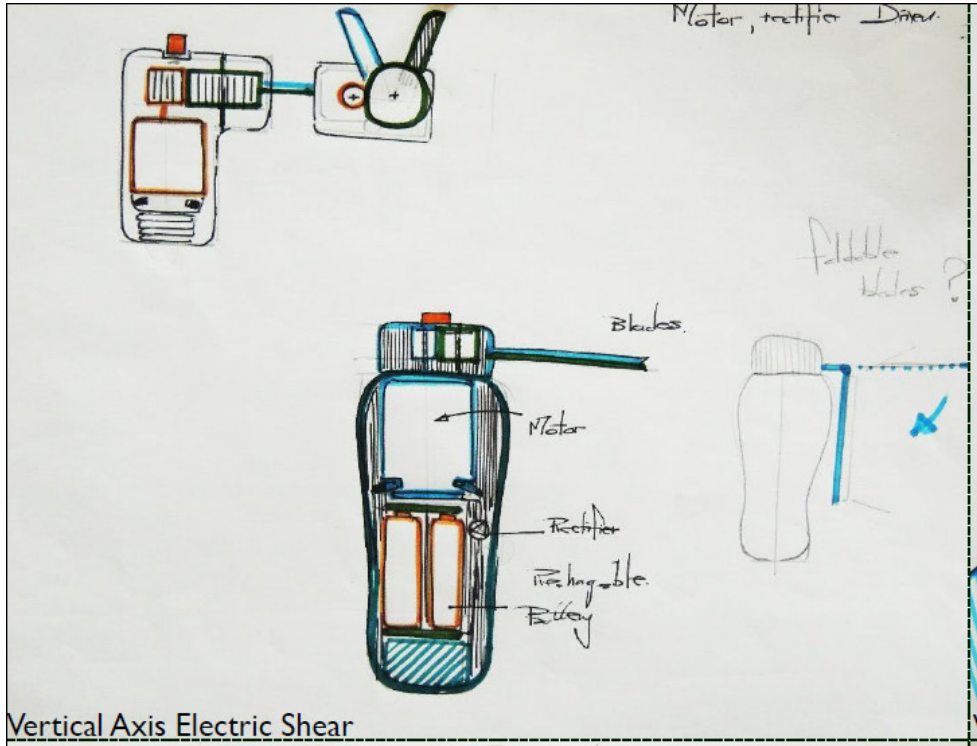


Mounted Guitar Pick Type

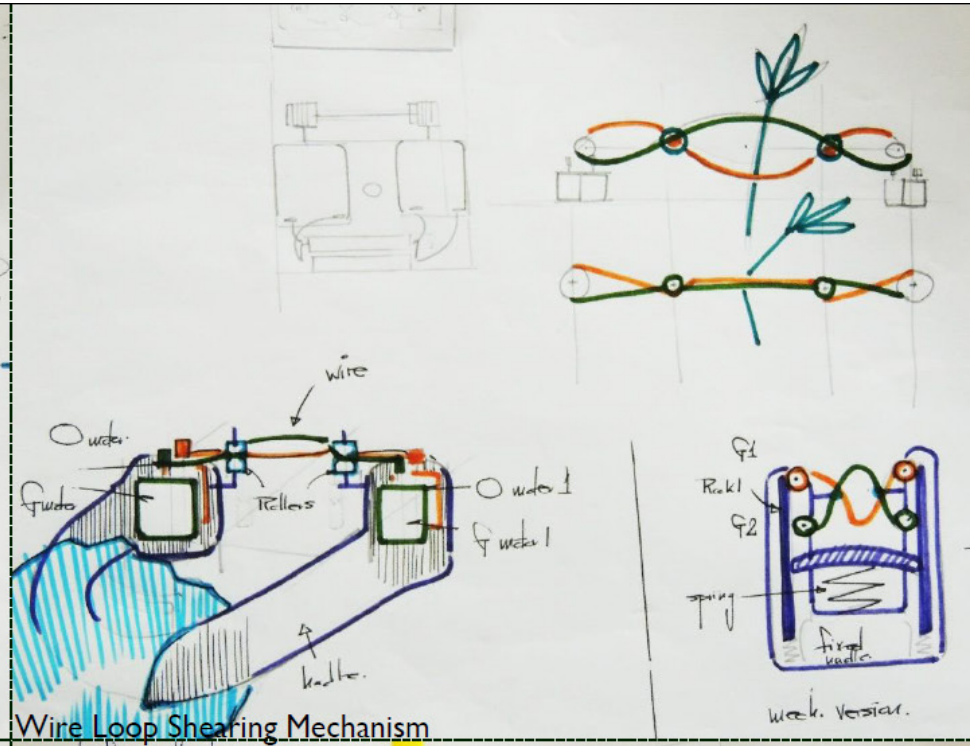


2 Finger, Mating Blade Type

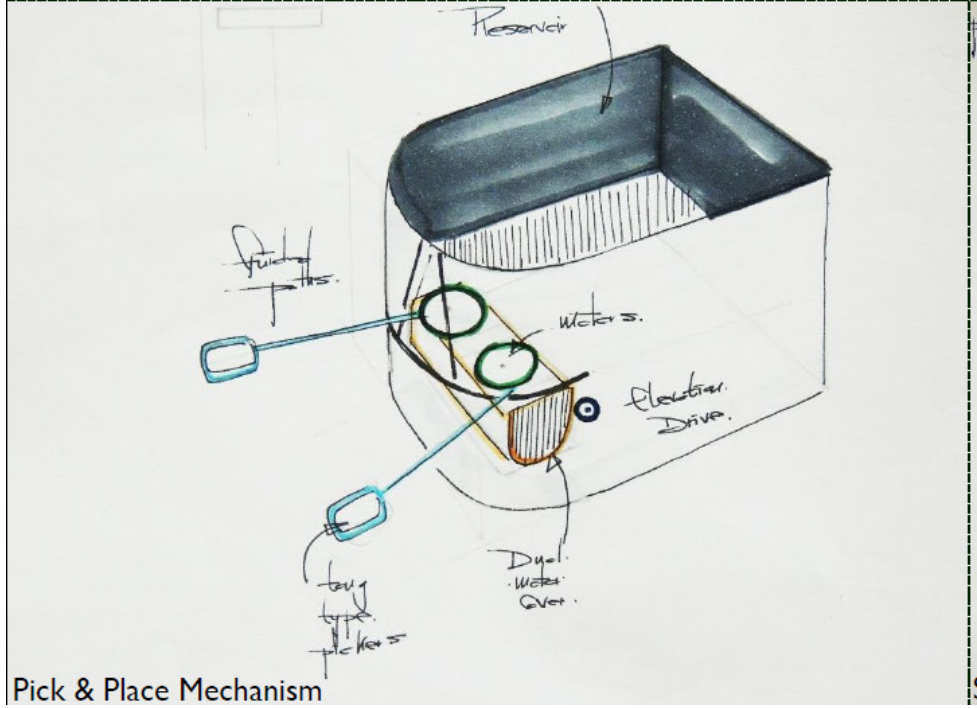
IDEATION :ELECTRIC ASSIST



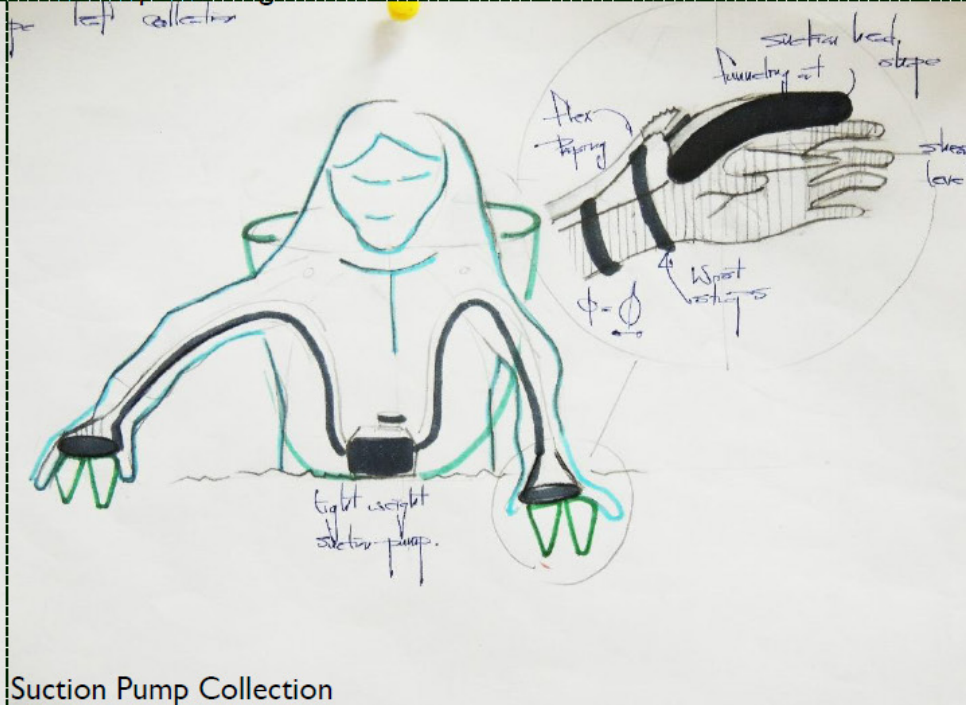
Vertical Axis Electric Shear



Wire Loop Shearing Mechanism

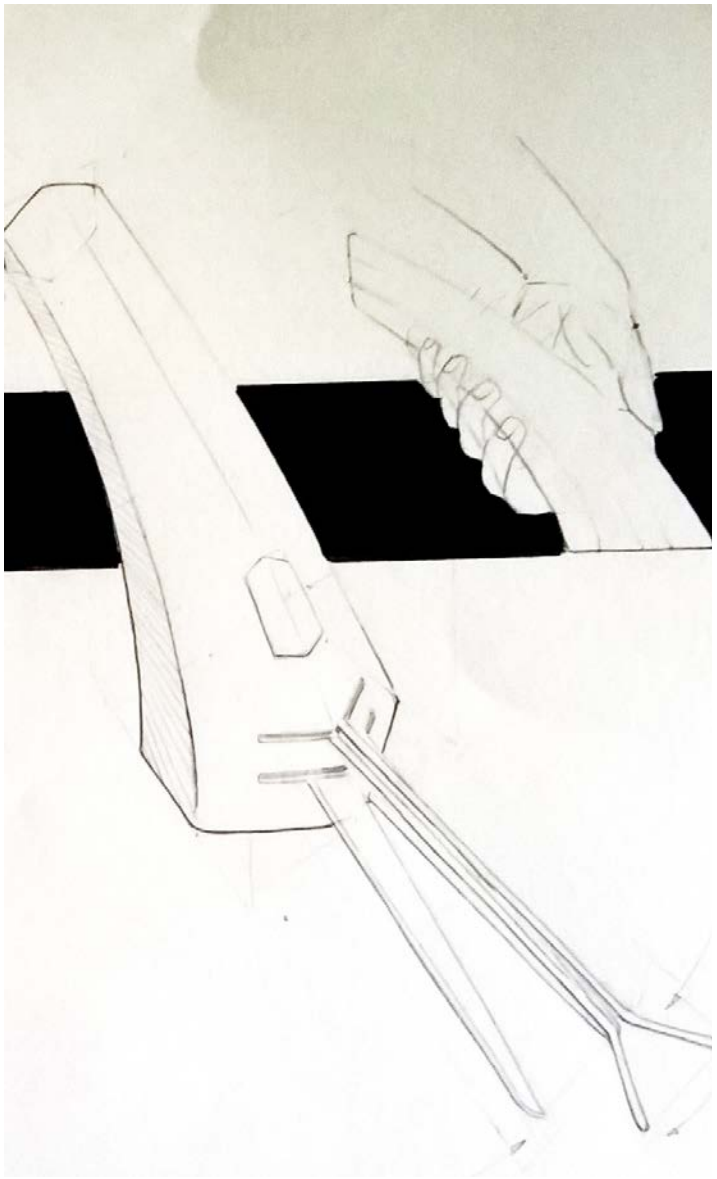


Pick & Place Mechanism



Suction Pump Collection

3 CONCEPT DIRECTIONS

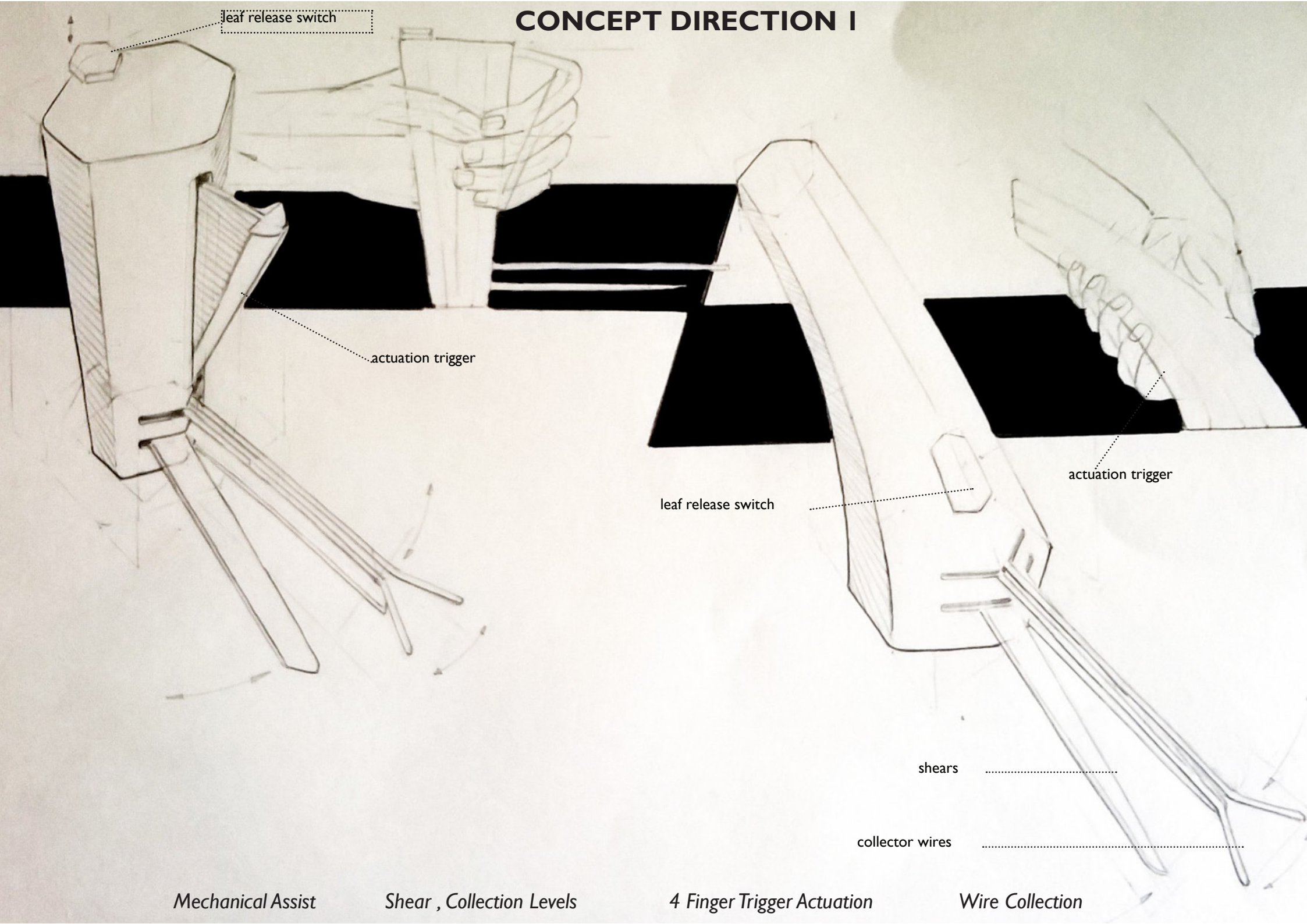


Concept Direction 1: Top Collector Type

Concept Direction 2: C –Shaped Type

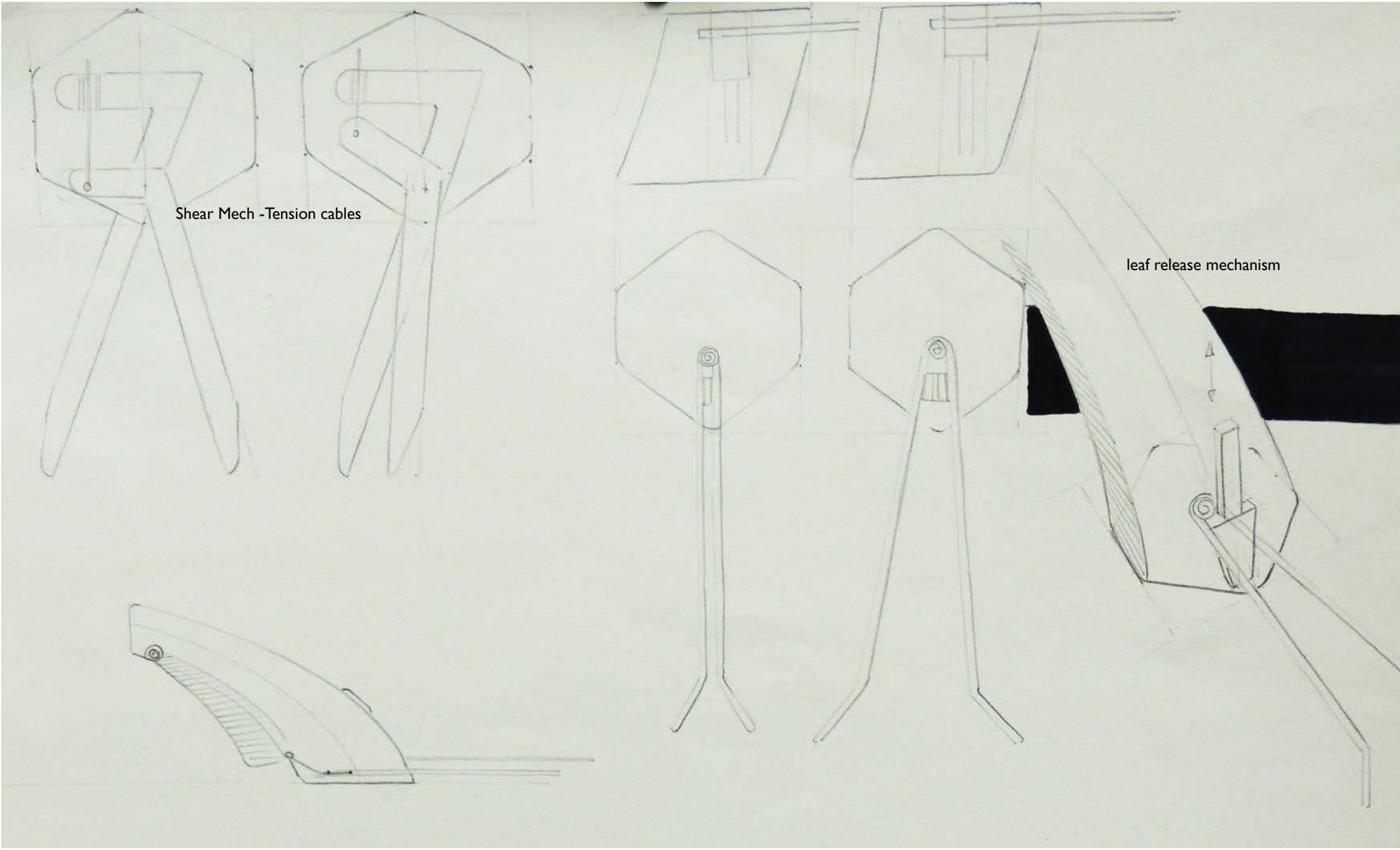
Concept Direction 3: Hand-worn Type

CONCEPT DIRECTION I



Mechanical Assist *Shear , Collection Levels* *4 Finger Trigger Actuation* *Wire Collection*

CONCEPT DIRECTION I -CONTD.



CONCEPT DIRECTION 2

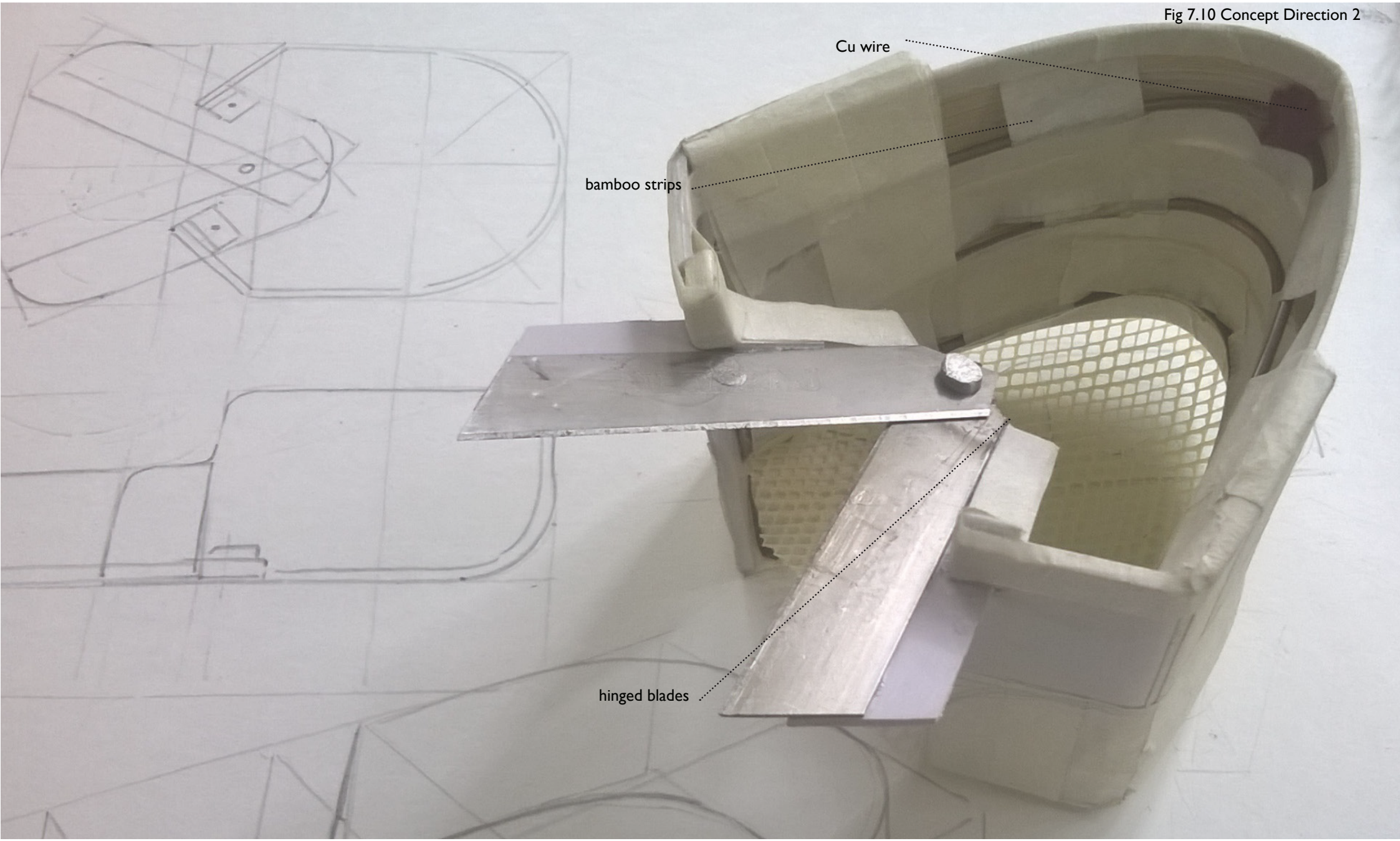
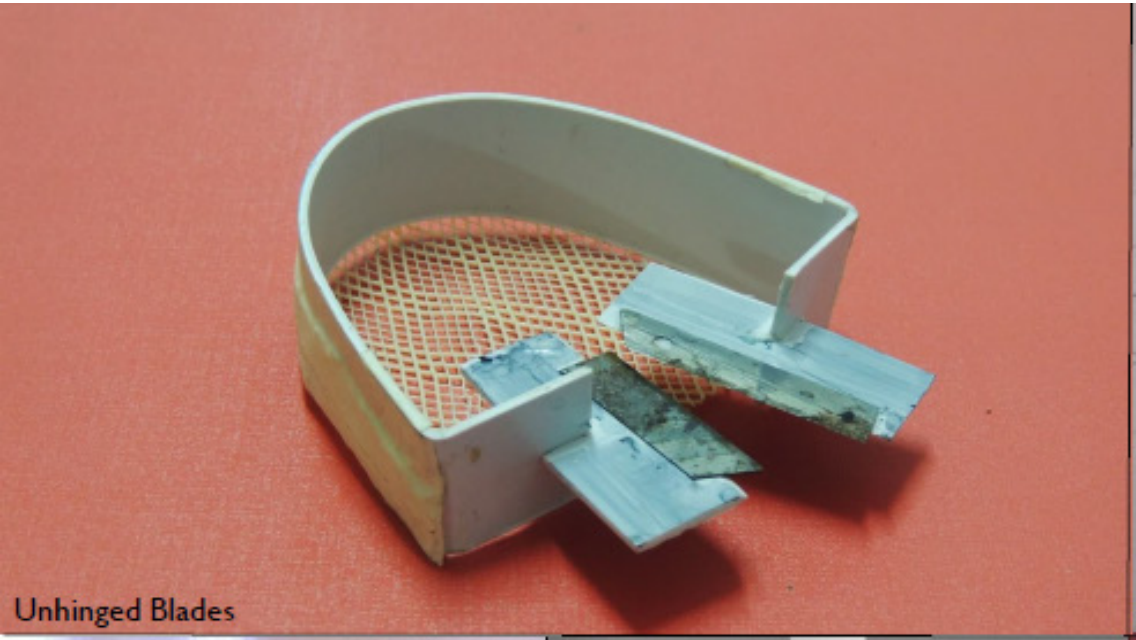
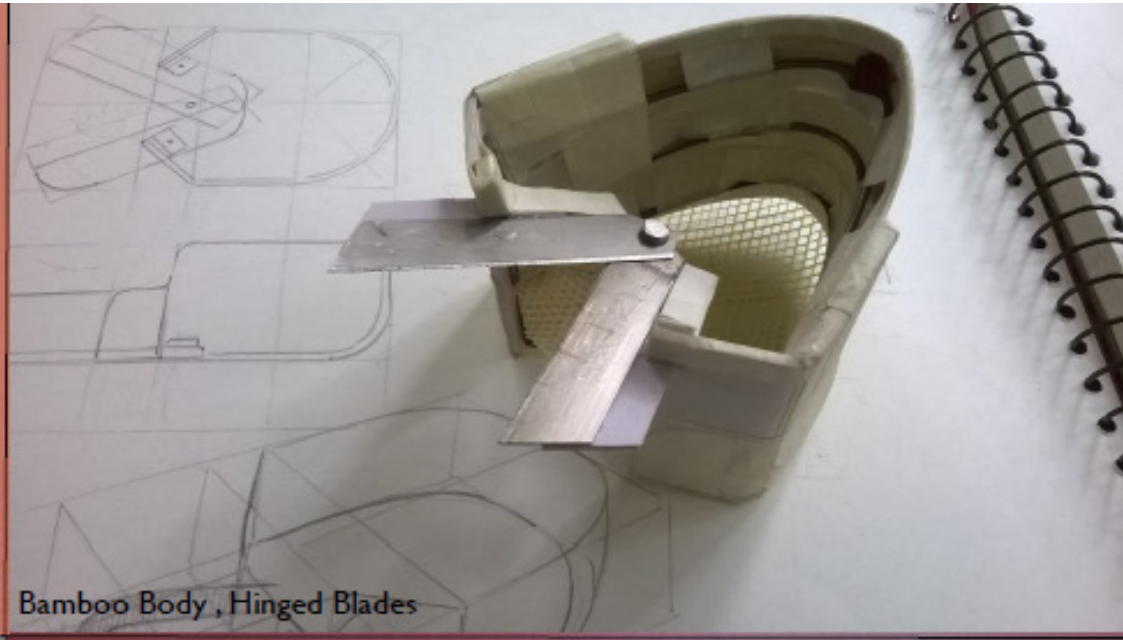


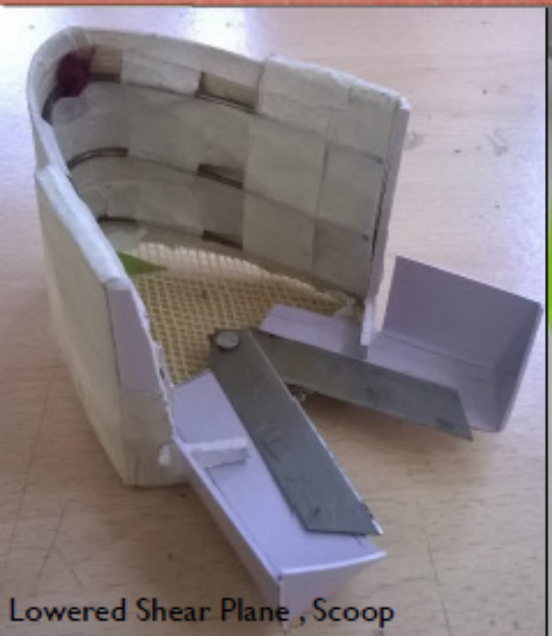
Fig 7.10 Concept Direction 2

Pre-stressed Frame *Hinged blade shearing* *Collection Basket* *Larger Muscle Groups*

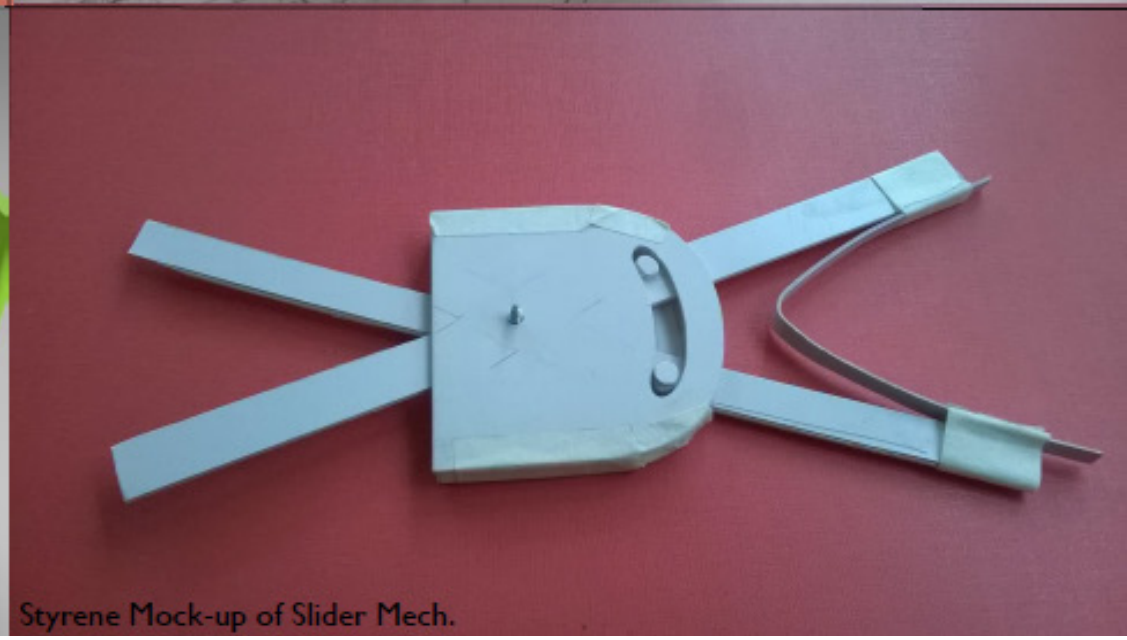
CONCEPT DIRECTION 2 -CONTD.


Unhinged Blades


Bamboo Body , Hinged Blades


Lowered Shear Plane , Scoop


Blade , Collector Slider Mech.


Styrene Mock-up of Slider Mech.

2 *Obtrusive leaves* *Collection Efficiency* *Presicion Required* *Learning Curve*

CONCEPT DIRECTION 2 -REFINEMENT

Handle Stereotype *Torsion Spring Back* *Blade Mount, Scoop* *Visibility*

CONCEPT DIRECTION 2 -TESTING

Test Mock-up

Notch Type Varient

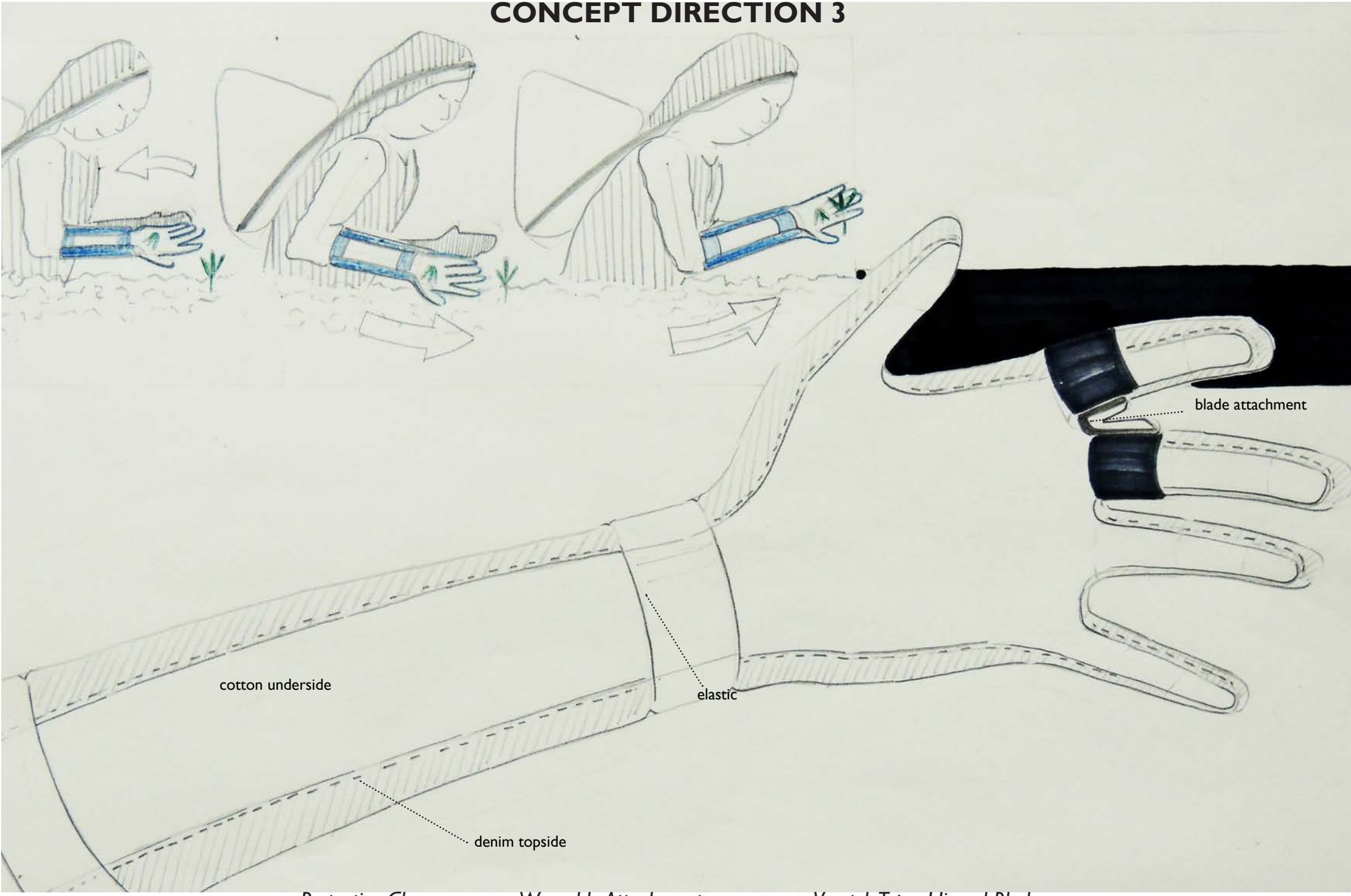
Blade Profile Varients

Shear Junction Alignment

60% Collection Efficiency

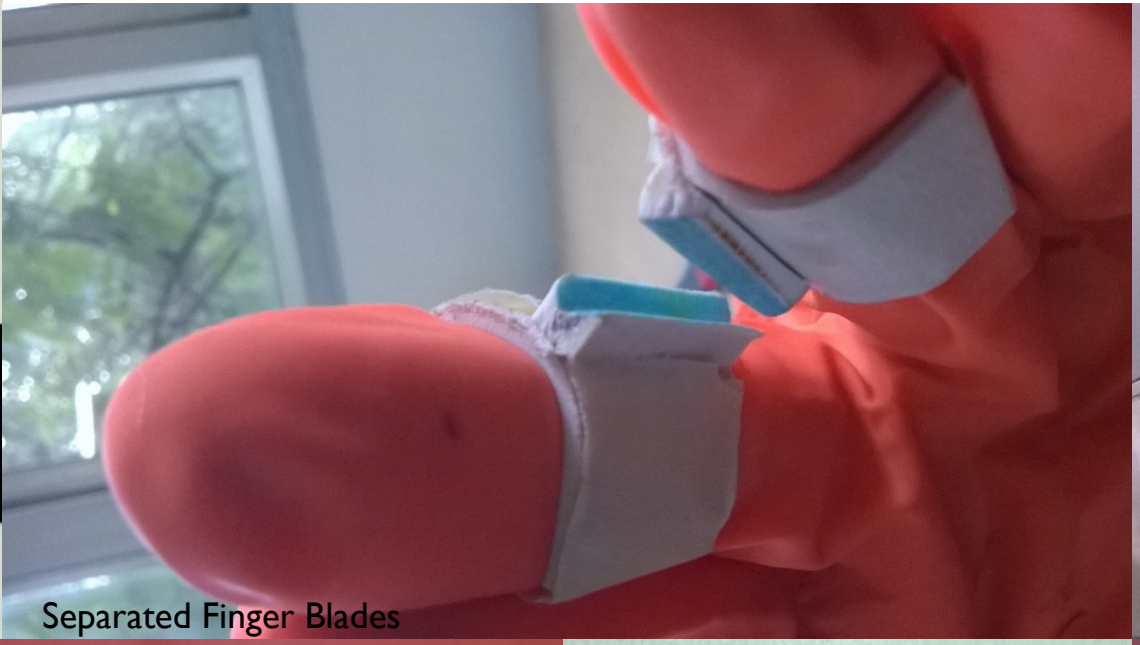
Approach Time

CONCEPT DIRECTION 3



Protective Gloves *Wearable Attachment* *V-notch Type ,Hinged Blade*

CONCEPT DIRECTION 3 -CONTD.



Separated Finger Blades

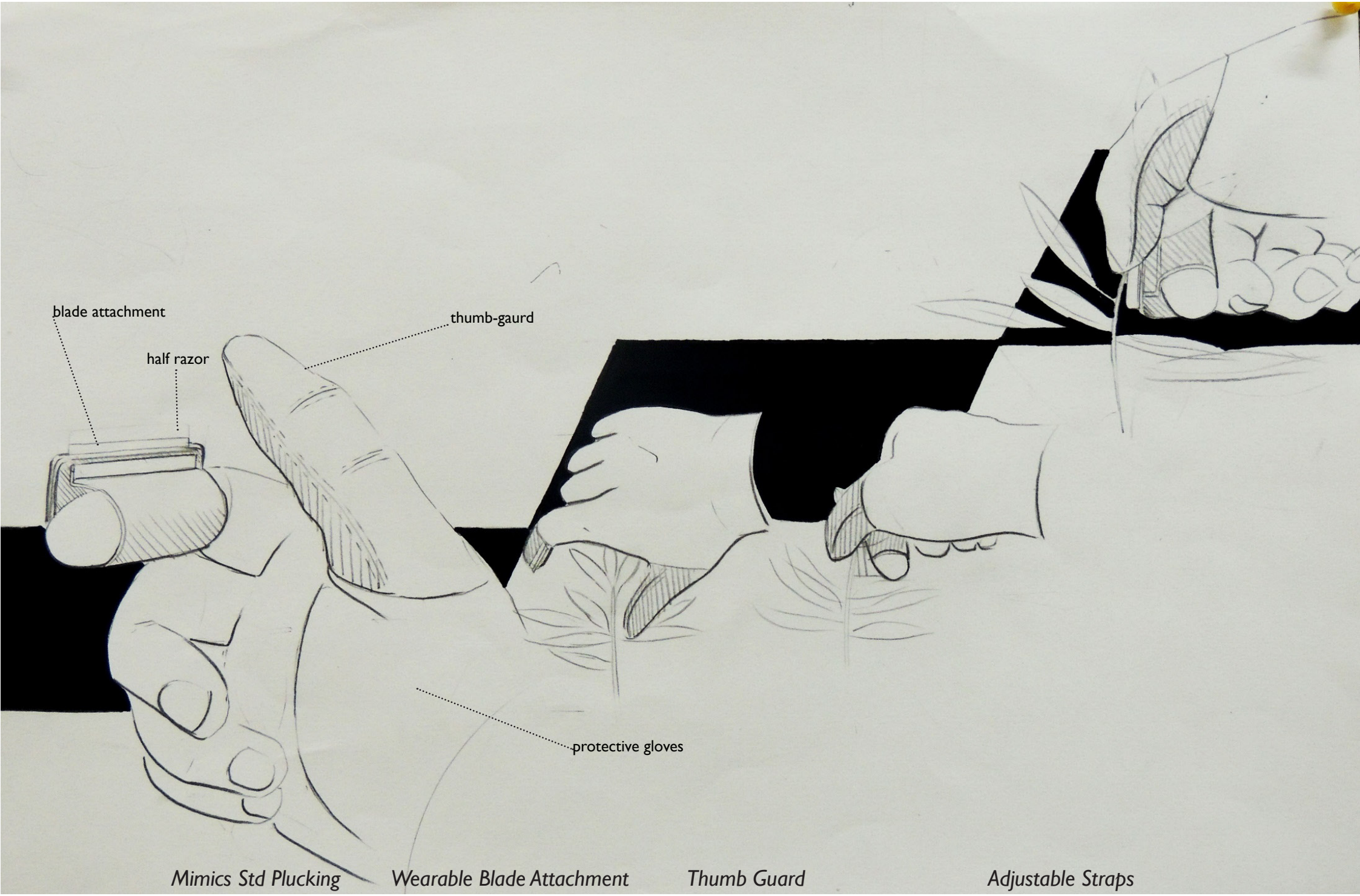
DIY Jeans-Cotton Glove

Curved Blade with teeth

V-Notch Blade finger straps

Hinged V-notch blade

CONCEPT DIRECTION 3 -REFINEMENT

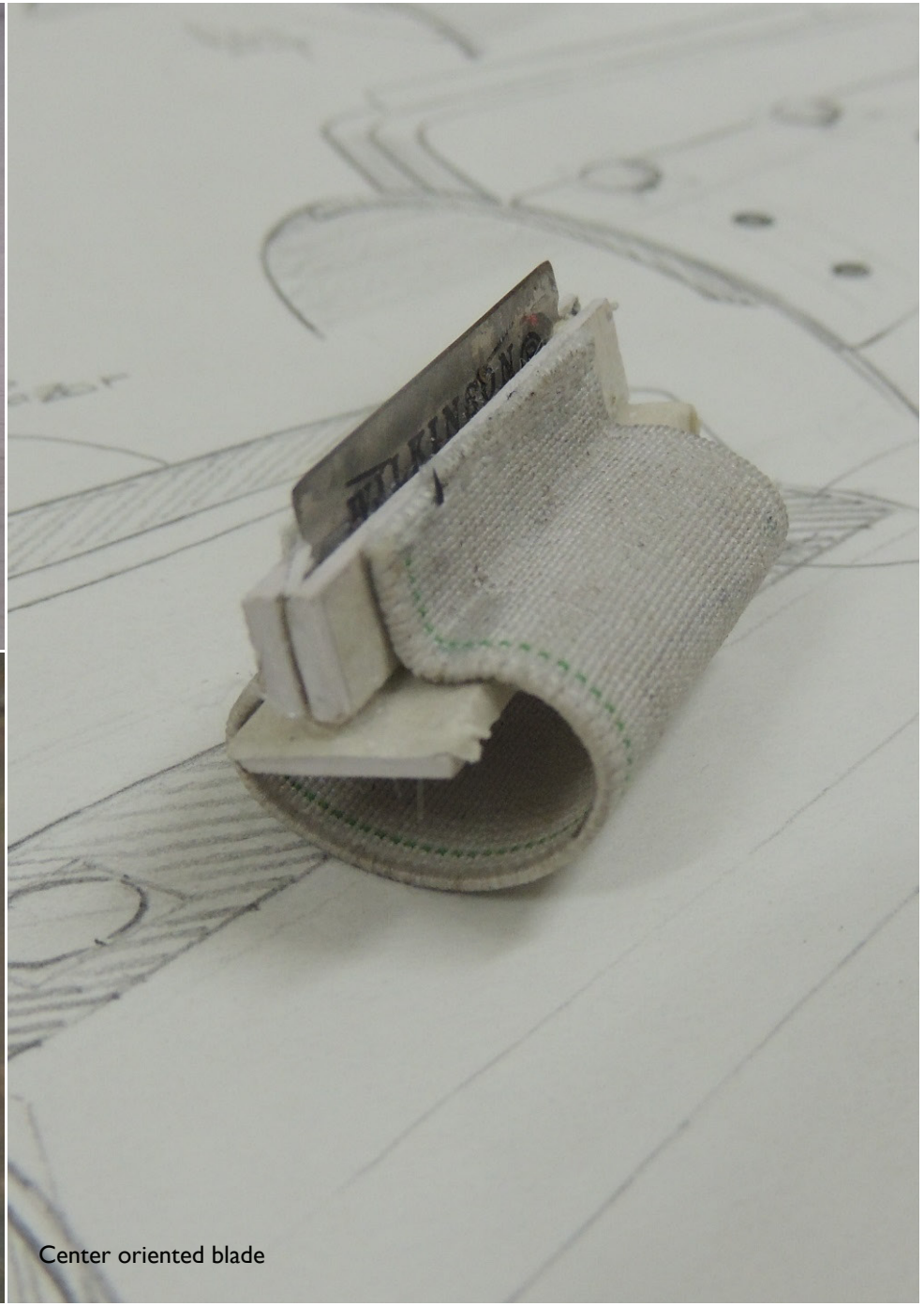


Mimics Std Plucking *Wearable Blade Attachment* *Thumb Guard* *Adjustable Straps*

CONCEPT DIRECTION 3 -TESTING

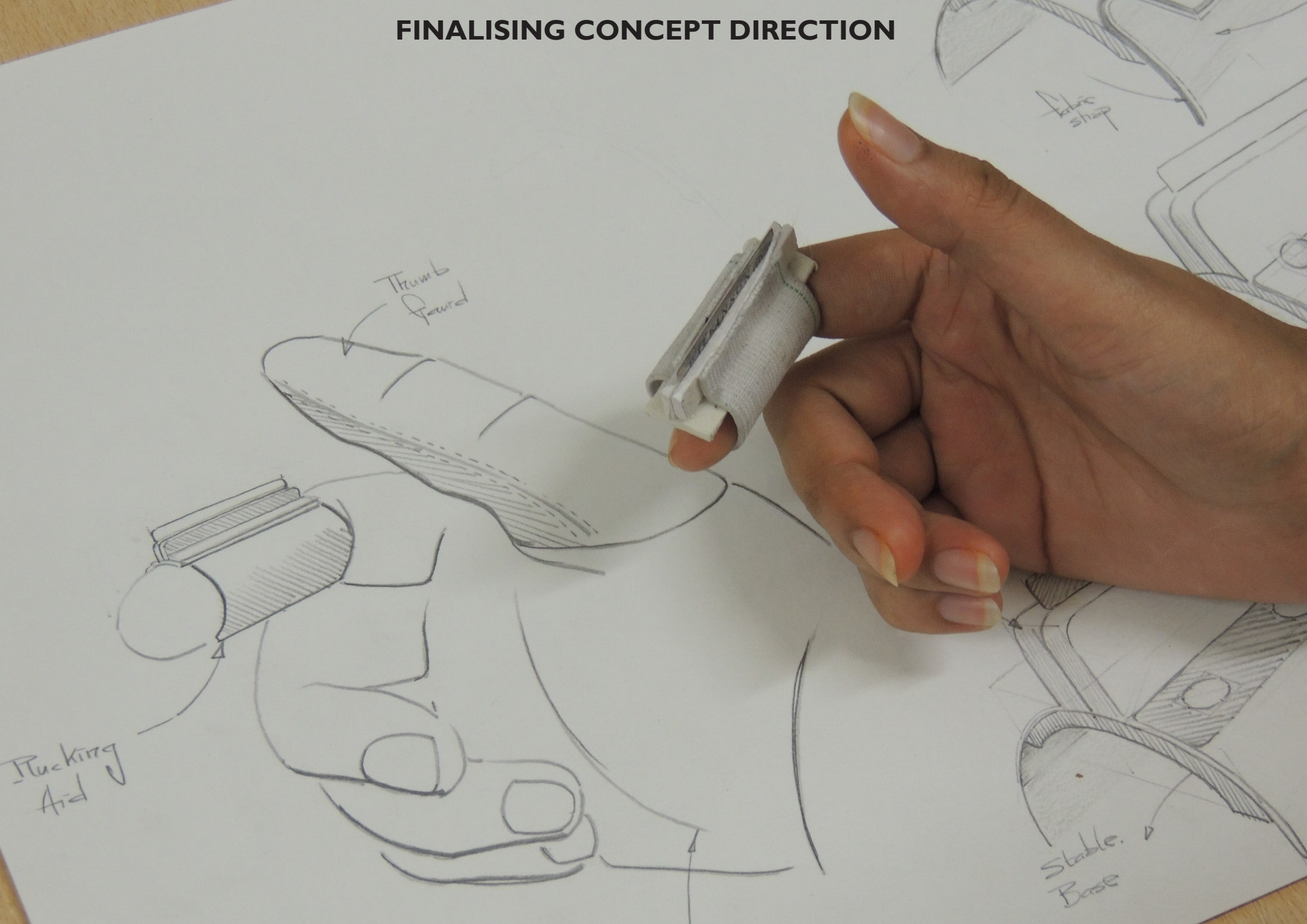
Side oriented blade

Double blade varient

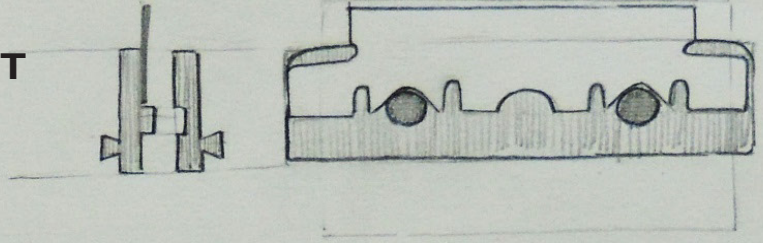


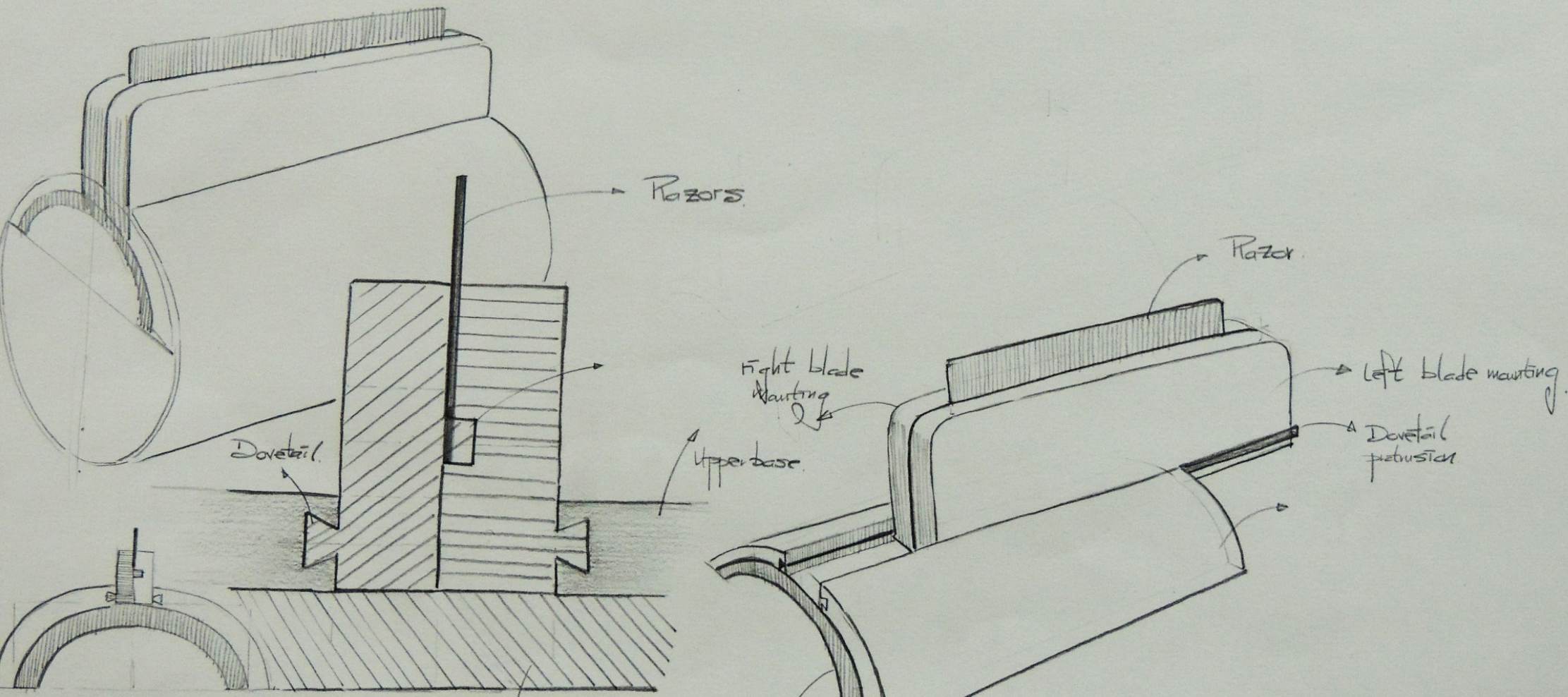
Center oriented blade

FINALISING CONCEPT DIRECTION



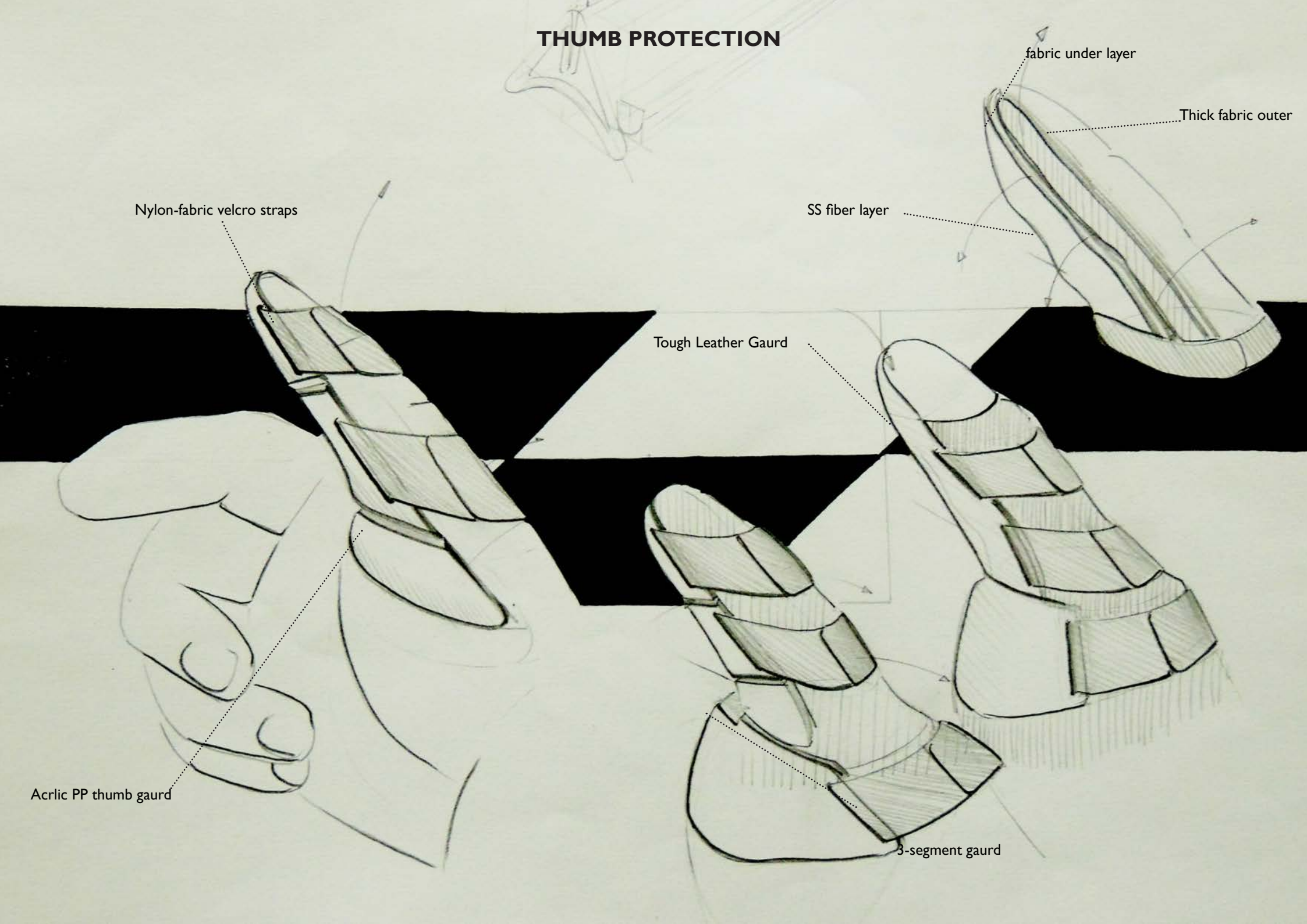
3 PART BLADE ATTACHMENT



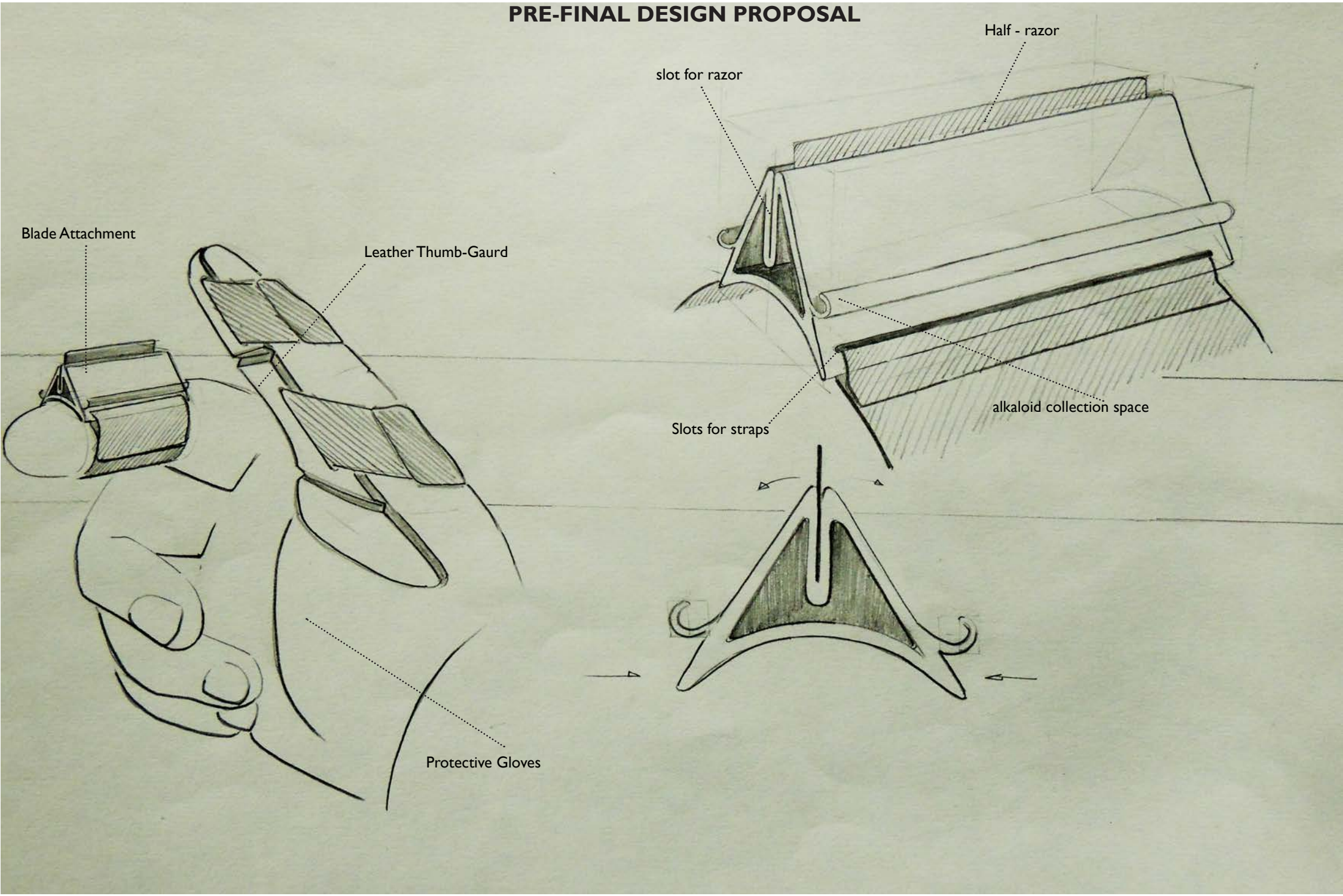


3 Part Blade Attachment *Blade Replacability* *Slots & Snaps* *Velcro Fasteners*

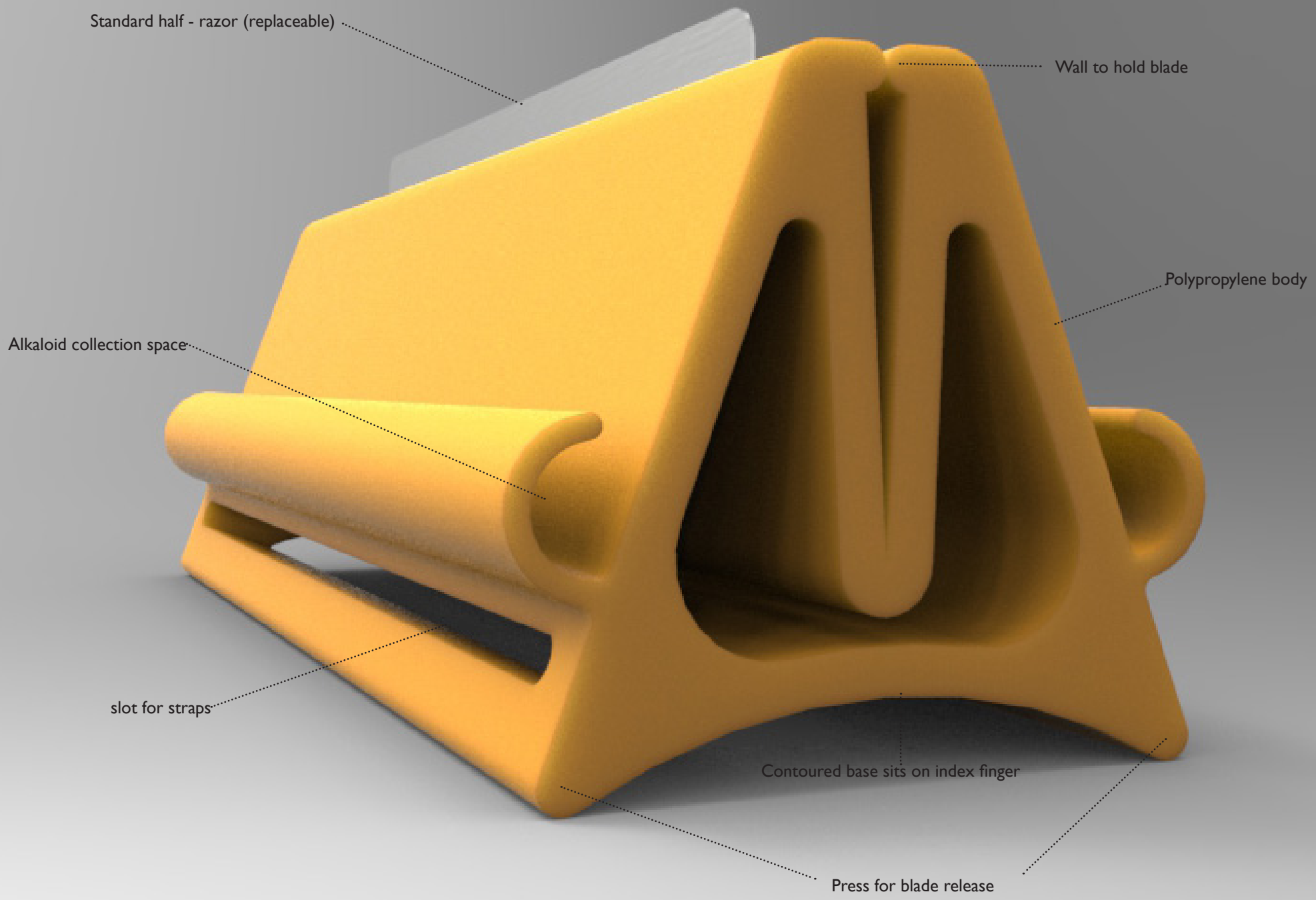
THUMB PROTECTION



PRE-FINAL DESIGN PROPOSAL



PRE-FINAL DESIGN PROPOSAL



PROTOTYPING FOR USER TESTING

PROTOTYPE DEPLOYMENT & USER TESTING

1. No. of test subjects :	5 tea pluckers
2. Duration of training with prototypes:	30 minutes / subject
3. Comparison :	20 min hand plucking v/s 20 min proto-plucking
4. Quantitative data:	Weight of Plucked leaves (Grams)
5. Qualitative data:	Plucking Effort required (Scale of 5) Pain Experienced whilst plucking (Scale of 5) Quality of plucked leaves (Scale of 5)




6-8 *Hand Plucking* *Pulling Off Leaves* *Holding Collected Leaves* *Single-hand Use of Proto*

USER TEST DATA TABULATION

Sl #	Name (M/F)	Age	Experience	HAND-PLUCKING (20 MINUTES)				
				Weight of Plucked Leaves (grams)	*Average Plucking Rate (grams/min)*	*Plucking Effort (Score/5)*	*Pain Experienced (Score/5)*	*Leaf Quality (Score/5)*
1	Kirpa Hasda (F)	27	5 Yrs	1200	60	4	3	4
2	Nancy Khardiya (F)	24	6 Mns	2000	100	3	4	3
3	Anima Indwar (F)	22	4 Mns	1200	60	5	3	4
4	Hasina Sheikh (F)	35	17 Yrs	1500	75	4	5	4
5	Anand Sheikh (M)	21	2 Mns	1500	75	4	3	3

Sl #	Name (M/F)	Age	Experience	PROTO-PLUCKING (20 MINUTES)				
				Weight of Plucked Leaves (grams)	*Average Plucking Rate (grams/min)*	*Plucking Effort (Score/5)*	*Pain Experienced (Score/5)*	*Leaf Quality (Score/5)*
1	Kirpa Hasda (F)	27	5 Yrs	500	25	2	1	4
2	Nancy Khardiya (F)	24	6 Mns	500	25	1	1	4
3	Anima Indwar (F)	22	4 Mns	400	20	2	1	4
4	Hasina Sheikh (F)	35	17 Yrs	500	25	1	1	4
5	Anand Sheikh (M)	21	2 Mns	600	30	1	1	4

COMPARISON OF PLUCKING EFFORT

Sl #	Name (M/F)	Age	Experie	HAND-PLUCKINC	PROTO-PLUCKING (20 MIN)	PERCENTAGE DECREASE
				Plucking Effort (Score/5)	*Plucking Effort (Score/5)*	
1	Kirpa Hasda (F)	27	5 Yrs	4	2	50.00%
2	Nancy Khardiya (F)	24	6 Mns	3	1	66.67%
3	Anima Indwar (F)	22	4 Mns	5	2	60.00%
4	Hasina Sheikh (F)	35	17 Yrs	4	1	75.00%
5	Anand Sheikh (M)	21	2 Mns	4	1	75.00%
					AVERAGE REDUCTION % =	**65.33%**

LEGEND FOR SCORES -PLUCKING EFFORT	
Score/5	**Represents**
1	Minimal effort required to pluck leaves
2	Lesser effort required to pluck leaves
3	Fair amount of effort required to pluck leaves
4	More effort required to pluck leaves
5	Maximum effort required to pluck leaves

COMPARISON OF PAIN EXPERIENCED

Sl #	Name (M/F)	Age	Experier	HAND-PLUCKING (20 MIN)	PROTO-PLUCKING (20 MIN)	PERCENTAGE DECREASE
				Pain Experienced (Score/5)	*Pain Experienced (Score/5)*	
1	Kirpa Hasda (F)	27	5 Yrs	3	1	66.67%
2	Nancy Khardiya (F)	24	6 Mns	4	1	75.00%
3	Anima Indwar (F)	22	4 Mns	3	1	66.67%
4	Hasina Sheikh (F)	35	17 Yrs	5	1	80.00%
5	Anand Sheikh (M)	21	2 Mns	3	1	66.67%
					AVERAGE REDUCTION % =	**71.00%**

LEGEND FOR SCORES -PAIN EXPERIENCED	
Score/5	**Represents**
1	Minimal pain or discomfort experienced
2	Lesser pain or discomfort experienced
3	Fair amount of pain experiences
4	More pain or discomfort experienced
5	Maximum pain or discomfort experienced

COMPARISON OF LEAF QUALITY

Sl #	Name (M/F)	Age	Experience	HAND-PLUCKING (20 MIN)	PROTO-PLUCKING (20 MIN)	PERCENTAGE INCREASE
				Leaf Quality (Score/5)	*Leaf Quality (Score/5)*	
1	Kirpa Hasda (F)	27	5 Yrs	4	4	0.00%
2	Nancy Khardiya (F)	24	6 Mns	3	4	33.33%
3	Anima Indwar (F)	22	4 Mns	3	4	33.33%
4	Hasina Sheikh (F)	35	17 Yrs	4	4	0.00%
5	Anand Sheikh (M)	21	2 Mns	3	4	33.33%
					AVERAGE IMPROVEMENT % =	**20.00%**

LEGEND FOR SCORES -LEAF QUALITY	
Score/5	**Represents**
1	Poor leaf quality
2	Below average leaf quality
3	Satisfactory leaf quality
4	Good leaf quality
5	Very good leaf quality

COMPARISON OF WEIGHT PLUCKED

Sl #	Name (M/F)	Age	Experience	Manual Plucking (2 handed) 20 min	Manual Plucking (1 handed) 20min
				Weight of Plucked Leaves (grams)	*Weight of Plucked Leaves (grams)*
1	Kirpa Hasda (F)	27	5 Yrs	1200	600
2	Nancy Khardiya (F)	24	6 Mns	2000	1000
3	Anima Indwar (F)	22	4 Mns	1200	600
4	Hasina Sheikh (F)	35	17 Yrs	1500	750
5	Anand Sheikh (M)	21	2 Mns	1500	750

Sl #	Prototype Plucking (1 handed) 20min	Percentage Decrease 1	Percentage Decrease 2
	Weight of Plucked Leaves (grams)	*(Comparison Vs 2 Handed)*	*(Comparison Vs 1 Handed)*
1	500	58.33%	16.67%
2	500	75.00%	50.00%
3	400	66.67%	33.33%
4	500	66.67%	33.33%
5	600	60.00%	20.00%
	AVERAGE REDUCTION % =	**65.33%**	**30.67%**

INFERENCES FROM USER TESTING

SAFETY HAZARDS

- Extremely sharp SS razors would slash through their skin if the pluckers absent-mindedly brush their face or body to remove insects.

BLADE ATTACHMENT

- Makes approach to leaf difficult hence yielding a low collection efficiency - it is difficult to grip the leaves once they are cut.
- Decreasing height would ensure more plucking force applied at shear junction.

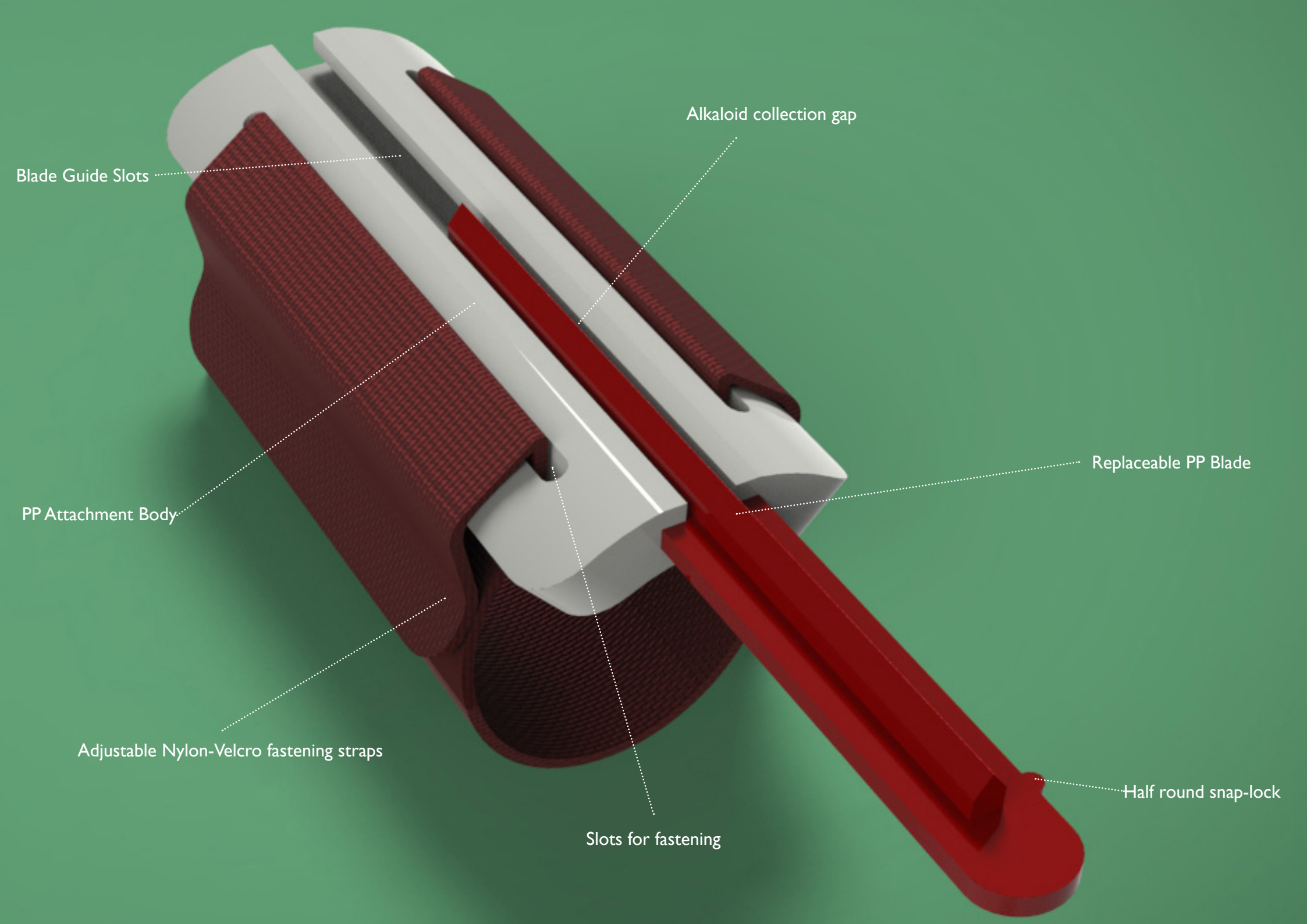
FASTENING BANDS

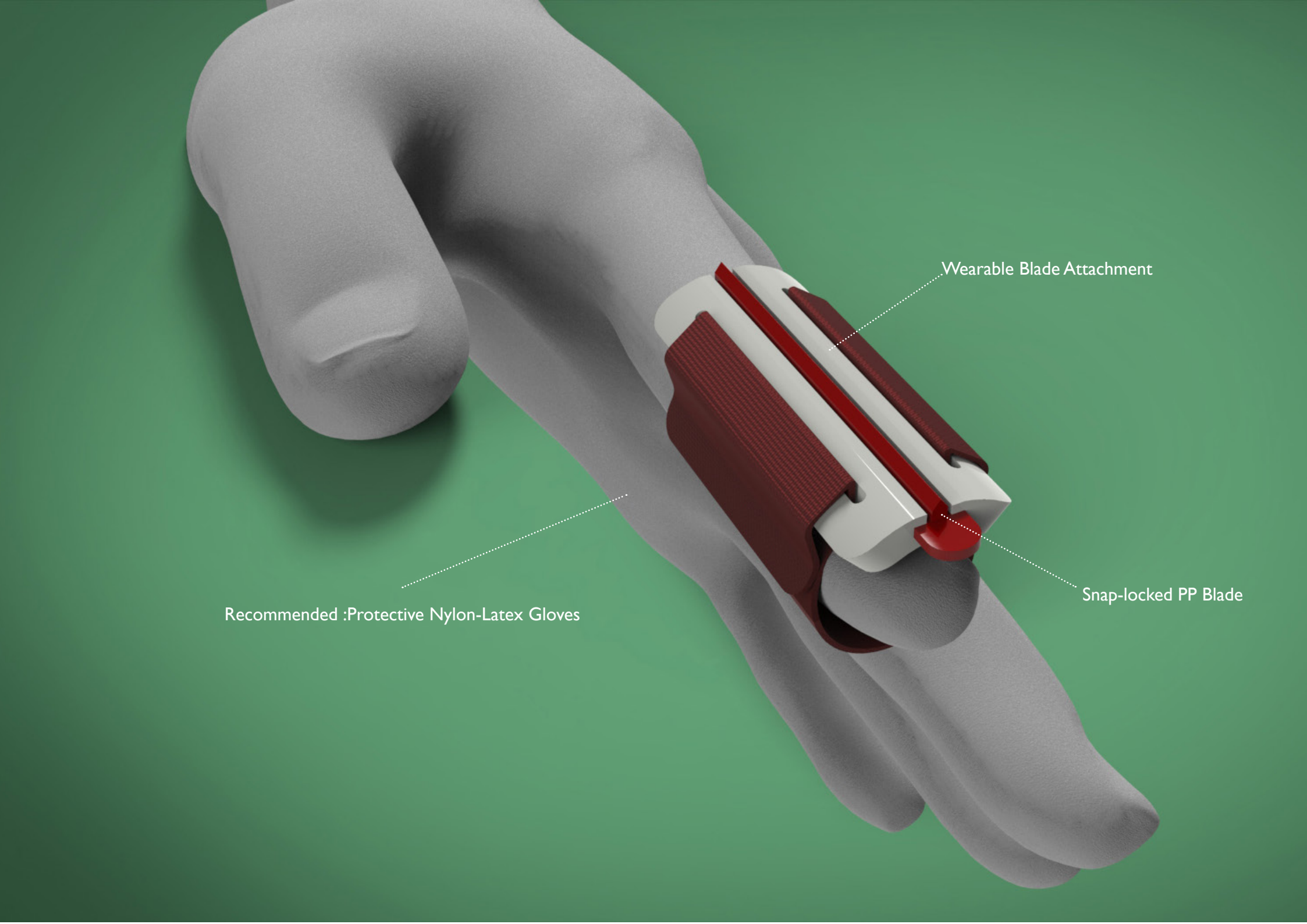
- Elastic straps taken for the field test eventually loosen and rotate about the index finger and thumb.

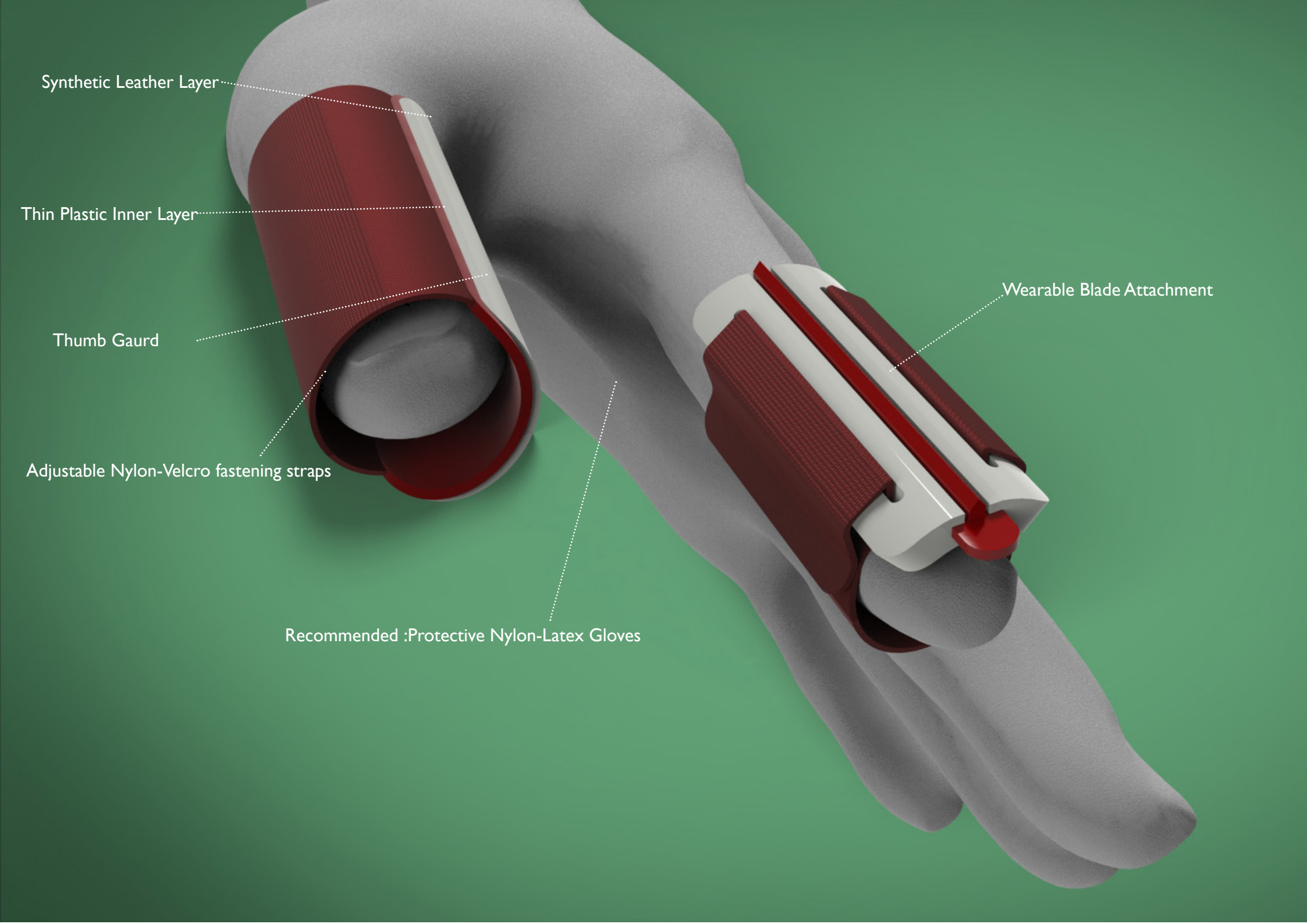
TRAINING TIME

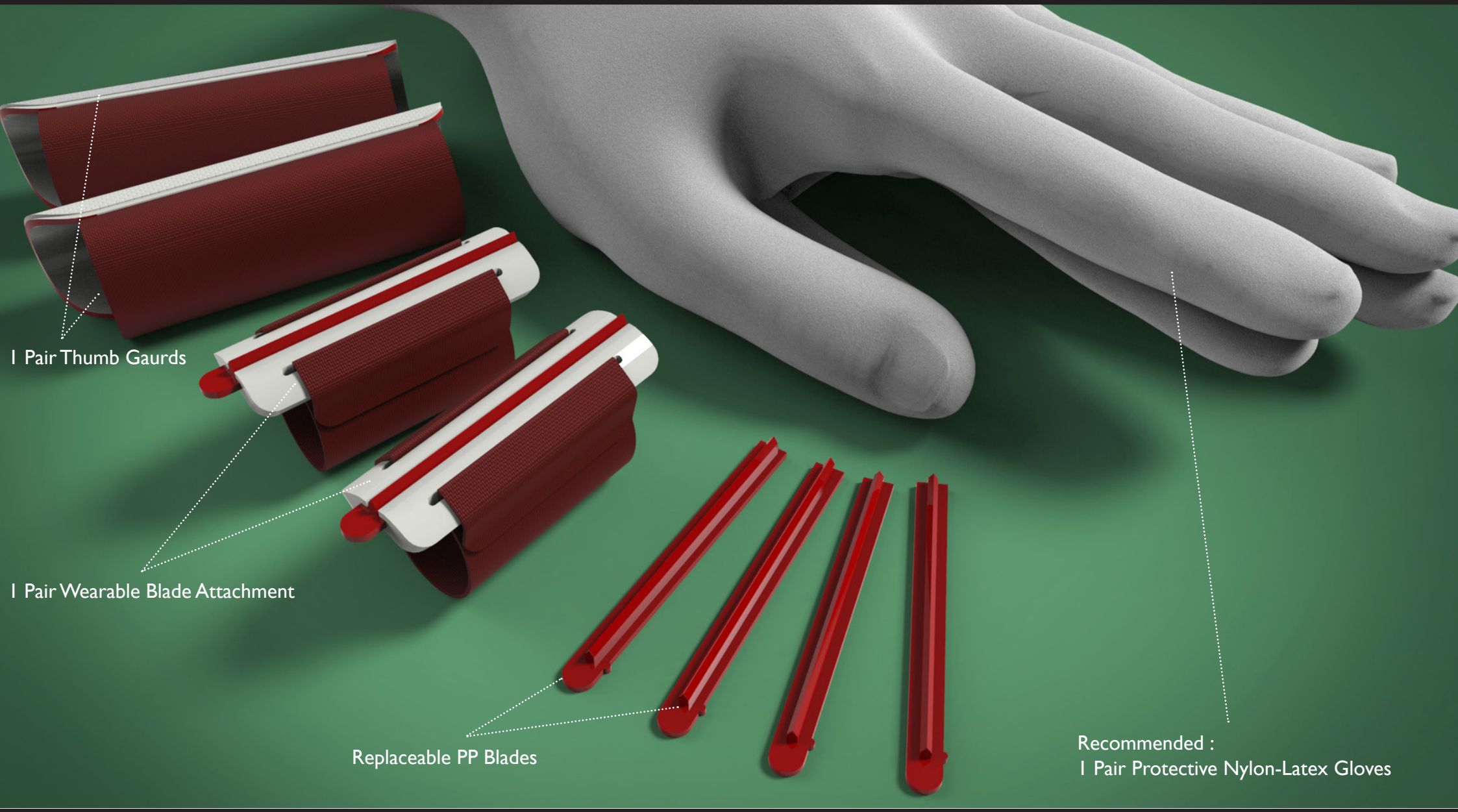
Workers need to get accustomed to the aid , prototypes could be deployed for 30 days for deeper insights & more accurate data on usage patterns.

FINAL DESIGN PROPOSAL


Alkaloid collection gap
Blade Guide Slots
Replaceable PP Blade
PP Attachment Body
Adjustable Nylon-Velcro fastening straps
Half round snap-lock
Slots for fastening


Wearable Blade Attachment
Snap-locked PP Blade
Recommended :Protective Nylon-Latex Gloves


Synthetic Leather Layer
Thin Plastic Inner Layer
Thumb Gaurd
Adjustable Nylon-Velcro fastening straps
Recommended :Protective Nylon-Latex Gloves
Wearable Blade Attachment


1 Pair Thumb Gaurds
1 Pair Wearable Blade Attachment
Replaceable PP Blades
Recommended :
1 Pair Protective Nylon-Latex Gloves

FURTHER SCOPE

Eliminate blade safety concern completely.
Designing for better collection efficiency.
Address static contraction of muscles.
Strain-gauge testing for plucking effort.
Business model & Branding.

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