DESIGN OF A MANUALLY OPERATED BRICK MOULDING MACHINE

Project 2 - Report

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APPROVAL SHEET

Industrial Design Project II

"Manually Operated Brick Moulding Machine"

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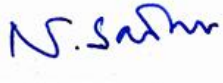
M.Des., Industrial Design,
2015-2016
Is approved as a partial fulfilment of requirements of a post graduate degree in Industrial Design at IDC, IIT-Bombay.

External Examiner



Internal Examiner

Project Guide

Chairperson

DECLARATION

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all the principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed..

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I would like to express my special thanks of gratitude to my project guide **Prof. Gaur G. Ray** and also to **Industrial Design faculties** who gave me inputs throughout the project, which helped me in doing a lot of research and I came to know about so many new things. I also want to thank **Amar Kundu** and **Lavanya Bachwal** for helping me in understand the minute details of the project. I also want to thank **Tata Centre for Technology and Design** who helped me a lot in the whole process.

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PROJECT DETAILS

Industrial Design Project II

"Design of a Manually Operated Brick Moulding Machine"
Location of the project : Bhramani brick kiln, Mehsana, Gujarat, India

Project Guide: Prof.Gaur G. Ray

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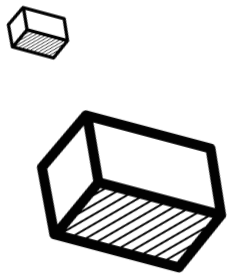

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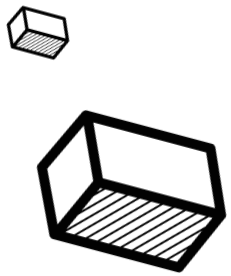


02 INTRODUCTION

INTRODUCTION

India is the second largest brick producer (after China) in brick making industry. Due to rapid urbanization, demands of bricks are increasing from day to day.

Brick kiln industry is one of the major unorganized sectors in India where most of the jobs are performed manually. While performing the job, the workers suffer biomechanically, physiologically and psychophysically. The workers are also exposed to high concentration of dust and temperature. The sustained awkward squatting posture adopted by the workers for more than 6 to 8 hours, imposes severe musculoskeletal stress and thereby likely to cause permanent musculoskeletal injury of the workers. Human body is not suitable for this type of unnatural stress. As per our previous study, the average age of the brick kiln workers is 28 years. Due to tremendous work related stresses, people beyond 40 yr of age are seldom visible in this operation

Previous studies in India showed that workers in brick making industries suffer from assorted health problems due awkward postures while making bricks and transferring high loads, heavy manual load handling, working under high environmental temperature with high level of dusts and facing extensive drudgery.

The purpose of the project is, therefore, to develop low-tech appropriate technology by introducing a versatile product which can help to reduce the drudgery in the most unplanned industry which is the brick making industry. It should create value for the human cost involved in such an intense process of brick moulding.

HISTORY

Fig 1: People making bricks in olden times

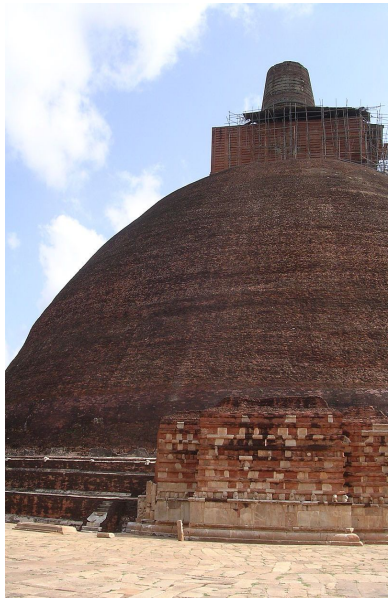


Fig 2 : Brick kiln

The bricks seem to have been produced since the dawn of the civilization in the sun-dried form. The Great Wall of China (210 B.C.) was built with both, burnt and sun-dried bricks. The other examples of the use of bricks in early stage of civilization could be cited in Rome and other places .

The medieval cities were of wood and because of the disastrous fire potential of wood; the bricks replaced the wood over the years. For instance, the great fire of London in 1666 changed London from being a city of wood to one of brick. A number of country farm houses still exists in Great Britain and profess to be monuments of the excellent hand-made bricks(*Fig.1: People making bricks in british era)*.

The bricks have been used all over the world in every class and kind of building. If the total bricks produced till today are to be counted, the figure would indeed be astronomical. It is understood that about 65 percent of the bricks in world goes into dwellings and the balance into commercial, industrial and institutional buildings.

The bricks have established as an age old material right from the thatched house to the multi-storeyed buildings.

In India, the process of brick making has not changed since many centuries except some minor refinements. There have been hardly any efforts in the country to improve the brick-making process for enhancing the quality of bricks. The main reason for this attitude is that the production of bricks has been largely remained confined to the unorganized small sector. Some of the large mechanized brick plants came up in the past but they failed for some reason or other. The result is that the construction industry is largely dependent on the small sector which is unable to deliver high quality bricks in view of rising fuel cost, outdated technology and lower efficiency of production.

BRICK KILNS IN INDIA

The brick technology in India varies from region to region and depends generally on scale of production, soil and fuel available, demand, market conditions and also on the enforcement of law for shifting from one technology to the other. The brick production in India takes place in units using century old production methods, involving manual and inefficient methods of clay preparation, hand moulding and firing. Since the drying and firing is done in open, the brick cannot be dried and fired during the rainy season, hence is mostly seasonal and operating from 6-8 months. 70% of brick production takes place in Indo-Gangetic (*as seen in Fig.3 : Major brick producers in india)*.

plain consisting of north and north-eastern parts of India using Bull's Trench Kiln (BTK) technology with fixed chimney. In peninsular India, the majority of brick production is through clamp kilns and BTKs. The main fuel used is coal and biomass.

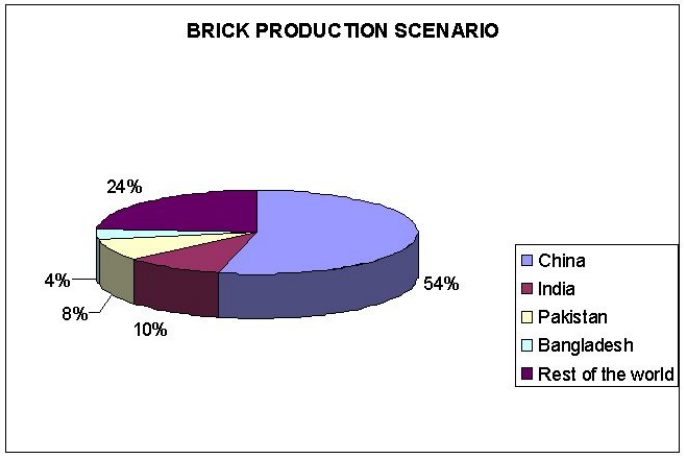


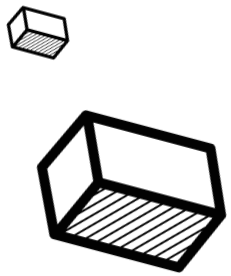
Fig 4 : Pie chart showing brick production in different countries

Fig 3 : Major brick producers in India

Scale of the project :

Right now the current design which is designed and developed is going to be tested at brick kiln situated in Gujarat. later on it can be replicated at the various brick kilns situated at West Bengal, Uttar Pradesh and Rajasthan, where the previous test were conducted to the check the ergonomic conditions of the workers in the brick kilns.

Low cost and frugal design can prove to be an easier medium for replicating such design for other parts of india where traditional brick making is still followed.



03 METHODOLOGY

METHODOLOGY

Explorative research techniques were followed for this project

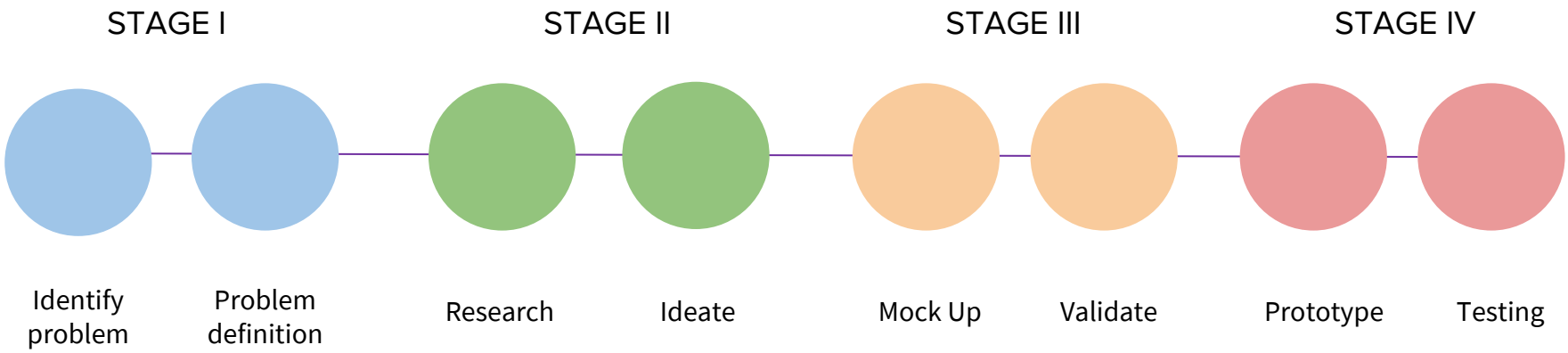
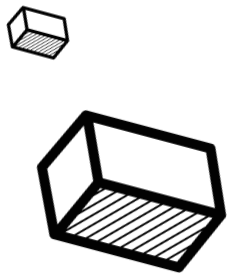


Fig 5: Graphical Representation of methodology followed



04 LITERATURE STUDY

TYPES OF BRICKS

Classification based on shape

The ordinary bricks are rectangular solids. But sometimes the bricks are given different shapes to make them suitable for particular type of construction. Here we have enlisted different types of bricks available with various shapes:

1. **Bullnose brick:** A brick moulded with a rounded angle is termed as a bullnose. This type of brick is used for a rounded quoin. A connection which is formed when a wall takes a turn is known as quoin. The centre of the curved position is situated on the long centre-line of brick.
2. **Channel bricks:** These types of bricks are moulded to the shape of a gutter or a channel and they are often glazed. These bricks are used to function as drains.
3. **Coping bricks:** These bricks are made to suit the thickness of walls on which coping is to be provided. Such bricks take various forms such as chamfered, half round or saddle-back.
4. **Cownose bricks:** A brick moulded with a double bullnose on end is known as a cownose.
5. **Curved sector bricks:** These bricks are in the form of curved sector and they are used in the construction of circular brick masonry pillar, brick chimneys, etc.
6. **Hollow bricks:** These are also known as the cellular or cavity bricks. Such bricks have wall thickness of about 20mm to 25mm. They are prepared from special homogeneous clay. They are light in weight about one-third the weight of the ordinary brick of the same size. These types of bricks can be laid almost about four times as fast as the ordinary bricks and thus the use of such bricks leads to speedy construction. They also reduce the transmission of heat, sound and damp. They are used in the construction of partitioning.
7. **Paving bricks:** These bricks are prepared from clay containing a higher percentage of iron. The excess iron vitrifies the bricks at a low temperature. Such bricks resist better the abrasive action of traffic. The paving bricks may be plain or chequered. These bricks are extensively used for garden walks, street pavements, stable floors, etc. These types of bricks also render the floor less slippery.
8. **Perforated bricks:** These bricks contain cylindrical holes throughout their thickness. These bricks are light in weight and they require less quantity of clay for their preparation. The drying and burning of these bricks are also easy. If perforated bricks of large size are used, it will result in the increase of output of mason. The perforated bricks are used in the construction of panels for lightweight structures and multi-storeyed framed structures. They may be circular, square rectangular or any other regular shape in cross-section. The distance between the side of brick and edge of perforation should not be less than 15mm. The distance

between the edges of successive perforations should preferably be not less than 10mm. The water absorption after immersion for 24 hours in water should not exceed 15 percent by weight. The compressive strength of perforated bricks should not be less than 7 N/mm^2 on gross area.

9. **Purpose-made bricks:** In order to achieve certain purpose, these types of bricks are made. The splay or can't bricks are made for jambs of doors and windows. The arch bricks are made of wedge shape to keep mortar joint of uniform thickness. The ornamental bricks are prepared for corbels, cornices, etc. Similarly, engineering bricks are prepared for constructions where high durability, compressive strength and adequate resistance to sudden shocks are required. These types of bricks are usually more costly than the ordinary bricks. But they grant safe, clean and quick construction. Hence, their cost is justified by their excellent performance in situation for which they are purposely prepared (*Fig 7)*.

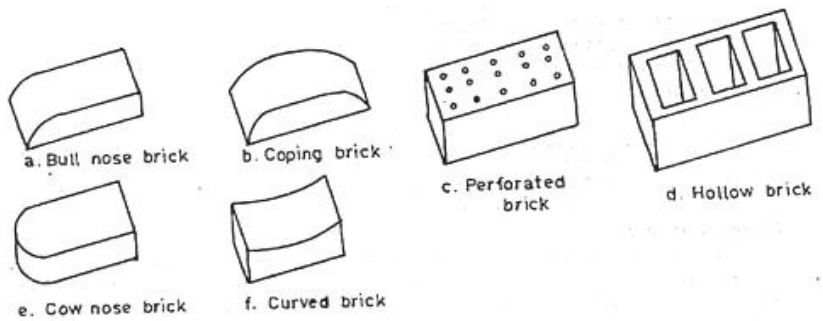


Fig 6: Types of bricks

Fig 7: Purpose made bricks

CLASSIFICATION OF BRICKS

Classification based on Quality of bricks

Bricks can broadly be categorized into two types as follows on the basis of how it is manufactured:

1. Unburnt or sun-dried bricks
2. Burnt bricks

Unburnt bricks

Unburnt bricks or sun-dried bricks are the types which are dried with the help of heat received from sun after the process of moulding. These bricks can only be used in the construction of temporary and cheap structures. Such bricks should not be used at places exposed to heavy rains.

Burnt Bricks

Burnt bricks are prepared by burning the brick-mould in the kiln inside the factory. These are the most commonly used bricks for construction works. They can be further classified into following four categories:

First class bricks

These bricks are table-moulded and of standard shape and they are burnt in kilns. The surfaces and edges of the bricks are sharp, square, smooth and straight. They comply with all the qualities of good bricks. These bricks are used for superior work of permanent nature.

Second class brick

These bricks are ground-moulded and they are burnt in kilns. The surface of these bricks is somewhat rough and shape is also slightly irregular. These bricks may have hair cracks and their edges may not be sharp and uniform. These bricks are commonly used at places where brickwork is to be provided with a coat of plaster.

Third class bricks

These bricks are ground-moulded and they are moulded in kilns. These bricks are not hard and they have rough surfaces with irregular and distorted edges. These bricks give dull sound when struck together. They are used for unimportant and temporary structures and at places where rainfall is not heavy.

Fourth class bricks

These are over-burnt type of brick with irregular shape and dark colour. These bricks are used as aggregate for concrete in foundations, floors, roads, etc. because of the fact that the over-burnt bricks have a compact structure and hence they are sometimes found to be stronger than even the first class bricks.

DIMENSION OF BRICKS

The bricks are prepared in various sizes. The custom in the locality is the governing factor for deciding the **dimensions or size of bricks.** Such bricks which are not standardized are known as the *traditional bricks*.

If bricks are large, it is difficult to burn them properly and they become too heavy to be placed with a single hand. On the other hand, if bricks are small. more quantity of mortar is required.

For India, a brick of standard size ***190 mm x 90 mm x 90 mm*** is recommended by the BIS. With mortar thickness, the size of such a brick becomes ***200 mm x 100 mm x 100 mm*** and it is known as the ***nominal size of the modular brick***. Thus the nominal size of brick includes the mortar thickness.

It is found that the weight of 1 cu.m of brick earth is about 18 kN. Hence the average **weight of a brick** will be about 30 to 35 N.

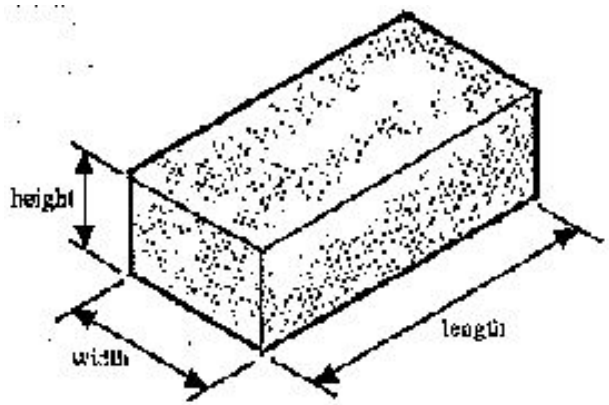


Fig 8: Standard dimension of brick

COMPOSITION OF RED CLAY BRICKS

Following are the constituents of good brick material:

- **Alumina:** It is the chief constituent of every kind of clay. A good brick should contain 20% to 30% of alumina. This constituent imparts plasticity to the clay so that it can be moulded. If alumina is present in excess, with inadequate quantity of sand, the raw bricks shrink and warp during drying /burning and become too hard when burnt.
- **Silica:** It exists in clay either as free or combined. As free sand, it is mechanically mixed with clay. In combine form, it exists in chemical composition with alumina. A good brick material should contain about 50% to 60% of silica. The presence of this constituent prevents cracking, shrinking and warping of raw bricks. It thus imparts uniform shape to the bricks. The durability of bricks depends on the proper proportion of silica in brick material. The excess of silica destroys the cohesion between particles and the bricks become brittle.
- **Lime:** A small quantity of lime not exceeding 5 percent is desirable in good brick material. It should be present in a very finely powdered state because even small particles of the size of a pinhead cause flaking of the bricks. The lime prevents shrinkage of raw bricks. The sand alone is infusible. But it slightly fuses at kiln temperature in presence of lime. Such fused sand works as a hard cementing material for brick particles. The excess of lime causes the brick to melt and hence its shape is lost. The lumps of lime are converted
- Into quicklime after burning and this quick lime slakes and expands in presence of moisture. Such an action results in splitting of bricks into pieces.
- **Oxide of iron:** A small quantity of oxide of iron to the extent of about 5 to 6 percent is desirable in good brick material. It helps as lime to fuse sand. It also imparts red colour to the bricks. The excess of oxide of iron makes the bricks dark blue or blackish. If, on the other hand, the quantity of iron oxide is comparatively less, the bricks will be yellowish in colour.
- **Magnesium oxide:** A small quantity of magnesium oxide in brick material imparts yellow tint to the bricks and decreases shrinkage.

Reference : http://www.civileblog.com/bricks/

QUALITIES OF A GOOD BRICK

The good bricks which are to be used for the construction of important structures should posses the following qualities:

1. The bricks should be table-mounted, **well burnt in kilns**, copper-coloured, **free from cracks and with sharp & square edges**. The colour should be uniform and bright.
2. The bricks should be **uniform in shape** and should be of **standard size**.
3. The bricks should give a **clear metallic ringing sound** when struck with each other.
4. The bricks when broken or fractured should show a bright homogeneous and uniform compact structure free from voids.
5. The bricks **shouldn't absorb water more than 20 percent** by weight for first class bricks and 22 percent by weight for second class bricks, when soaked in cold water for a period of 24 hours.
6. The bricks should be sufficiently hard. **No impression** should be left on brick surface, when it is scratched with fingernail.
7. The bricks **should not break into pieces** when dropped flat on hard ground from a height of about one meter.
8. The bricks should have **low thermal conductivity** and they should be **sound-proof.**
9. The bricks, when soaked in water for 24 hours, should not show deposits of white salts when allowed to dry in shade.
10. No brick should have the **crushing strength below 5.5 N/mm^2.**

STRENGTH OF BRICKS

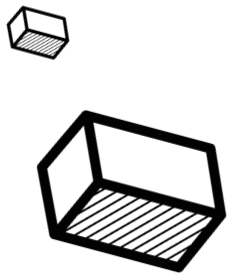
Following factors affect the strength of bricks:

1. Composition brick making material
2. Preparation of clay and blending of ingredients
3. Nature of moulding adopted
4. Care taken in drying and stacking of raw or green bricks
5. Type of kiln used including type of fuel and its feeding
6. Burning and cooling processes
7. Care taken in unloading

It is thus obvious that not only the bricks of different brick fields will have different strengths, but in the same brick field, the bricks of the same batch may have different strengths.

The average crushing strength and tensile strength of hand moulded bricks are 60,000 kN/m^2 and 2000 kN/m^2 respectively. The shearing strength of bricks is about one-tenth of the crushing strength. In practice, however, the bricks are not subjected to the tensile stresses.

It may be noted that the strength of brickwork mainly depends on the type of mortar used and not so much on the individual strength of the bricks.



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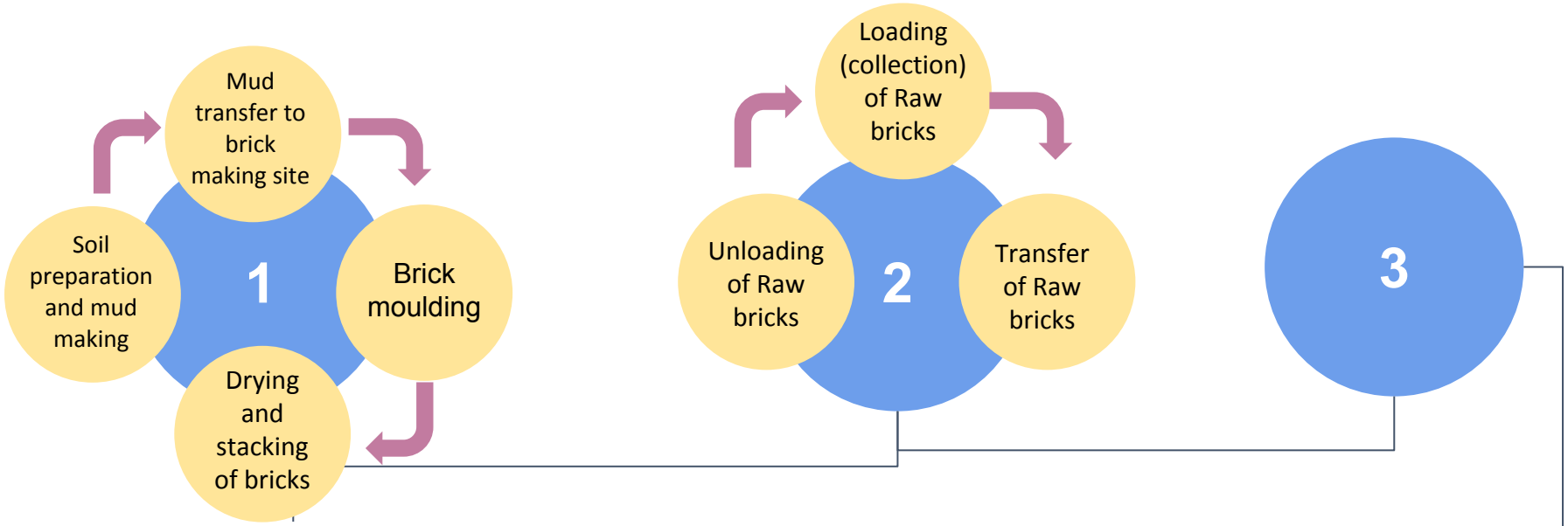
TRADITIONAL BRICK MAKING PROCESS AND PROBLEM IDENTIFICATION

TRADITIONAL BRICK MAKING PROCESS



Phase I : Bricking moulding operation (thapera)

Phase II : Transferring of raw bricks operation (Bharai)

Phase III: Stacking of raw bricks for firing (khadkan)

Phase V: Driving the red bricks (Nikashi)

Phase IV: Exposing bricks to high kiln temperature(Jalaai)

Different Facets in Brick Making

WORKING CONDITIONS

The workers in the brick making industry have to go under lot of unsafe conditions. The working hours,enviroment around them,airflow,heat etc directly affects their body and causes various mental and physical issues.

- High heat
- Dusty surrounding
- Always in contact of dampness
- High Air velocity
- Changing temperature

Fig 9 : Cracking of skin due to moisture

Fig 10 : Working in high heat

Fig 11 : Dusty surroundings

Fig 12 : Squatting position

Fig 13 : Bending position

Fig 14 : Heavy load

ACTIVITY 1

Fig 15 : Breaking larger soil lumps into smaller fragments

Fig 16 : Wet mud for tempering

Mud Preparation:

This activity is important for breakdown of the larger soil lumps into smaller fragments. This activity is usually done by only the males. In the mud preparation, the worker mixes the clay with proportionate amount of salt, coal powder, husk and water to make the consistency of the mud appropriate for the moulding of bricks. After mixing all ingredients, the wet mud is left for about three hours for tempering. This makes the mud just optimum for moulding purpose. After making mud, both the male (usually husband) and the female (wife) with a help of a shovel loads the cart with mud. The male counterpart then takes the mud to the site for brick moulding by pushing the cart. Entire mud is shifted and forms an aisle next to which moulding job goes on.

ISSUES OF ACTIVITY 1

Physical Issues related to Mud preparation activity

High degree of sustained forward trunk bending in the waist region (Lumbosacral) is the rout of cause of **slipped disk phenomenon**, **back ache and back pain**. The severe sustained back bending and musculo-skeletal stress imposed on the hip, knee and ankle joints in association with repetitive muscle force development in thigh, calf and foot muscles during stomping during mud making. Apart from high physiological demand, mud transfer also demands good muscle strength. This causes impact on the musculoskeletal system especially on the wrist, arm, shoulder and back.

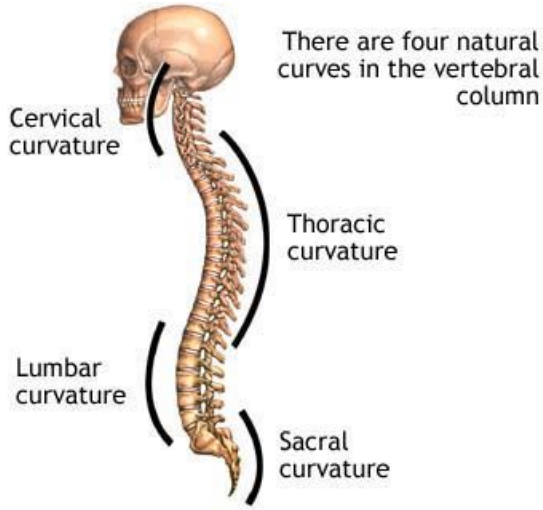


Fig 17 : Musculoskeletal system

ACTIVITY 2

Fig 18 : Workers moulding bricks

Fig 19 : Worker moulding bricks

Brick Moulding:

It is the second most important step for brick making and at the same time very time consuming which causes human fatigue. A semi-skilled but experienced worker is required for brick moulding. Locally, the migrated workers are known as pathera/thapera. Once the heap of mud is laid on the brick moulding site, the husband and wife sit down in a squatting posture keeping (*fig 18*) the mud heap in the middle and start moulding raw bricks by using metal or wooden moulds.

ISSUES OF ACTIVITY 2

Issues Related with Brick Moulding Activity

Workers work in sustained **knee-up squatting posture** throughout entire work period usually for **8 to 10 hours**. They work continuously minimum for 45 minute to one hour. **Loss of sensation** in lower leg during operation, **fatigue in calf**, thigh and ankle are other associated features. Severe back, shoulder, arm pain are very common disorders as reported by all the workers.

Workers used to handle about 6 kg loads per moulding operation. Each hand is used to share about 3.0 kg with a frequency of 3 bricks per minute by male and 2.2 bricks per minute by female workers. Thus a male worker handles 18 kg about and a female workers handle about 13.2 kg respectively per minute.The number of bricks produced per head per day ranges from 600 to 800. This leads to minimum 3600 kg of cumulative load handling by both hands a day which is practically beyond human limit.

As handling of mould is done by hand, palm and fingers, such heavy load handling during turning the mould likely to cause severe **musculoskeletal stresses** on thumb, other fingers and wrist. The upper arm muscles specially biceps also gets heavily loaded for lifting and holding operation of the mould with mud. Sustained high degree of bending posture is the most detrimental posture observed during the raw bricks stacking activity.Though reduced weight, but handling dry raw bricks, average weight 3 kg per bricks, in sustained repetitive manner causes a cumulative load of 1500 kg (3kg X 500 bricks) just for this transfer job. Human anatomy is not designed for such heavy manual load handling.

Fig 20 : Squat position

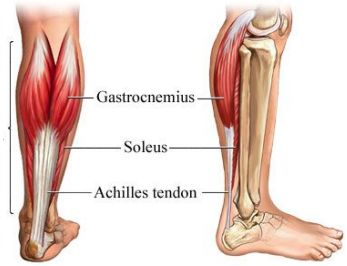


Fig 21 : Fatigue in calf

Fig 22 : Pain stresses in hands

Fig 23 : Musculoskeletal stresses

ACTIVITY 3

Fig 24 : Workers transferring bricks

Fig 25 : Bending position

Brick Transfer

Total output of this industry is 40,000 bricks per day. Usually 5 numbers of khadkan workers are engaged in this work. Every worker arranged near about 8,000 bricks per day. To arrange the bricks they had to adopt bending posture very frequently,basically 2 bricks at a time. This repetitive bending posture creates severe musculoskeletal problems especially in the lower back, neck, hip and knee joints as reported by the workers. Apart from high repetitive bending, these workers also handle about 24,000 kg load a day (3kg X 8000 bricks) which causes lot of body stress.

Also the dust from the dry bricks is also one of the cause of respiratory disorders.

ISSUES OF ACTIVITY 3

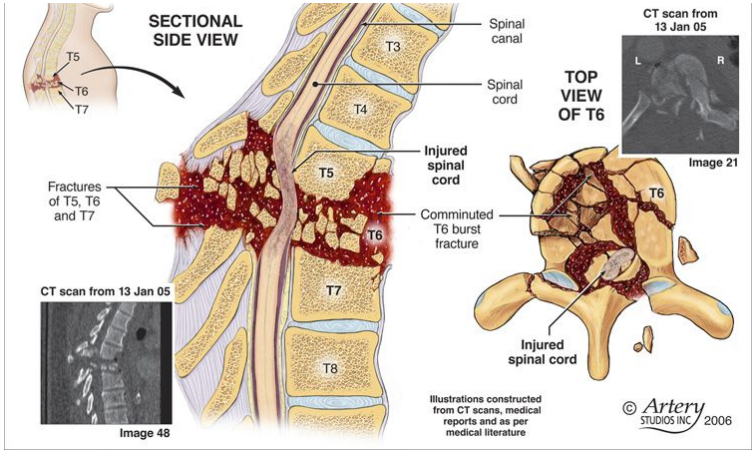


Fig 26 : Spinal Cord Injury

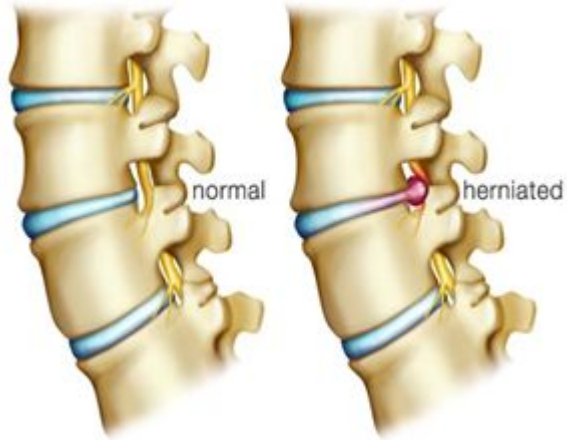


Fig 27 : Slipped disc phenomenon

Physical problems related to bharai activity

Arrangement of bricks during bharai activity demands highly repetitive below waist bending work for the loading and unloading of the brick activity. Therefore, biomechanically such work is highly detrimental in terms of neuromuscular activity with possible lead towards **spinal cord injury** and **slipped disc phenomenon.**

ACTIVITY 4

Fig 28 : Arranging the bricks

Fig 29 : Firing green bricks to hard red bricks

Firing of Bricks:

Firing of sun dried bricks under controlled temperature is very important step the under bricks making activity. Locally known as Jalaai is the process by which the brick is green brick is strengthened and the colour is changed from gray (dry mud) to brick red (baked brick) by baking at a constant temperature of 900 – 1000 degree centigrade for a specific time. After the transfer and arranging the raw bricks in proper way (khadkan), experienced male workers (locally known as Jalaaiwaia) are required for burning of green bricks to hard red colour bricks. The main tasks of Jalaai wala is maintaining the fire inside the kiln, supervision of the fire temperature and accordingly determine the time to bake the bricks, charging the kiln with coal and changing of air duct as the fire advances to next raw brick blocks inside the kiln.

PHYSICAL ISSUES OF ACTIVITY 4

Physical issue related to firing of bricks

The work environment temperature **(42-44 C)** is very high for the workers. There are no personal protective gadgets/clothes to save themselves from radiant heat. They use locally invented wooden sandal to protect their feet from surface heat. This extreme heat definitely creates physical **(heat stress)** and thereby **mental stresses** to these workers. Moreover a Worker has to get into the Air Flow channel which is about 8 feet below the top surface of the kiln for closing an old one and opening a new path along with the fire path. This is an extreme heat stress condition where the worker can work maximum for 60 to 90 sec after which he has to come out,take a rest and go down again in the trench. The job is highly dangerous as the worker going underneath has no heat protection and cold air circulation mechanism. In case he faints at the bottom of the trench, it will be very difficult to rescue him as he wears no rope harness to retract him out.

ACTIVITY 5

Fig 30 : Stacking bricks

Fig 31 : Wheelbarrow for transfer of bricks

Fig 32 : Transferring bricks

Bricks Removing:

The final stage of brick production is removing the cold baked (Red color) bricks from the kiln by using a manually drawn wheelbarrow and stacking those bricks at a distance encompassing the kiln. These workers are locally known as Nikashi.

PHYSICAL ISSUES OF ACTIVITY 5

Physical issue related to brick removing:

Manual handling of load by using a cart is one of the major biomechanical issues for nikashi activity. The high physiological demand as recorded in this study coupled with the body ache/body pain report expressed by the workers leads towards strong possibility of MSD. Apart from the back ache, back pain, shoulder pain, pain in thigh and calf are also prominent in this operation,generation of high pushing force as against the ground condition may be the reason for that.

Frequent bending coupled with twisting trunk also leads to severe back pain and if this work posture allow to be continued it will lead to severe spinal cord injury. Due to high dust exposure,the Nikashi workers probably also suffer from pulmonary disorders as they work under high degree of dusty environment.

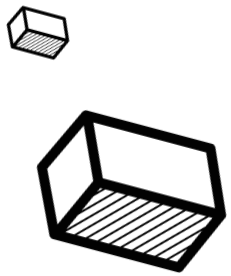
SCALE OF THE PROBLEM

Fig 33 : Bharai workers making brick in brick kiln

Brick kiln industry is one of the major unorganized sectors in India where most of the jobs are performed manually. While performing the job, the workers suffer biomechanically, physiologically and psychophysically. The workers are also exposed to high concentration of dust and temperature. The sustained awkward squatting posture adopted by the workers for more than 6 to 8 hours, imposes severe musculoskeletal stress and thereby likely to cause permanent musculoskeletal injury of the workers. Human body is not suitable for this type of unnatural stress. As per our previous study, the average age of the brick kiln workers is 28 years. Due to tremendous work related stresses, people beyond 40 yr of age are seldom visible in this operation.

During the questionnaire survey conducted in previous research,It was observed that almost 100 % of the workers responded that they were feeling severe pain in different body part. Maximum people felt pain in low back, shoulder, thigh and calf muscle.

By using some internationally accepted posture evaluating tools (RULA, REBA, OWAS), most of the currently adopting postures in different brick making activities need to be changed immediately for prevention of permanent musculoskeletal injury among the workers. It is evident both from the literature and present study that the workers in brick kiln industry are working under high physiological & biomechanical risk conditions which must be relooked at for prevention of drudgery of the workers throughout the country.

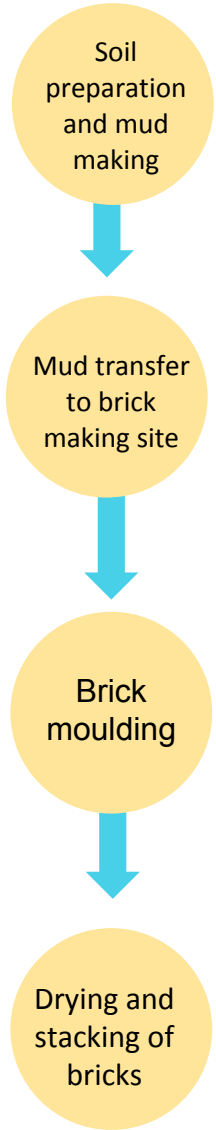


07

MMA OF BRICK MOULDING PROCESS

MICROMOTION ANALYSIS

Phase II : Bricking moulding operation (thapera)

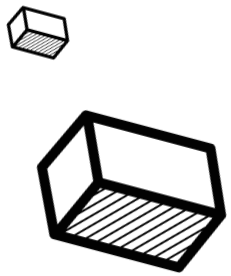


- In soil preparation the worker needs to dig a pit for mud
- The breakdown of mud is done either by the bulldozer or by the worker depending upon the lump size.
- Then he adds water into the mud to make it wet.
- he lets the mud soak the water for about half and hour.
- after that salt is added and later on husk is also added.
- charcoal is added in considerable amount when needed
- He uses his feets to mix the water with the mud.

- One person is required to transfer the Mud from the preparation area to moulding area.
- The person typically uses wheelbarrow to transfer the mud.
- The person lines up the mud on the ground for moulding to begin

- The bharai worker sits on the ground and starts dusting the mould
- he then dust of the extra sand and creates lump of mud to be fed in the mould
- he uses jerk action to fill the mould so that the mould is completely filled
- He presses the mud inside and scraps of the excess mud
- He then carries the mud to the drying area and demoulds the brick by applying sudden jerk to the mould while sitting in squatting position

- One person is needed to turn the bricks after 2 days so that the other side gets dried properly
- The person needs to bend and stake the brick in the wheelbarrow so that it can be stacked for further drying and baking



08 DESIGN INTERVENTION

PREVIOUS DESIGN INTERVENTION

The Design intervention were conducted by the team under Prof. G.G.Ray, which improved the ergonomics of the traditional brick making process and reduced the drudgery By conducting various trials and concept implementations in the field.

One of the intervention was of using rounded edge brick moulds(*Fig 31 figure showing types of mould concepts)* ,which can be used for brick moulding process conducted over a platform which can help to eliminate the squatting position shown in (*Fig 32 Representation of conveyor belt type brick moulding station)*. The bricks can be transferred by kart hence mounting the pallets on a wooden frame for drying.

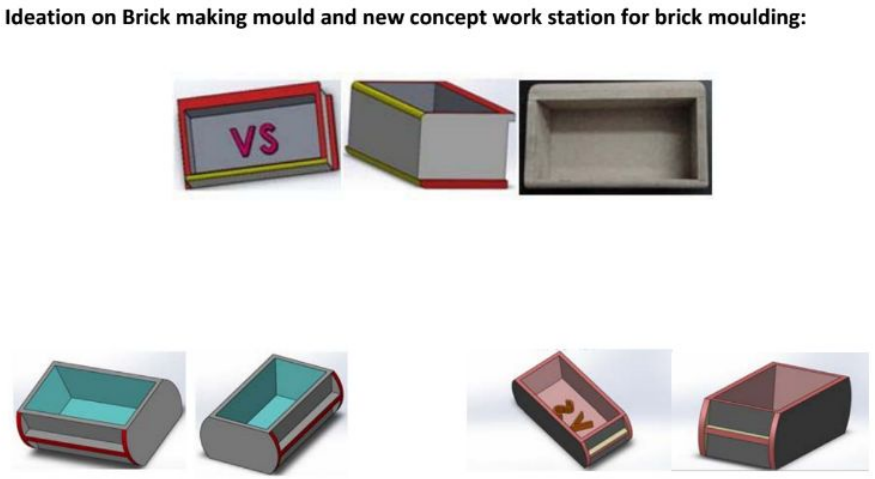


Fig 34 : Types of mould concepts

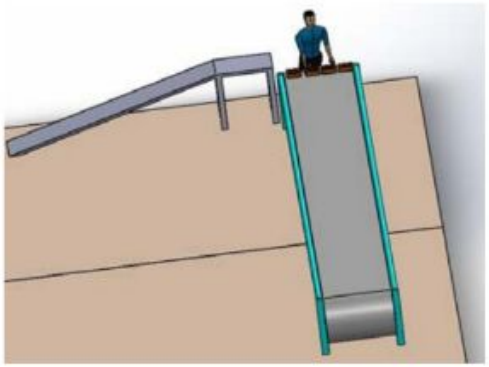


Fig 35 : Conveyor belt type brick moulding station

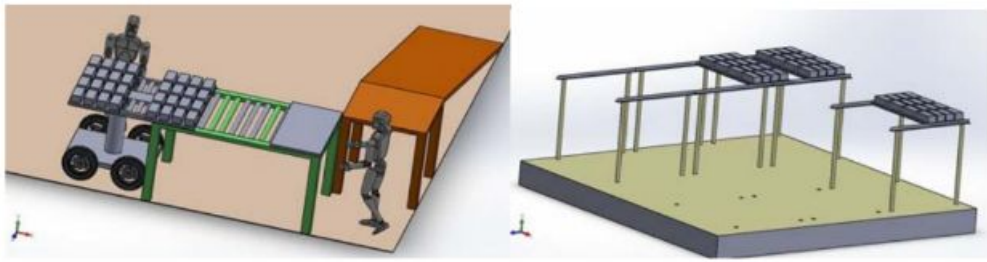
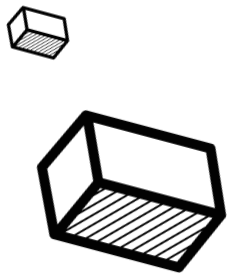


Fig 36 : Brick transfer by means of cart and drying of bricks on a wooden structure



09

PROJECT BRIEF

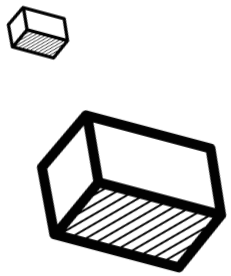
PROJECT BRIEF

To design a **manually operated and ergonomic brick moulding machine** for the '**Bharai**' workers in the brick making industry to **reduce drudgery** and **increase productivity** without compromising the quality of the bricks produced.

DESIGN CRITERIA

The Design Criteria which was given was after the observations based on the previous study conducted in the brick kiln.

1. The brick moulding machine should be able to mould bricks directly on the platform or on the ground
2. There should be **minimum manual handling** of the brick.
3. It should **eliminate the stress** caused on the human body due to the traditional brick moulding practices.
4. It should be designed is such a way that the process which are around it should be minimised or should be made more **ergonomic and productive**.
5. Care should been taken that this improvisation **should not replace man power** or should not reduce the job opportunity but **reduce the human cost for the job**.
6. Serviceable and easy to maintain.
7. The design of the product should be **minimalistic** and must have minimum number of parts.
8. The machine parts of the machine should follow the standards to keep the cost low.
9. It should be **manually powered**.
10. It should be **affordable** so that it is easily acceptable by the brick kiln workers.



10 PATENT STUDY

PATENT STUDY 1

Brick Molding Machine

US 4105383 A

Brick forms on stackable pallets are delivered in succession by a conveyor belt beneath the outlet of a clay hopper equipped with an internal vibrator and a clay feed auger. A pivoted flapper blade trips over each brick form divider wall and assures that the clay is forced first into the forward part of each mold cavity. Water is supplied to the front face of the flapper blade. Immediately beyond the hopper outlet, a diaper assembly having a mechanical vibrator engages each moving form to vibrate the clay and promote random clay crystal orientation. A strike blade on the diaper assembly removes excess clay and water from the top of each moving form. Water is also supplied constantly to the strike blade.

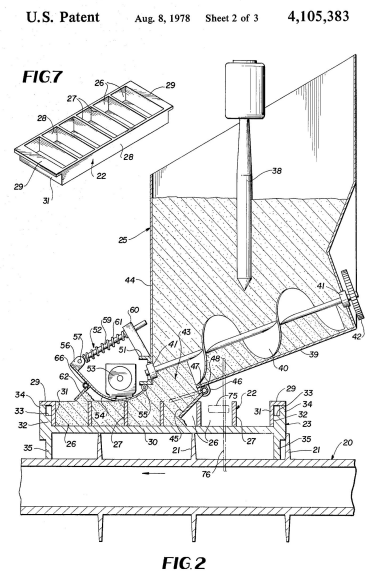


Fig 37

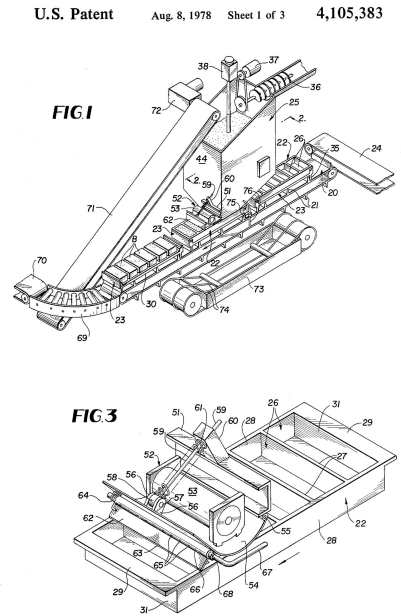
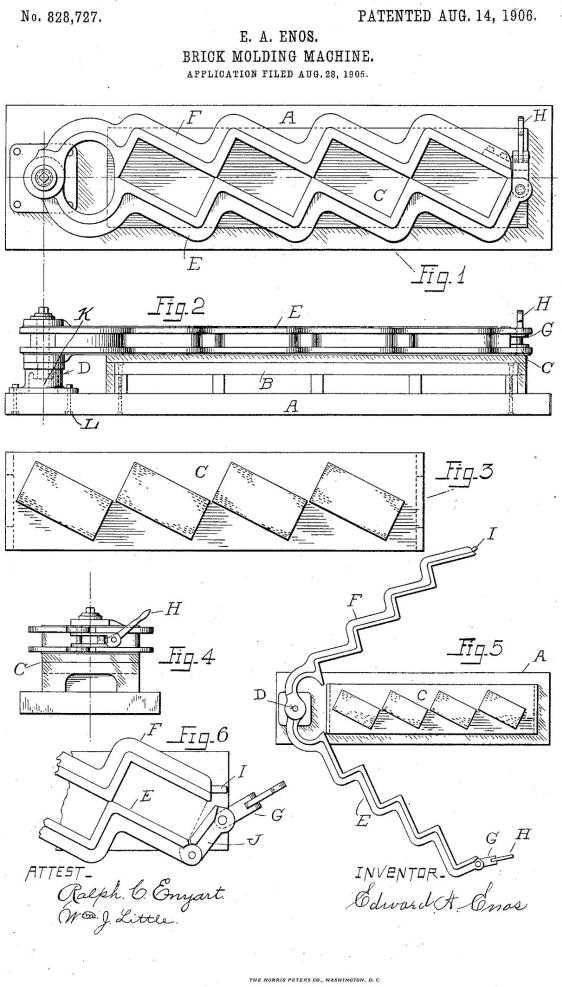


Fig 38

PATENT STUDY 2


No. 828,727. PATENTED AUG. 14, 1906.

E. A. ENOS.

BRICK MOLDING MACHINE.

APPLICATION FILED AUG. 28, 1905.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

ATTEST- Ralph C. Enyart. Wm. J. Little.

INVENTOR- Edward A. Enos

THE NORRIS PETERS CO., WASHINGTON, D. C.

Fig 39

Brick Molding Machine

US 828727 A

My invention relates to improvements in brick-molding machines in which are used two sides with rentrant angles, said sides being each hinged at one end thereof and of such a shape that when closed they form rectangular recesses for the reception of the material from which the bricks are molded. When the sides are swung open, the palletboard with the bricks thereon can be readily removed. I attain these objects by the apparatus illustratedin the accompanying drawings, in which* Figure 1 is a plan view of the machine with the bars closed and latched ready for the introduction of the cement or brick` composition. Fig` 2 is a side view of same in same relative position. Fig. 3 is a top view of pallet or mold board after removal from the machine, showing the freshly-molded bricks in position relative to the peculiar parting of mold side bars at geometrically opposite corners. Fig. 4 is an end elevation of the machine. Fig. 5 is a plan view, on a smaller scale, showing the mold-bars swung outward; and Fig. 6 is a plan view of a part of the machine, showing a modified form thereof.

PATENT STUDY 3

Brick Molding Machine

US 892574 A

In the embodiment illustrated, a suitable bed 5 is employed, having spaced upright guide standards 6 mounted thereon. The upper ends of these guide standards are connected to a cross head 7. Slidably mounted on the standards is a mold body 8, said body having collars 9 at its corners, through which the standards 6 pass. The mold body 8 is provided with a plurality of brick-shaping compartments 10, having open tops and bettoms, and of greater depth than the thickness of the completed bricks. This is an important feature, as hereinafter explained. The mold body is arranged to normally rest upon removable pallets, one of which is shown at 11, said pallets being placed upon the bed 5, between the standards, and con -stituting closures for the lower ends of the compartments 10. A plunger cooperates with the mold body, and comprises a plate 12, having collars 13 at its corners, which collars are slidably mounted on the stand ards 6. The plate is provided with a plurality of spaced depending heads 14 that are arranged to enter the different compartments 10, as will be clear by reference to Fig. 41.

While any suitable mechanism may be employed for operating the above described parts, in case the machine is to be manually operated, the following actuating means is preferably employed. A screw stem 15 is carried by the plunger, and passes through the cross head 7. A hand wheel 16, located below said cross head, has a hub 17, journaled therein, and surrounding the stem, having a threaded engagement with the same and retained by a collar 18 in the cross head. It will thus be evident that by rotatin the wheel 16 in one direction, the plunger .wiTl be moved downwardly into the mold body, and by rotating it in the opposite direction, said plunger will be elevated.

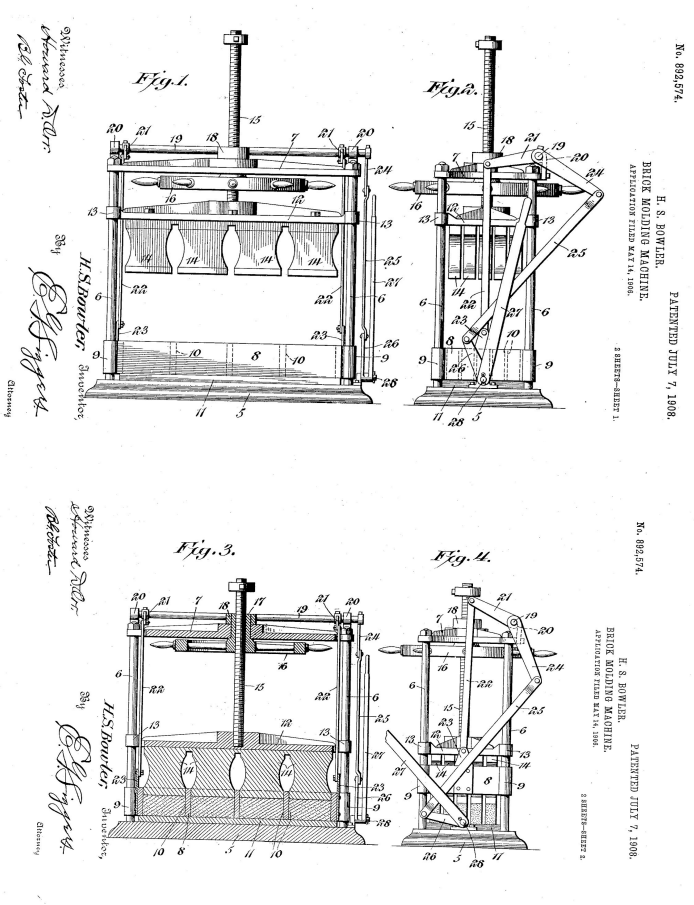


Fig 40

PATENT STUDY 4

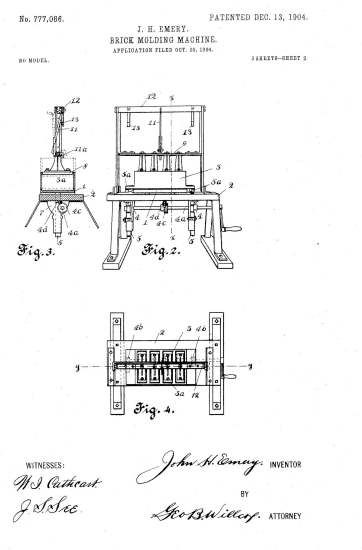


Fig 41

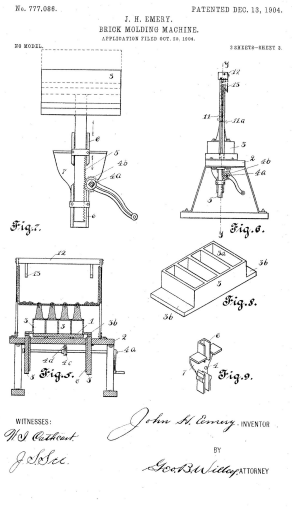


Fig 42

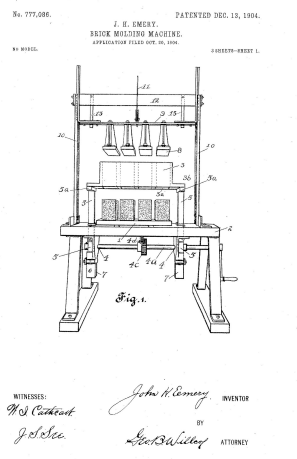


Fig 43

Brick Molding Machine

US 777086 A

This invention is a machine for molding bricks or blocks of cement or similar material; and the improvements consist in certain constructions and combinations of parts and the equivalents thereof by which I attain the objects of my invention. These objects are to provide means for molding upon a removable tray or other support a plurality of bricks, together with means for removing the bricks from the molds without removing them from the tray, means for preventing breakage of the bricks while being removed from the molds,and means for suspending the brickforming mechanism of the machine out 01" the way while the molds are being filled.

A mold or nest of cells 3 rests upon the tray 1 while the bricks are being formed. This mold 3 is preferably a casing formed with a number of vertical cells 3, each cell being of the size and form of the completed brick. The cells are open top and bottom, and the lower edge of the mold 3 is provided with laterally-extending flanges 3, by which the mold is raised and lowered. Beneath the table 2 is mounted, by means of suitable bearings 4, a shaft 4, carrying a pair of pinions at". These pinions engage a pair of racks 5, that are moved up and down simultaneously by the pinions. The racks are alined by vertical guides 6, carried by the bracket 7, which also carries the bearings l. Crossbars 5 are secured to the upper ends of the racks 5, and upon these cross-bars the molds 3 are lifted.

PATENT STUDY 5

Brick Molding Machine

US 800500 A

This invention relates to an improved brickmachine, and has for its object to provide an inexpensive, durable, and eflicient machine of this character by means of which bricks, tiles, building-blocks, and similar articles may be conveniently and rapidly manufactured.

A further object of the invention is to provide a tamping-carriage mounted on the bed of the machine and movable to operable position above the mold-box, so that after the mold-box has been filled the cement, concrete, or other material may be thoroughly tamped and the carriage withdrawn to permit the removal of the molded product.

A still further object is to provide the mold box with a plurality of division plates or partitions, so that a number of bricks or tiles may be formed at each operation of the machine, and, further, to provide means for ejecting said bricks or tiles without chipping or otherwise injuring the same.

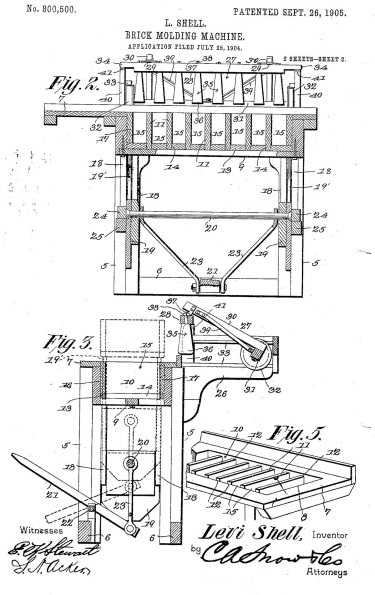


Fig 44

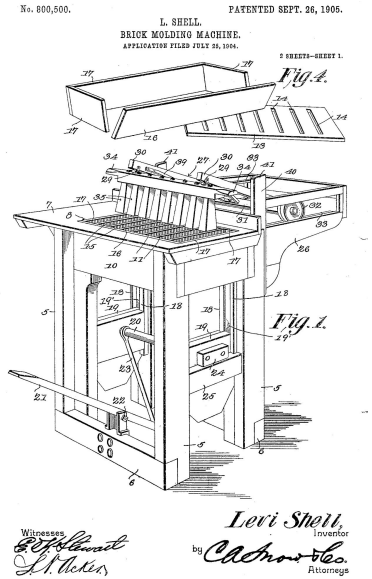
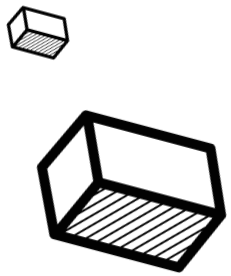


Fig 45



11

ENVIRONMENTAL CONDITIONS

PEDOLOGY STUDY

Soil is our prime natural and economic resource. Soils in India differ in composition and structure.hence it is necessary to study the soil structure to find the topography and type of soil available at a particular region for making a strong brick.

Soils of India: Six Different Types of Soils found in India are as follows:

1. Alluvial soil [43%]
2. Red soil [18.5%]
3. Black / regur soil [15%]
4. Arid / desert soil
5. Laterite soil
6. Saline soil
7. Peaty / marshy soil
8. Forest soil
9. Sub-mountain soil
10. Snowfields

Since Gujarat comes in the alluvial and black soil area(*Fig 45 : Major soil groups)*, we will discuss more about that type of soil

Alluvial soil:

- Mostly available soil in India (about 43%) which covers an area of 143 sq.km.
- Widespread in northern plains and river valleys.
- In peninsular-India, they are mostly found in deltas and estuaries.
- Humus, lime and organic matters are present.
- Highly fertile.
- Indus-Ganga-Brahmaputhra plain, Narmada-Tapi plain etc are examples.
- They are depositional soil – transported and deposited by rivers, streams etc.
- Sand content decreases from west to east of the country.
- New alluvium is termed as **Khadar** and old alluvium is termed as **Bhangar**.
- **Colour:** Light Grey to Ash Grey.
- **Texture:** Sandy to silty loam or clay.
- Rich in: potash

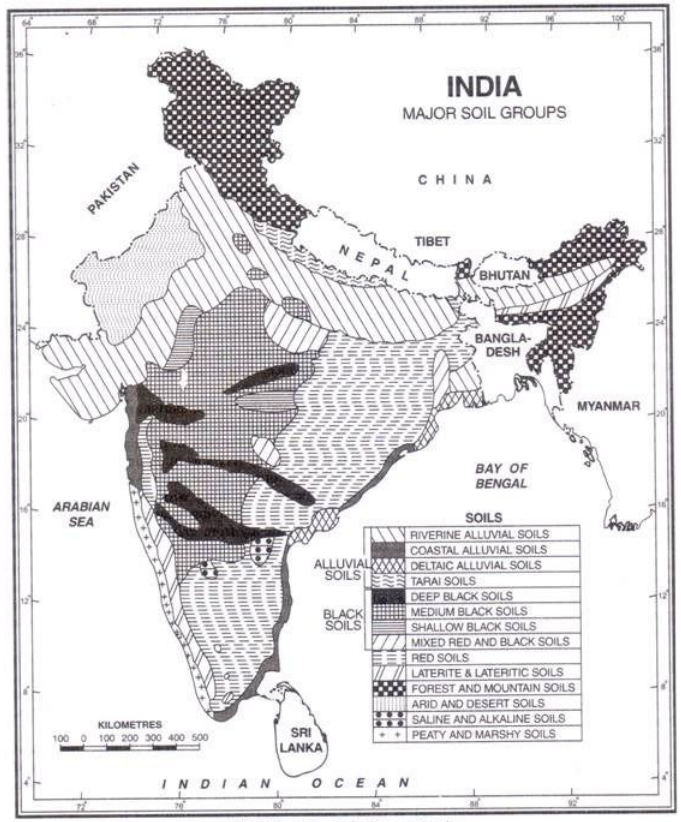


FIG. 7.1. Major Soil Groups of India

Fig 46 : Major soil groups

WATER AVAILABILITY

Water map:
India is one of the most water-challenged countries in the world, from its deepest aquifers to its largest rivers. Groundwater levels are falling as India's farmers, city residents and industries drain wells and aquifers. What water is available is often severely polluted. And the future may only be worse, with the national supply predicted to fall 50 percent below demand by 2030.

Gujarat is typically a dry and hot region with varying temperature.

The study of water Availability in Mehsana and Gujarat is important because brick making industries requires a lot of water for different purposes.

As seen in the map (*Fig 46 : Water stresses in India)*
the Mehsana area is connected to Narmada canal which provides water in that region.

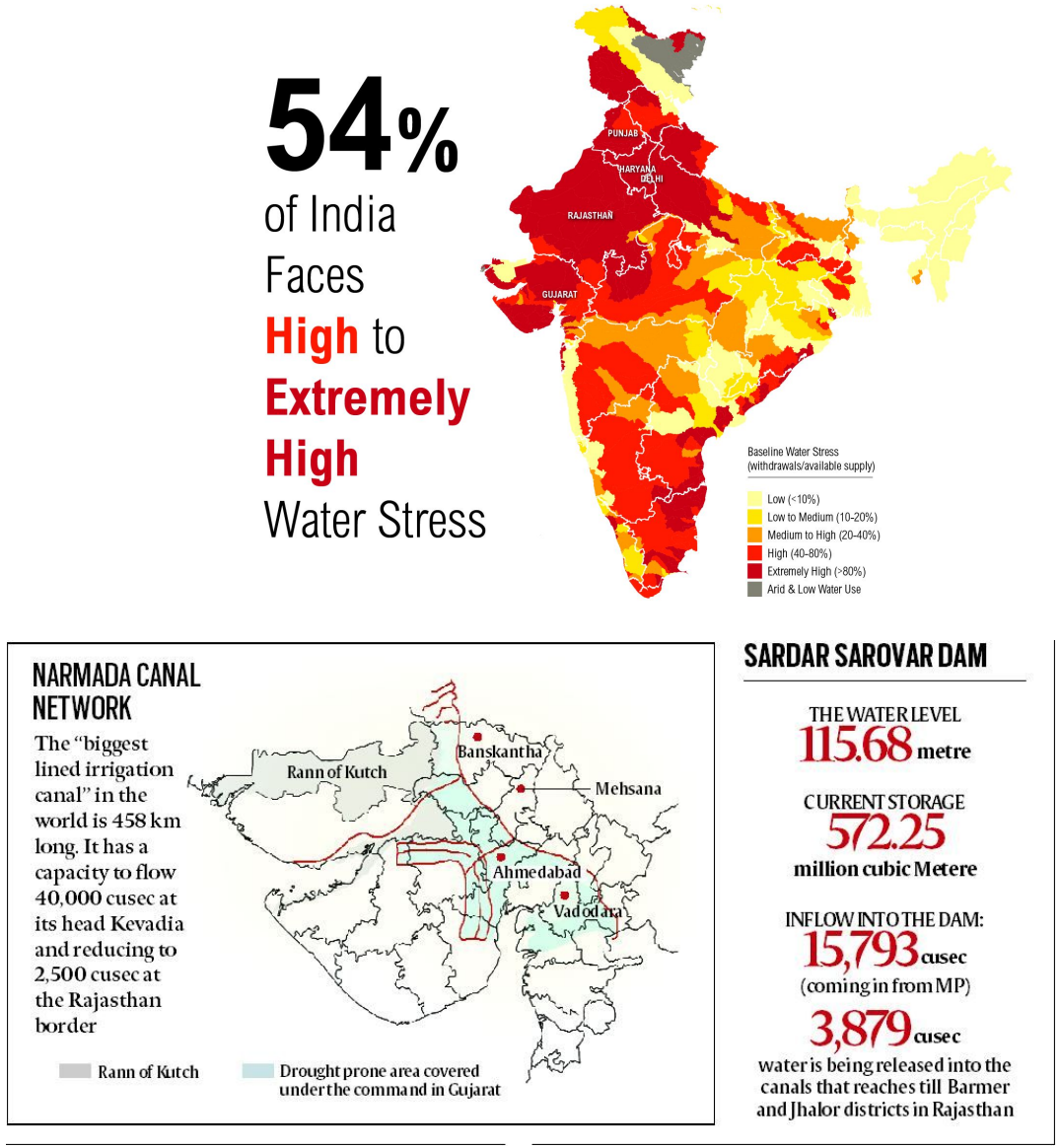
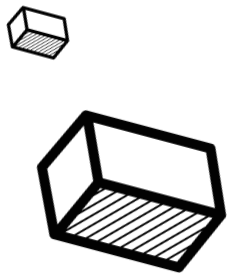


Fig 47 : Water stresses in India

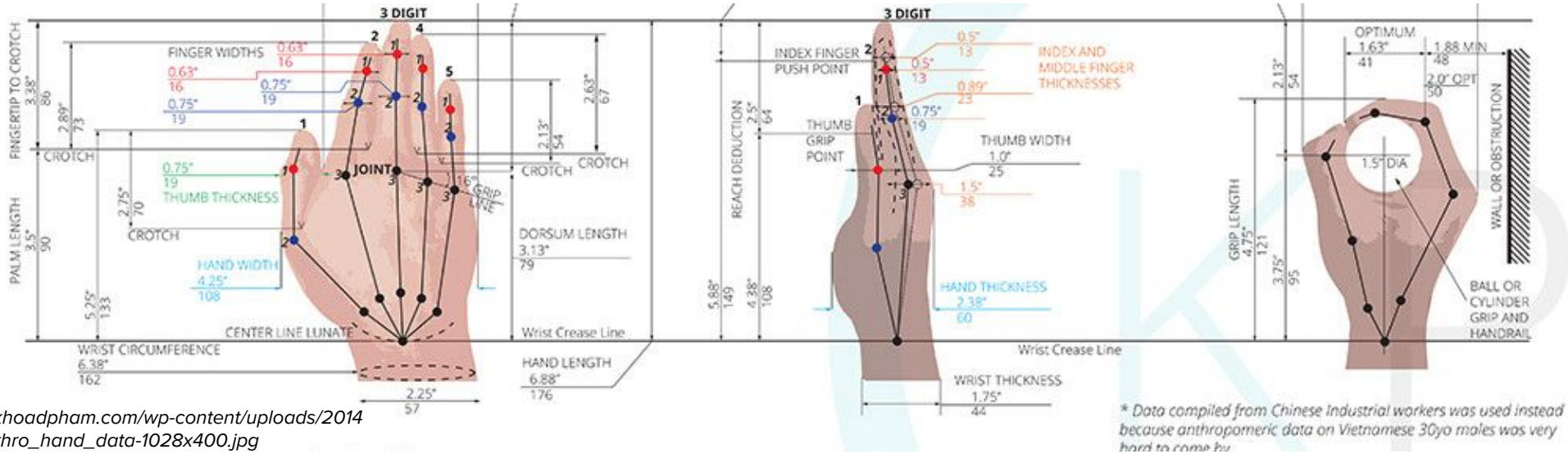


12

ANTHROPOMETRIC STUDY

STUDY OF ANTHROPOMETRIC DATA AND APPLICATION

R.No.	Parameters		Min	Percentiles					Max	Mean	±SD	Ratio
				5th	25th	50th	75th	95th				
1	**Weight, Kg.**	Male	34	42	48	54	62	76	118	57	11	
		Female	30	35	41	48	55	66	88	49.5	9.9	
		Combined	30	40	47	53	60	74	118	55.2	11.3	
2	**Normal standing**	Male	1396	1529	1598	1646	1688	1751	1939	1645	74	0.99
		Female	1276	1406	1457	1504	1548	1615	1681	1506	68	0.99
		Combined	1276	1439	1541	1610	1671	1741	1939	1607	98	0.99
3	**Stature**	Male	1486	1537	1599	1648	1691	1781	1950	1650	70	1
		Female	1288	1429	1478	1517	1567	1632	1711	1523	66	1
		Combined	1288	1465	1555	1619	1673	1771	1950	1614	87	1
4	**Eye**	Male	1293	1419	1485	1529	1571	1645	1821	1530	68	0.93
		Female	1215	1315	1368	1411	1454	1514	1600	1411	62	0.93
		Combined	1215	1355	1445	1507	1557	1633	1821	1502	84	0.93



http://khoadpham.com/wp-content/uploads/2014/01/anthro_hand_data-1028x400.jpg

* Data compiled from Chinese Industrial workers was used instead because anthropomeric data on Vietnamese 30yo males was very

MOTION STUDY

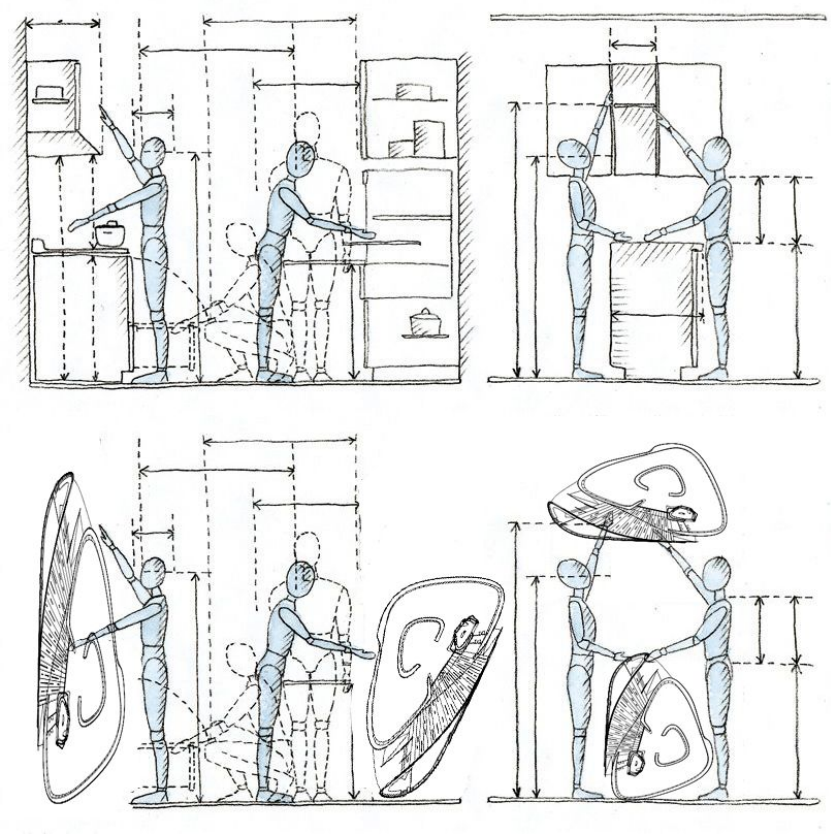


Fig 49 : Motion study of hand and body movements

Anthropometric data study is necessary for considering the ideal dimensions of a average human body for user centric design (*Fig 47 : Anthropometric Data).*

The figure shows motion study of an average person performing day to day task in different position.

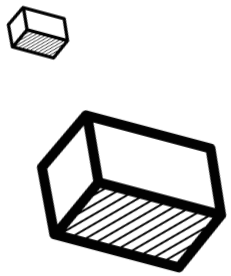
Its seen that repetitive long traverse of the ligaments cause more stress on the body also lifting ability of the person is reduced.

Continuous standing is also not advisable and the person should break in intervals.

Lifting and pushing actions cause strain on the back in both repetitive or heavy lifting action.

It is advisable to keep the arms near body while lifting heavy objects.

When a load has to be manually handled, it should be held or manipulated as close to the body as possible. Twisting, turning and bending of the back should be avoided.



13 MARKET STUDY

MARKET STUDY

Market study is basically conducted to see which are the existing products so that new ideas can be generated and repetition of product should not take place.

In the market study conducted, we found that one the most popular manually operated brick moulding machines are QMR2-40 and T-500

QMR2-40

QMR2-40 manual clay block making machine is one new kind of small manual brick making machine, which is cheap and durable, easy to operate and no need power.It is quick in product forming, high in product density and strong in pressing power.

After remolding, people can stand on the brick. Consumption of materials can be reduced. This machine uses a mixture of soil and cement to make stabilized bricks at a ratio of between 5 and 10% cement to soil, depending on the soil type available.Bricks are interlocking so there is no need for mortar when building. Easy Operation. Hand press concrete /cement brick making machine

Fig 50 : Manual interlocking block machine

1.Raw material ratio:
A:Method one: 5% cement + clay
Method two: 8% cement + clay
Method three: 10% cement + clay
Method four: 10% cement + sand
2.What kind of bricks can be produced by the machine?
A:Our machine can produce interlocking brick, paver brick with differents sizes.Different bricks can be made by changing different moulds.
3.What models of the machines can be choosed for customers?
A:We have full auto , semi auto, manual ,mobile, egg laying , paver machine for your choice.
4.How about the working life of our machine?
A:Our machine can be used for over 8 years.

Fig 51 : Fábrica bloquera T-500

Fábrica bloquera T-500

The Bloquera T-500 is manual brick moulding machine which moulds bricks directly at the drying area

Basically, it has two parts one is the mould which is an open ended box with lever. The second is the emboss plate which compresses the mixture in the mould for making a firm and even brick

Produces	Pieces per pallete	Parts made in 8 hours
Producto	**Piezas por tarima**	**Piezas fabricadas en 8 hrs.**
Block 10x20x40 Sólido o con huecos	1	200
Block 12x20x40	1	200
Block 15x20x40	1	200
Block 20x20x40	1	200
Tabicon 10x14x28	2	400
Adoquín Hexagonal 20x23 cms	2	400
Adoquín Tabasco (I) 16x20 cms.	4	800

COLOUR CODING

Understanding the color code for agricultural shops can help workers identify switches, control knobs, adjusting handles, and hazardous areas. Additionally, introducing color into a work area creates an attractive place to work. The colors used to mark agricultural shops are much easier to identify than text messages. When color, along with universal symbols, is incorporated into an agricultural shop, safety becomes less dependent on the need to read signs. This is helpful with an international workforce that may not read English as the primary language. The key is to learn the color code and encourage everyone to adopt it.

The safety colors are:

Red: Fire equipment, safety switches, and other types of emergency equipment are red.

Orange : Electrical controls, switches, and levers have orange background.

Yellow : Levers and adjustment knobs are yellow.

Blue : Machine is “out of order”

Green : Safety equipment is identified by safety green. first aid, safety areas, and areas where medical treatment is given.

Grey : Work area floors, tabletops and the bodies of machines, for good visibility with contrasting machine.

White : Marks traffic flow around the workshop area.

Black-and-white stripes: traffic control

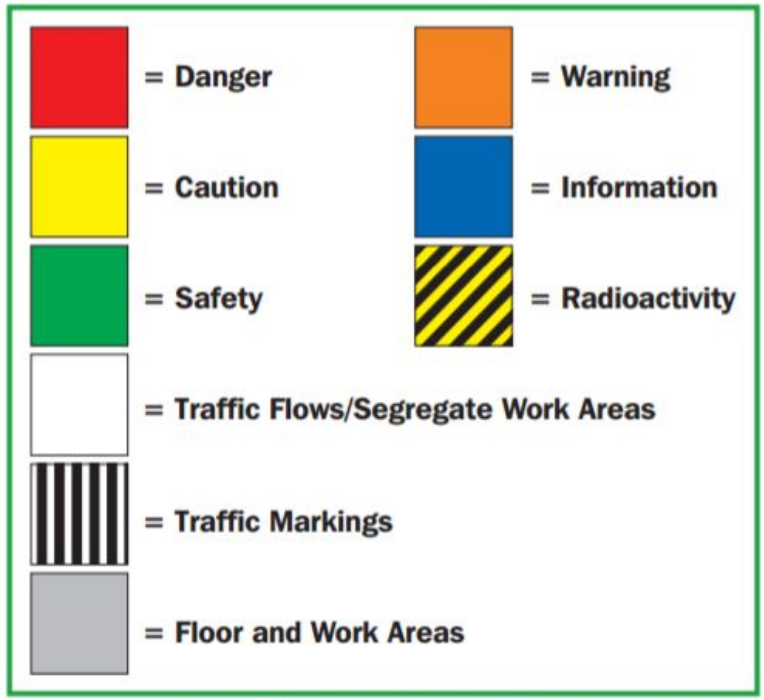
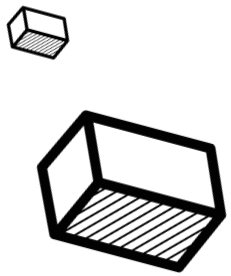


Fig 52 : The nine safety colours



14 IDEATIONS

IDEATION 1

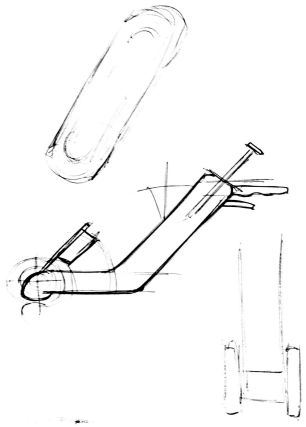


Fig 53 : Basic flap plunger concept

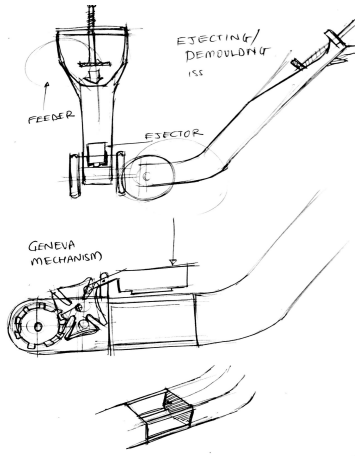


Fig 54 : Ejector with geneva mechanism

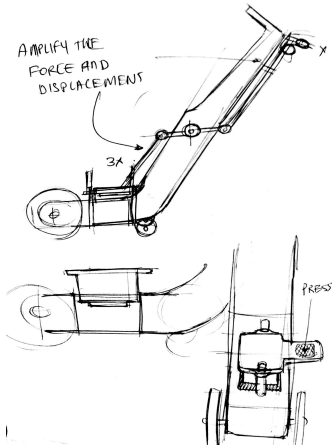


Fig 55 : Ejector with connected bar mechanism

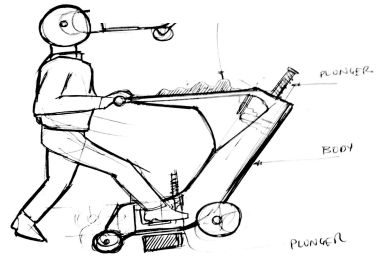


Fig 56 : The pedal type ejector

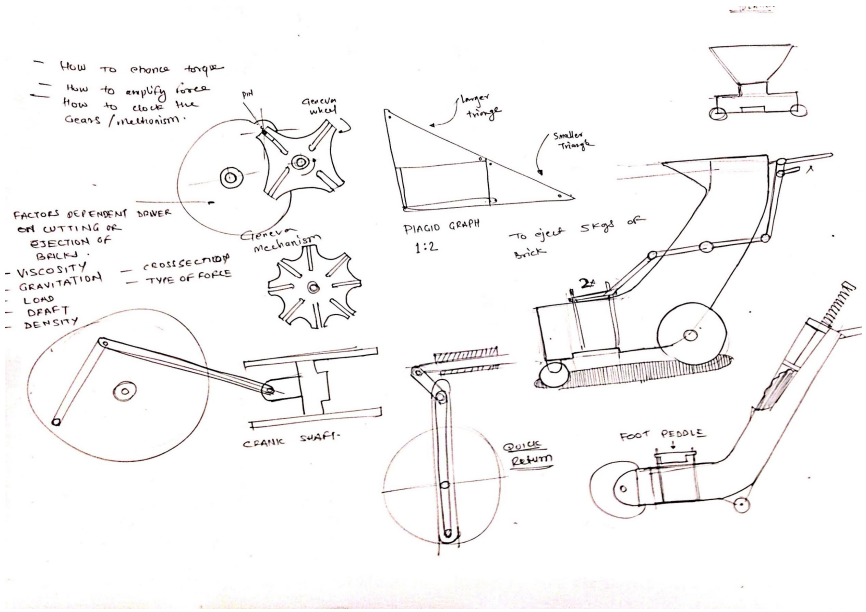


Fig 57 : Different type of mechanism which can be used for the concept. but the most suitable mechanism is the connected bar mechanism.

Fig 58 : Final render of the model with the foot pedal type concept

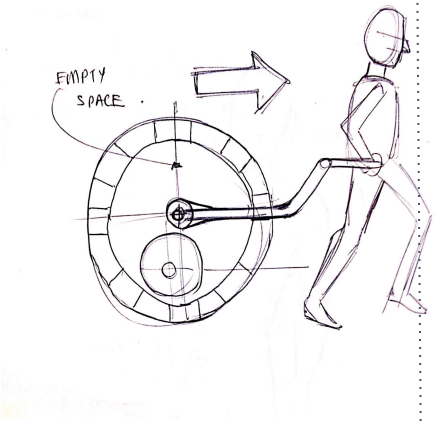


Fig 59 : Pull type type wheel concept

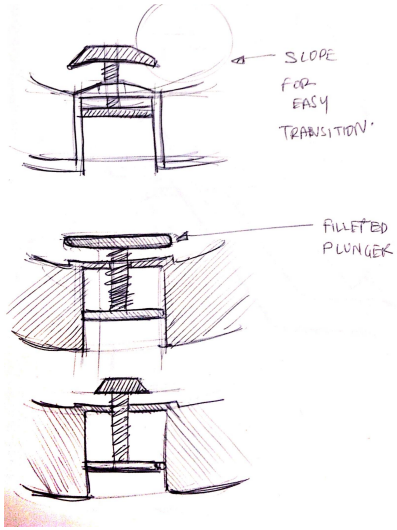


Fig 60 : Types of plunger with different curvature

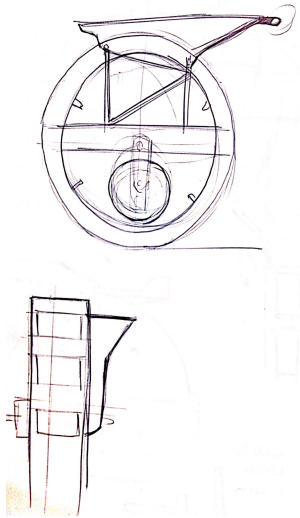


Fig 61 : Orientation

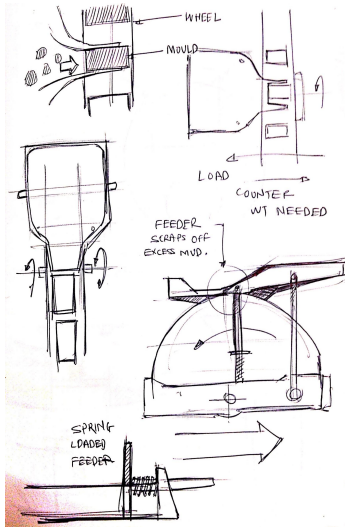
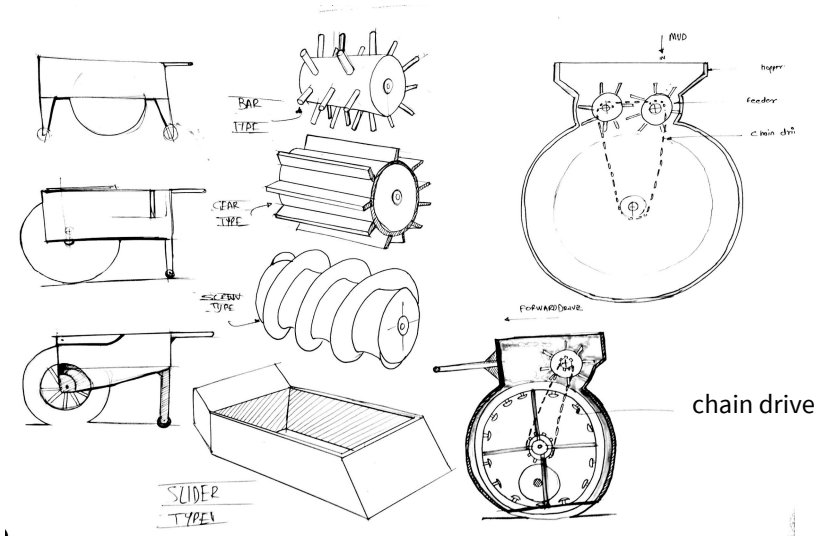


Fig 62 : Feeder mechanism



chain drive feeder

Fig 63 : Different types of cart and feeder mechanisms

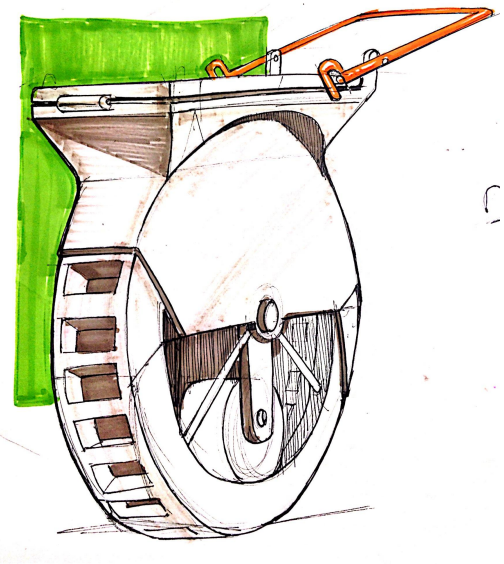
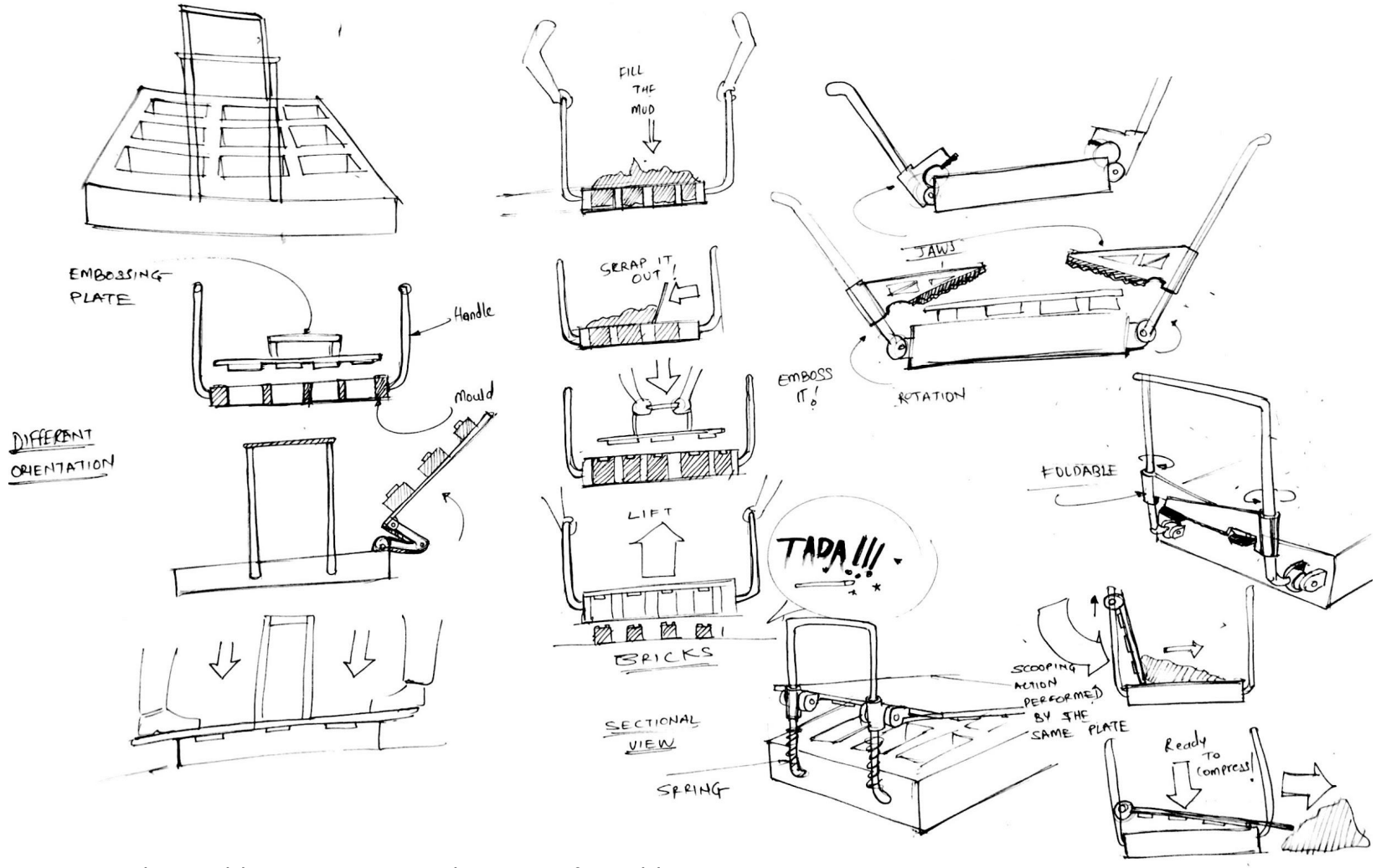


Fig 64 : Concept with Wheel type.

IDEATION 3



Instead of using on single mould we can use combination of mould on a single go.
Use of emboss plate can help to brand the brick as well as eject the brick from the mould.
Use of jaws and hinged handle can help to eject the brick faster.

Fig 65 : Use combination of mould on a single go.

IDEATION 4

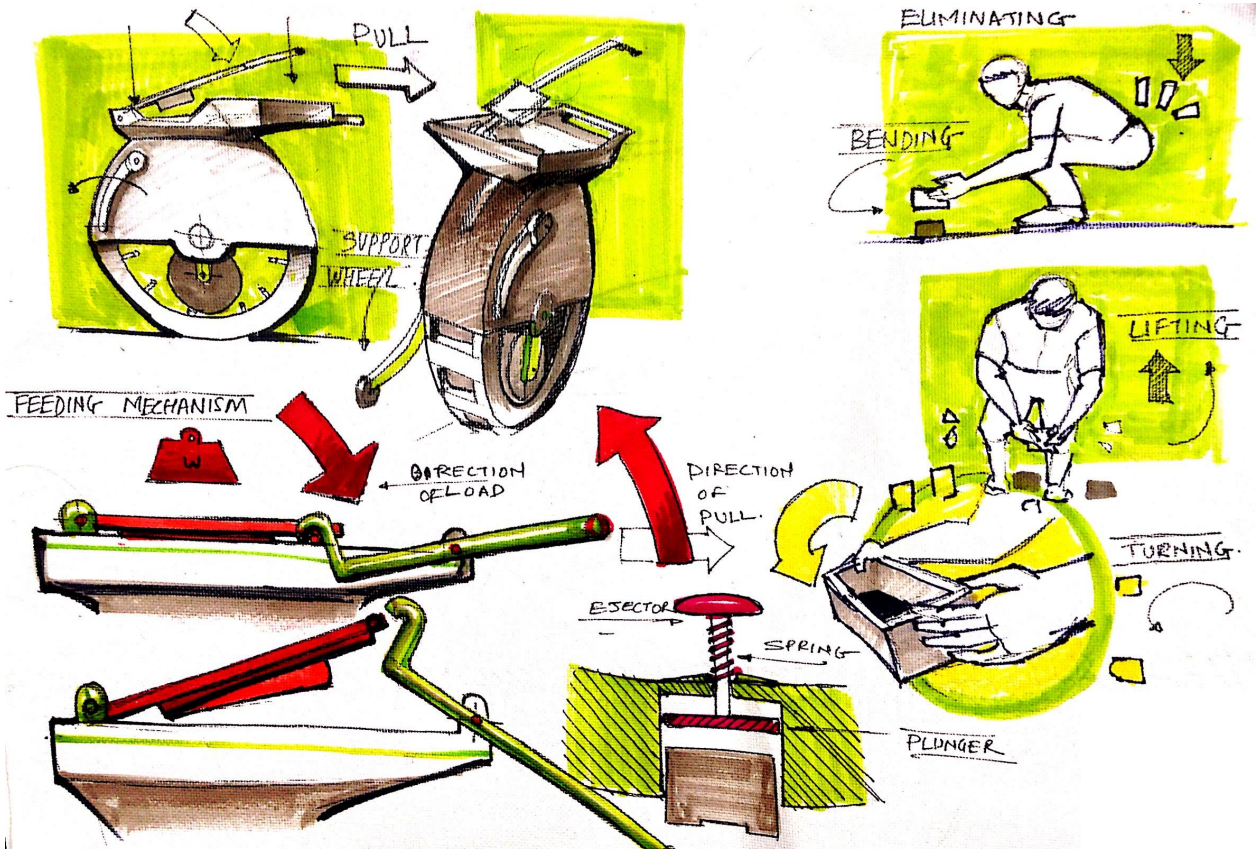


Fig 66 : An offset wheel which acts as a dead weight pushes the plunger on the moulds which pushes the bricks out

Rolling Barrel type

This concept has a number. of moulds on it circumference.

Each mould has **spring loaded actuator**, to push the brick out.

The central hub has a **follower** which presses the actuator.

The feeding action is based on lever type. The feeder is fed with the mud and the the cover is closed by the feeding person and locked the auxiliary lever is pulled by the person which locks the cover and creates pressure on the mud which pushes the mud in the mould.

Pulling action makes the wheel rotate due to which the filled mould comes on the ground

IDEATION 5

Tumble mould type:

This type mould has mould on both the faces.

Box moulder:

This mould has slots in the box for moulding with a embossing plate over it .

The plate can be used for branding,scrapping feed and ejecting bricks.

Two workers are required for this operation.

First worker feeds the moulds and evens it.

The second person lifts the mould by using the bar and topples in on the ground.

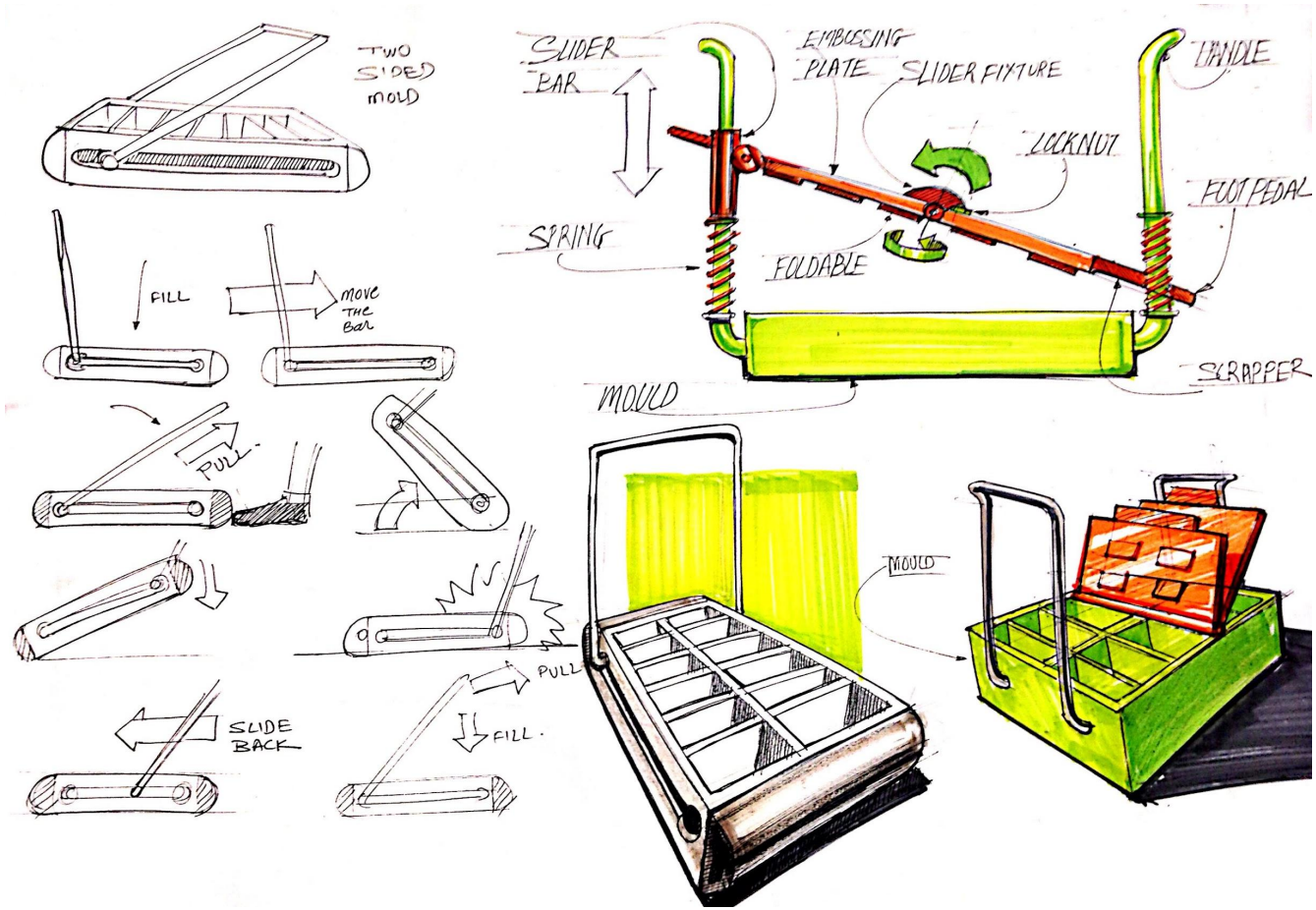


Fig 67 : Tumble mould type

IDEATION 6

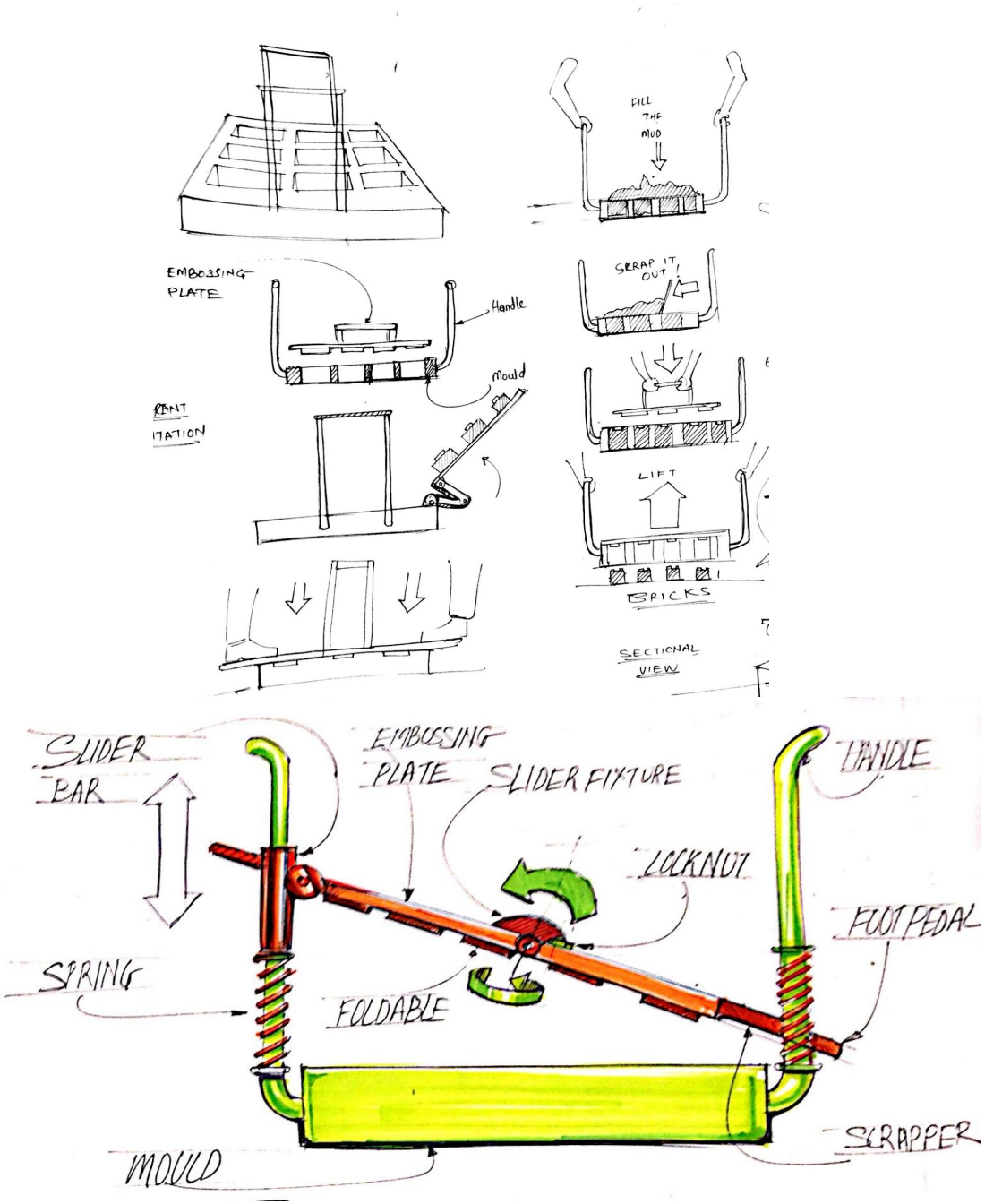


Fig 68 : Foot press concept

Foot press concept

In this concept open ended mould is used. The mould is placed on the ground where the laying and drying is suppose to happen. The mould is filled by the mud lumps made by the worker or just by evenly spreading it by hands or plough.

The emboss Plate is then opened and the its pressed against the mould so that the mud in the mould can get compressed. Later the mould is lifted by two people along with the plate.

Process elimination:

Twisting action of hands, repetitive bending, transfer and repetitive manual handling of bricks is reduced.

Cons:

- Heavy to lift.
- The person needs to sit on the ground or bend to fill the mould.

IDEATION 7

Table type brick cutter
This concept consist of a cylindrical cutter which is rotated by rotation of flywheel which helps to keep a constant pace.

The mud fed in the machine is in a precompressed slab which is done by another machine.

The slab is cut and moved forward by using knurled conveyor.

Pros :

- Simple and easy to make.
- Easy maintenance.
- Batch type brick moulding.

Cons :

- Needs clay extruder for brick slab.
- Requires more of human force.

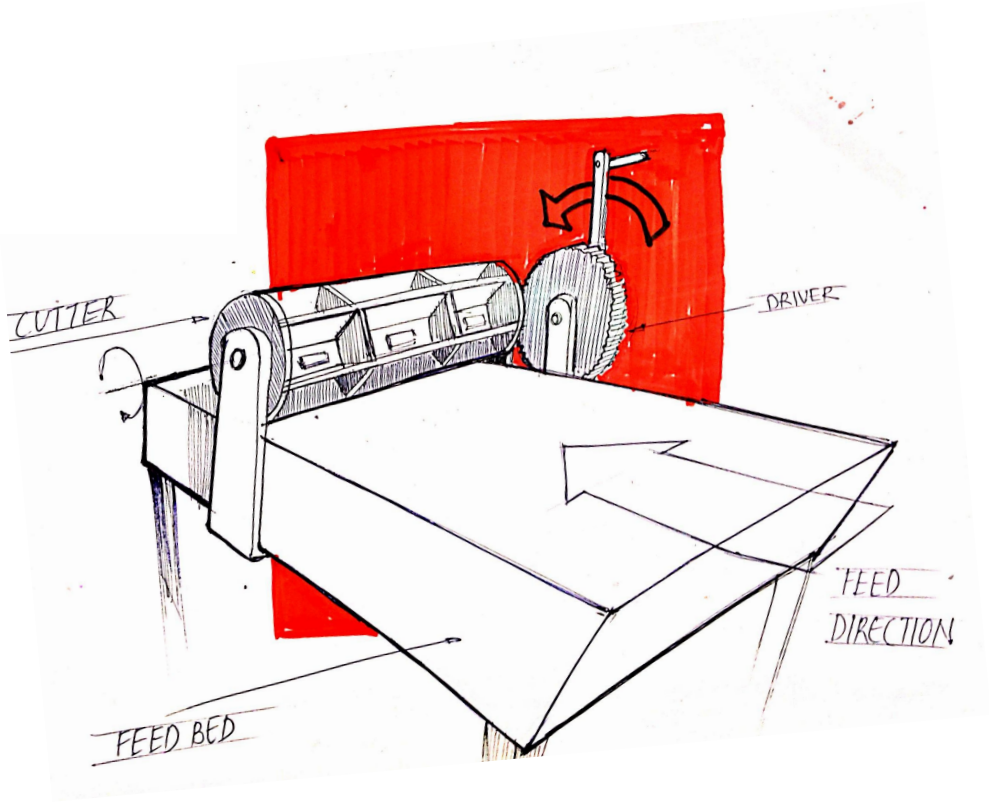


Fig 69 : Table type brick cutter concept

IDEATION 8

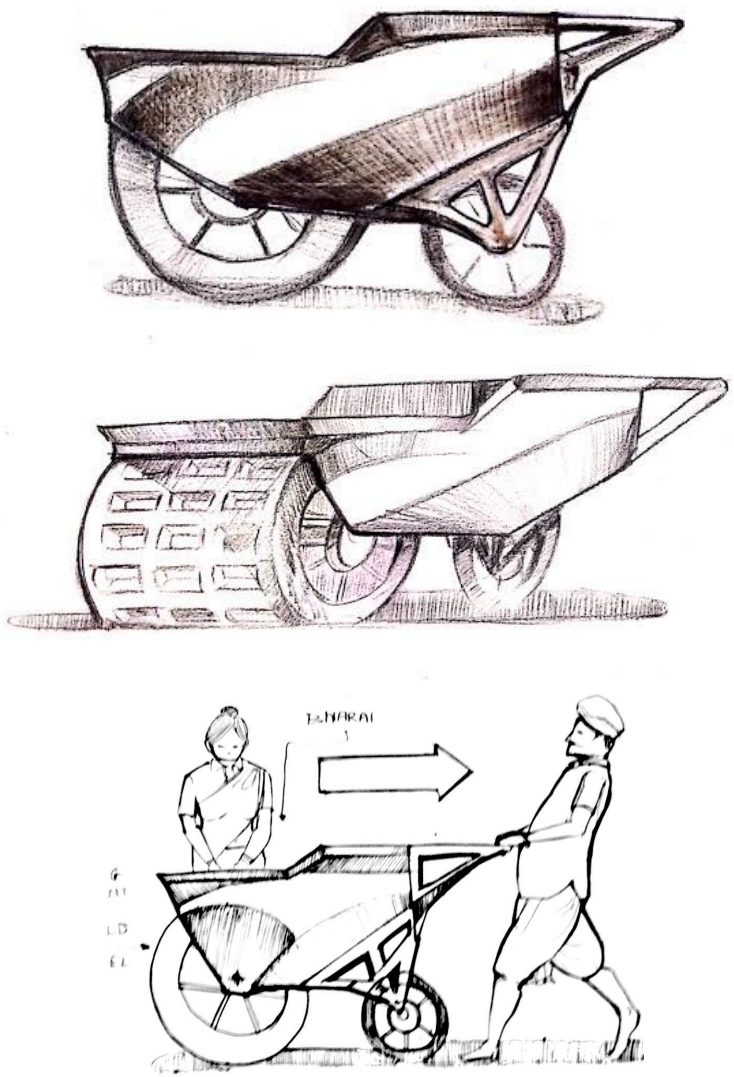


Fig 70 : Wheelbarrow type concept

Wheelbarrow type (Manual feeding)

This concept consist of a cylindrical type mould. which ejects the bricks by using the ball bearing concept which creates sudden jerks for even filling and extraction of mould.

For continuous feeding of mud is possible.Three people can operate this cart. A person is required for filling of mould by hand and other person to pull the cart and feed the cart with mud.

A feeding barrel can be used for pressurized feeding of mud in the moulds.

Pros:

- No bending is required
- Excess operations are eliminated,less time consuming,continuous process

Cons:

- For feeding the person needs to lift the mud and fill the cart
- Complex to manufacture

IDEATION 9

Wheelbarrow type concept ideations

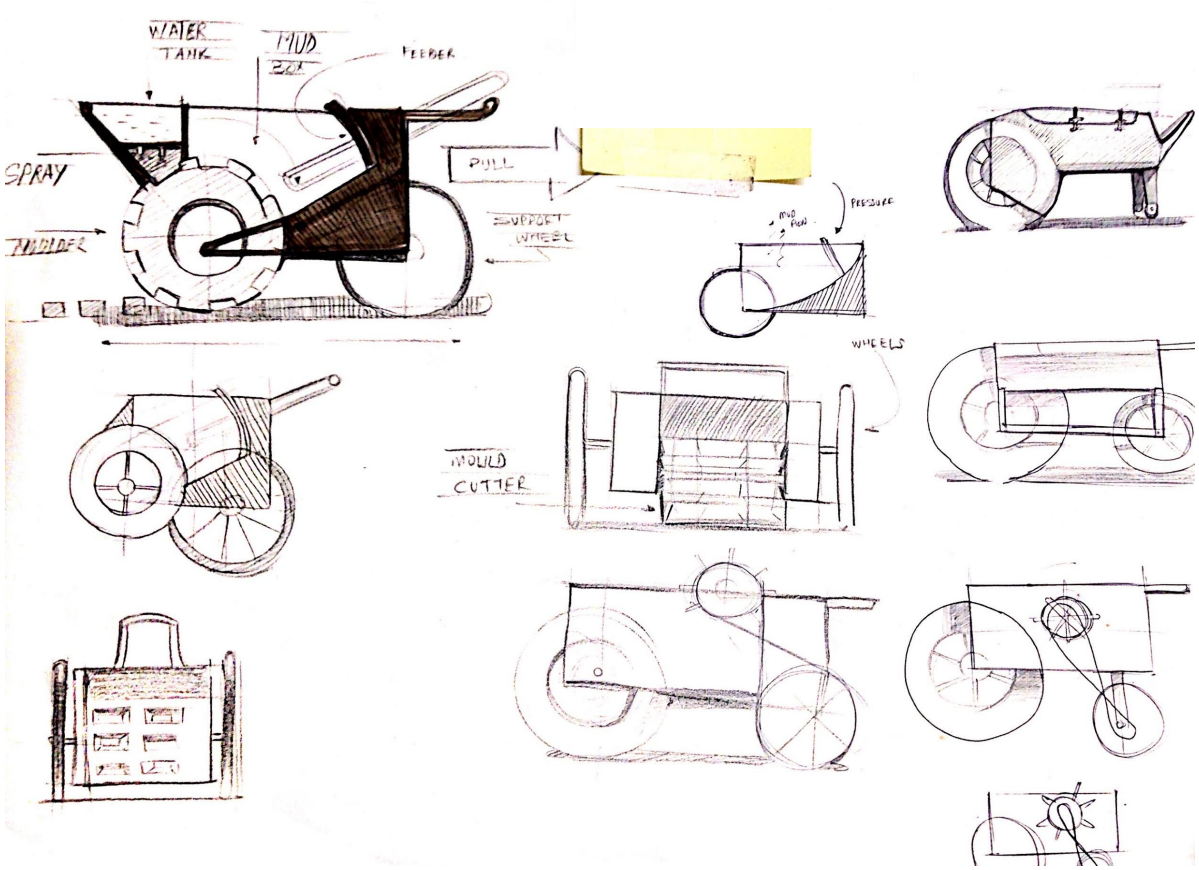


Fig 71 : Different types of automated feeding mechanism for the cart concept to eliminate manual feeding of the moulds

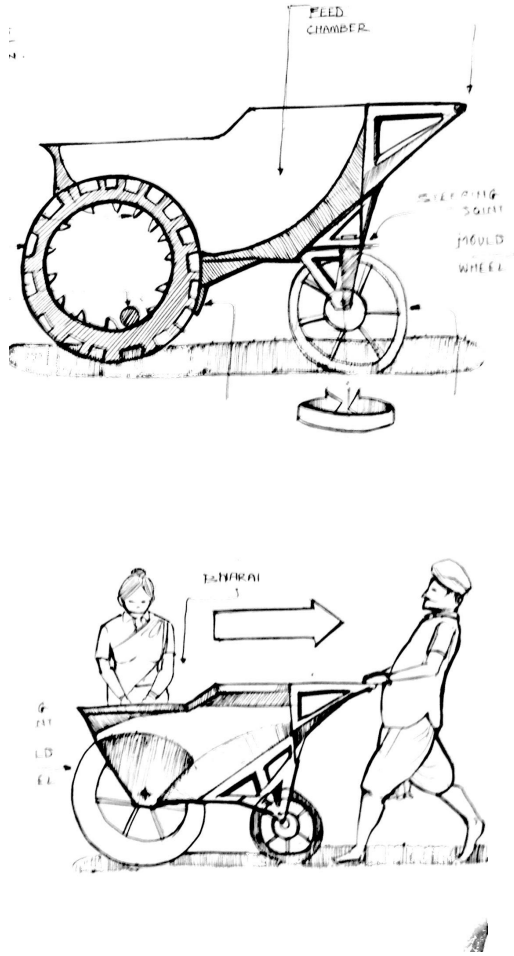


Fig 72 : Representation of the workers operating the cart.

IDEATION 10

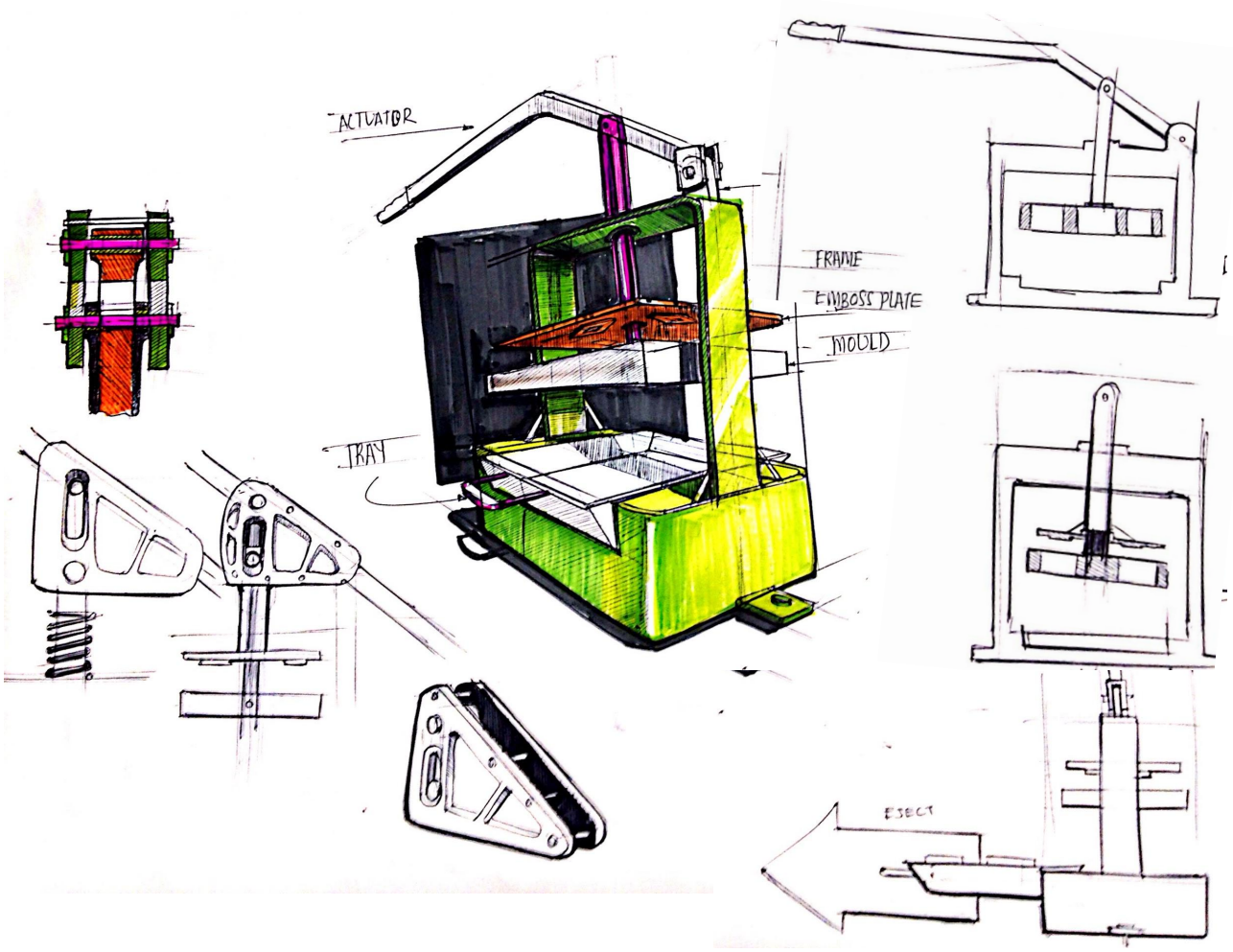


Fig 73 : Punching Machine type concept

Punching Machine Type:

The concept comprises of two plates,one hollow with brick mould and another with logo.

This concept is operated by three workers which, one person feeds the mud from the mud pit, 2nd person prepares the mud lumps and cleans the mould, the third person operates the mould and the fourth person carries the brick tray to the drying area.

This machine has two stage punching.
1st stage:brick mould punches the brick
2nd stage: punches the logo and compresses the brick.

Pros :

- Minimal design.
- Easy transfer of bricks in a tray in trolley.
- Multiple bricks moulded at a time.
- Mud is filled with pressure for better strength.
- Eliminates hand twisting action
- Robust and frugal

Cons :

- Heavyweight.
- Feeding is difficult
- Requires casting for certain parts.
- Requires more manual handling of bricks
- Repetitive pulling action can cause stress on arms
- weight of mould is heavy.

Process influence:

- moulding and demoulding on the ground eliminated.
- brick transfer from ground eliminated.
- bending and wrist stress is reduced.

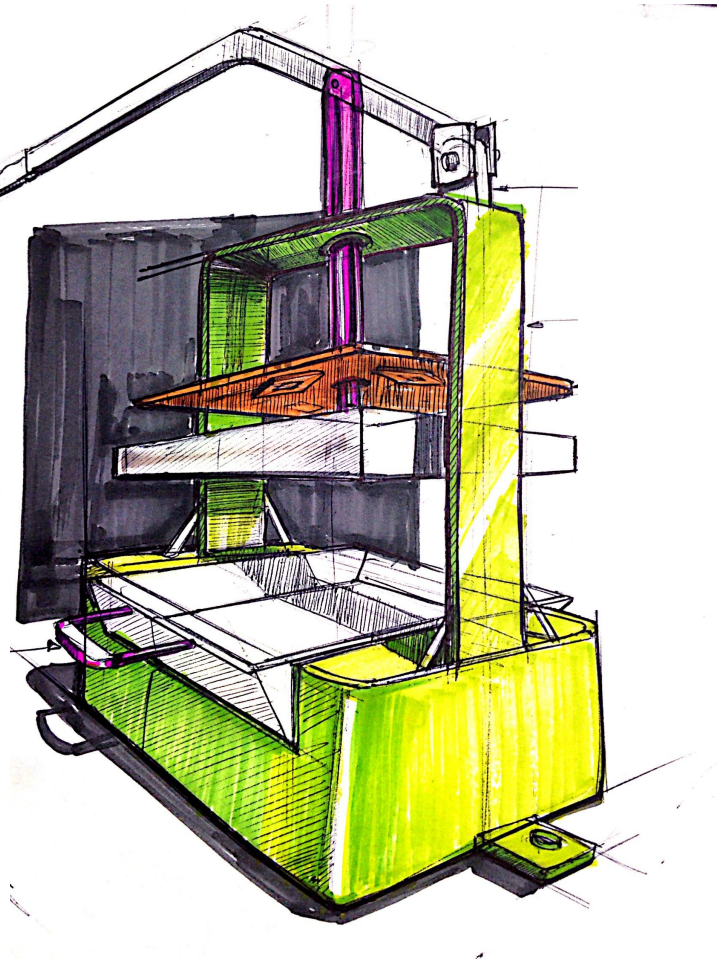


Fig 74 : Punching Machine type concept

IDEATION 11

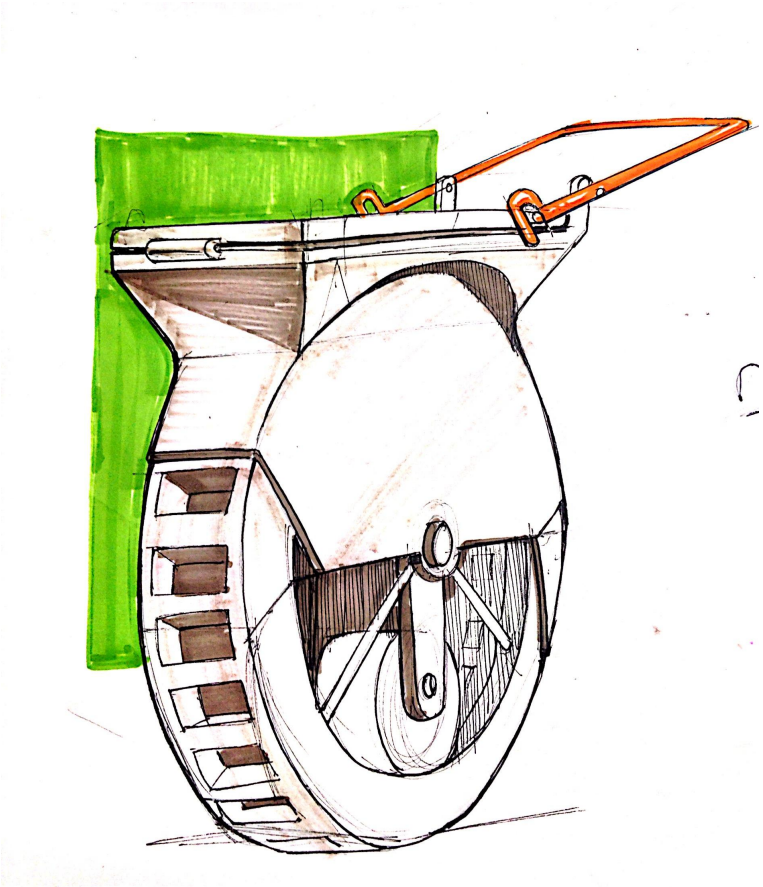


Fig 75 : Wheelbarrow type concept

Pros :

- Direct laying of bricks on the drying area.
- Easy transfer of bricks.
- Multiple bricks moulded at a time.
- Easy to turn.
- Mud is filled with pressure for better strength.
- Robust and frugal

Cons :

- Balancing issue.
- Continuous feeding not possible.
- Complicated construction.
- The person needs to stop multiple times for feeding.

Processes influenced:

- Brick moulding on ground by hand
- Transfer of bricks from moulding area to drying area.

IDEATION 12

Why moulding on station?

- Better working position
- Less travel
- Brick transfer at shoulder level
- Increased efficiency

By incorporating the semi automated brick moulding machine the the stress on the hands will further reduce.

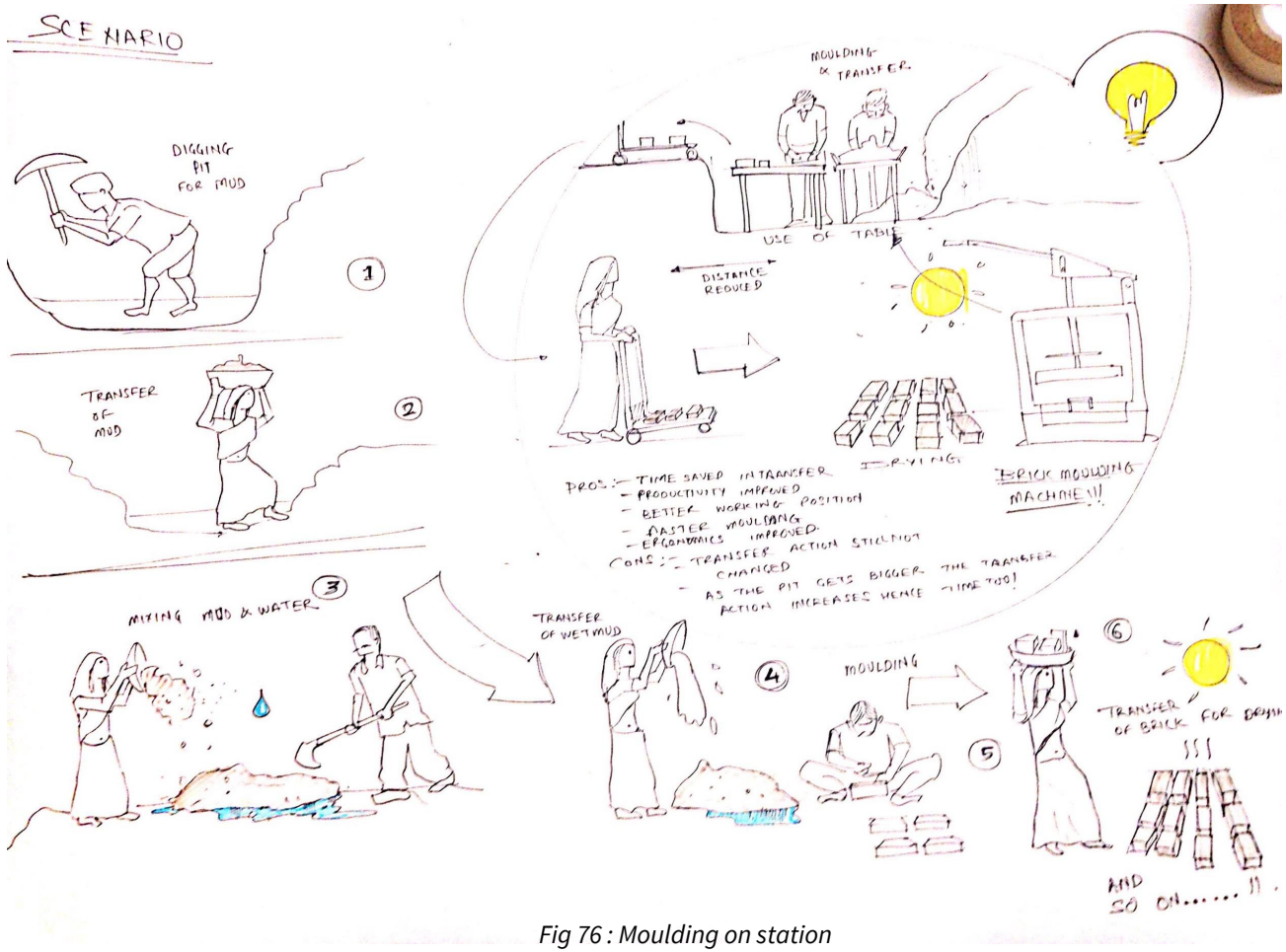


Fig 76 : Moulding on station

IDEATION 13

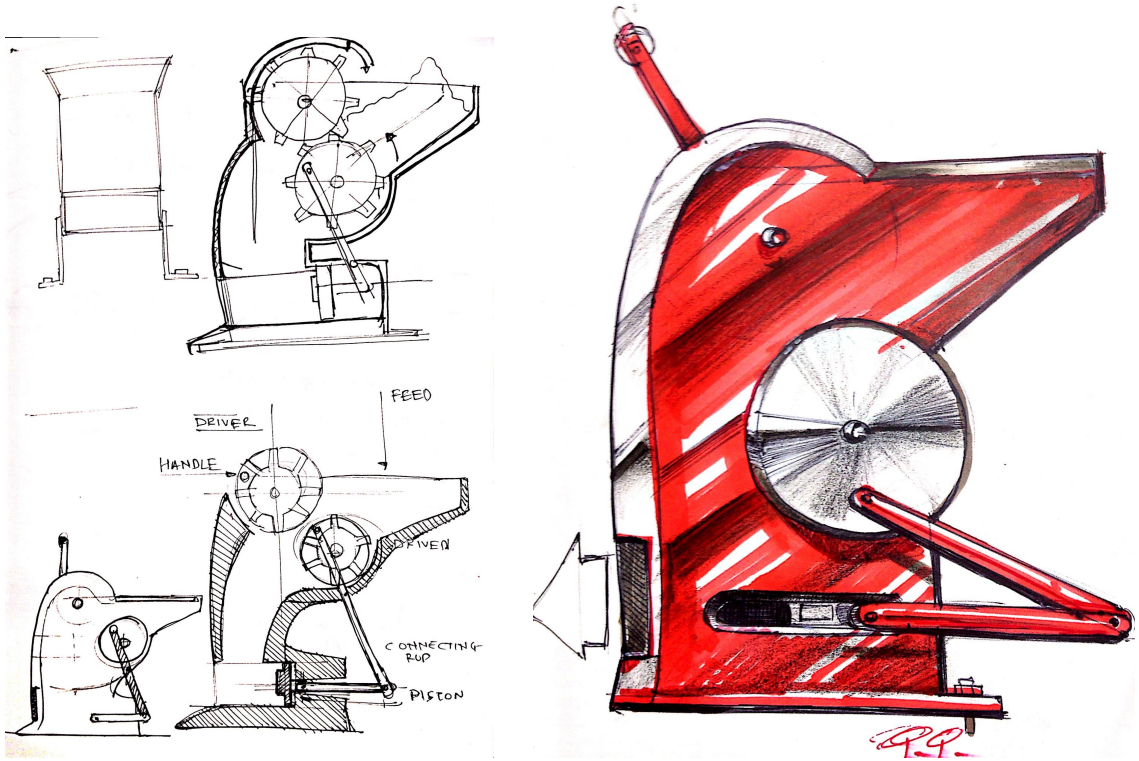


Fig 77 : Table top brick moulder

Table top brick moulder

This type incorporates two feeding wheels which is manual driven,the bottom wheel is connected to the piston which ejects the brick out.

Pros :

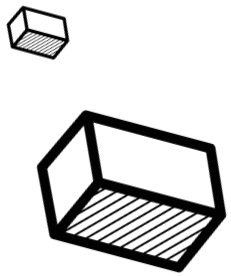
- Easy and simple design
- Eliminates stress on palm and hand
- Automould refilling
- Mud is filled with pressure for better strength.
- Eliminates
- Compact design

Cons :

- Requires high torque to turn the wheel.
- Will better work with a motor.
- Manufacturing cost is high

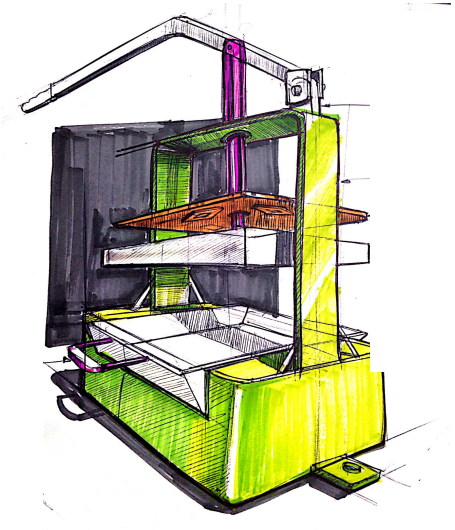
Process influence:

- moulding and demoulding on ground with twisting action is eliminated.
- brick transfer from ground eliminated.
- time saving as the number of operations are reduced

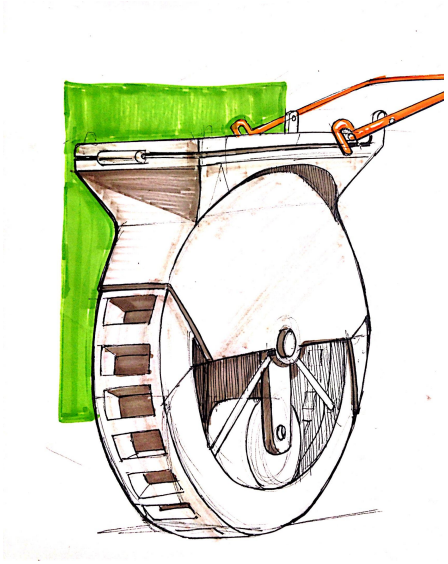


15 CONCEPTS VERSION I

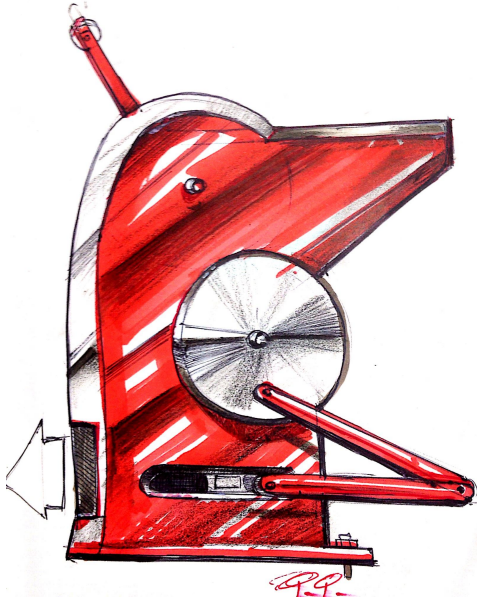
CONCEPTS VERSION 1



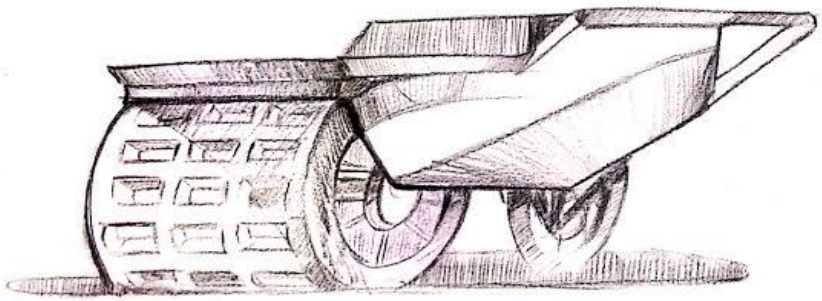
CONCEPT I : Platform type brick moulder



CONCEPT II : wheelbarrow type brick moulding machine



CONCEPT III : Table top brick moulder



CONCEPT IV : wheelbarrow type brick moulding machine whine horizontal mould arrangement

These four ideas were filtered after considering pros and cons of each ideation.
Which categorizes as two table top concepts and two pushcart type concepts.
The main criteria for selecting most ideal concept are:

1. The design should be minimal
2. The fabrication of the design should be frugal
3. The overall cost should be kept low.
4. The machine should not be fully automated.

CONCEPT A

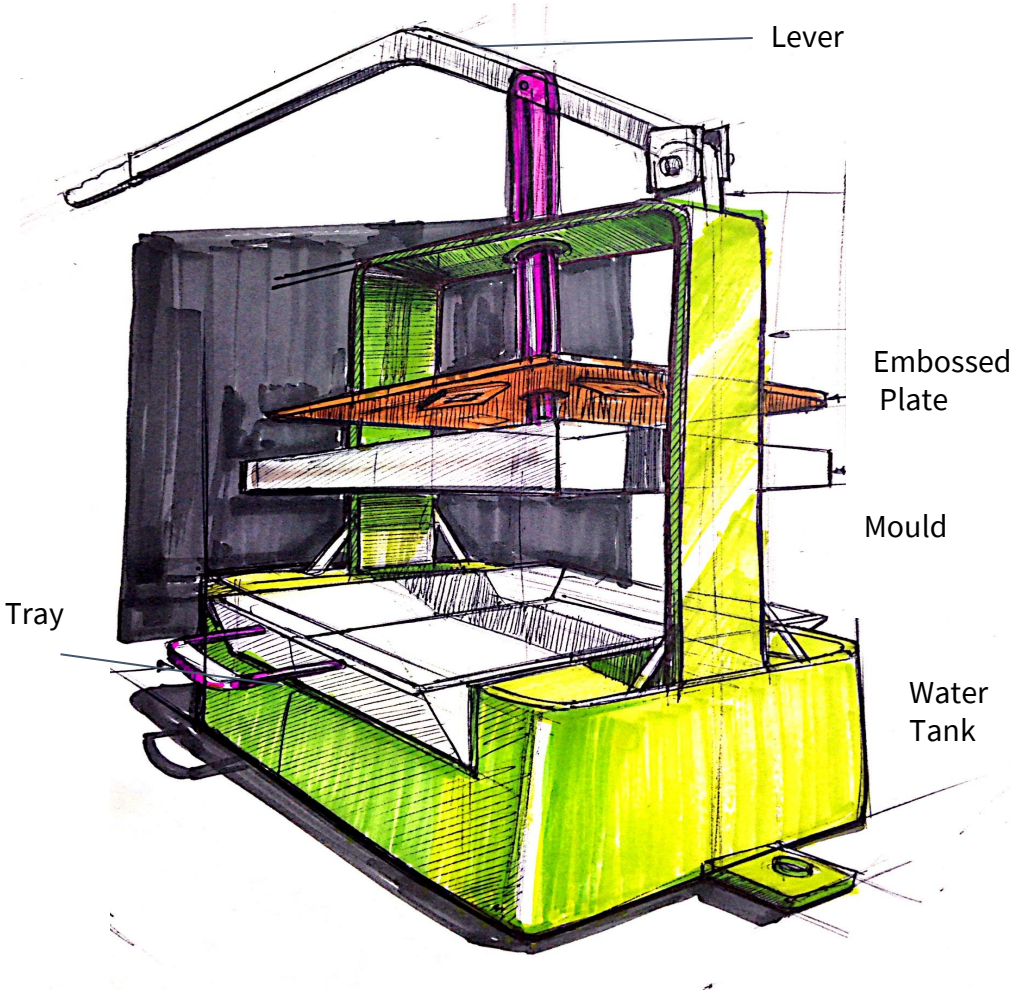


Fig 78 : Platform brick moulder

Platform brick moulder

The concept is considered based on the simplicity of moulding bricks by on lever action.

The concept consist of frame with a removable tray with a mould and a cover plate linked to the lever.

Its simple and minimal design made it one of the optimal design solution to the problem addressed

The working of the concept is as follows:

1. A empty tray is inserted over the water tank and the mould is brought down to set on the tray .
2. Mud is then filled in it and levelled after which the cover plate is brought down and pressed against the mould to create an impression.
3. Once it is done the lever is pulled up to lift the mould and the cover plate so that it releases the brick. The tray with the bricks is carried away and the mould is dipped in the water tank lubrication and lifted up so that a new tray can be inserted over the water tank.

This concept was selected on the basis of:

- Easy design and manufacturing.
- Suitable for platform moulding as platform
- Moulding is already been accepted by the workers in that particular kiln.
- Robust design which can withstand bad conditions.
- Use of tray makes carrying the bricks easier.

CAD MODEL FOR CONCEPT A-1

Fig 79

VARIOUS PARTS OF CONCEPT A-1

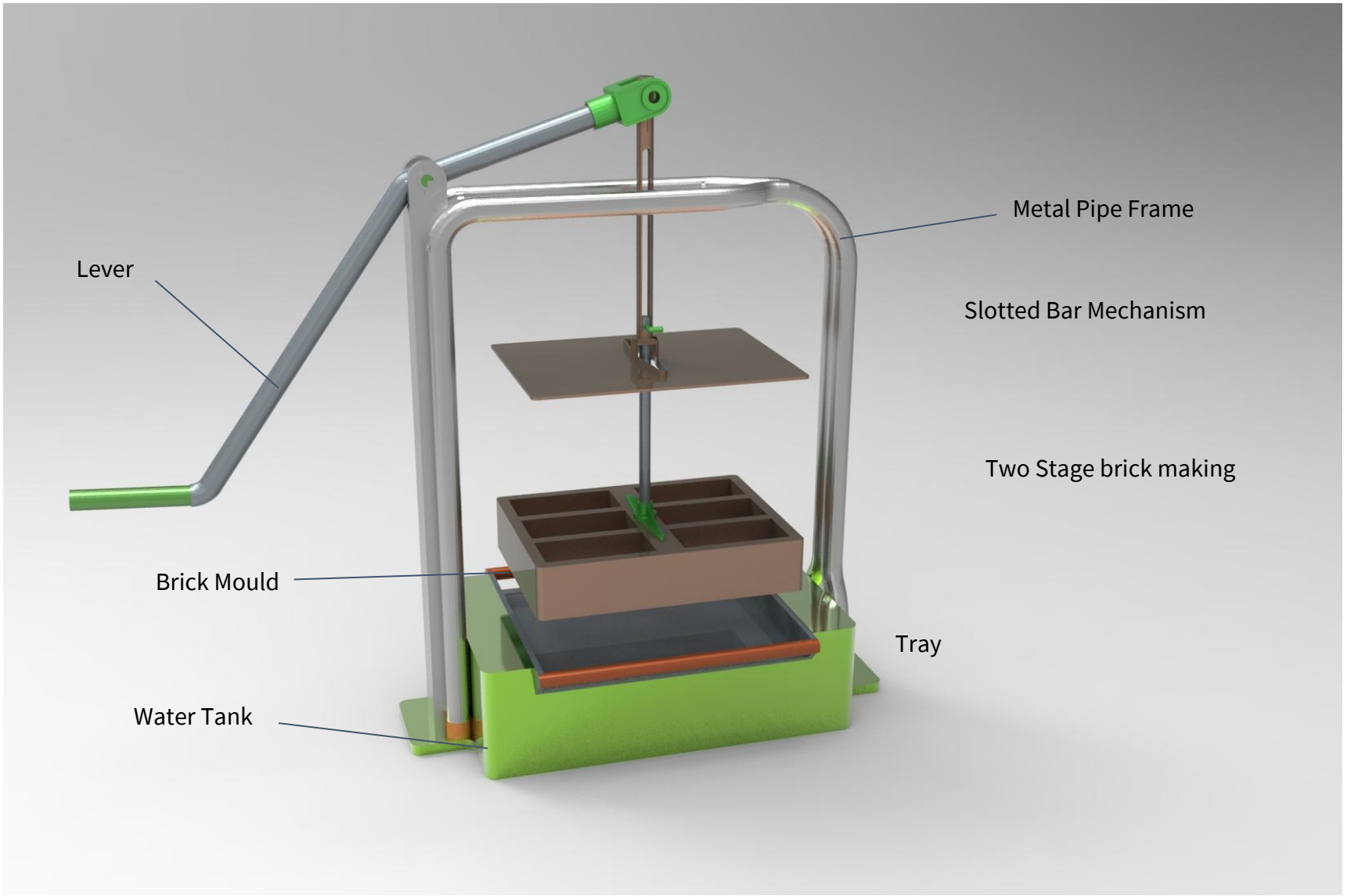


Fig 80 : Detailed parts of concept A1

CAD MODEL FOR CONCEPT A-1

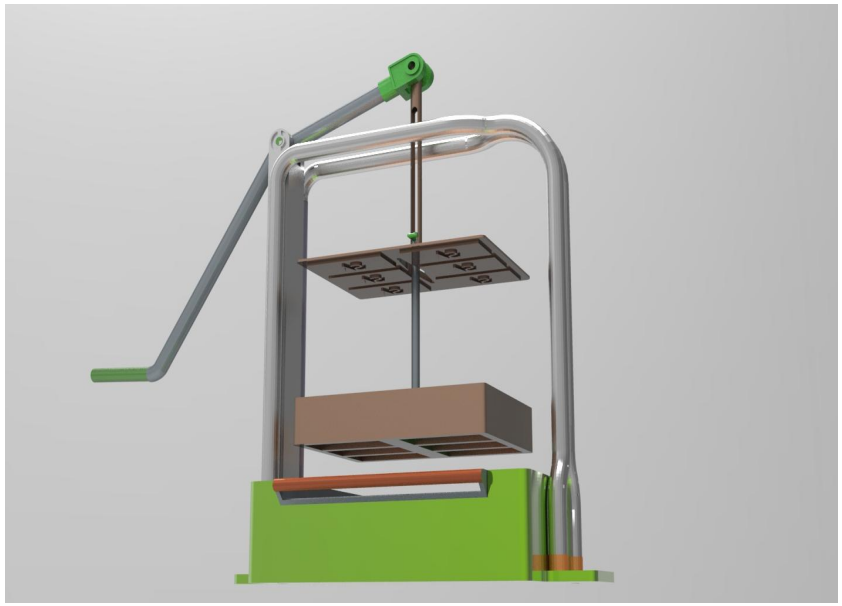


Fig 81 : Body

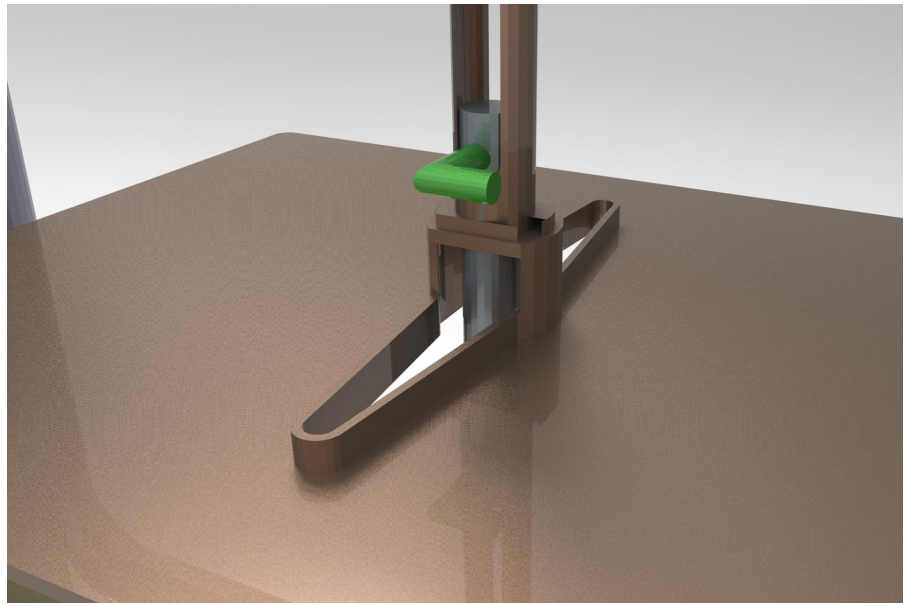


Fig 82 : Cover plate details

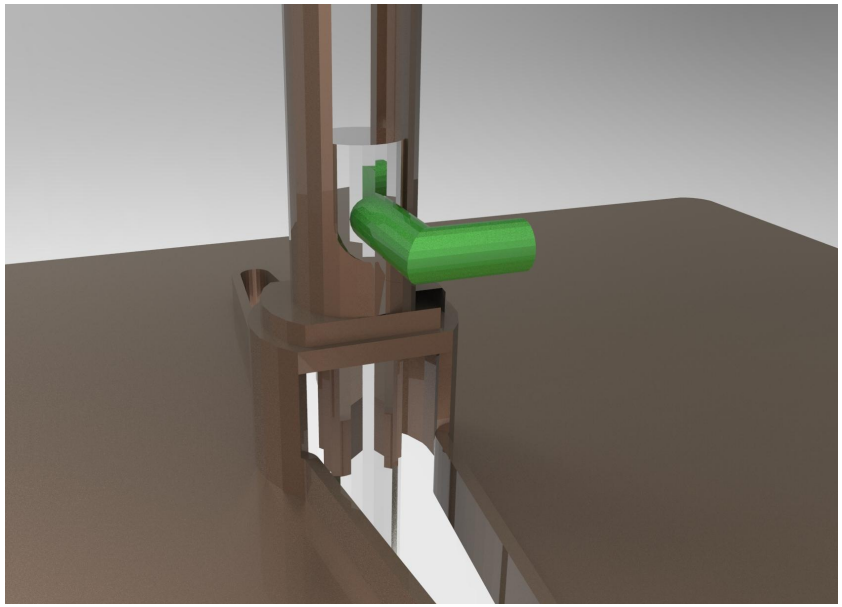


Fig 83 : Slotted bar

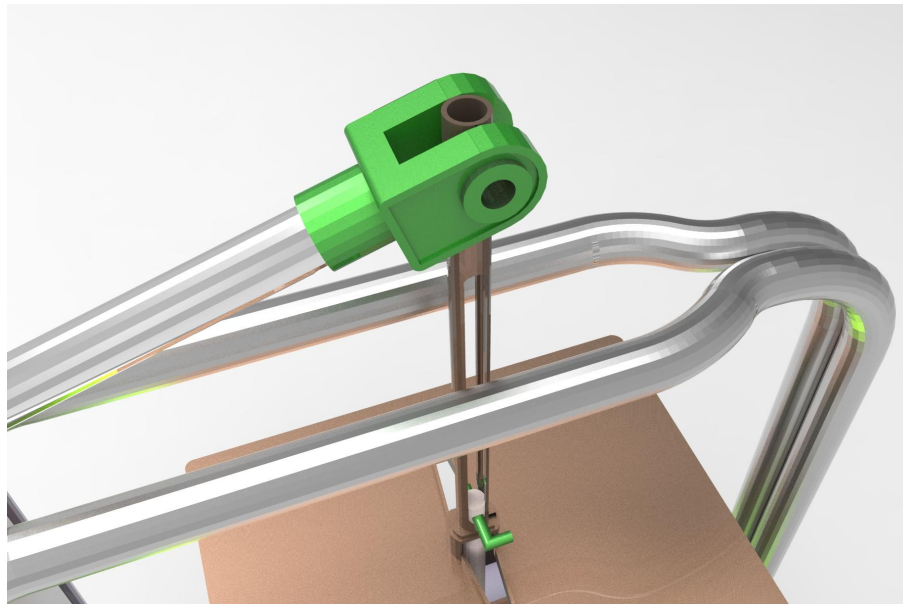


Fig 84 : Coupling detail

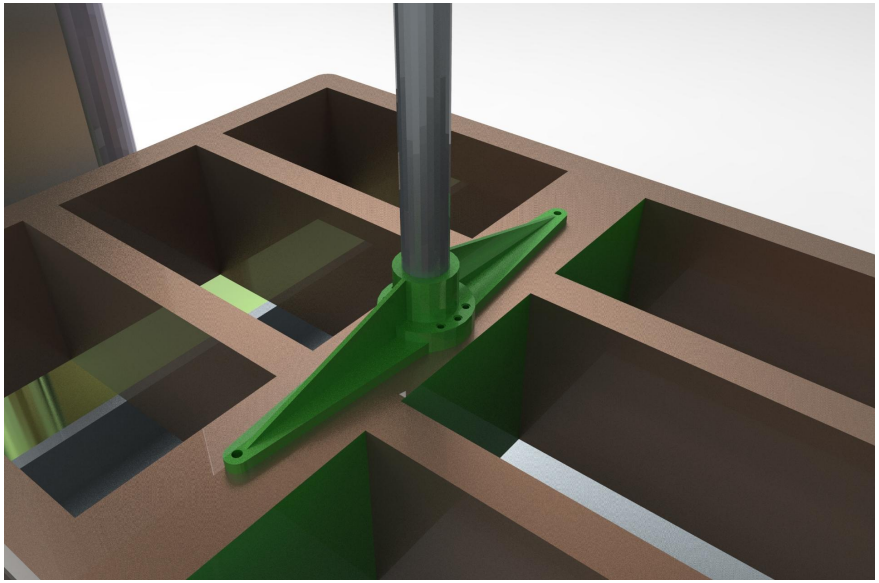


Fig 85 : Joinery Detail and mould

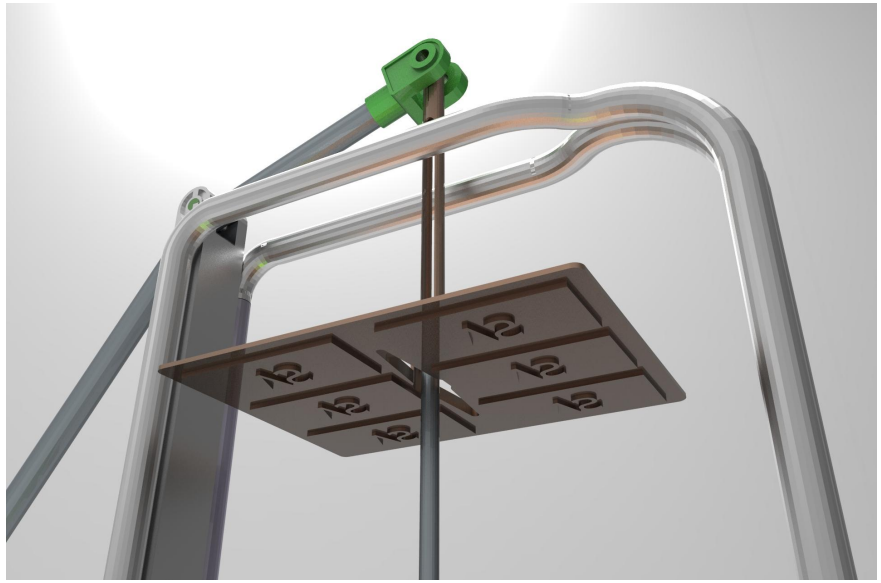


Fig 86 : Cover plate

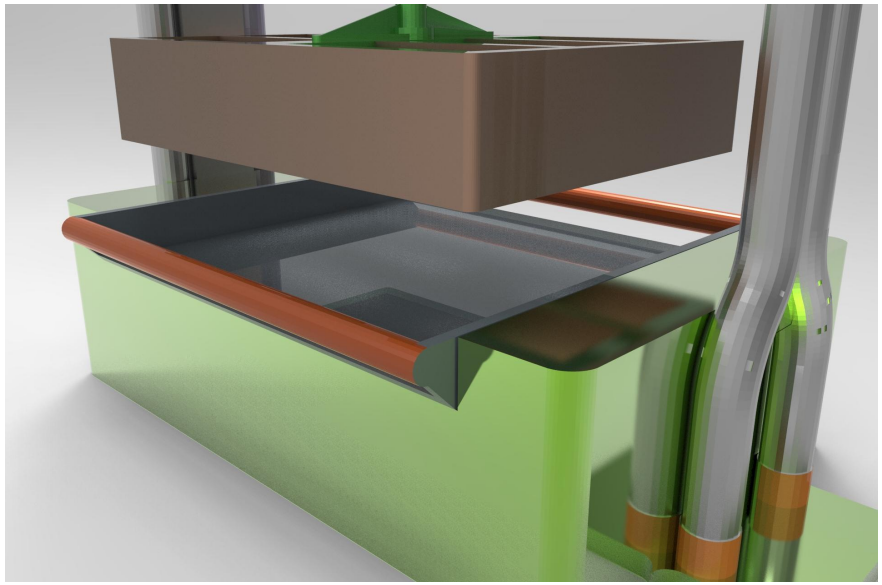


Fig 87 : Lubrication tank

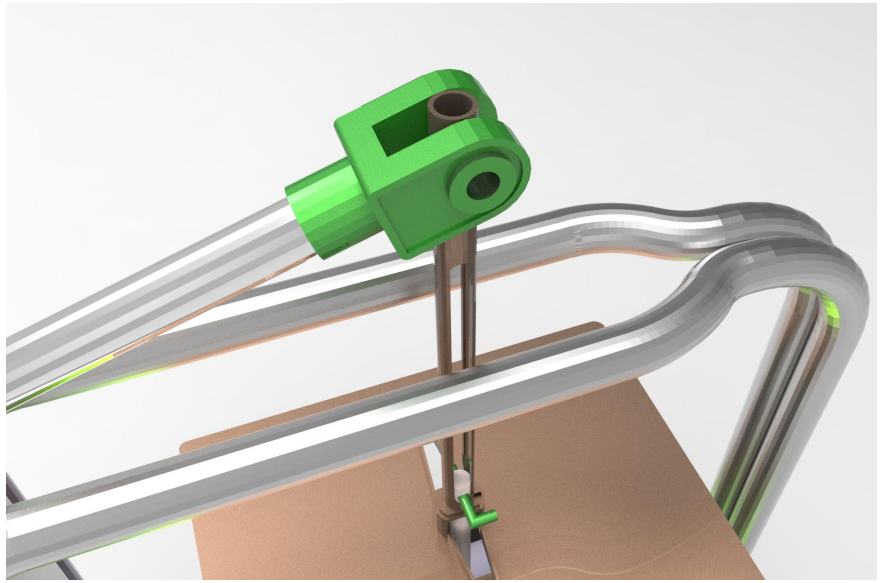


Fig 88 : Coupling

MOCK UPS OF CONCEPT A-1 & A-2

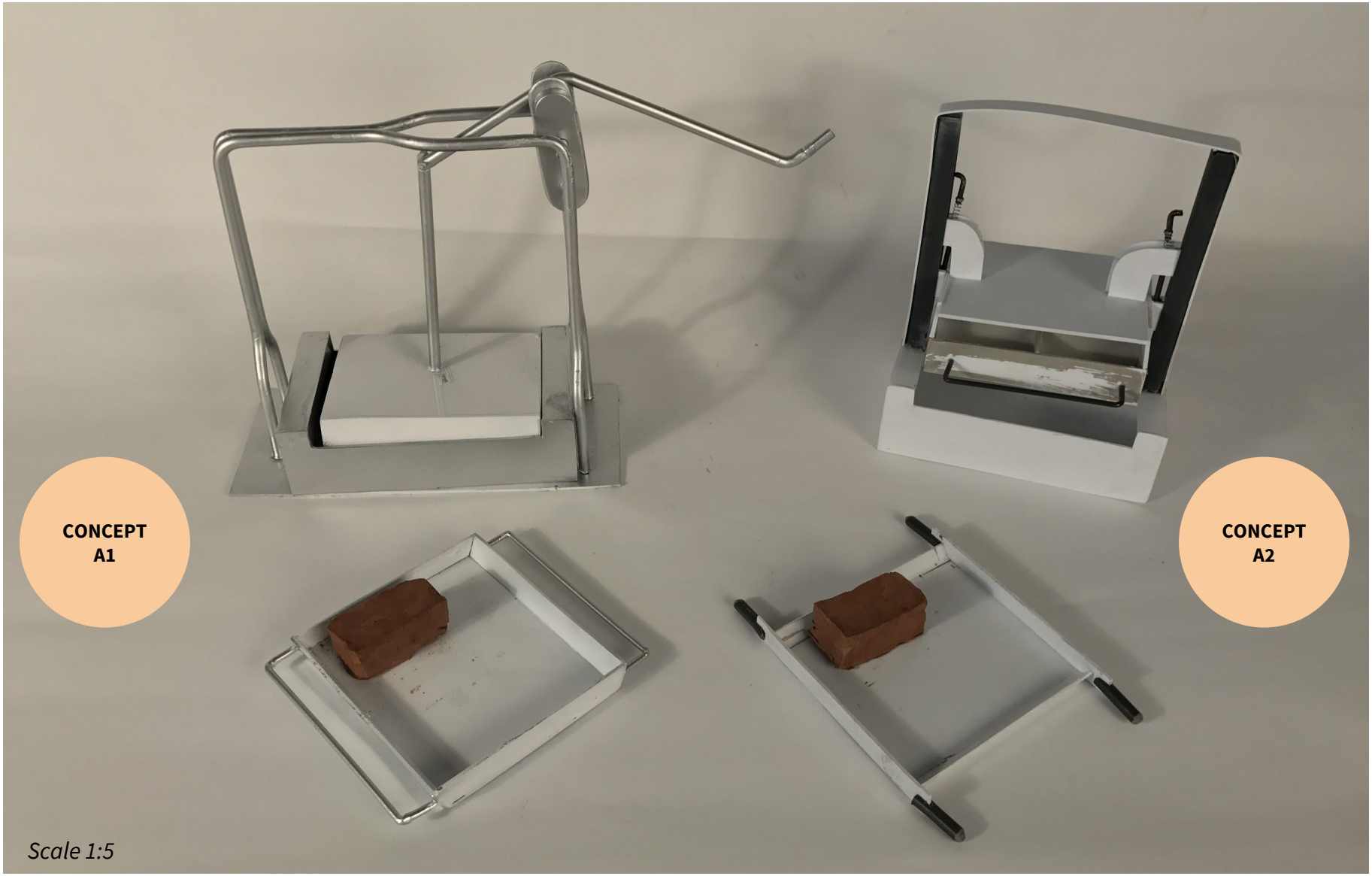


Fig 89 : Mockups of concept A1 and A2

MOCK UP OF CONCEPT A-1

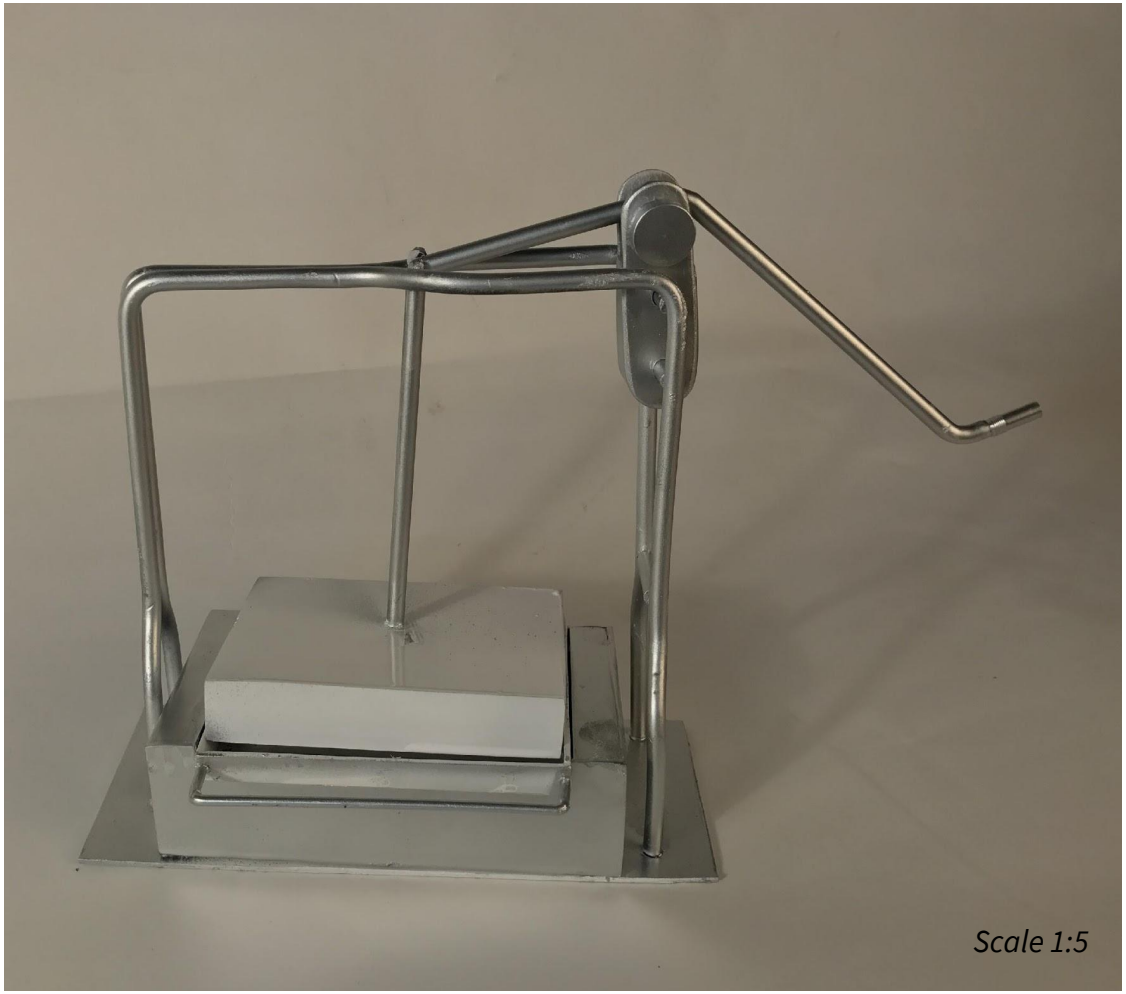


Fig 90 : Mockup of concept A1

Two variations were made of the selected concept to find out the optimum design by studying small scale models of the concept.

One of the model is Concept A1 which adheres to the design of the initial cad model.

VARIOUS PARTS OF CONCEPT A-1

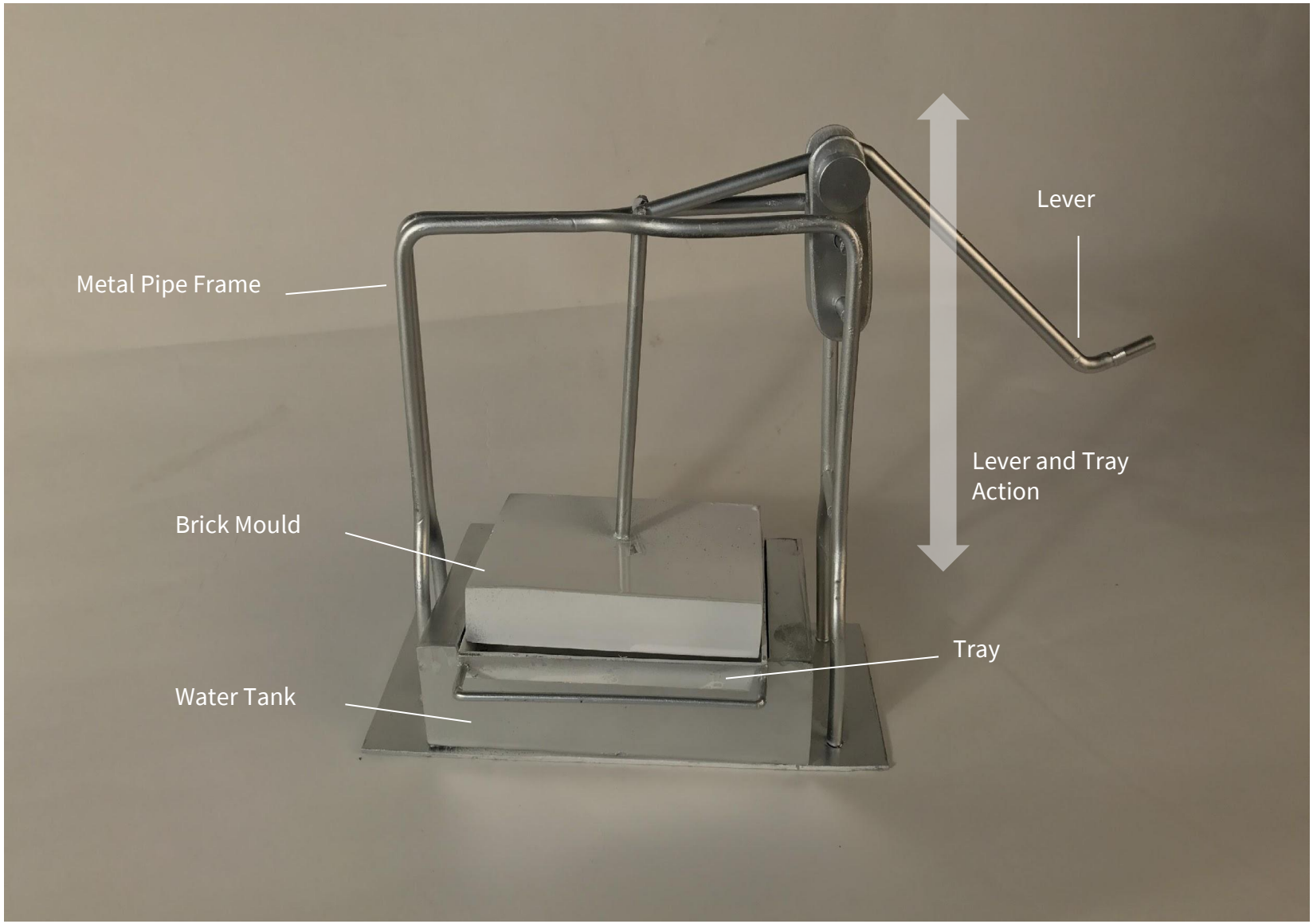


Fig 91 : Detailed parts of concept A1

MOCK UP OF CONCEPT A-1

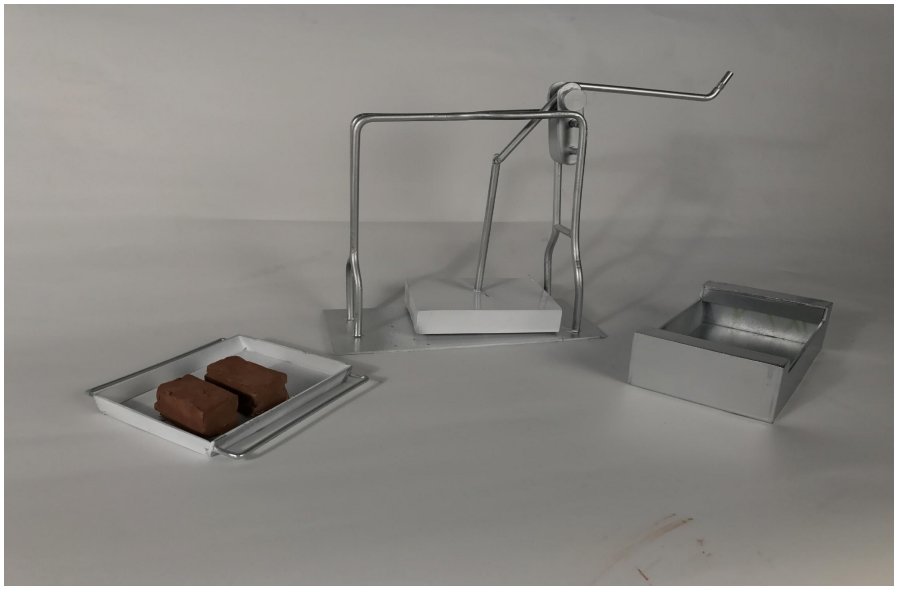


Fig 92 Different parts of the concept

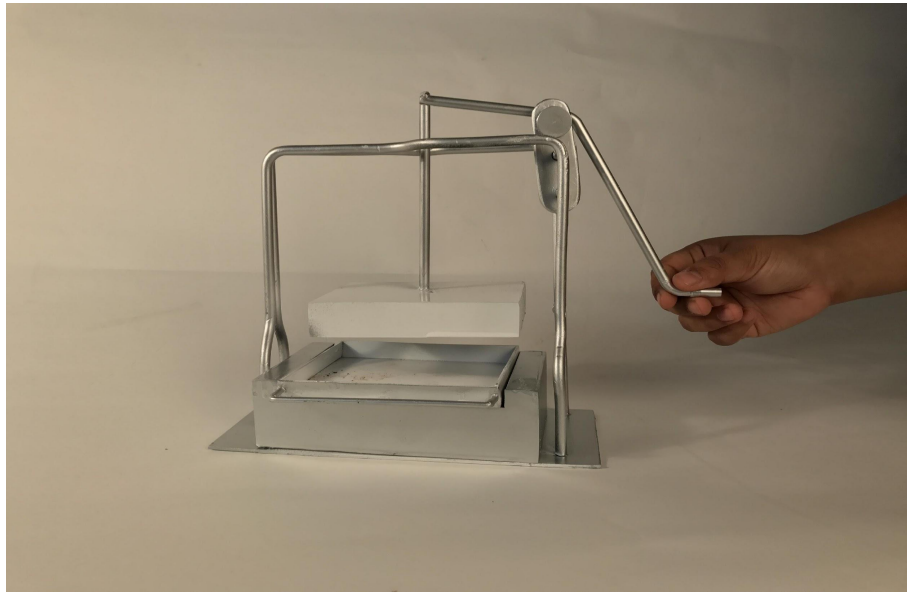


Fig 93 Lever to pull the plate up and down

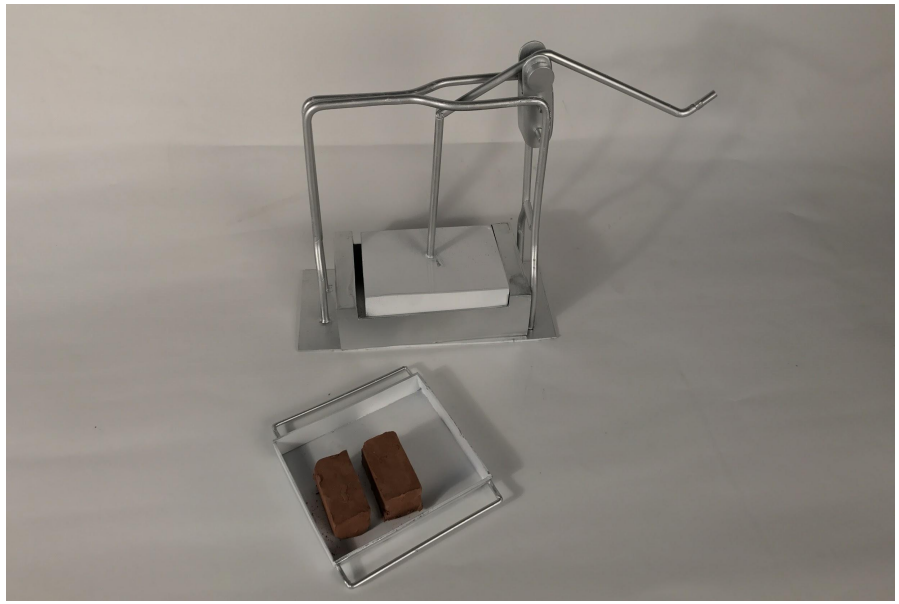


Fig 94 tray for carrying the bricks out

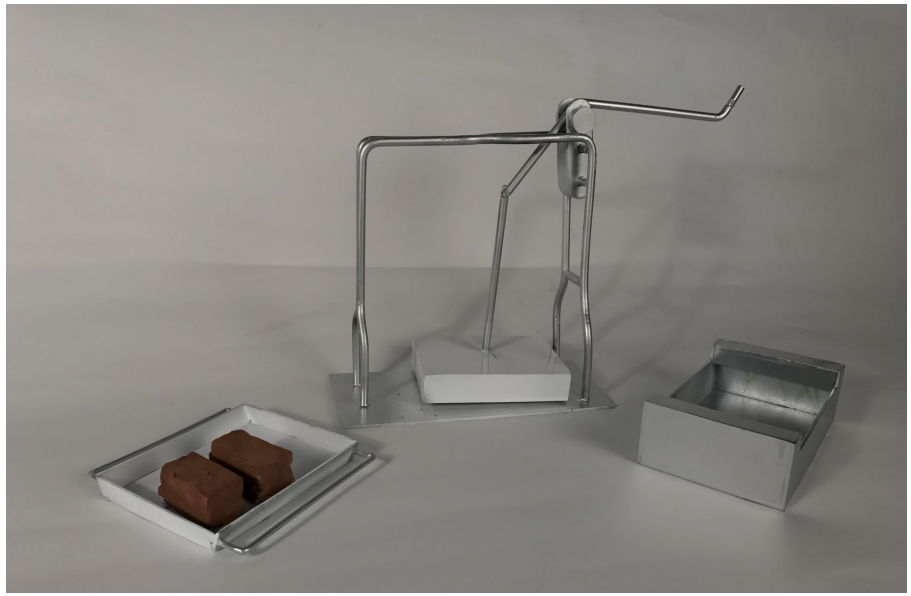
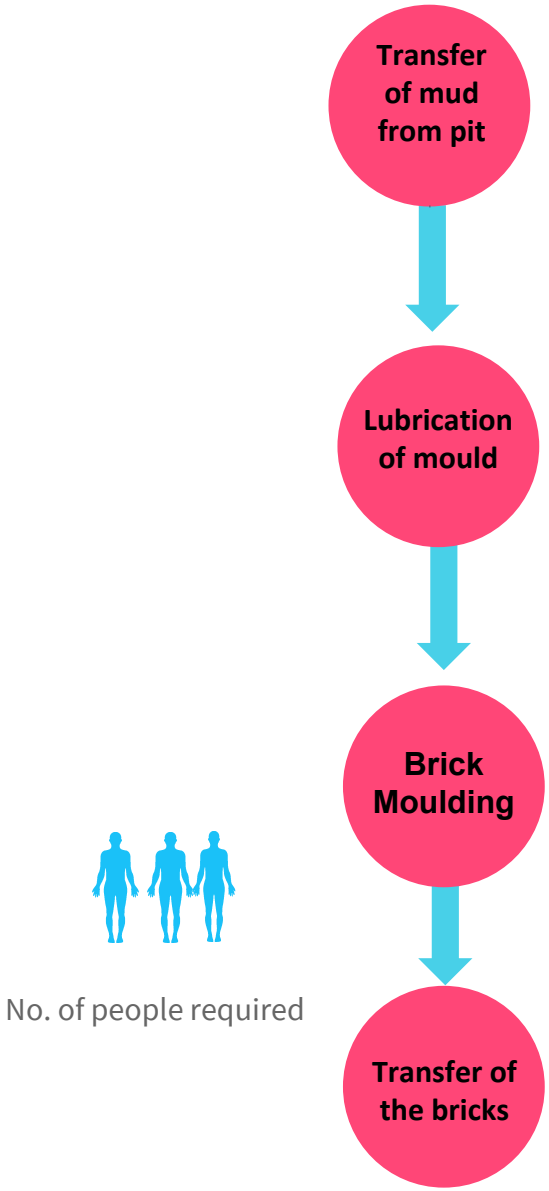


Fig 95.

MICROMOTION ANALYSIS OF CONCEPT A-1



1. In this concept the conventional method of mud preparation and transfer is employed.
2. The worker involved in this task has to carry the mud in a cart till to the machine
3. The worker needs to bend and take the mud to the platform by using some tool.
4. he has to make a small pile of mud on the feeder

1. The person responsible for the pressing job has to clean and lubricate the mould by bringing the mould down to the water tank by releasing the lever slowly..
2. He then has to bring the the mould back to the upper position so that the base where the brick has to be moulded that tray should come by pulling the lever downward..
3. After the tray has been placed by the feeding person the mould is set on the tray and it is filled by using lumps of mud, with sudden jerking action.

1. The mud is evenly spread and pushed by hands
2. The person then brings the emboss plaste down to emboss the logo on the brick as well as to compress the brick much further so that the gaps in the mould are completely filled by the mud for this he has to push the lever upwards to apply pressure on the emboss plate.
3. The person then pulls the lever back so that the emboss plate can come up and then lifts the second stage pulls the mould up.
4. The moulded brings are then moulded away by the person responsible for transferring the bricks to the drying area.

1. The person then lifts up the brick tray and puts it in the trolley which carries around 3 trays with 6 bricks each to the drying area.
2. since the composition of bricks used is dry composition the bricks can be transfer by hands to the ground,but it requires lot of bending action.

DESIGN ISSUES OF CONCEPT A-1

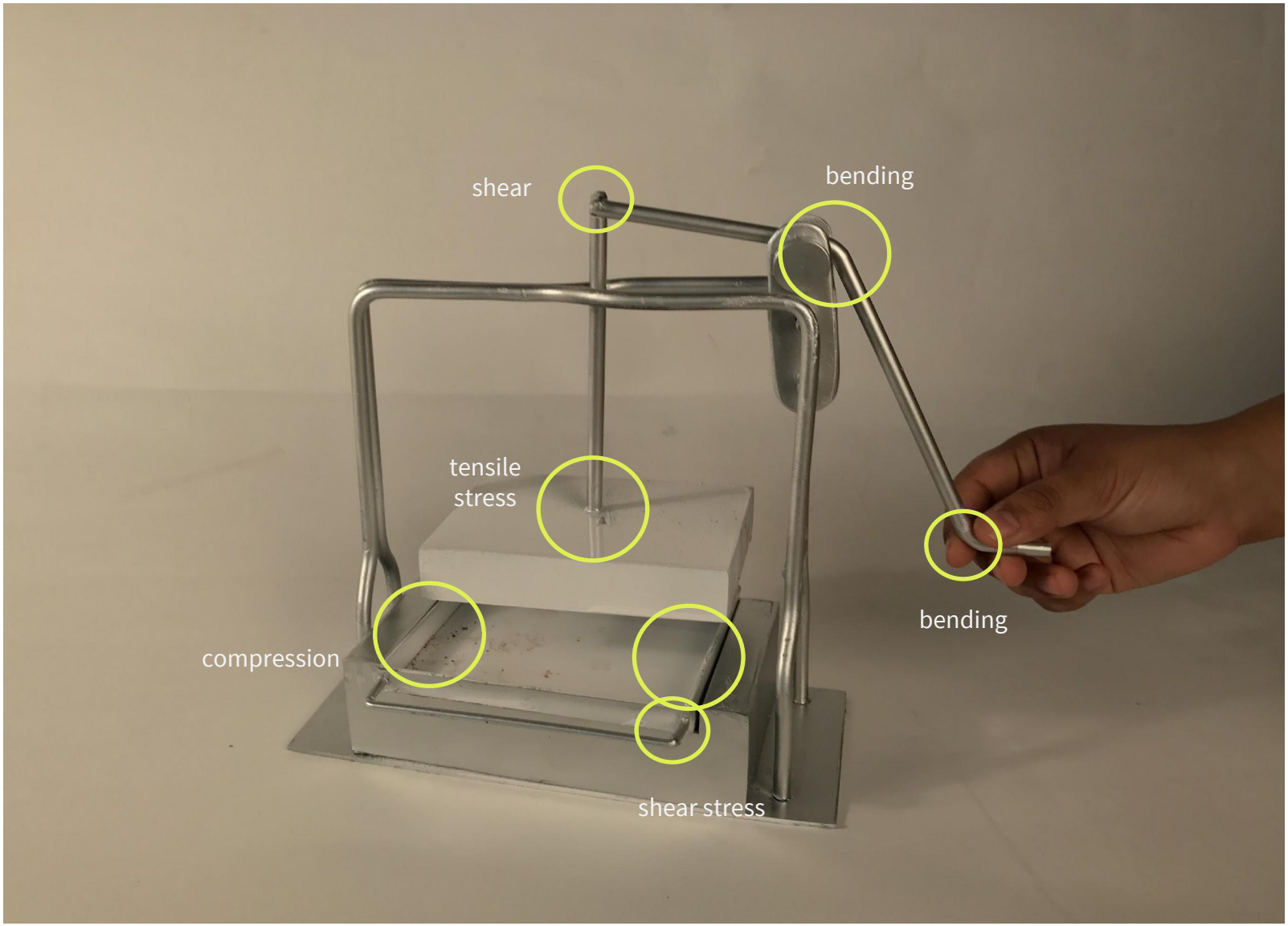


Fig 96 : Design issues in concept A1

DESIGN ISSUES OF CONCEPT A-1

From mockups and cad model different issues witht the design were identified*(fig .96)*.

The problems are listed below:

1. The person operating the machine has to continuously hold the lever for controlling the action.
2. The direction of force applied for compressing the mould is not the natural action which is followed usually, it is in fact it's opposite to gravitational force which is undesirable.
3. The activities which are related to brick moulding machine are not defined well.
4. The use of guides is not present since a guide is needed for perfect fitting of mould in the tray.
5. The overall design is non appealing.
6. Each bricks weigh around 5 kg, total number of 6 bricks are moulded in the particular machine,which will weigh around 35 kg including tray, which is way too heavy for a person to carry.
7. The feeding of the mould is not defined as vibration/compression are required for even filling of mould.
8. The person needs to constantly bend to feed the mould since the mud is being transferred in cart.

MOCK UP OF CONCEPT A-2

Fig 97 : Mockup of concept A2

Two variations were made of the selected concept to find out the optimum design by studying small scale models of the concept.

One of the model is Concept A1 which adheres to the design of the initial cad model.

DIFFERENT PARTS OF CONCEPT A-2

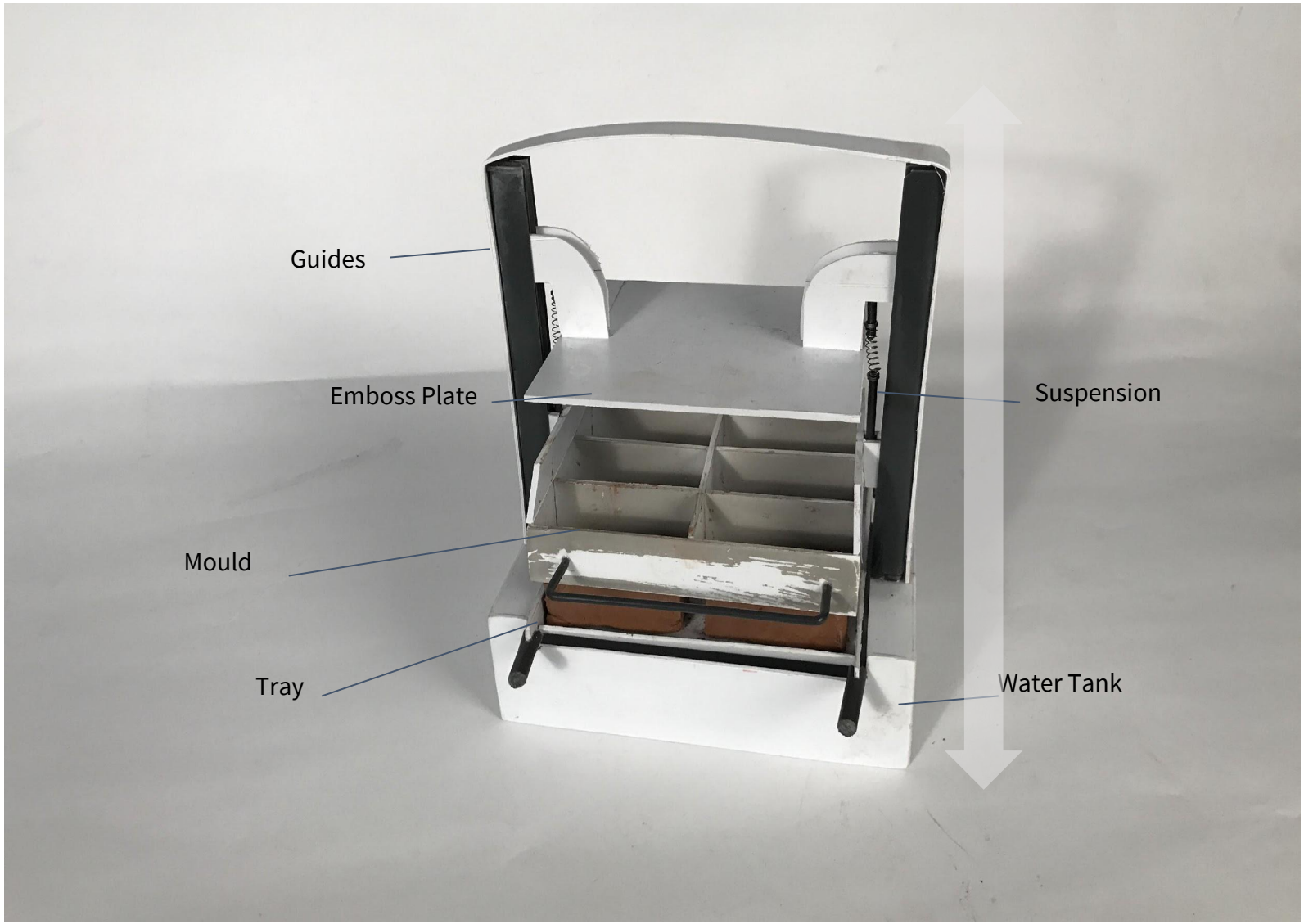


Fig 98 : Detailed parts of Concept A2

MOCK UP OF CONCEPT A-2

Fig 99 :Different components of the machine

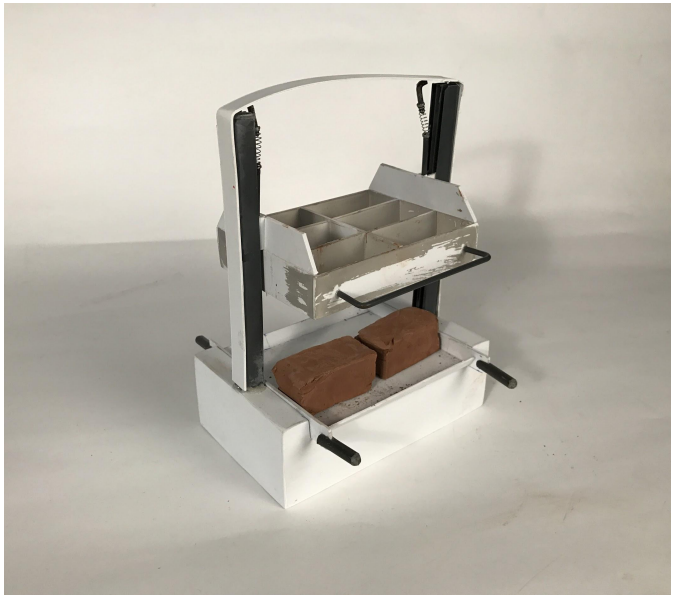
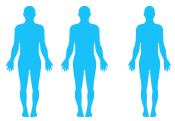


Fig 100 :vertical sliding tray which is spring loaded

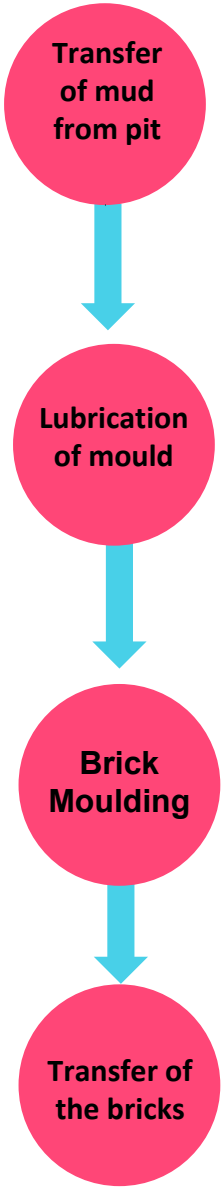
Fig 101 : cover plate is provided above the mould which also slides in the same channel

Fig 102

MICROMOTION ANALYSIS OF CONCEPT A2



No. of people required



1. In this concept the conventional method of mud preparation and transfer is employed.
2. The worker involved in this task has to carry the mud in a cart till to the machine
3. The worker needs to bend and take the mud to the platform by using some tool.
4. he has to make a small pile of mud on the feeder

1. The person responsible for the pressing job has to clean and lubricate the mould by bringing the mould down to the water tank.
2. He then has to bring the the mould back to the upper position so that the base where the brick has to be moulded that tray should come.
3. After the tray has been placed by the feeding person the mould is set on the tray and it is filled by using lumps of mud, with sudden jerking action.

1. The mud is evenly spread and pushed by hands
2. The person then brings the emboss plaste down to emboss the logo on the brick as well as to compress the brick much further so that the gaps in the mould are completely filled by the mud.
3. The person then lifts the emboss plate up and then lifts the mould up..
4. The moulded brings are then mouled away by the person responsible for transferring the bricks to the drying area.

1. The person then lifts up the brick tray and puts it in the trolley which carries around 3 trays with 6 bricks each to the drying area.
2. since the composition of bricks used is dry composition the bricks can be transfer by hands to the ground,but it requires lot of bending action.

DESIGN ISSUES OF CONCEPT A-2

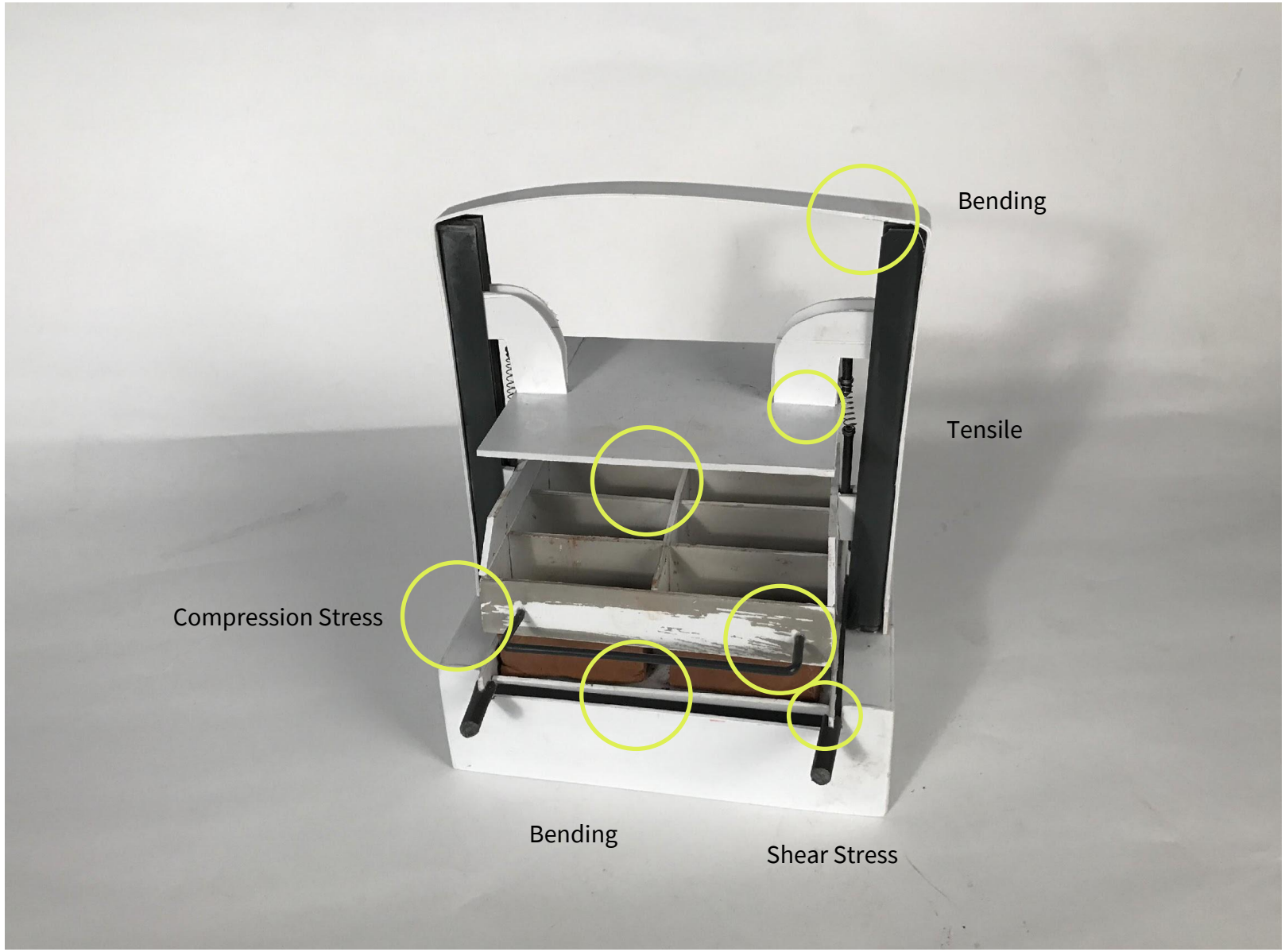


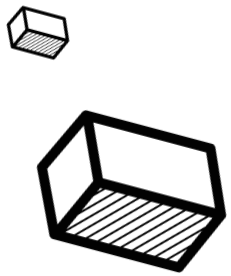
Fig 103 : Design issues in concept A2

DESIGN ISSUES OF CONCEPT A2

From mockups and CAD model different issues with the design were identified.

The problems are listed below:

1. The person operating the machine has to continuously perform actions in vertical direction.
2. The person has to apply manual force in order to compress the bricks, which is undesirable.
3. The activities which are related to brick moulding machine are not defined well.
4. The suspension system/hydraulics can fail after long use.
5. The overall cost of the product will be high.
6. The guides need to be installed at the corners of the mould for better stability.
7. The guides need to be telescopic than normal slider ones.
8. The person needs to constantly bend to feed the mould since the mud is being transferred in cart.
9. Carrying six bricks at a time is not suitable for an ergonomic design.



16 CONCEPTS VERSION II

MODIFIED CONCEPT A-3

In the stage jury lot of corrections were given regarding the design. Hence, more concepts were generated to find the optimal design solution.

Table Top Variant

Concept was made to solve the issues related with the previous table top vertical brick moulding machine.The mould has plunger that uses the foot pedal to apply force upward for compression of mud in the mould.

It has a slider feeder which feeds the mould situated below the table.The mould has a 10 mm compression tolerance which eliminates the repetitive feeding of the mould. The mould gets over loaded so that the moulded brick could get compressed to the standard size.

This design eliminates the flaws in the previous concept which makes it more ergonomic for the user to operate.

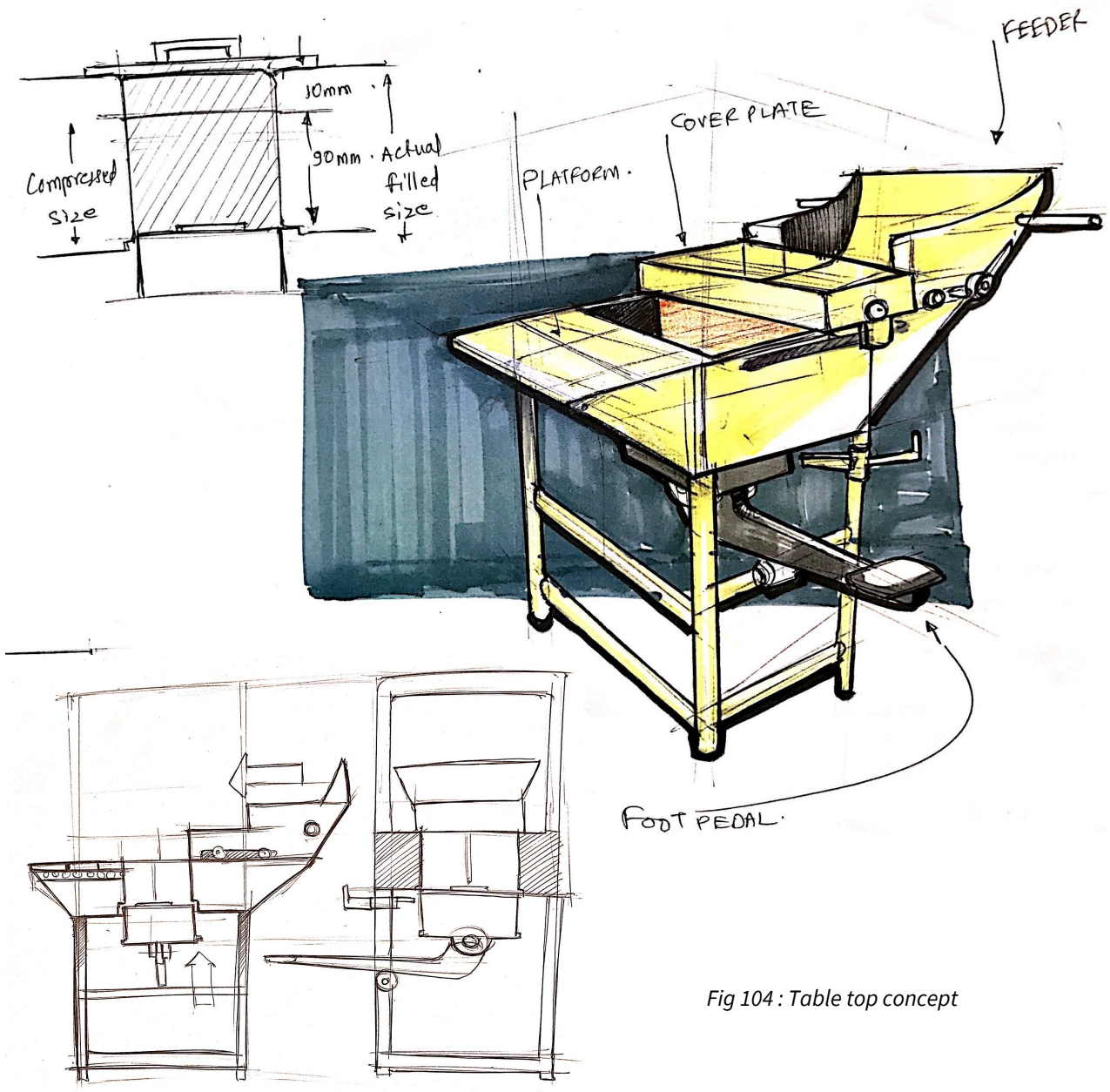
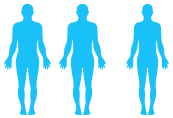
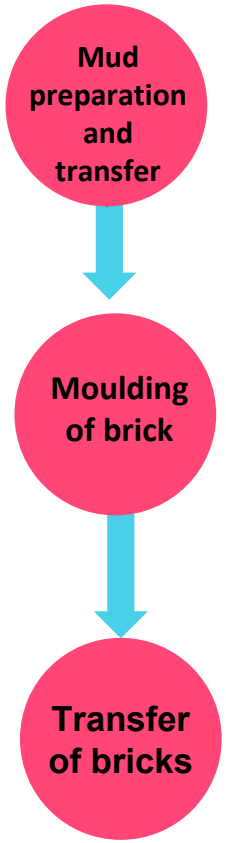


Fig 104 : Table top concept

MICROMOTION ANALYSIS OF CONCEPT A-3



No. of people required

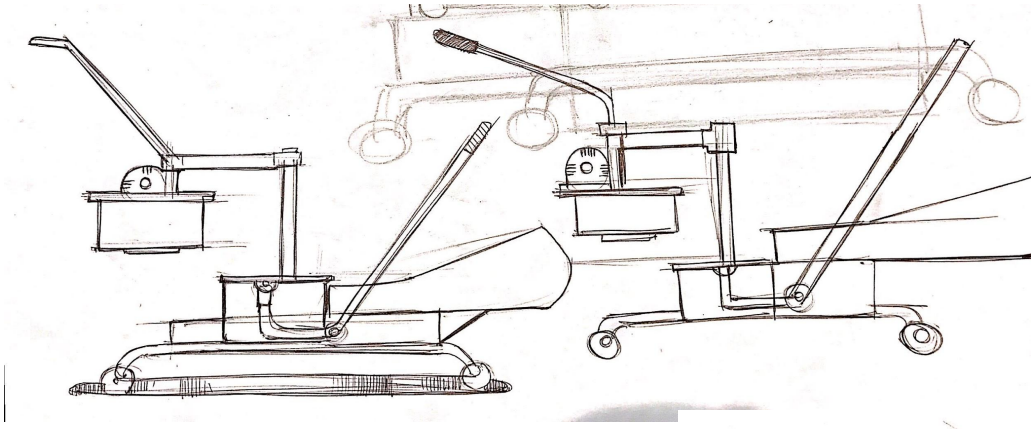


1. The mud needs to be cleaned and filtered out after digging.
2. The mud need to be soaked in less quantity of water.
3. The worker needs to transfer the mud to the moulding area by using cart
4. The feeder needs to be brought down.
5. The person who brought the mud needs to fill the feeder by plough and load it back.

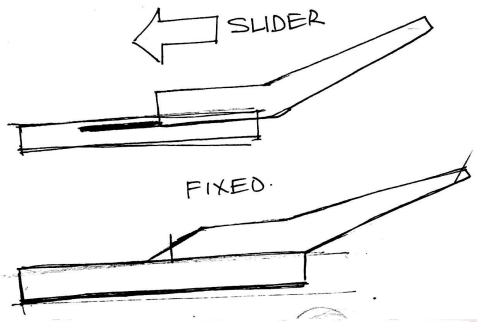
1. The person operating the machine needs to slide the feeder 2x.
2. He needs close the lid of the mould
3. Then stand on the foot pedal to apply pressure.
4. Then slide back the lid
5. Then press the pedal again to eject the brick
6. The pedal gets locked by a small latch.

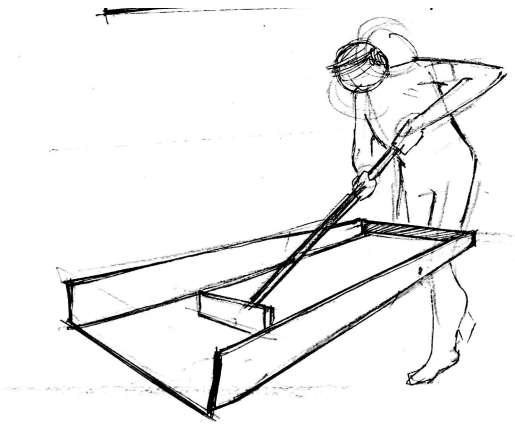
1. The person responsible for carrying the bricks to the drying area need to slide and stack the brick on the trolley.
2. The worker can push the cart away for drying.

CONCEPT B-1



1. Types of feeder
2. Fixed and sliding





A sweeping tool is used for pushing the mud in the mould

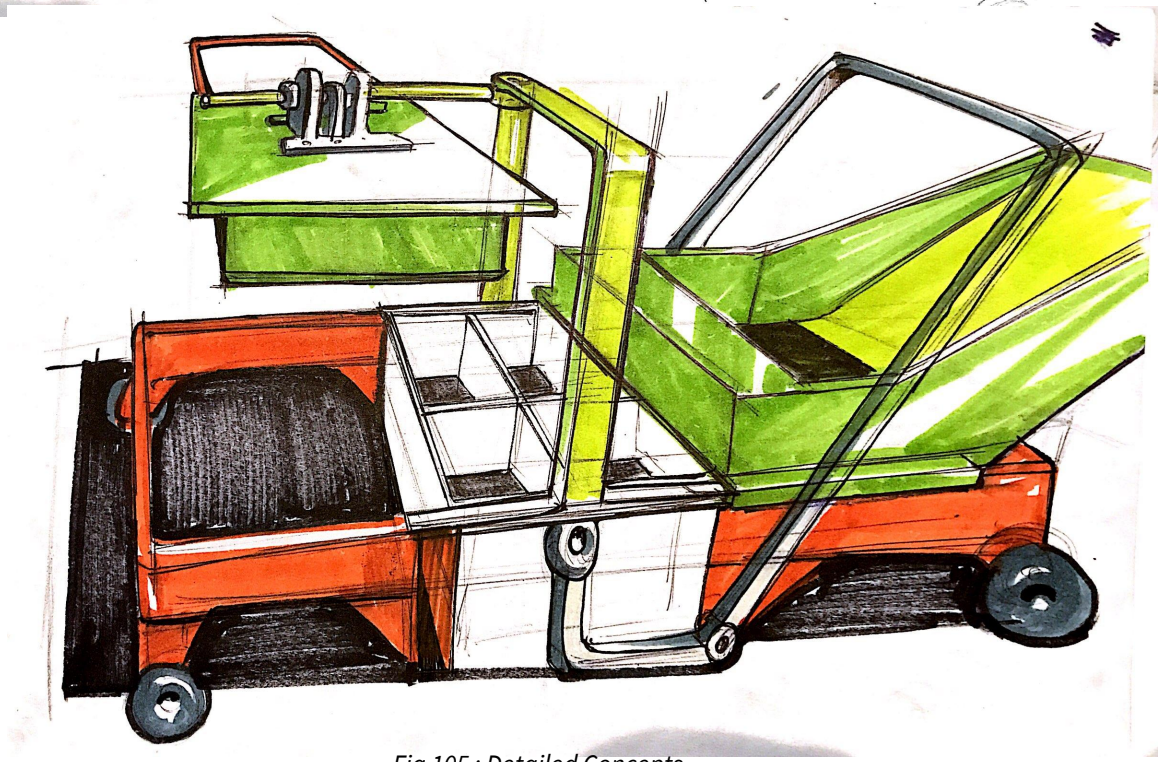
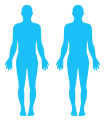


Fig 105 : Detailed Concepts

MICROMOTION ANALYSIS OF CONCEPT B-1



No. of people required

Mud preparation and transfer

1. The mud needs to be cleaned and filtered out after digging.
2. The mud need to be soaked in less quantity of water.
3. The worker needs to transfer the mud to the moulding area by using cart
4. The cart needs to be toppled on the feeder and spreaded out by the feeding person.
5. The machine shakes the feeder .

Moulding of brick

1. The person operating the machine needs to slide the mud using a shovel.
2. Then he comes back to lock the emboss plate to the frame
3. Then releases the lever so that the emboss plate can come down on the mould
4. He starts the motor for vibration up to 30 secs
5. Then the pulls the bar up by which the mould comes up and emboss plate comes along with it and gets lock on its original position
6. The person operating the feeder moves the machine forward for next batch of bricks
7. The lever is released and the mould sits back on its position.

Transfer of bricks

1. No transfer of bricks.

CONCEPT B-2

Pull cart variant
This concept was made to simplify the rigorous bending action of feeding in the table top concept A1, A2 and A3.

This concept consist of a sliding mould and sliding emboss plate which moulds the brick directly on the drying area. Hence eliminating the drudgery in feeding and transferring of the bricks.

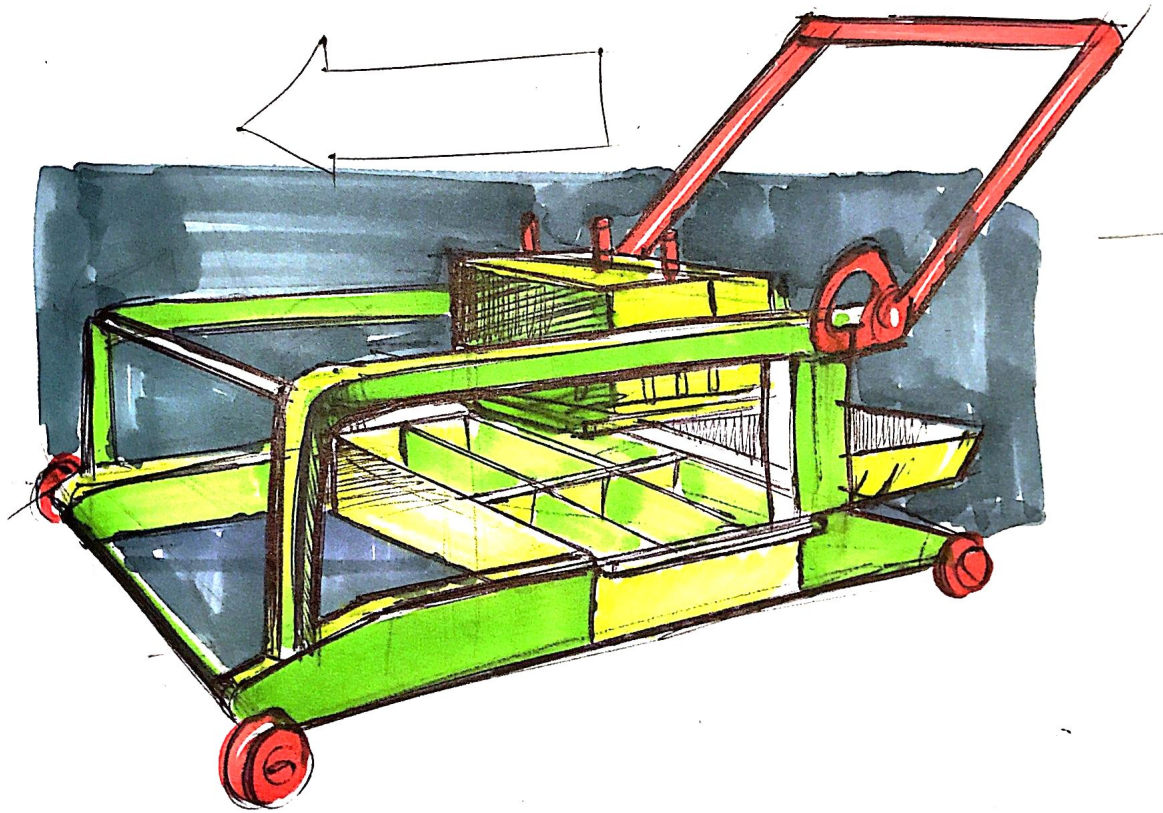
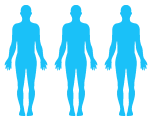


Fig 106 : Pull cart concept

MICROMOTION ANALYSIS OF CONCEPT B-2



No. of people required

Mud preparation and transfer

1. The mud needs to be cleaned and filtered out after digging.
2. The mud need to be soaked in less quantity of water.
3. The worker needs to transfer the mud to the moulding area by using cart
4. The person pulling the art needs to release the
5. The machine shakes the feeder .

Moulding of brick

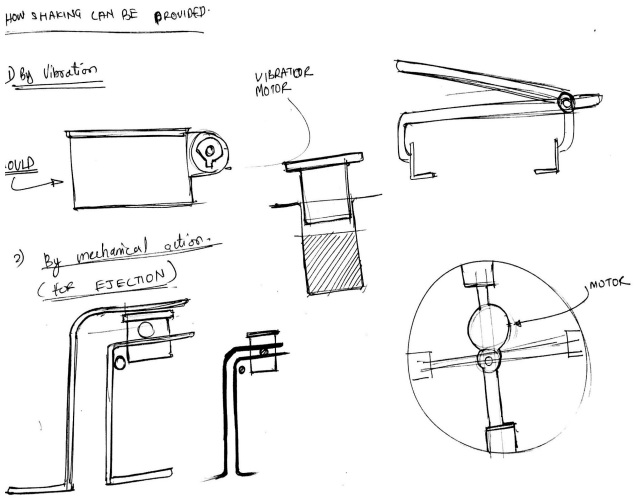
1. The person operating the machine needs to slide the feeder 2x.
2. Then he comes back to lock the emboss plate to the frame
3. Then releases the lever so that the emboss plate can come down on the mould
4. He starts the motor for vibration up to 30 secs
5. Then the pulls the bar up by which the mould comes up and emboss plate comes along with it and gets lock on its original position
6. The person operating the feeder moves the machine forward for next batch of bricks
7. The lever is released and the mould sits back on its position.

Transfer of bricks

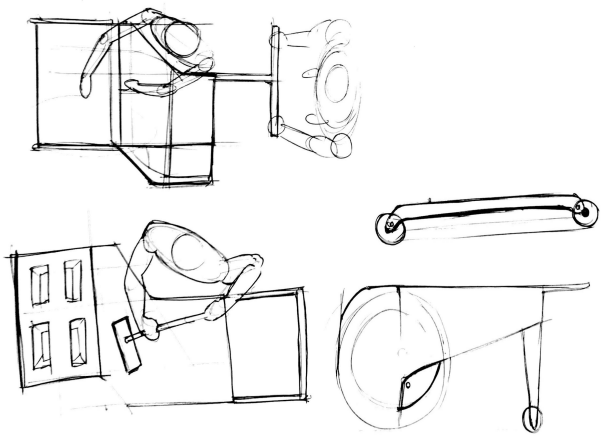
1. No transfer of bricks.

CONCEPT C

Wheel Barrow Type Concept Ideations

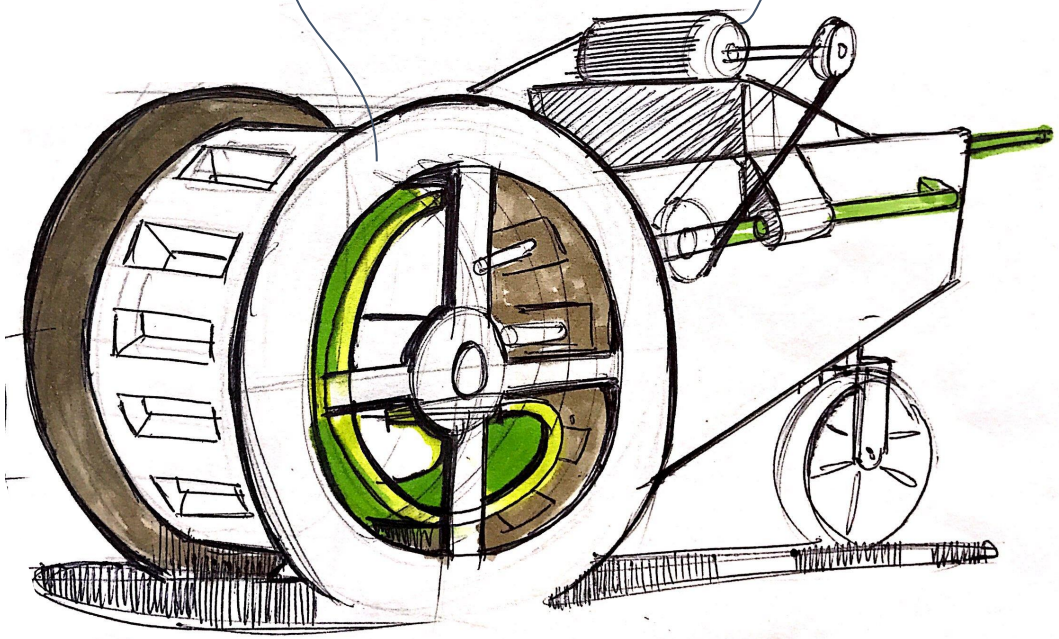


Different mechanisms that can be used.



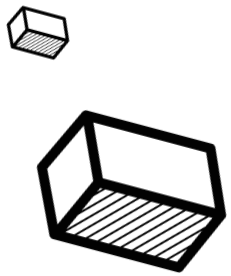
Curved plate used instead of follower

used of motor for pushing mud



Representation of the workers operating the cart.

Fig 107 : Wheelbarrow type concept



17

FINAL CONCEPT

FINAL CONCEPT

Modified Wheelbarrow Type Concept

This concept consist of a cylindrical type mould. which ejects the bricks by using the plunger which is actuated by a stationary curved plate.

The mud feeding is done by releasing the freewheel by pulling a lever. which brings the feeder down.

The plunger is brought back to original position and the mud is fed.After refilling the cart it pulled back up and the motor is started for feeding.

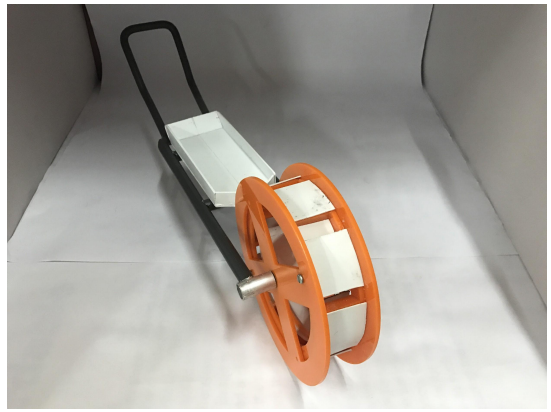
The moulds get filled by mud and later ejected when brought down..

Pros:

- No bending is required,
- Excess operations are eliminated, less time consuming, continuous process

Cons:

- High overall cost
- Complicated Design



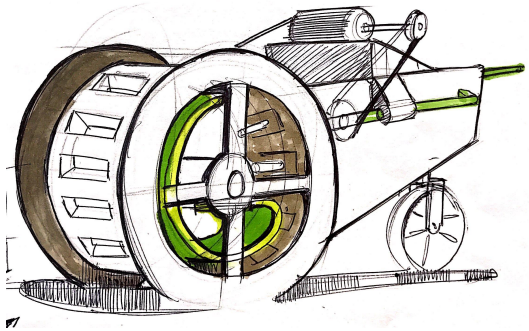


Fig 108 : Sketch of concept C

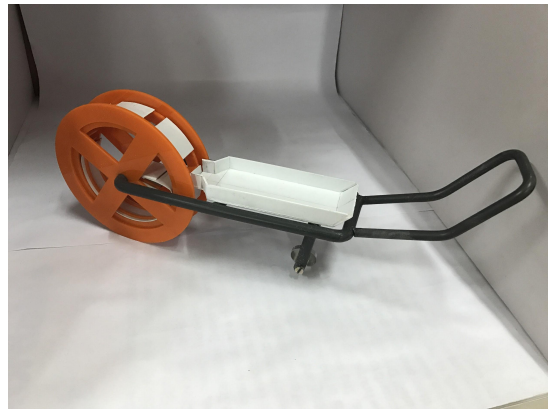
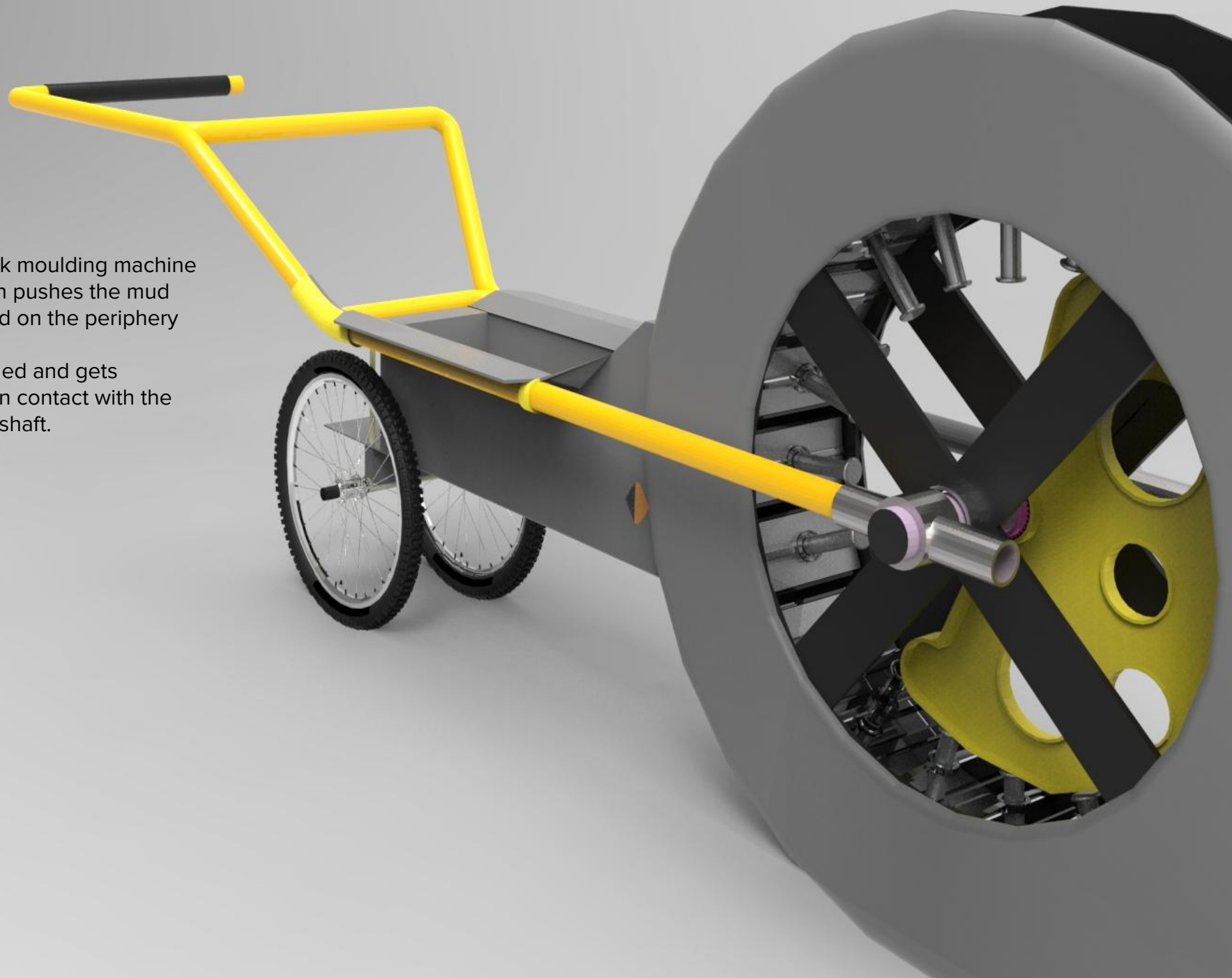


Fig 109 : Mock up model

FINAL CONCEPT

FINAL CONCEPT

The Wheelbarrow type brick moulding machine consists of a extruder which pushes the mud towards the moulds situated on the periphery of the wheel.
The moulds are spring loaded and gets actuated when they come in contact with the cam situated at the central shaft.

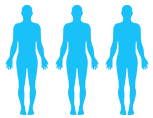


OPERATION

Working of the machine:

1. One person is needed for pulling the machine.
2. The machine is brought to the area and the mud is fed through the opening.
3. When the cart is pulled the wheel rotates the screw in the chamber.
4. As a result the mud is fed to the moulds.
5. The moulds are spring loaded and are lubricated with spraying of oil/water .
6. They get actuated when the mould comes to the downward position.
7. Hence the brick is ejected.

MICROMOTION ANALYSIS OF FINAL CONCEPT C



No. of people required

Mud preparation and transfer

1. The mud needs to be cleaned and filtered out after digging.
2. The mud need to be soaked in less quantity of water.
3. The worker needs to transfer the mud to the moulding area by using cart
4. The person pulling the Cart needs to release the lever to lower the cart
5. The feeder is brought back to it position and musd is fed
6. The cart is again brought to its original position by pulling it up..

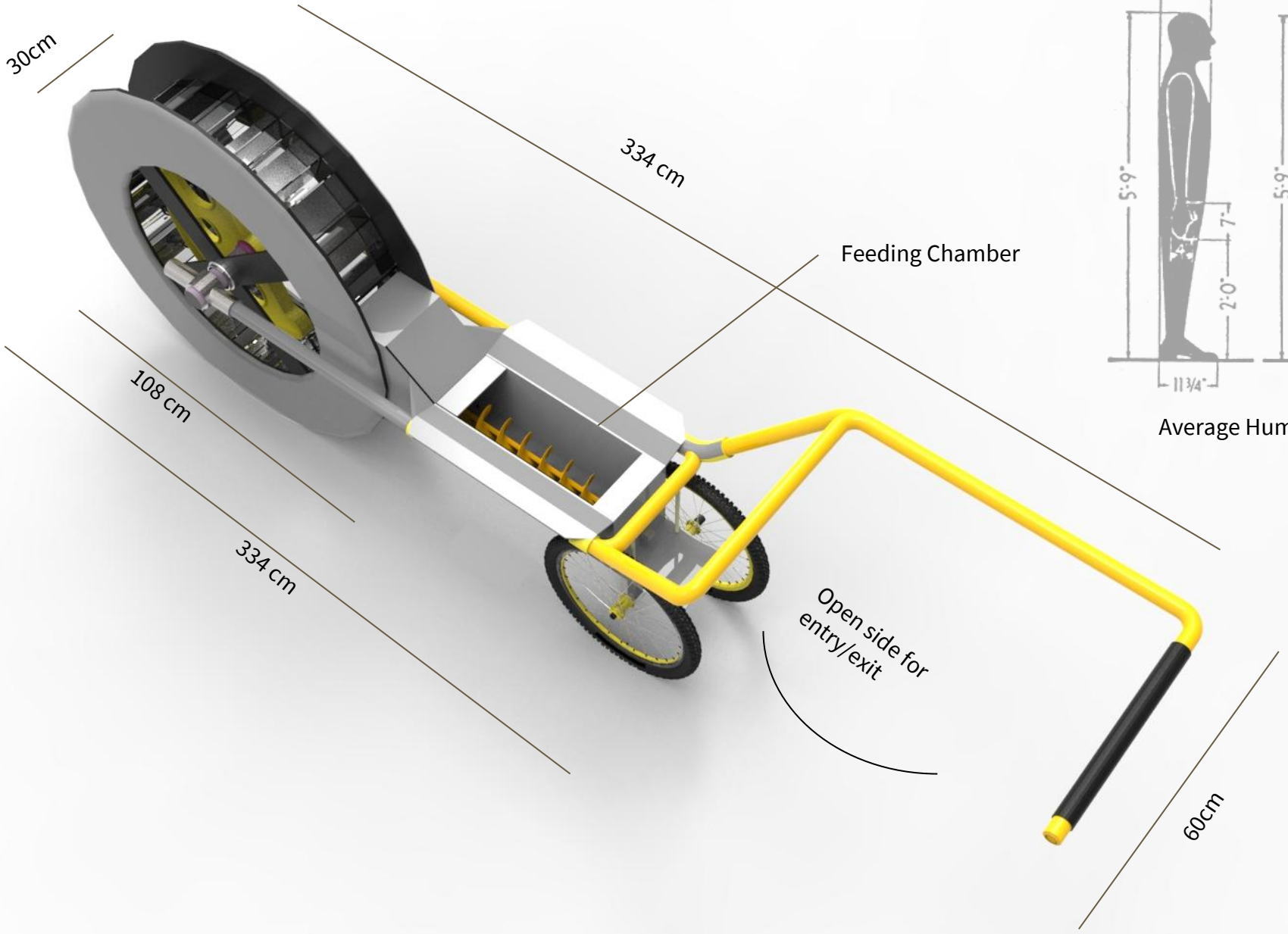
Moulding of brick

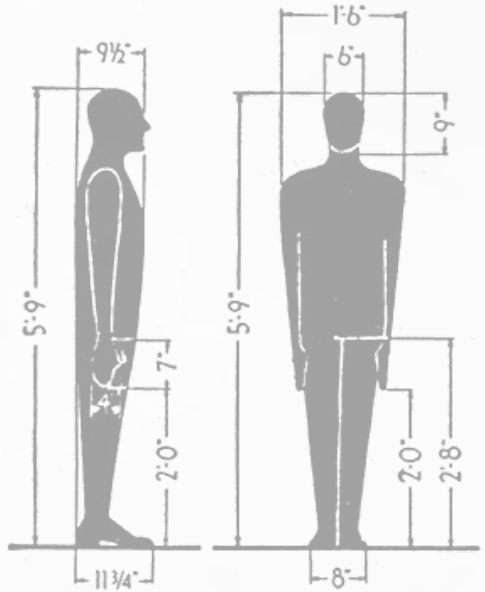
1. The person operating the machine needs to start the feeder motor
2. Then he starts pulling the cart which results in rotation of wheel
3. The rotation of the wheel causes the mould gets filled with mud and at bottom position it ejects the brick.
4. Another person needs to check the lubrication of moulds by applying oil .
5. The carts stops when the mud gets emptied.

Transfer of bricks

1. No transfer of bricks..

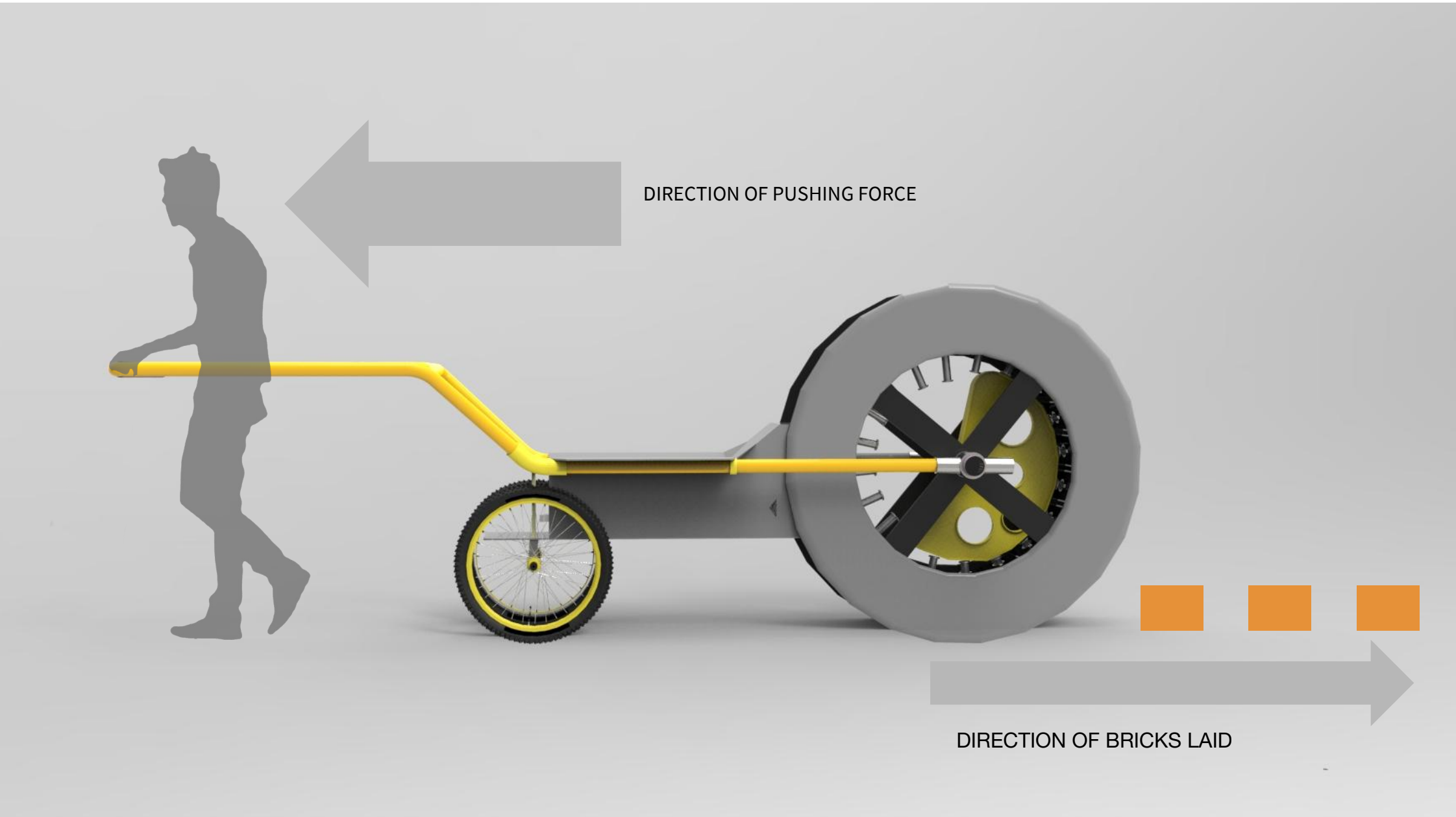
DIMENSIONS



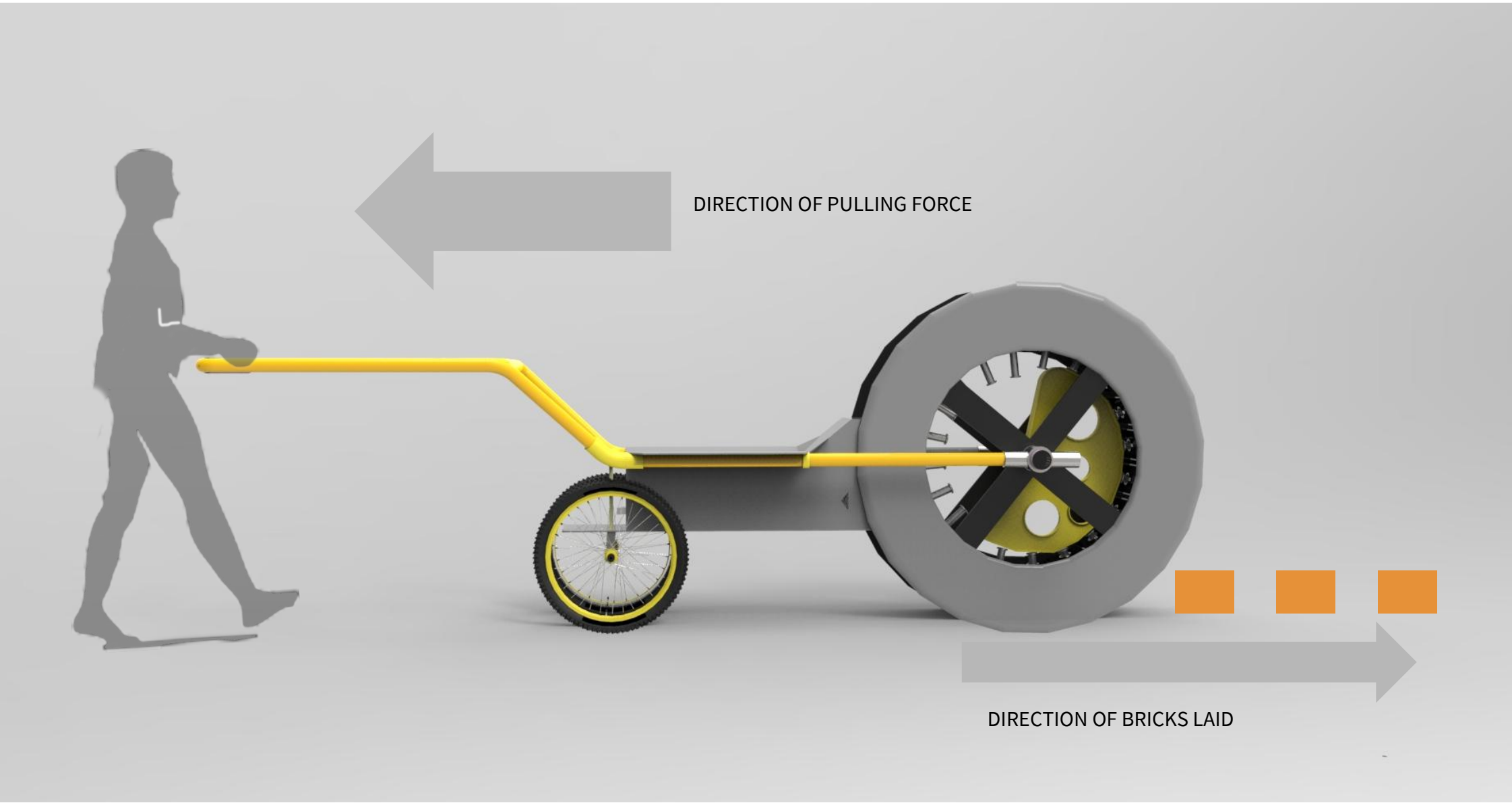


Average Human Dimensions

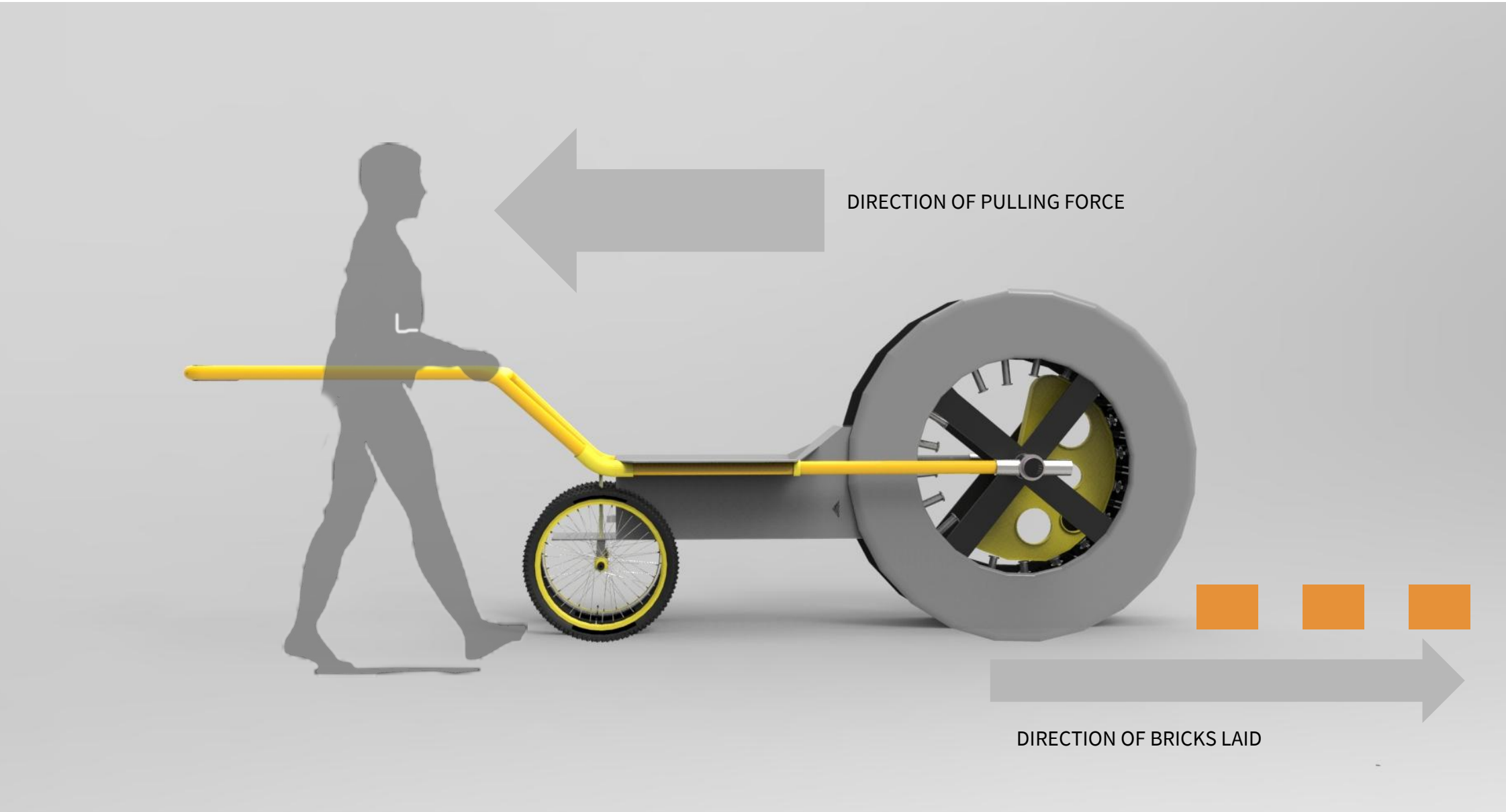
USER INTERACTION



USER INTERACTION



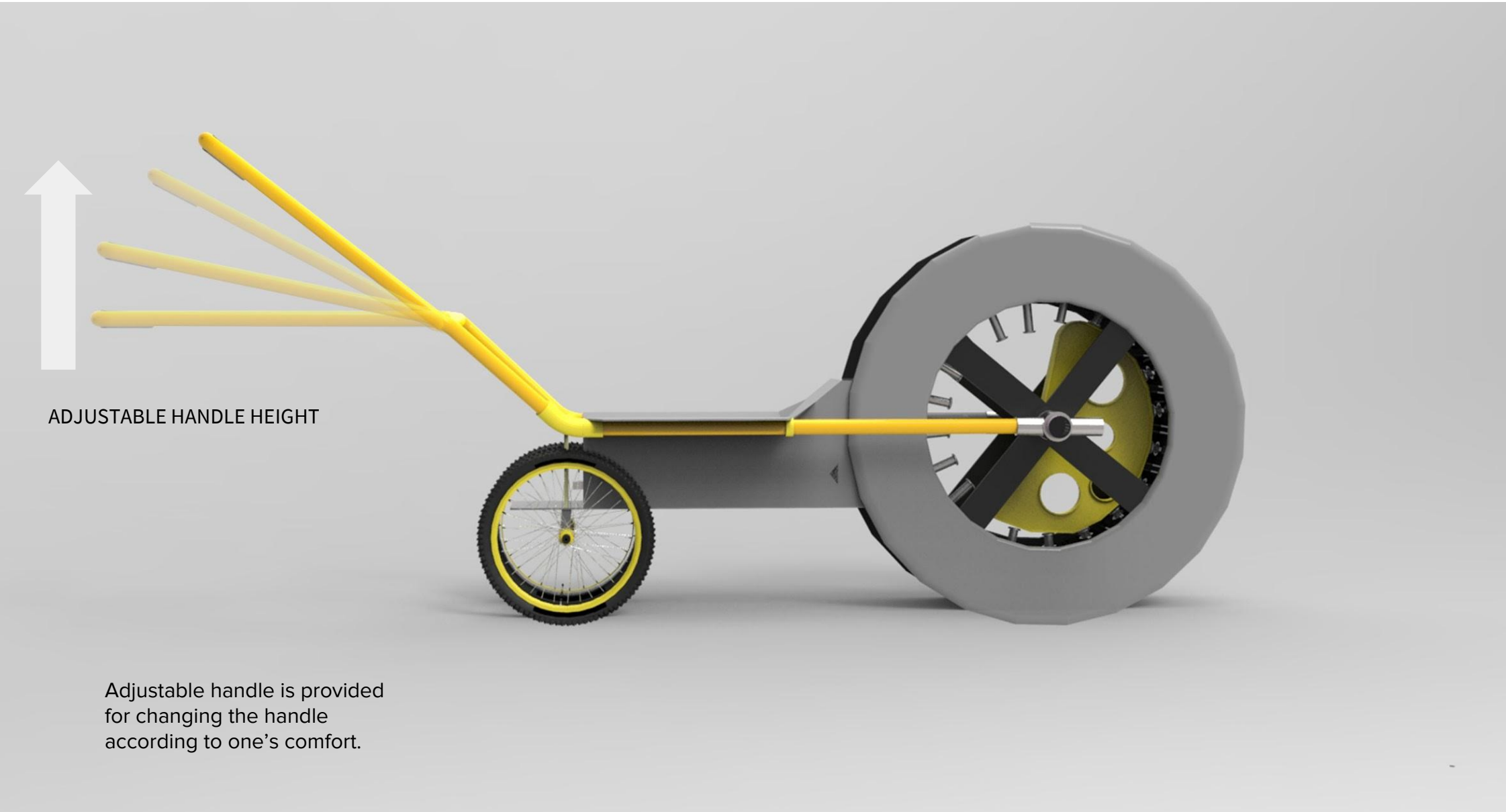
USER INTERACTION



FEATURES

Wheels can turn to provide 180 degree turning to the whole machine.

FEATURES



Adjustable handle is provided for changing the handle according to one’s comfort.

MECHANISM

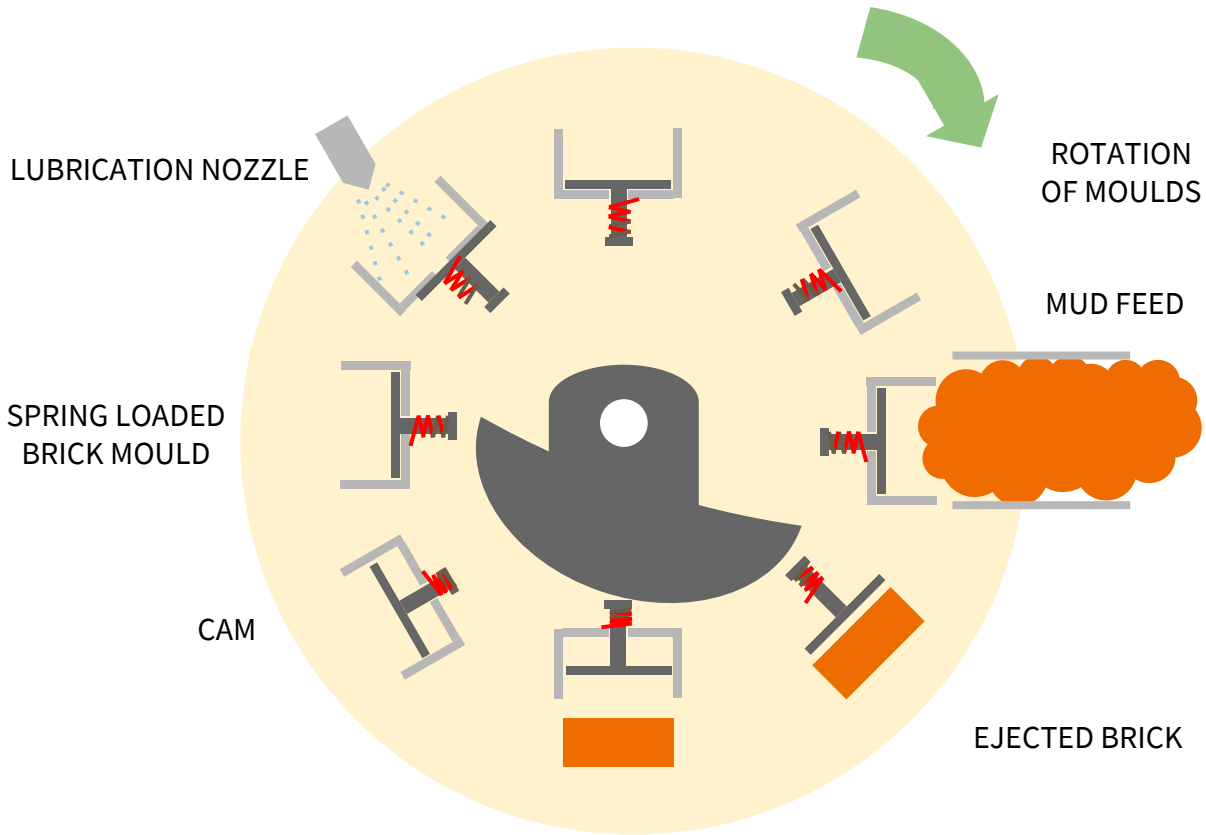


Fig 110 : Working of brick moulding mechanism

The diagram *(Fig 110)* shows the working of the brick moulding drum.

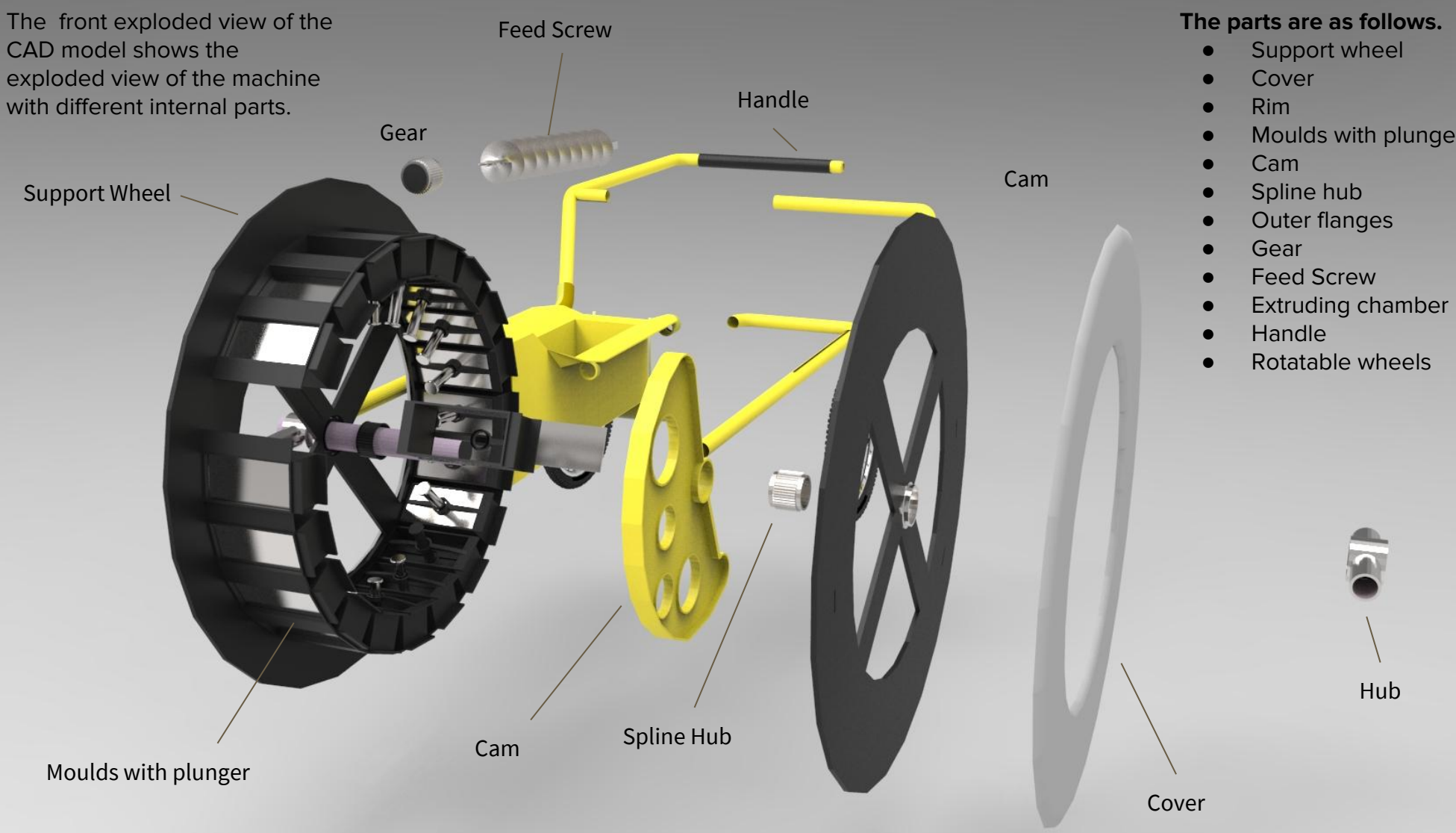
The drum consist of series of moulds mounted on the periphery of the wheel rim. The mould consist of spring loaded plunger mechanism.
The whole is mounted on a central shaft which has a central cam mechanism to actuate the pistons.
The mud is extruded in the piston by means of a screw type extruder which runs on electric supply.

Since the wheel is rotating the piston rotates and gets filled simultaneously.
When the piston reaches the bottom dead center it gets actuated by means of the centrally mounted cam which presses the piston outwards resulting in ejection of bricks directly on the ground.

As the piston moves towards top,it gradually disengages with the cam where they get lubricated by means of a spray of lubricant.

EXPLODED VIEW

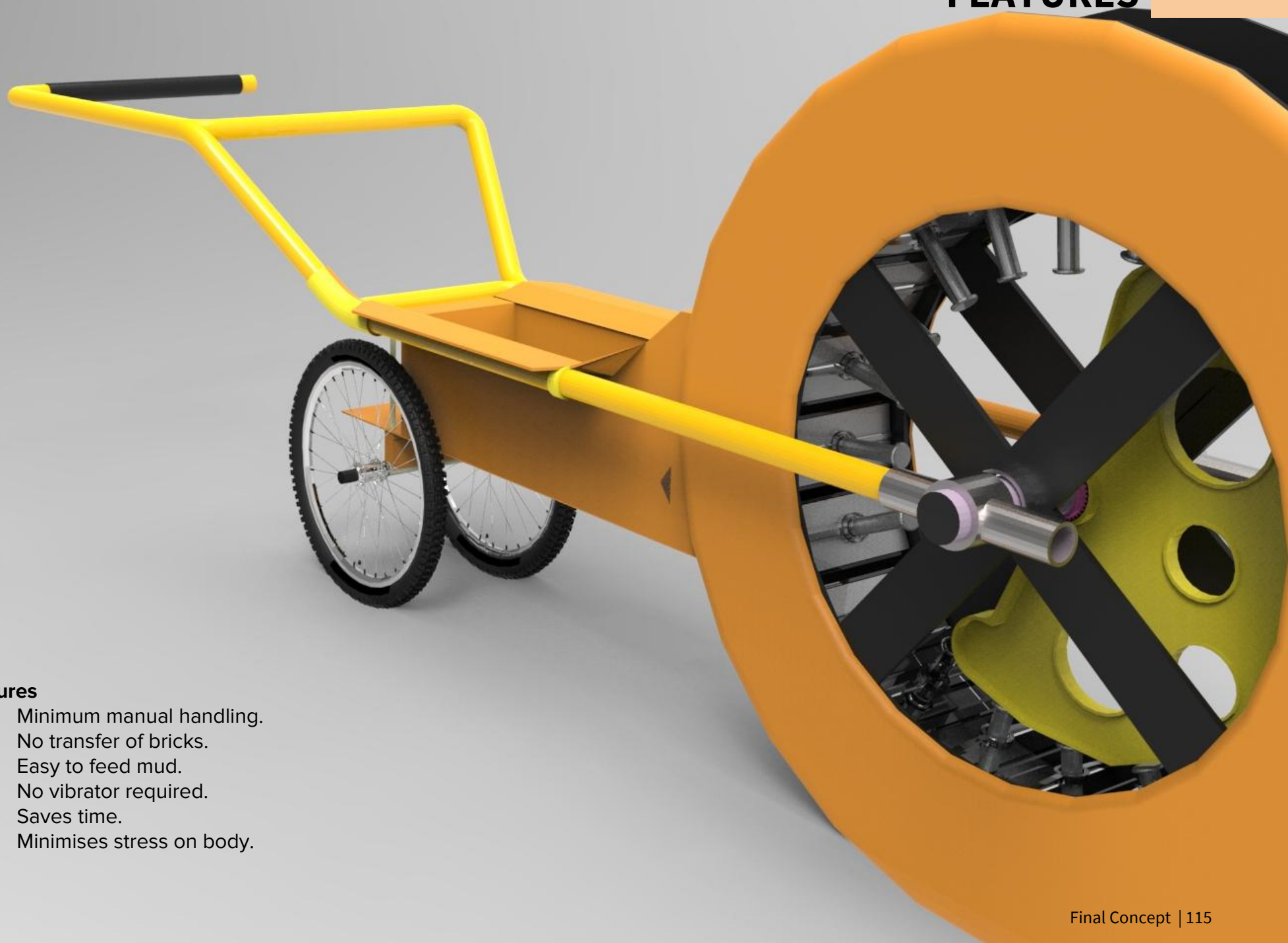
The front exploded view of the CAD model shows the exploded view of the machine with different internal parts.



The parts are as follows.

- Support wheel
- Cover
- Rim
- Moulds with plunger
- Cam
- Spline hub
- Outer flanges
- Gear
- Feed Screw
- Extruding chamber
- Handle
- Rotatable wheels

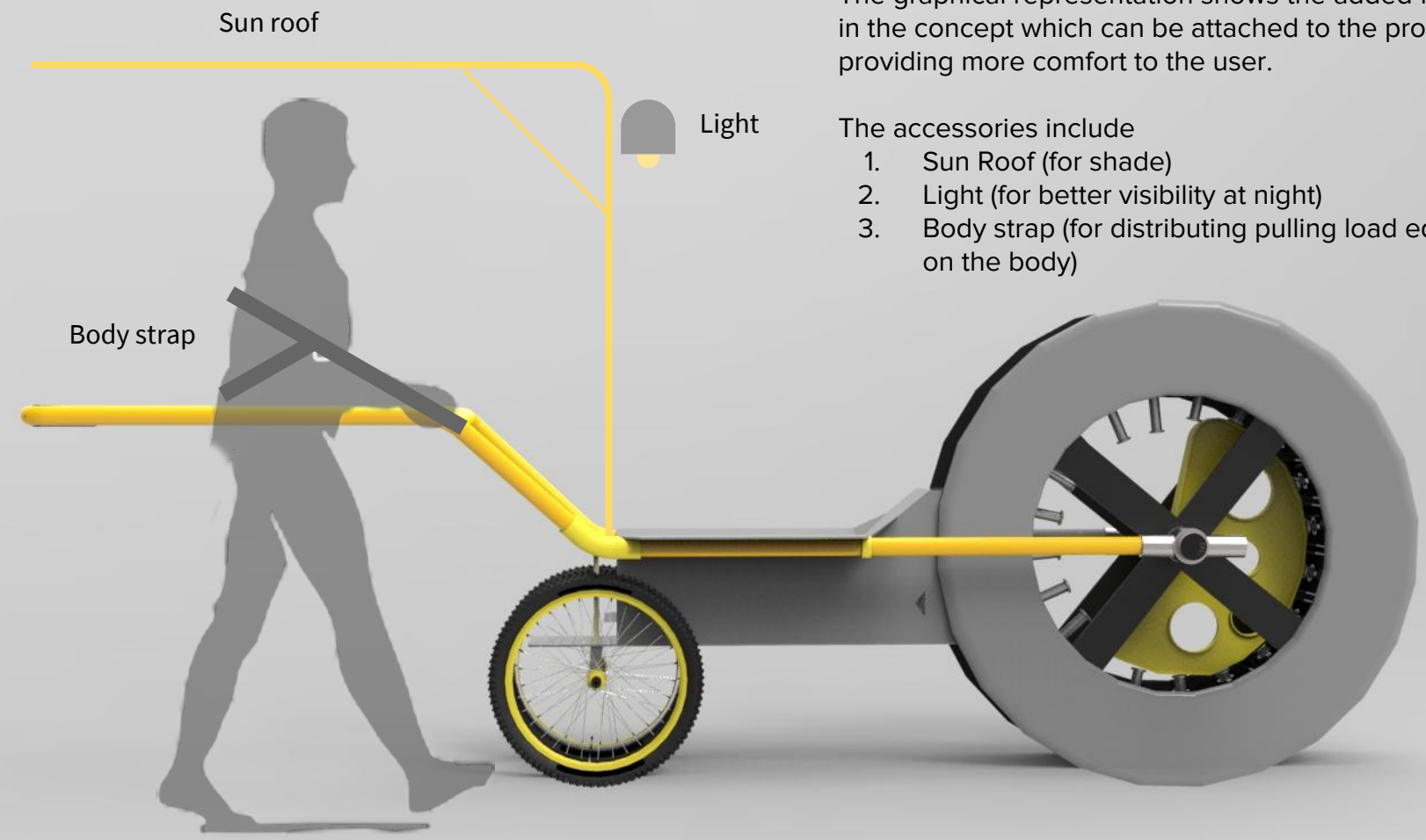
FEATURES



Features

- Minimum manual handling.
- No transfer of bricks.
- Easy to feed mud.
- No vibrator required.
- Saves time.
- Minimises stress on body.

ADDED FEATURES

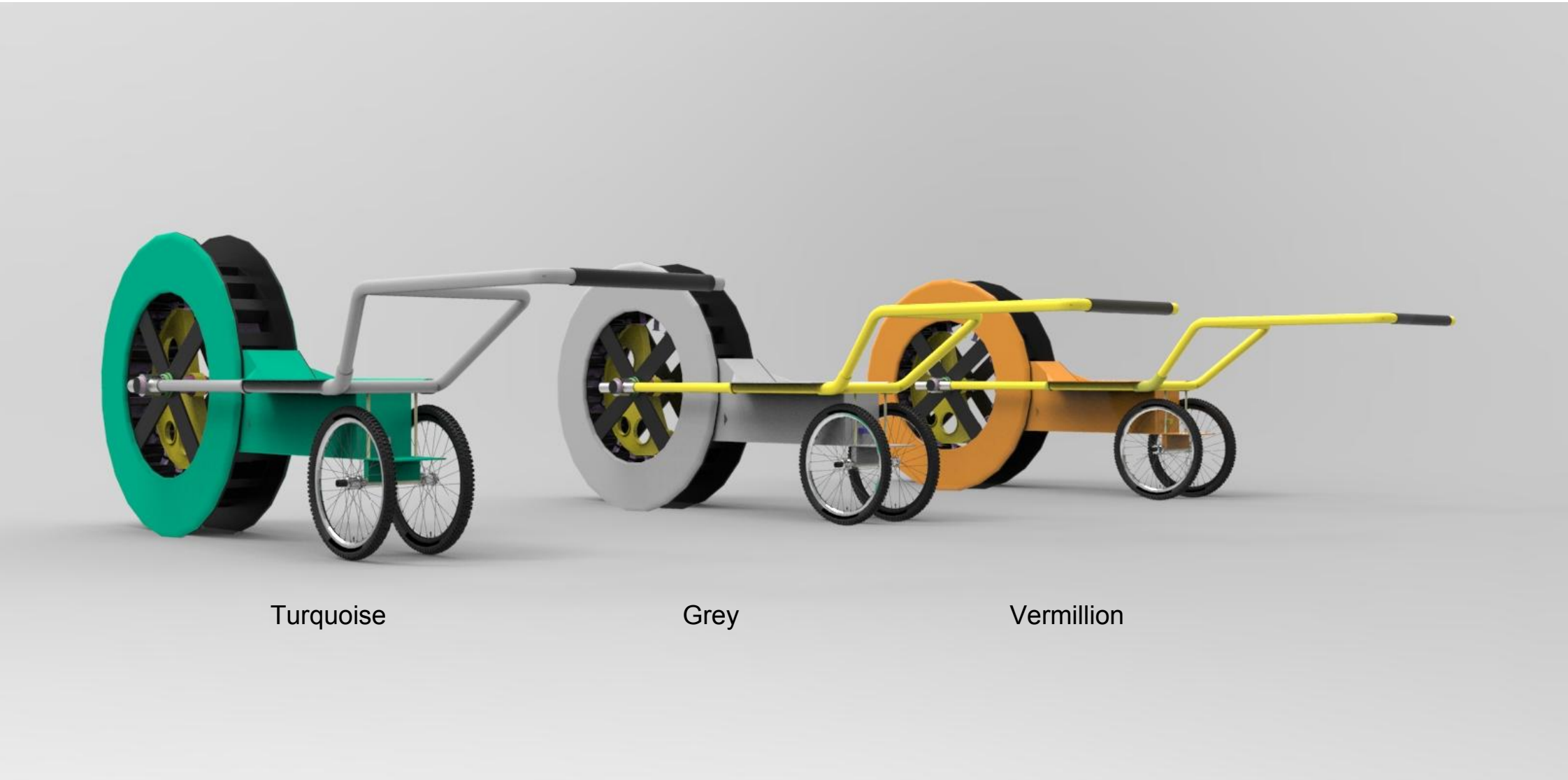


The graphical representation shows the added features in the concept which can be attached to the product for providing more comfort to the user.

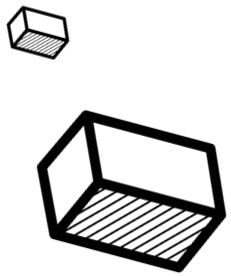
The accessories include

1. Sun Roof (for shade)
2. Light (for better visibility at night)
3. Body strap (for distributing pulling load equally on the body)

COLOUR VARIANTS



Turquoise Grey Vermillion



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