DESIGN AND FABRICATION OF MANUALLY OPERATED BRICK MOULDING MACHINE

This report is being submitted as particial fulfillment of M.Des. Project III

Project III Report
2017

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Project Details

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Tata Centre
Technology and Design, IIT BOMBAY

Industrial Design Project III

"Design and fabrication of a Manually Operated Brick Moulding Machine."

Location of the project : Bhramani brick kiln, Mehsana, Gujarat, India.

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Approval Sheet

Industrial Design Project III

"Design and fabrication of Manually Operated Brick Moulding Machine"

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2015-2017

is approved as a partial fulfilment of requirements of a post graduate degree in Industrial Design at IDC, IIT Bombay.

Project guide :

Project guide :

Project guide

Internal Examiner :

External Examiner :

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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Acknowledgement

I would like to express my special thanks of gratitude to my project guides **Prof. N Sadhu**, **Prof. Gaur G. Ray** and **Prof. V. Bapat**. I also want to thank 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 Mr.**Amar Kundu** and Ms.**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.

Secondly I would also like to thank my parents and my friends **Devanshi** and **Ramkumar** who helped me a lot in completing various things related to the project within the limited time frame.

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Introduction

After China, India is the second largest brick producer 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 psycho-physically. 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 acute health problems due awkward postures and repetitive manual load handling while making and transferringbricks, 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.

Synopsis of Project 2

This project is the continuation of the P2. The P2 was more focused on the research, investigation and possible prototype development related to the probelm being addressed.

The P2 was compromised in three important stages. The first stage had the research on the task based analysis, health issues associated with the tasks, various patent study along with the market study,soil composition and time motion study.

This basic reasearch laid a foundation for the route to be followed on concept generation.

Ideations were made and potential concepts were developed based on that. The main motivation of the concept generation was to keep the product frugal and as simple as possible without using any external power source to run it, the cost was also one of the major concern.

After concept generation, more emphasis was given on concept evaluation and validation for finalizing a potential concept which can match all the ergonomics and mechanical standards and design criteria. Along with that various scale models were made to understand the process and various modification were made accordingly, based on the task analysis.

AIM

The main aim of the Project 2 was to conduct research and study various factors and issues associated with design of a brick moulding machine for the traditional brick making indutry.

OBJECTIVE

The earlier primary research showed that how we can address the problem and how many modes are there to solve the major issues related to the brick making industries. The different concepts and ideas showed that there can be a radical method for any problem and how to make it into reality will be covered in the second half of the project that is Project 3.

The Project 2 consisted of research and concept generation for designing a manually operated brick moulding machine.

TASK DESCRIPTION

The Tasks Carried out in the project 2 included Investigation of the issues, macro level analysis of the process and materials of brick and brick moulding process, Ideation of concepts, concept generation, concpet evaluation and validation ,quick mock up and final concept.

CONCLUSION

The various issues associated with the design and concepts where analysed, the major issues with the design where with the feeding mechanism and the brick laying method which was creating drudgery hence more research was needed to come up with a better solution.

Final Concept of P2

The final concept of P2 was a pull cart type of model in which mud can be feed once and the cart can be pulled away to lay bricks directly on the ground by the means of extruder and a set of plunger actuated moulds which ejects when the come in contact with the cam which is situated at the bottom dead center. *Fig : 1*

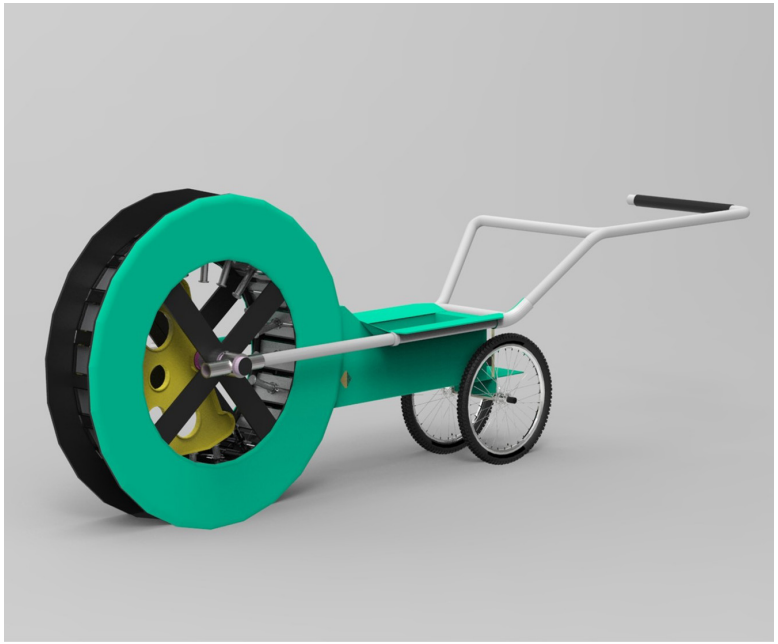


Fig : 1(Cad model of the cart concept)

The wheelbarrow Type Brick Moulding Cart

Number of people required for the operation : 3

Number of bricks made : 20/revolution

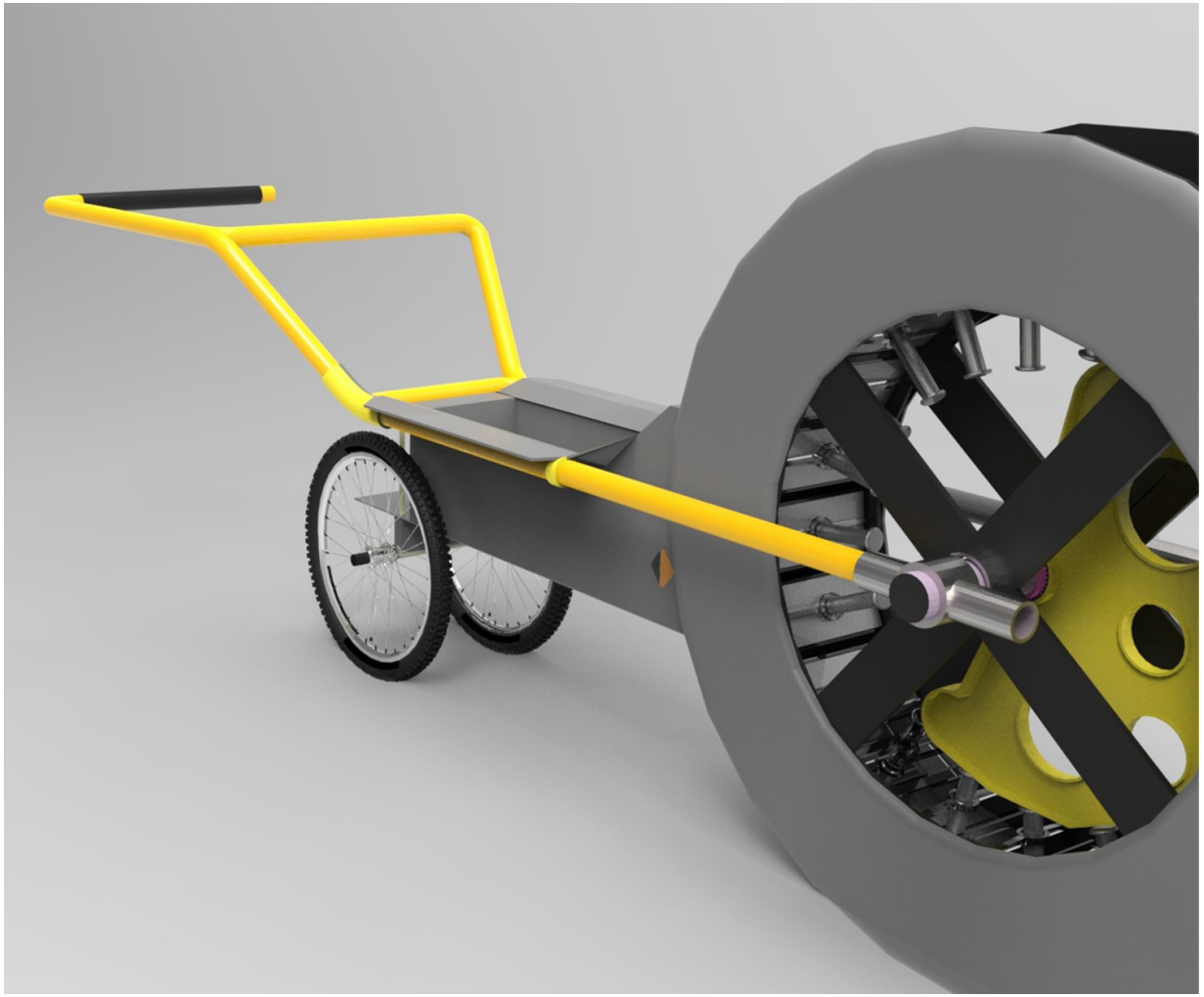


Fig :2 (Cad model of the cart concept)

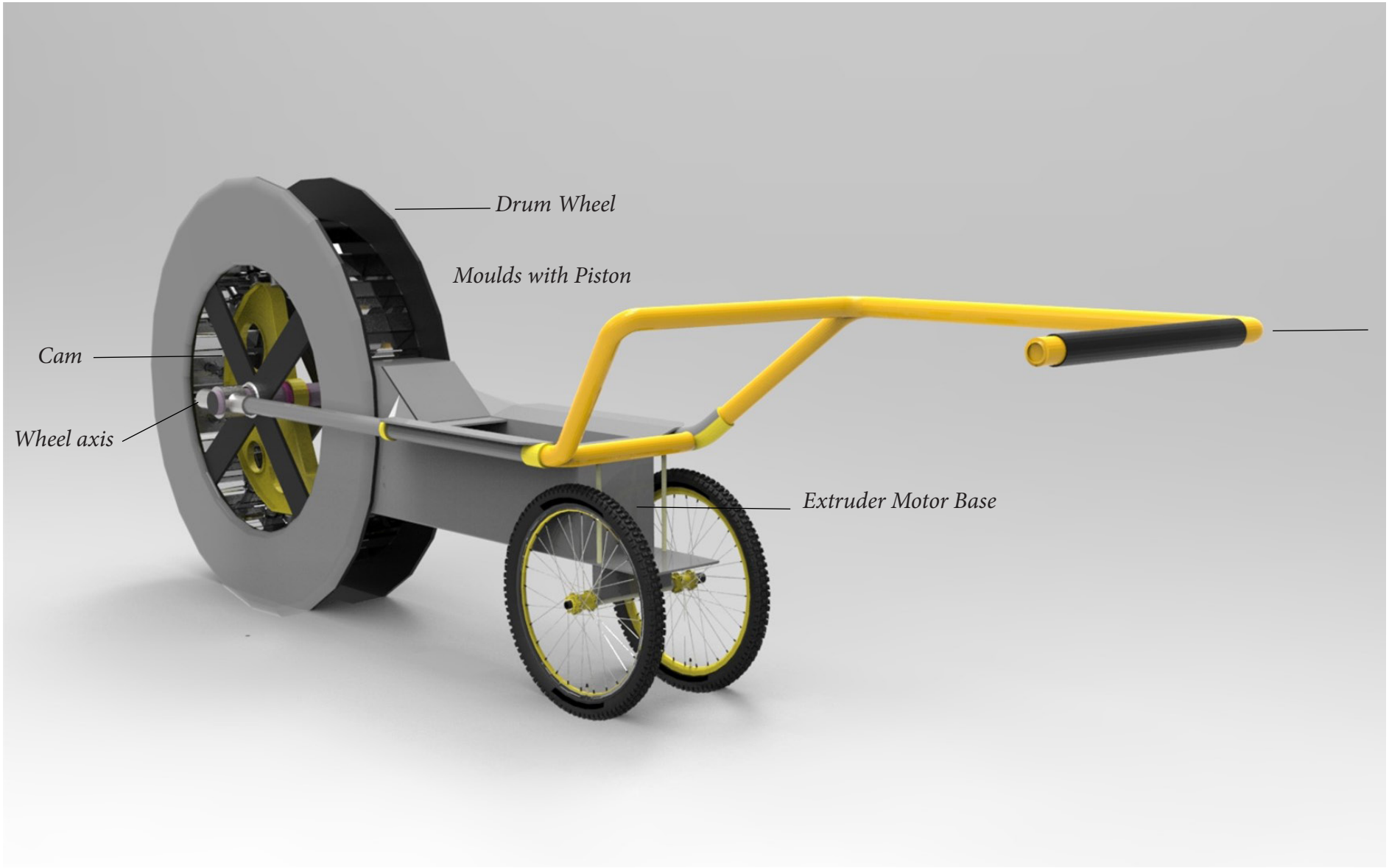


Fig :3 (Back view of the cart concept)

MECHANISM Mechanism

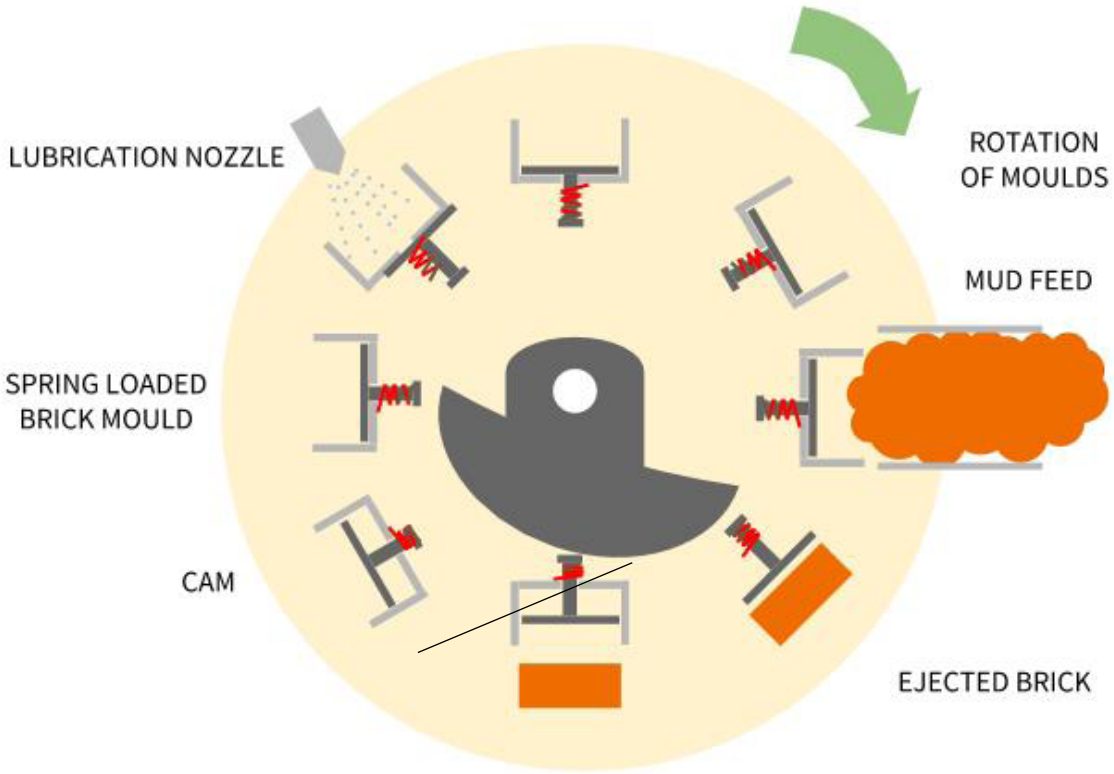


Fig : 4 (Graphical view of the working mechanism)

The diagram (Fig 4) shows the working mechanism 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.

Working

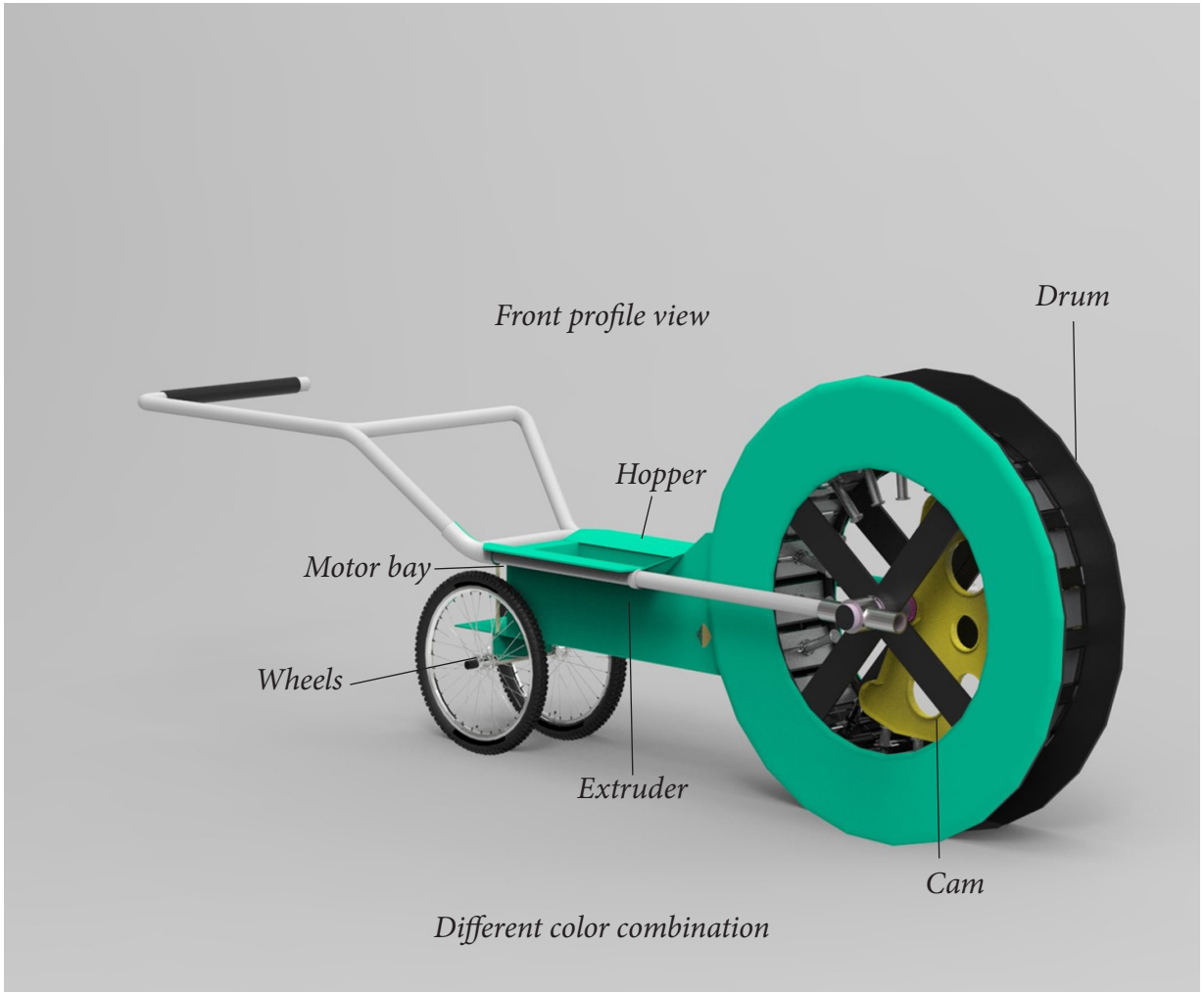


Fig : 5 (front profile view of the cad model)

The machine requires two people for pulling.The machine is brought to the drying laying area where a person responsible for bringing the mud loads the machine with a batch freshly prepared mud by means of a wheel barrow, since the height is kept low as tall as the height of the wheel barrow it makes it easy for the person to unload the mud in the chamber of the extruder based on the back of the machine as shown in the Fig.3. Once the mud is fed in the opening, an external 3 Hp motor is required to run the extruder screw which is situated at the back.

The extruder pushes the mud in the moulds situated at the periphery of the drum.When the cart is pulled, the wheel rotates. As a result the mud is fed to the moulds one by one. The moulds are spring loaded and are lubricated with spraying of oil/water. When the mould reaches at the bottom dead centre of the drum, an internal can located at the center actuates the plunger of the mould by which the bricks get ejected out.

The plunger has a logo die on it which embosses the logo directly on the brick when it gets eject out on the ground.

Dimensional View

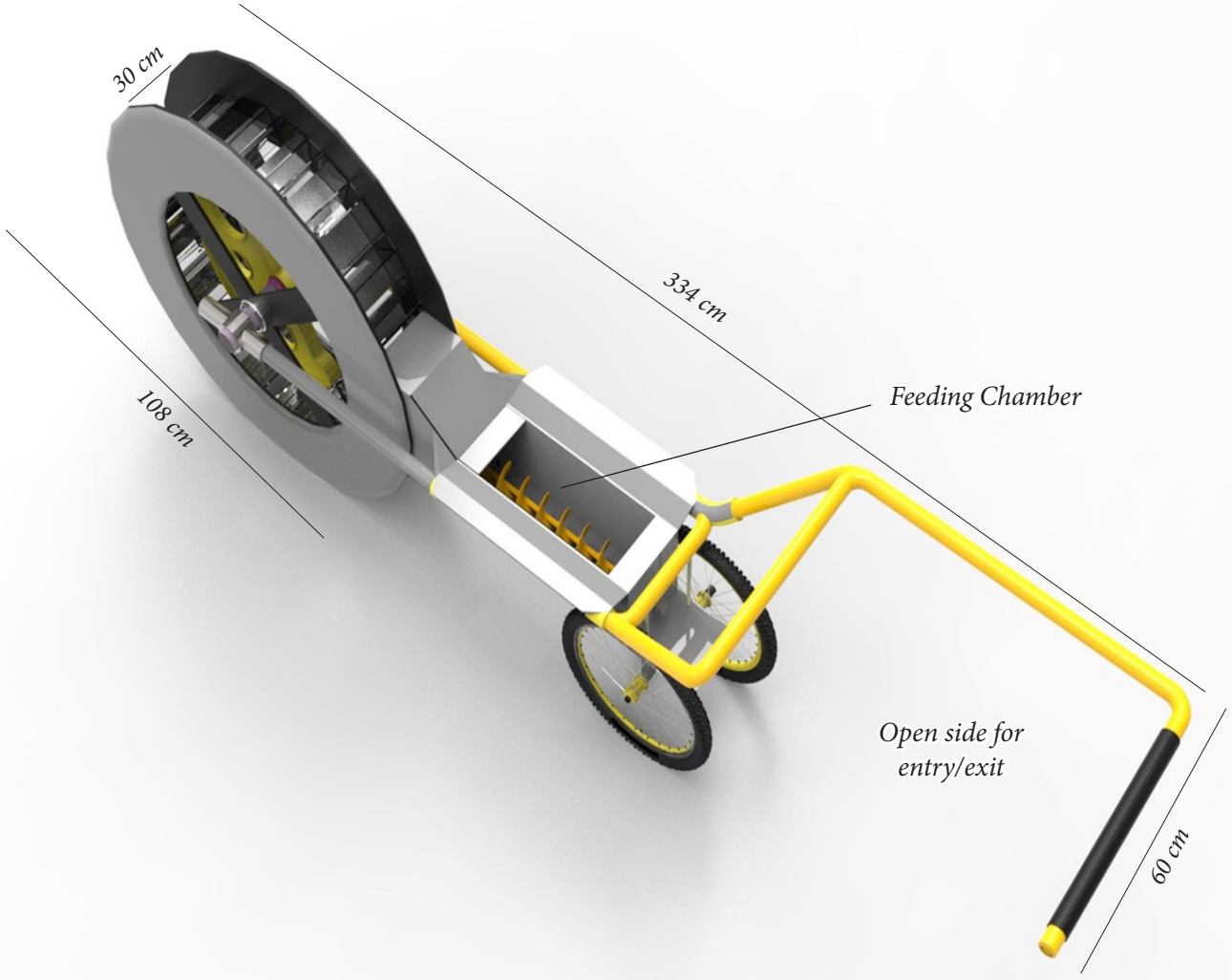


Fig : 6 (top view of the model)

The Fig. 7 shows the human interaction with the machine.
The person pulls the cart which in relation rotates the wheel, ejecting the bricks out by means of plungers in mould actuated by cam.

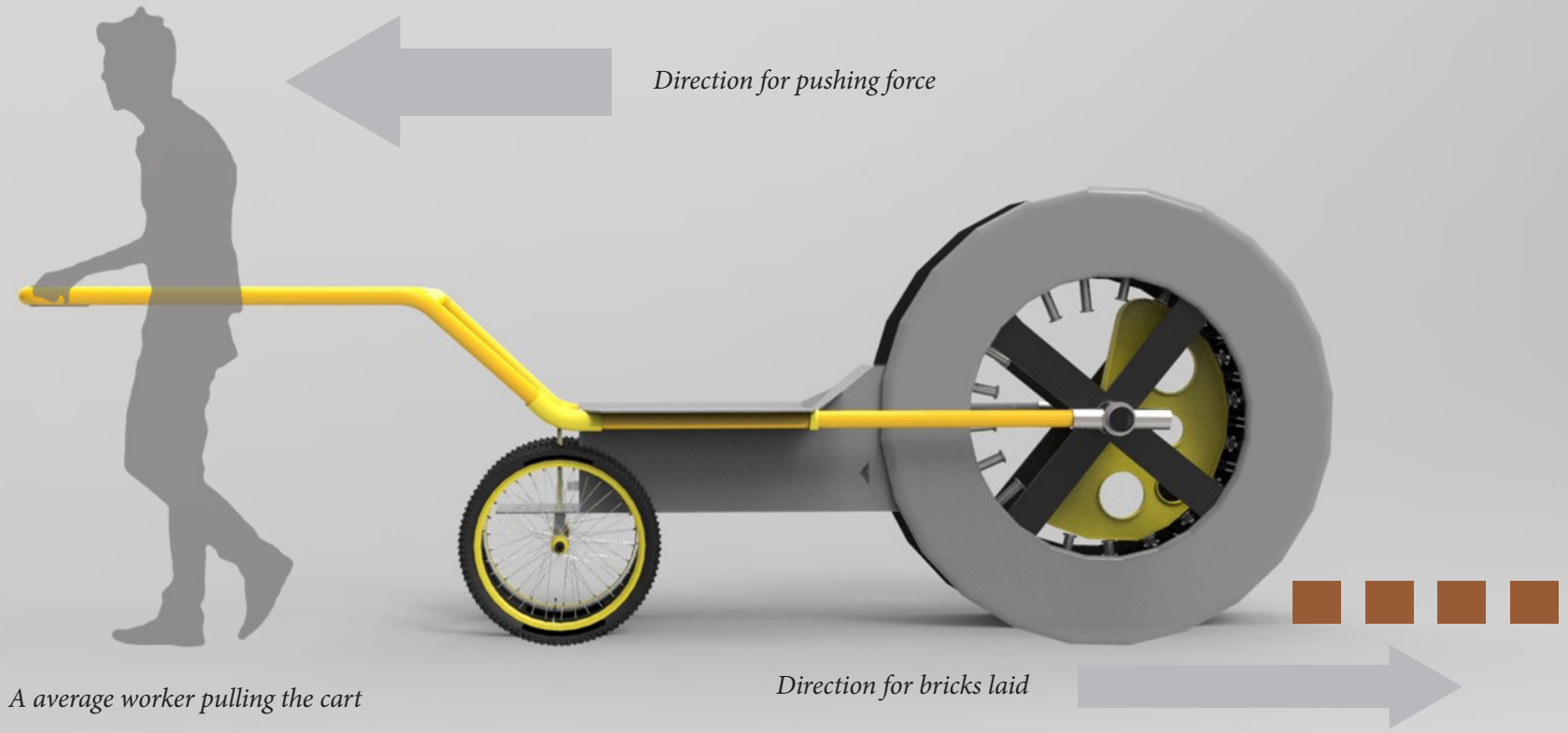


Fig : 7 (Figure representing the operation of the machine)

The Fig.8 shows that how the person can change the body position and cart pully by using his back to drag the cart backward direction, hence causing less stress on his hands for pulling

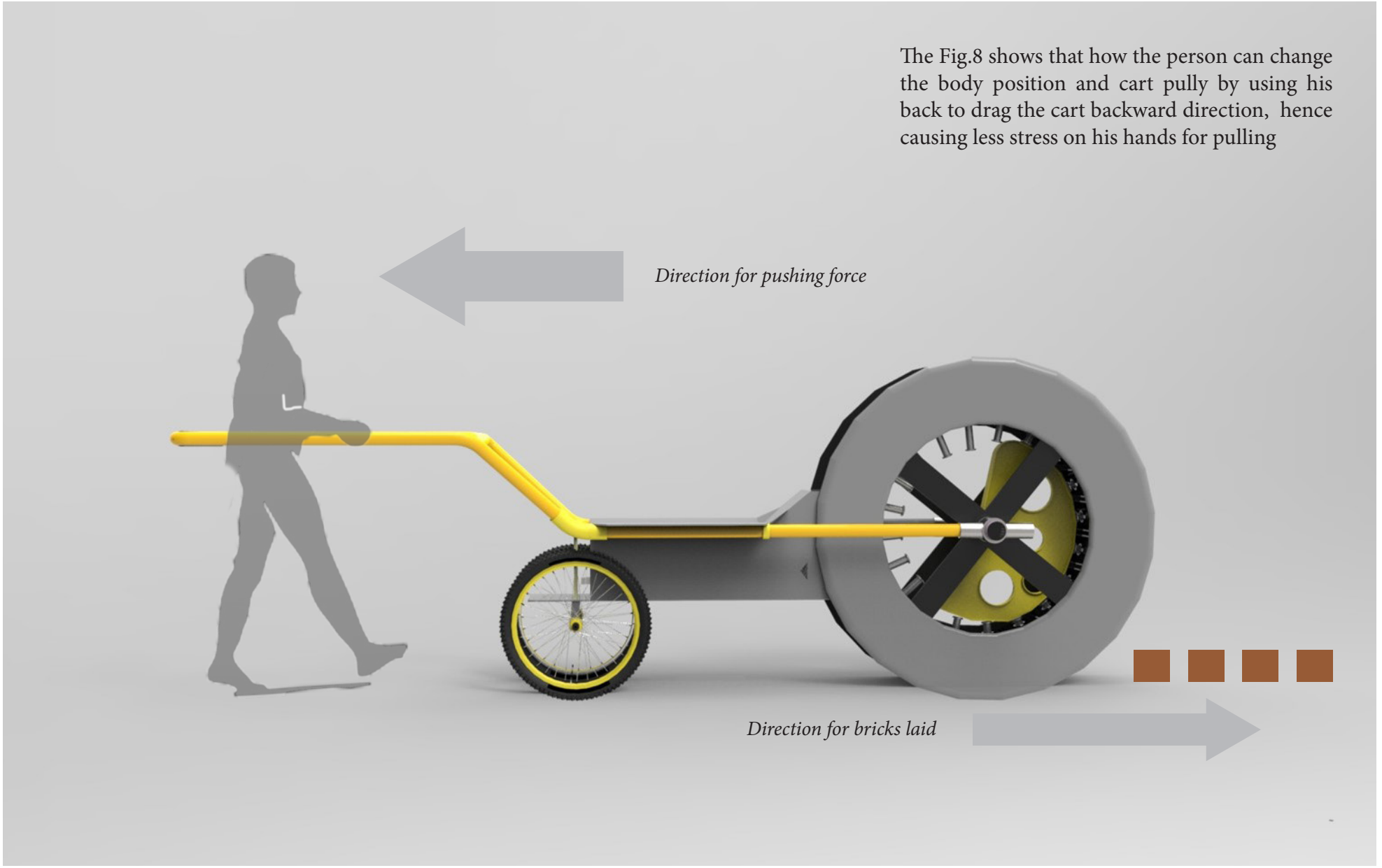


Fig : 8 (Figure showing the working of machine)

Exploded View

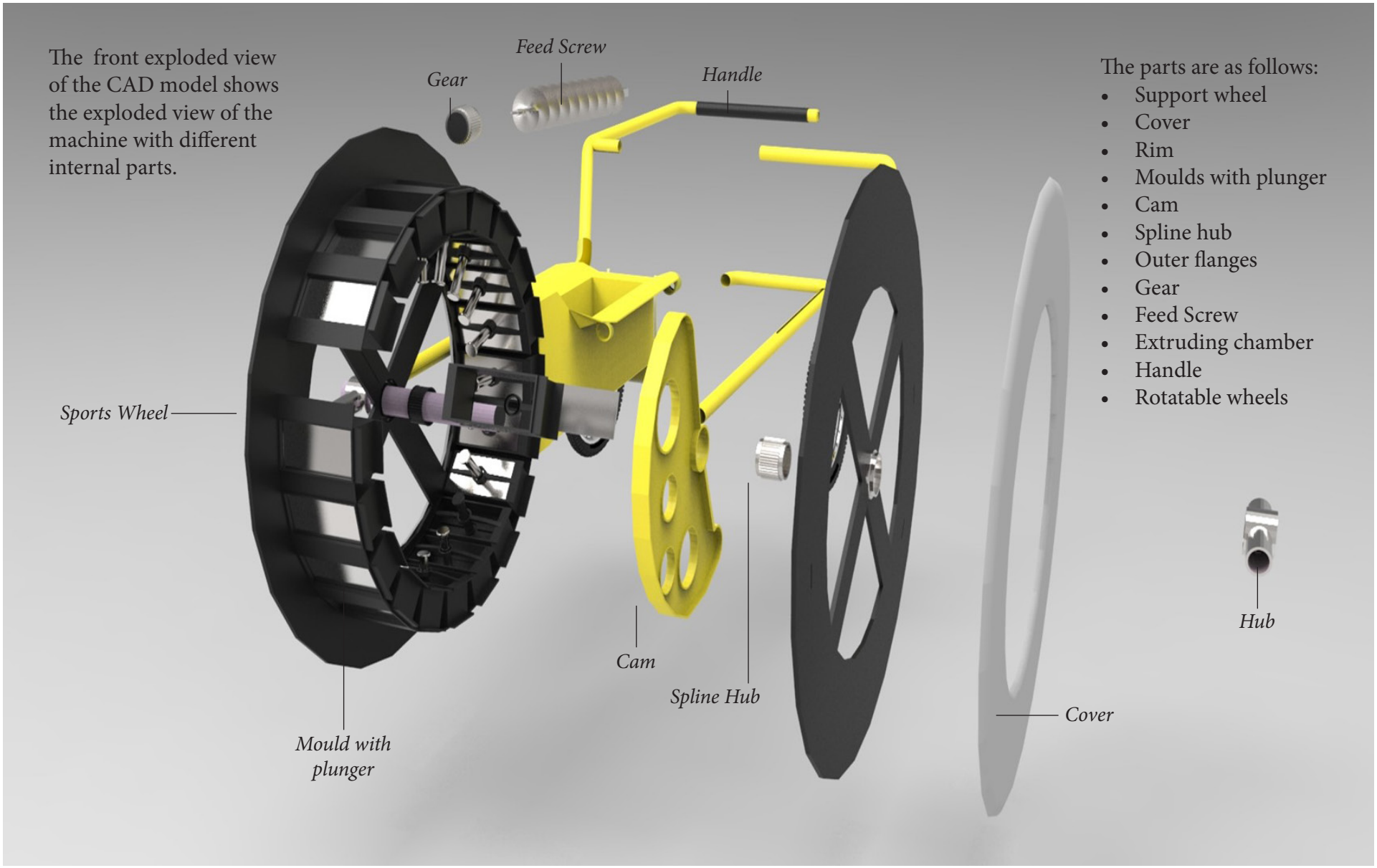


Fig : 9 (Exploded view of the machinet)

Pros and Cons of P2 Final Concept

Pros:

- Faster brick moulding
- Bending action of the body and twisting action of the hands removed
- The height of the feeder is of the same height of the mud cart

Cons:

- Surface contact of the wheel to the ground increases the dragging force required to pull the machine
- The person pulling the machine can not see whats is happening behind him or is he laying the brick with the alignment or not.
- The load of the whole machine is on the spoke wheels and the the drum which has thin surface contact with the ground which might create the wheel to get stuck in the ground or create more drag.
- Frequent loading of mud is required which is another hectic job to perform.
- The extruder cannot work without any external power supplied to it.
- No cleaning mechanism for moulds.

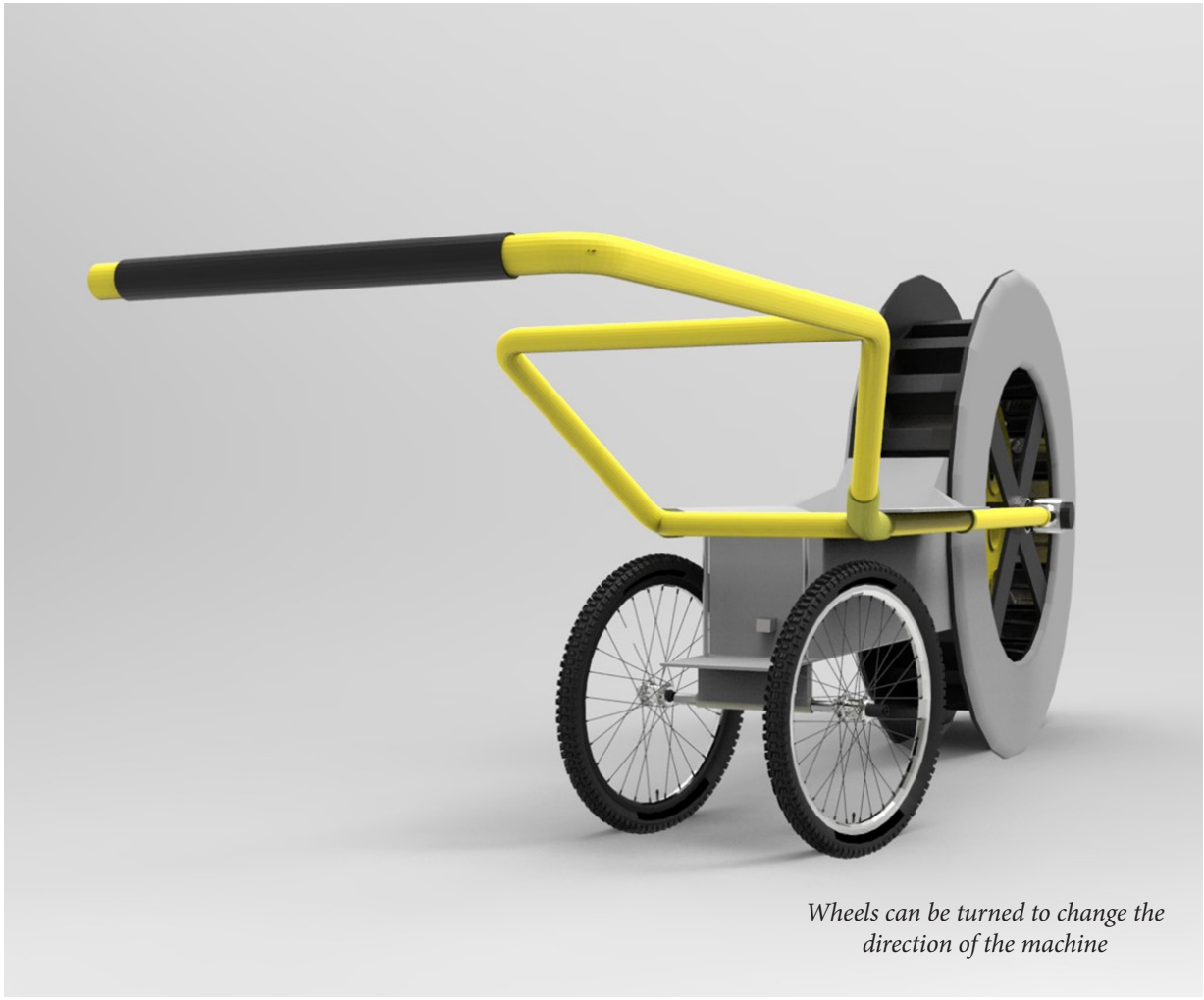


Fig : 10 (figure showing the back view)

Concept 2 (P2)

The concept 2 (fig:11) is a cart type moulding machine.The concept consist of a mould with a vibrator mounting on the top to allow efficient compression. the mud is fed by the loading tray situated at the back,since the tray is slidable ,its fills the mould by sliding action. after filling the vibrator is brought back and the bricks are compressed ,a secondary bar is provided to lift the moudl up along with the vibrating emboss platehence moulding bricks directly on the ground.

Pros :

- Easy to manuver
- Simple design
- Lays four bricks at a time
- More suitable for ash bricks

Cons:

- The type of mud used is very viscous thats why its difficult to feed it in the mould
- Overall weight of the machine is more
- Vibrator requires electrical supply

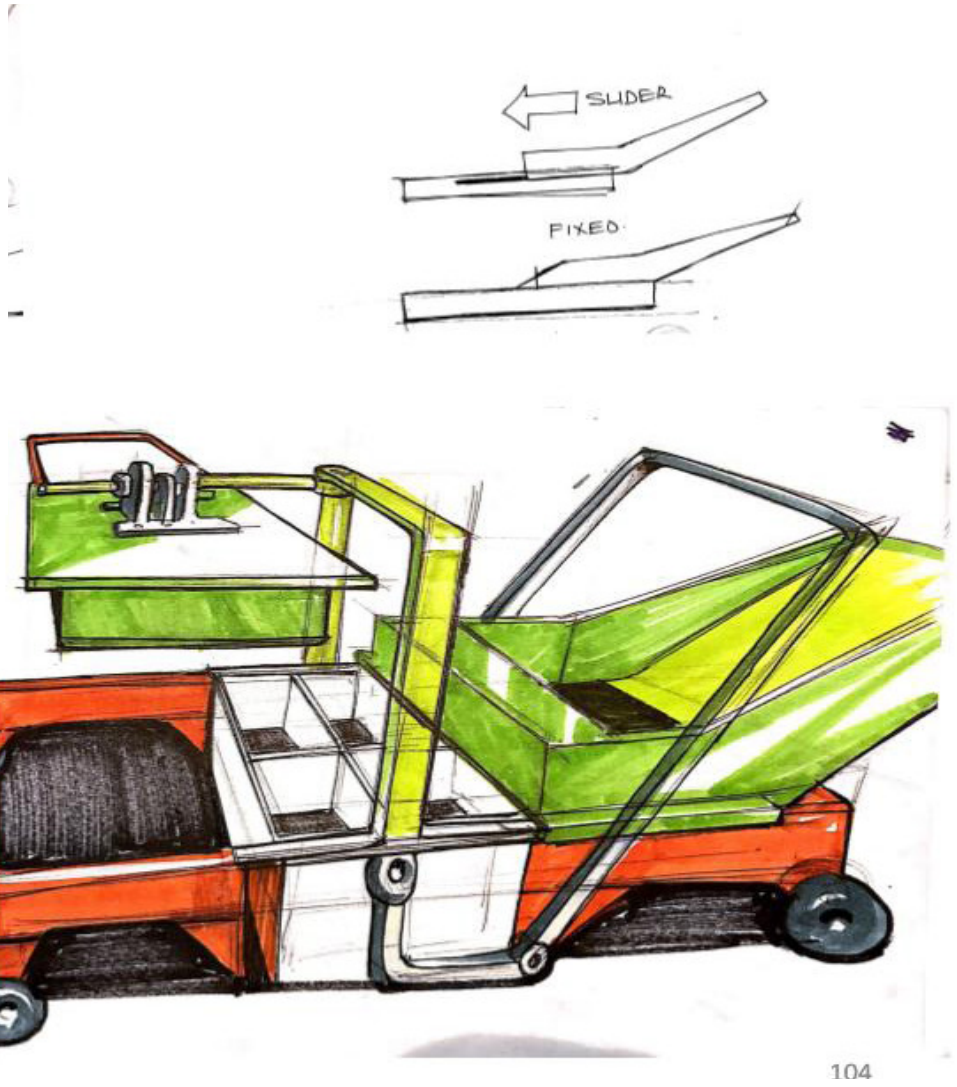


Fig : 11 (Ideation of the concept)

Concept 3 (P2)

Taking the consideration of th table top moulding unit from the P2 ideations .

This type of moulding very suitable for the brahmani brick kiln because they are already been introduced to brick moulding on the table which better for their posture and eliminates the bending action

Concept was made to solve the issues related with the previous table top vertical brick moulding machine (Fig:12).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 10mm 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.

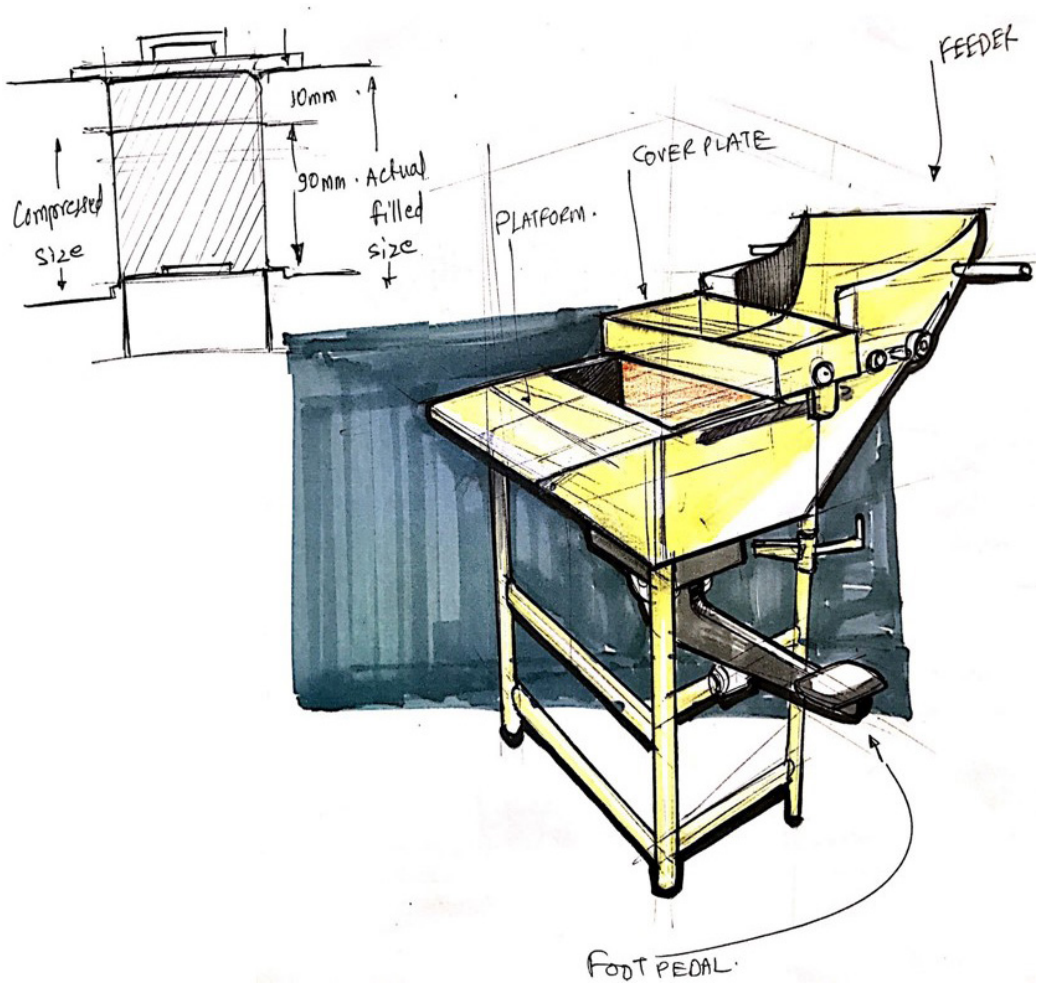


Fig : 12 (Ideation of the tabel type concept)

Concept Ratings

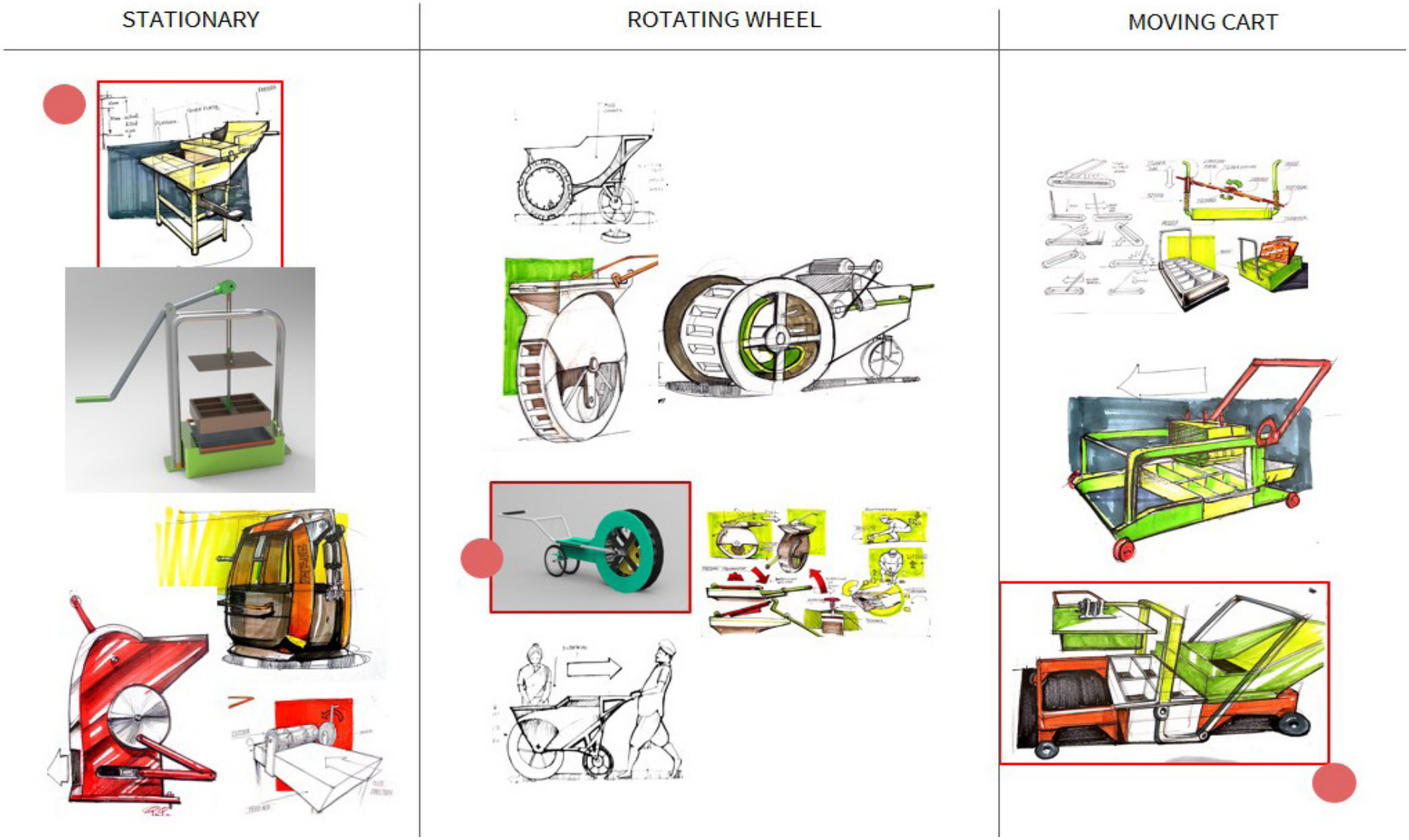


Fig : 13 (figure showing cocnept rating of different cocnepts)

Concept Rating Conclusions

The concept rating method to identify the most suitable concept for the required application as shown in (fig :13).

The analyzation of the concepts were based on:

- Ease of use
- Simplicity of the machine
- Easy maintainence
- Low initial cost
- Low running cost
- Less drudgery involved
- Frugality
- Acceptability of the workers

Three concepts were selected from each category based on given criteria and by experts advice and feedback.

The conclusion from the final mock up study came out to be that the design and major issues related with the ergonomics and mechanical point of view. The design required the need of an electrically driven motor to run the whole machine which led to increased cost and complexity of the brick moulding machine.

Hence a different alternative was looked to facililate the current employed method of making bricks on a workstation type setup which allows the user to mould bricks in a much better ergonomic position.

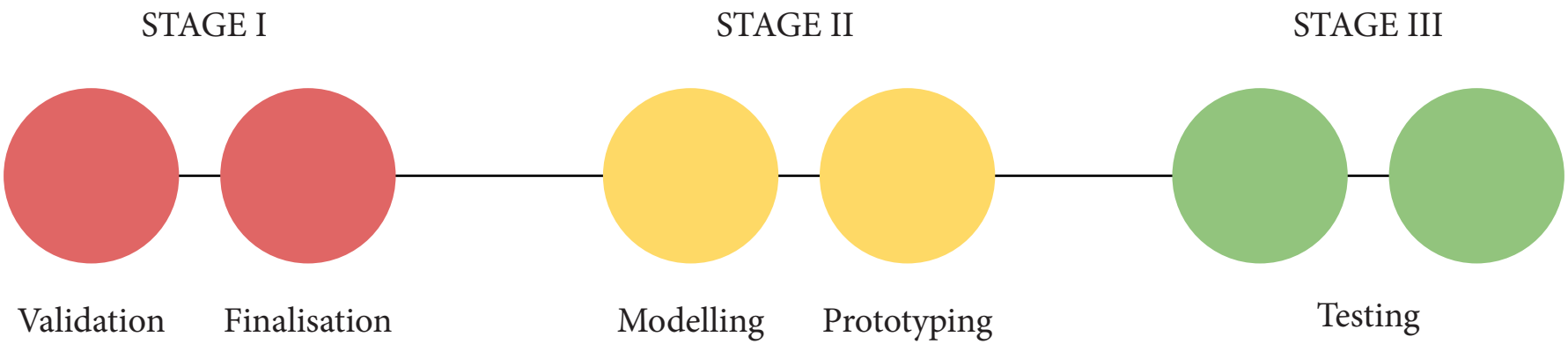
The final design selected was the table top brick moulding machine which can be further explored to make it more user friendly. Workers being familiar with the workstation type brick making setup was the another reason.

Chapter 1:
P3 METHODOLOGY,IDEATIONS AND CONCEPTS

PROJECT BRIEF

Design and fabrication of a manually operated 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 or affecting or replacing their livelihood by any sort of automation.

Methodology



(Graphical representation of the methodology)

Feeding of the Mould

Brainstorming is a method used for generating new alternatives to address a problem. Brainstorming was done for this project to generate new ideas for the different activities related with the brick moulding process and how can one make a mechanism for effieciently mould and demould a brick.

*The selected ideas are marked by green oval

1. Chain pulley
2. Conveyor belt
3. Extrusion
4. Cycle Mechanism
5. Chilli crushing machine mechanism
6. Pressurized mud
7. Pressure difference
8. Gravity
9. Origami
10. Footpath Making
11. Punching / Blanking Die
12. Rolling
13. Crank / extended Arm
14. Lemon squeezer

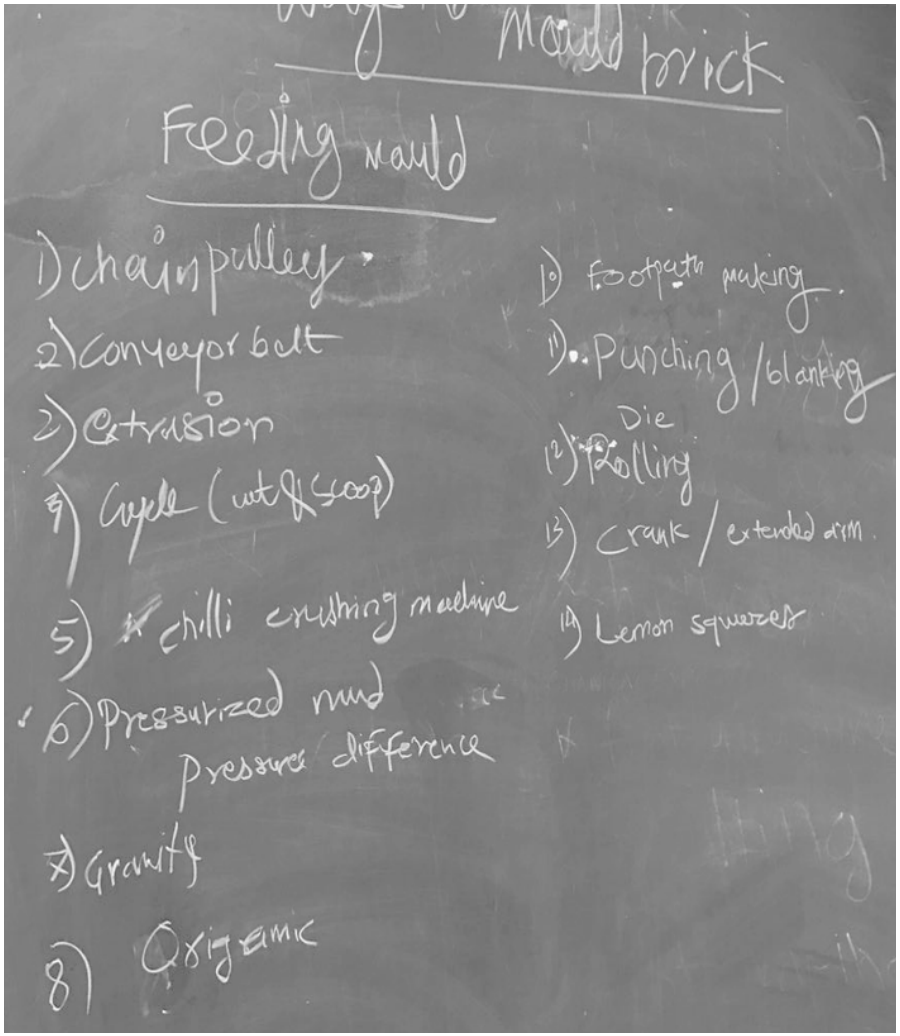


Fig : 14 (Brainstorming performed in class)

Ejection of Bricks

Fig : 15 (brainstorming of ejection of bricks)

Ejection of the brick is a crucial proccess in which the bricks need to be ejected from the mould once it is filled with mud.

The brainstorming shows in how many possible wasy it can be done.

1. Pneumatic Ejection
2. Tapping
3. Vibration
4. Heating
5. Jerk
6. Vaccum
7. Split mould
8. Gravity
9. Silicon mould
10. Water Jet
11. Ice cream scoop
12. Collapsible mould
13. Snap Fit
14. Cardboard Mould
15. Soap water solution
16. Spring press
17. Hydraulics

Cleaning and Lubrication of the Mould

The brick moulding process requires cleaning and lubrication so that the mud doesn't adhere to the surface of the mould. This method is required for traditional as well as modern brick moulding techniques.

The brain storming shows in how many other ways the lubrication can be done.

1. Soap and water mixture
2. Grease
3. Liquid clay
4. Oil
5. Pressurized water
6. Vibration
7. Sponge
8. Water tank
9. Washing machine
10. Car Washing
11. Spray
12. Dipping
13. Wire Brush
14. Husk and straws

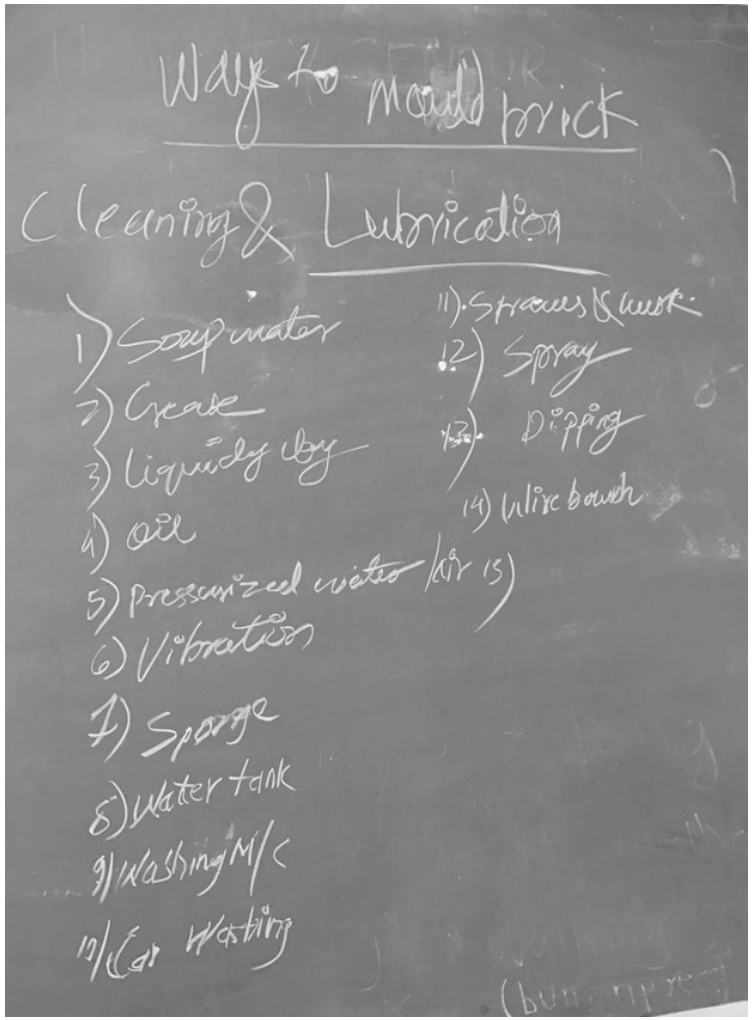


Fig : 16(brainstorming of cleaning of mould)

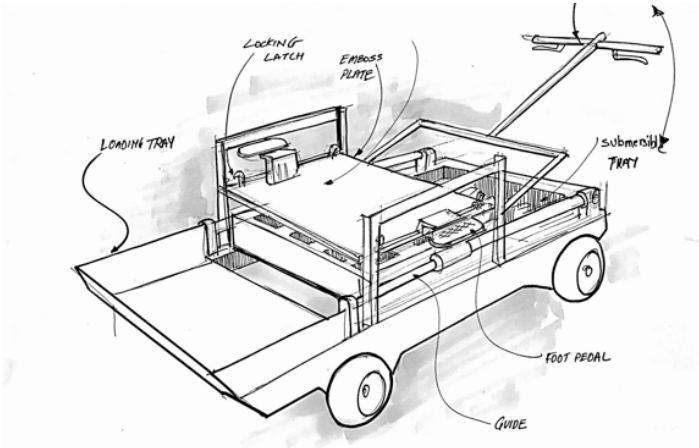
Considerations from Brainstorming

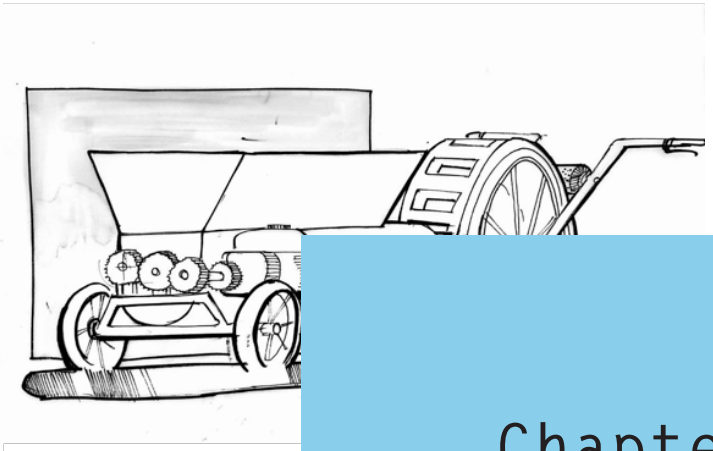
The following methods choosen by selecting the most appropiate and efficient to be used in the new concept.

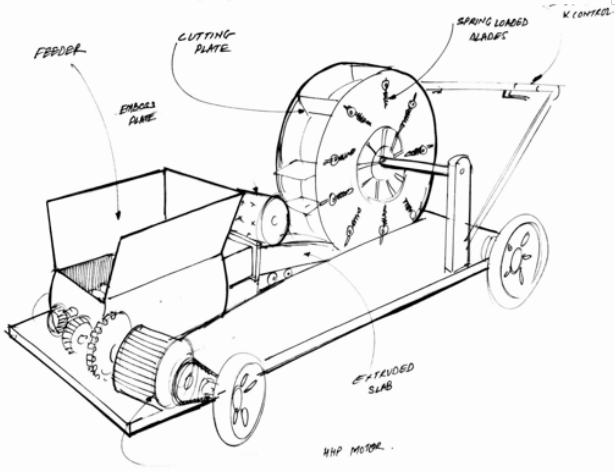
Feeding of mould: Punching/blanking Die
to get precise profile with better effiency

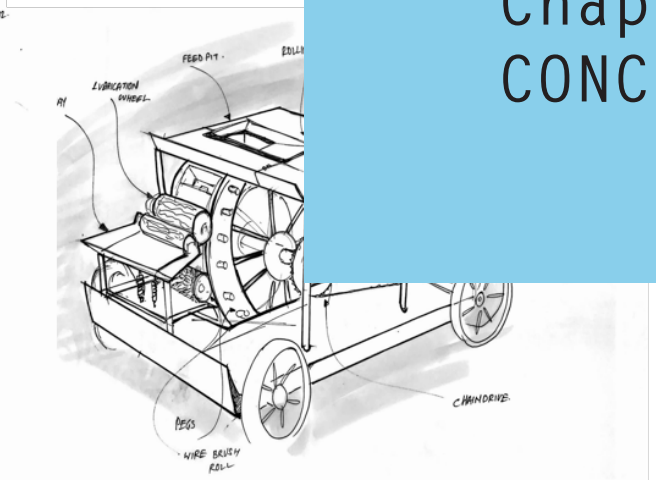
Ejection of bricks: Spring Press
for getting compact and compressed bricks which can easily manual handled

Cleaning and lubrication: Spray
spray of water or oil can be used for lubrication so that the bricks can be ejected from the mould with ease.









Chapter 2:
CONCEPT MODIFICATIONS

Concept Modification 1A

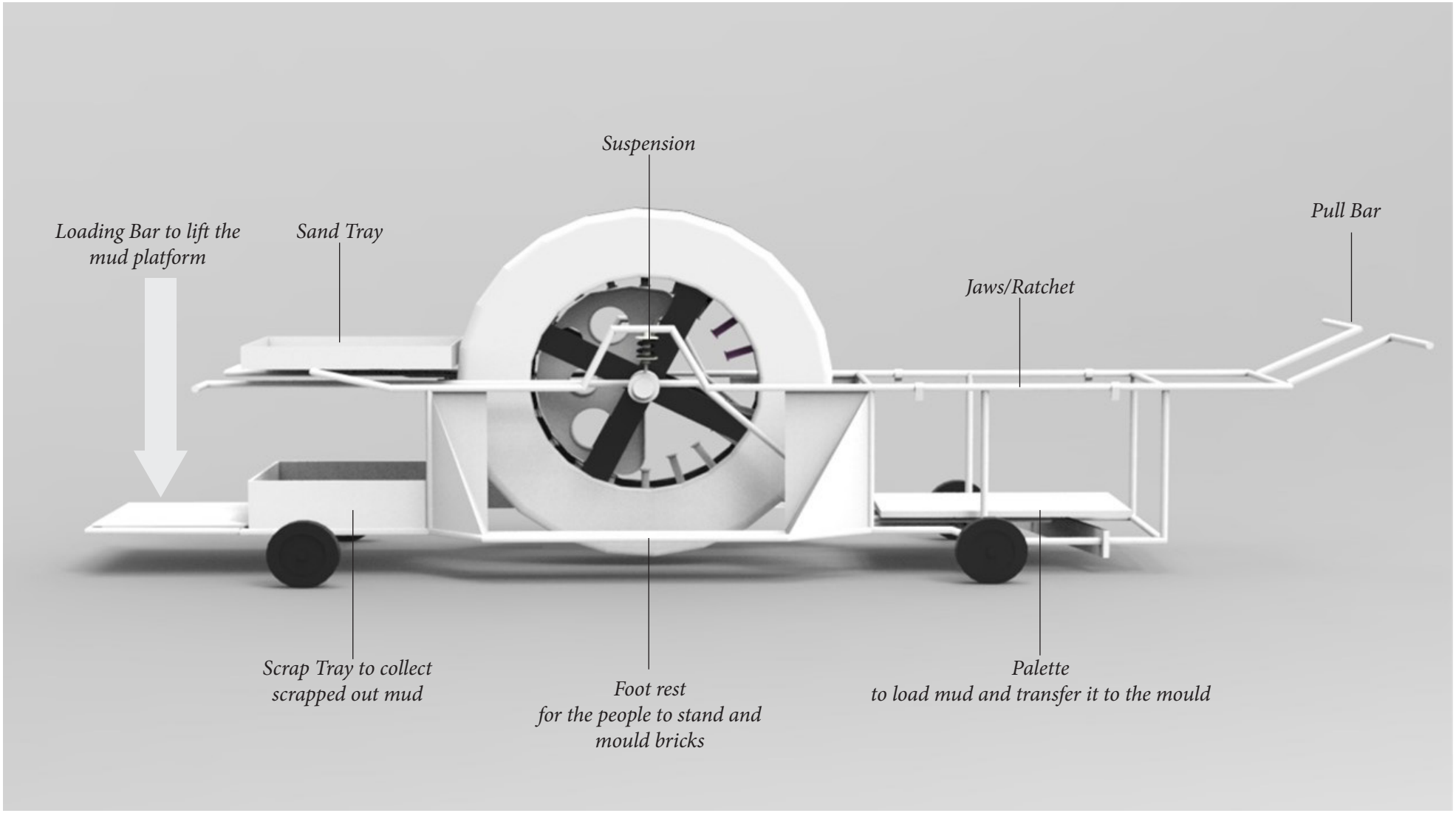


Fig : 17(figure showing the cad of modified brick moulding machine)

The wheel cart type brick moulding cart (shown in Fig. 17 & fig : 18) was further modified as earlier, it had various problems.
This concept was generated to accomodate two people on either side of the wheel so that they can easily feed the moulds by hands while the cart is moving.
It also has a moving platform to bring mud up once the mud is loaded on it by means of lever. The foot rest is provided for the people to stand and fill the moulds.

Issues

- Length of the machine is too long
- The person supposed to stand is not stable and not safe.
- The overall weight of the machine is heavy
- It needs frequent loading of mud
- The orientation of the mould to the feeder is not safe.
- The drum is still in the contact of the ground which makes it hard to drag with so much of machine weight.
- The bar made for lifting the table are not long enough to lift the mud up with less effort.
- No platform is provided for rolling the mud to feed the mould
- One extra person is needed for cleaning of the moulds
- Wheel size is very small

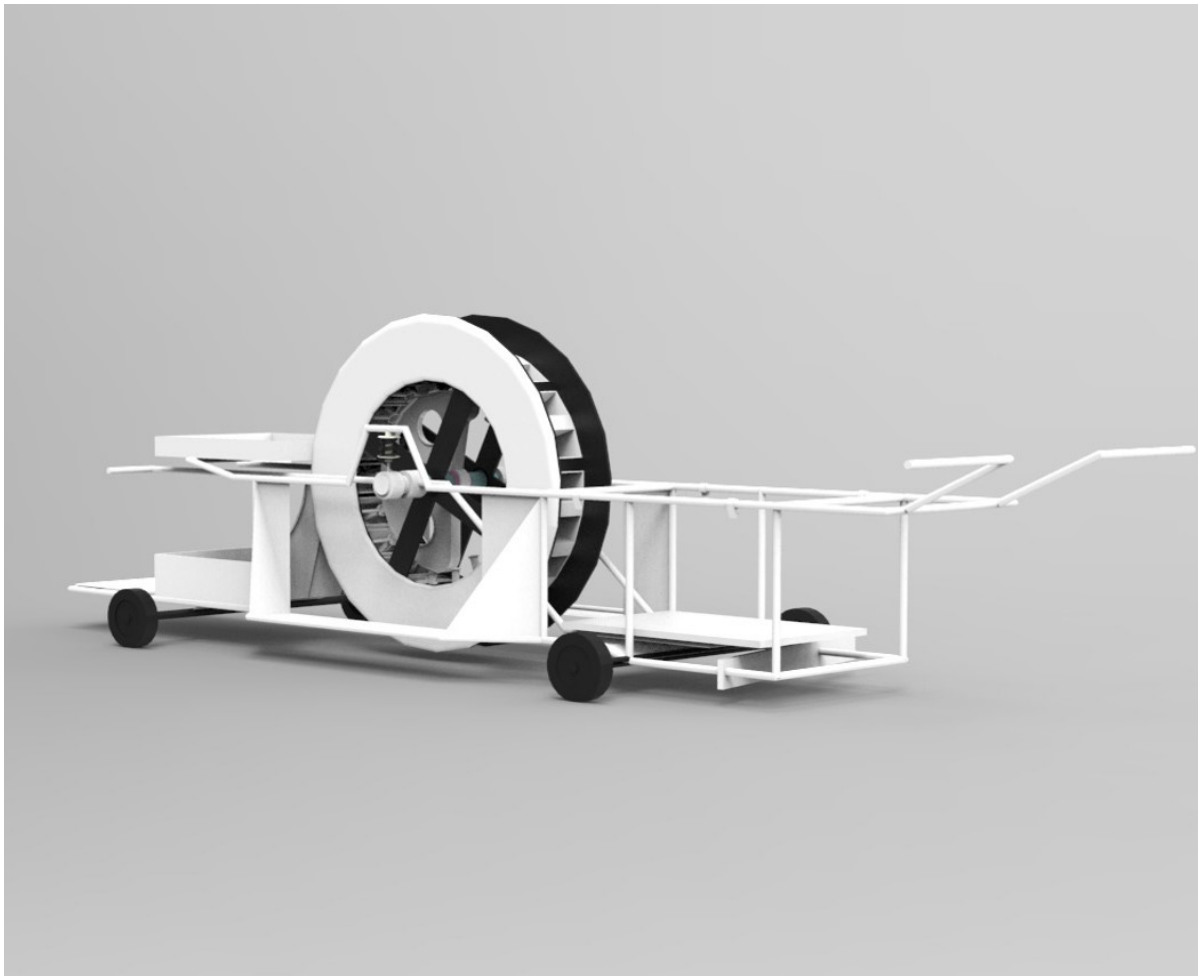


Fig : 18 (Profile front view of the machine)

Concept Modification 1B

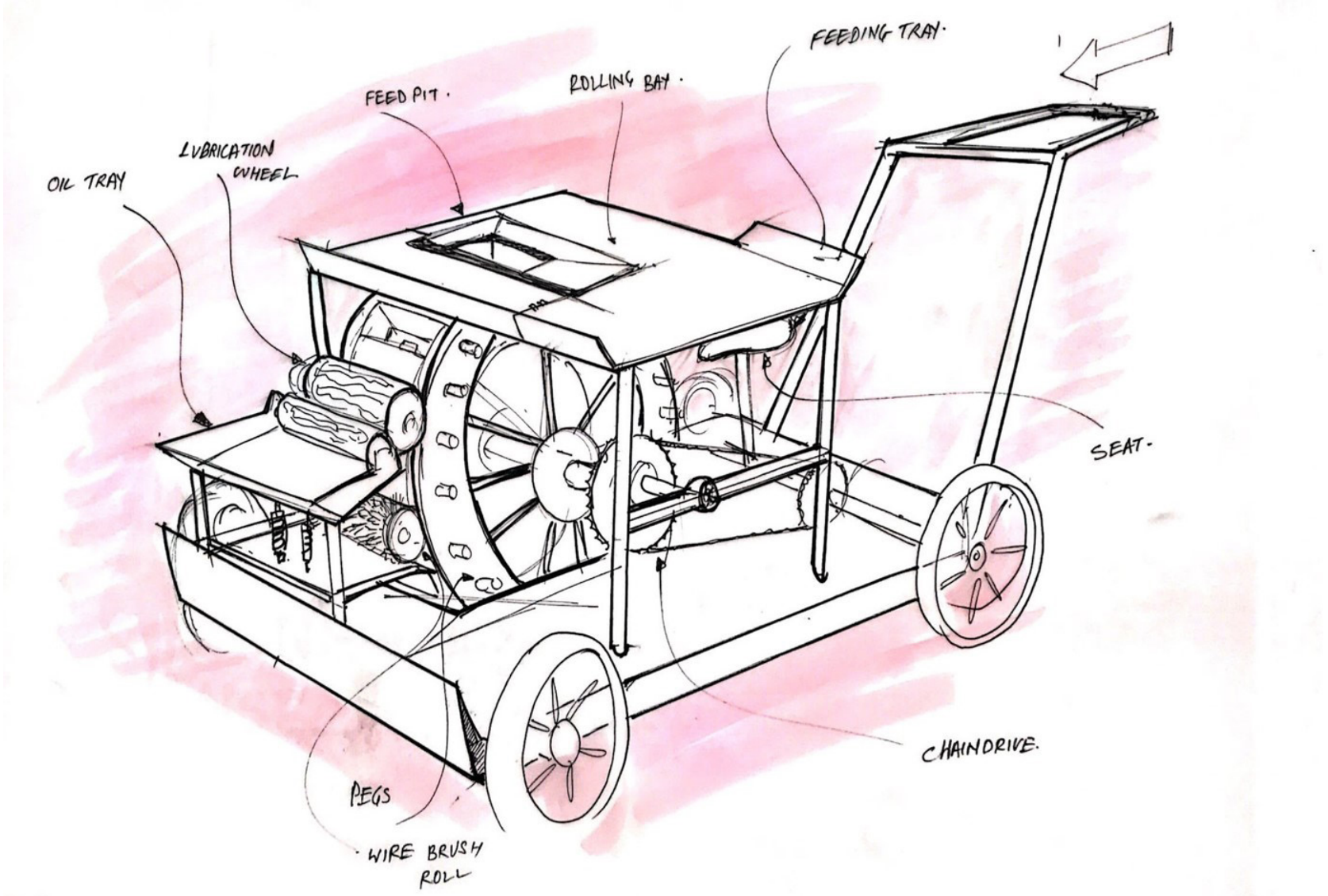


Fig : 19 (Ideation sketch of the concept 1B)

This particular concept is modification of the Drum Roll brick moulding concept (fig :19). Three to four people are required for operating the machine.

Two people are required to drag/push the cart. Another person is supposed to sit on the seat provided on the cart and mould the bricks in the provided caity when the mould gets aligned to the opening.provided in batch by a person responsible to bring the mud till the cart and load it to the platform. The overall weight of the cart is supposed to be around 500-600 kgs considering the weight of the mud loaded and all moulds filled with mud, weight of the person and the weight of the structure.

The height of the cart by which the mud is supplied is supposed to be the height of the moulding table on the machine.

Issues

- The window of the platform and the mould needs to be timed properly which is difficult since its been pushed by some other person.
- The overall weight of the machine is very heavy
- The cart full of mud need to supplied frequently which involves travel and bending action.

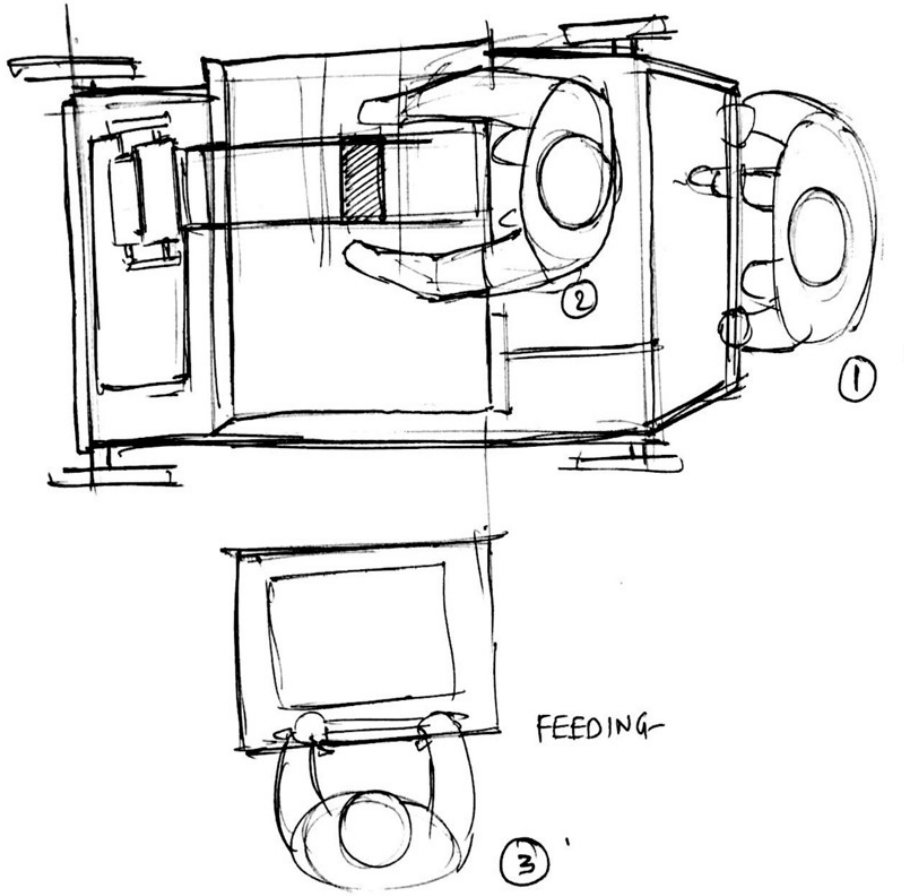


Fig : 20 (Top view of the kart type moudling)

Concept Modification 1C

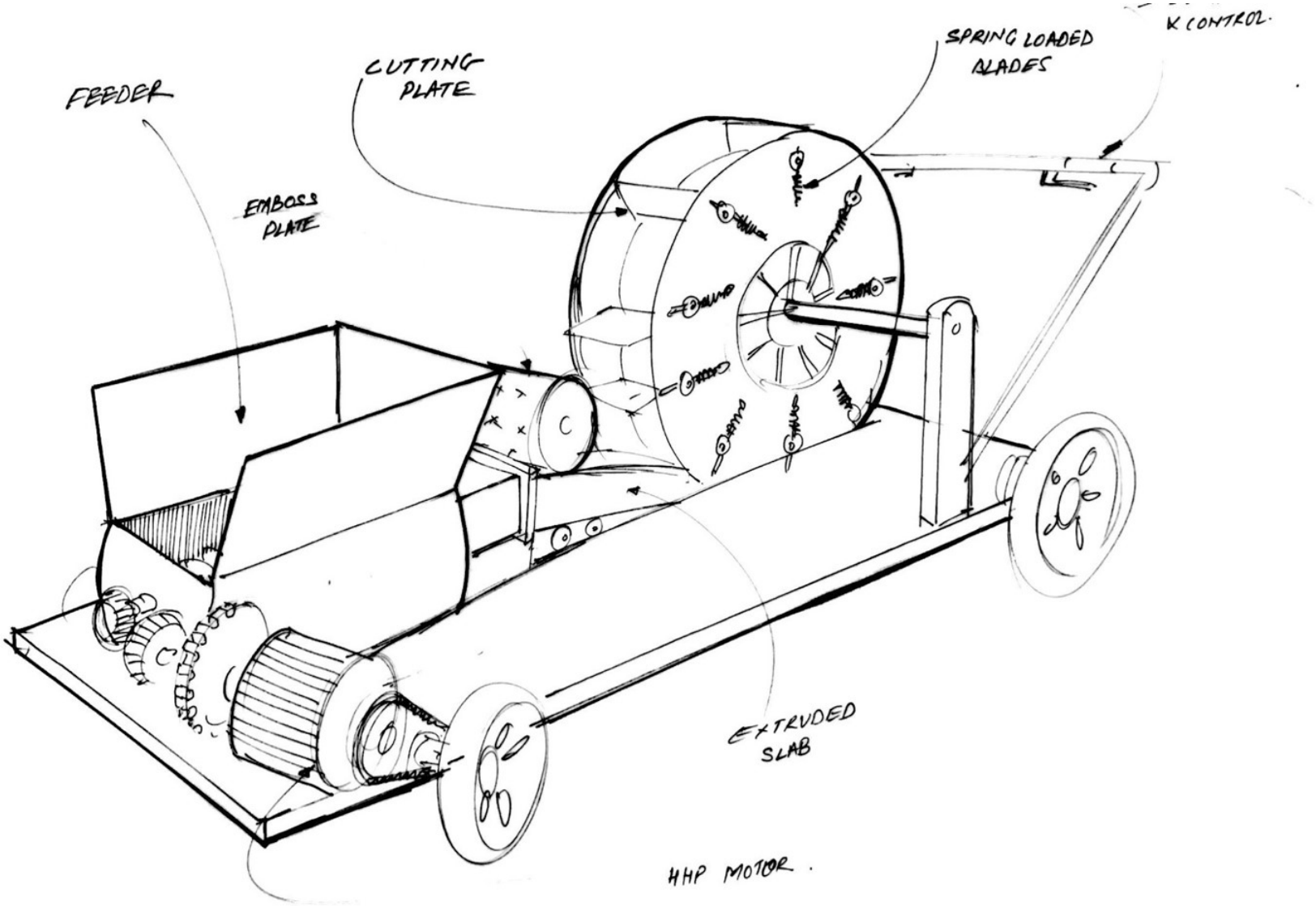


Fig : 21 (Ideation of the modified cart type concept)

This particular concept is another iteration of the of the drum roll mould concept (fig :21), but the moulding action of the pistons present in the previous concept is replaced by cutting blades which are spring loaded.

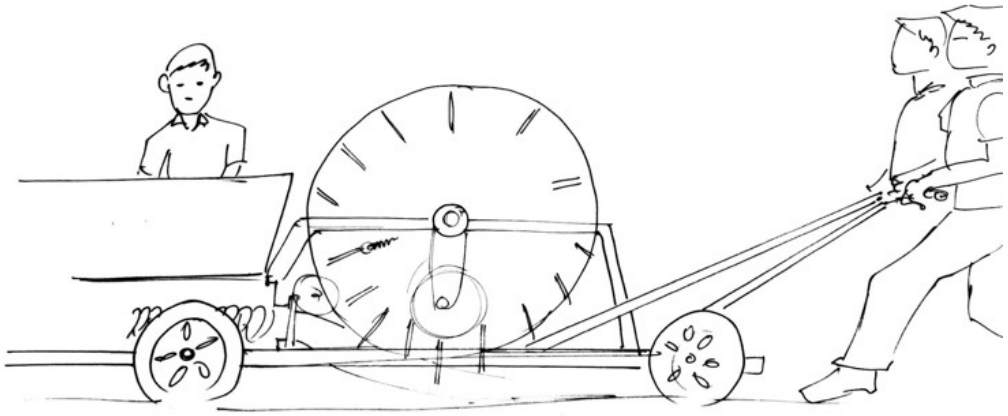
The machine is operated by three men as shown in (fig:22) in which cart is pushed by two men and the third person brings the mud to the feeder and feed it while the cart is moving.

The cart consists of a screw type feeder mechanism which is run by a motor. The motor can be AC motor or an IC engine.

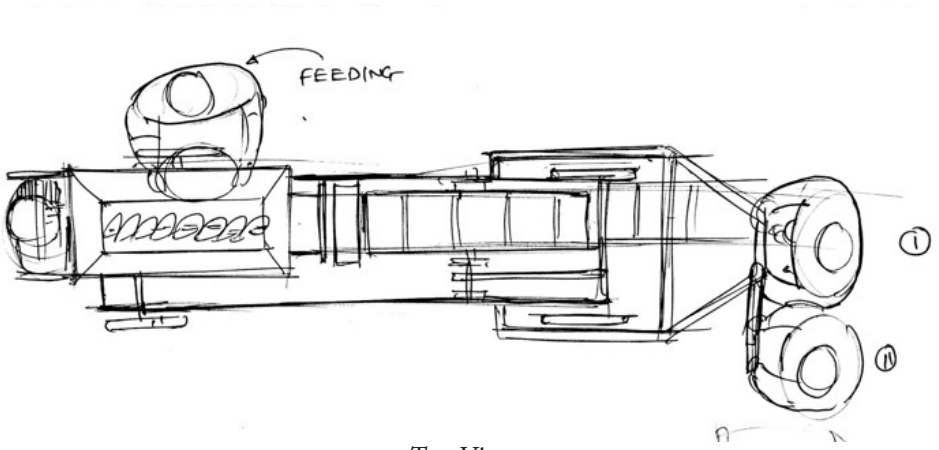
The extruder extrudes a long continuous slab of mud which gets an logo embossment by an auxiliary roller. The slab gets laid on the ground and the drum cuts the slab and the bricks are laid directly on the ground.

Issues

- The cutting action by plates is difficult to align by the extrusion speed
- The length of the machine is too long
- It is difficult to be pushed by two people.
- The tire mark might come on the freshly laid bricks.



Side View



Top View

Fig : 22 (Ideation of the modified cart type concept 1C

Exploration of mould types

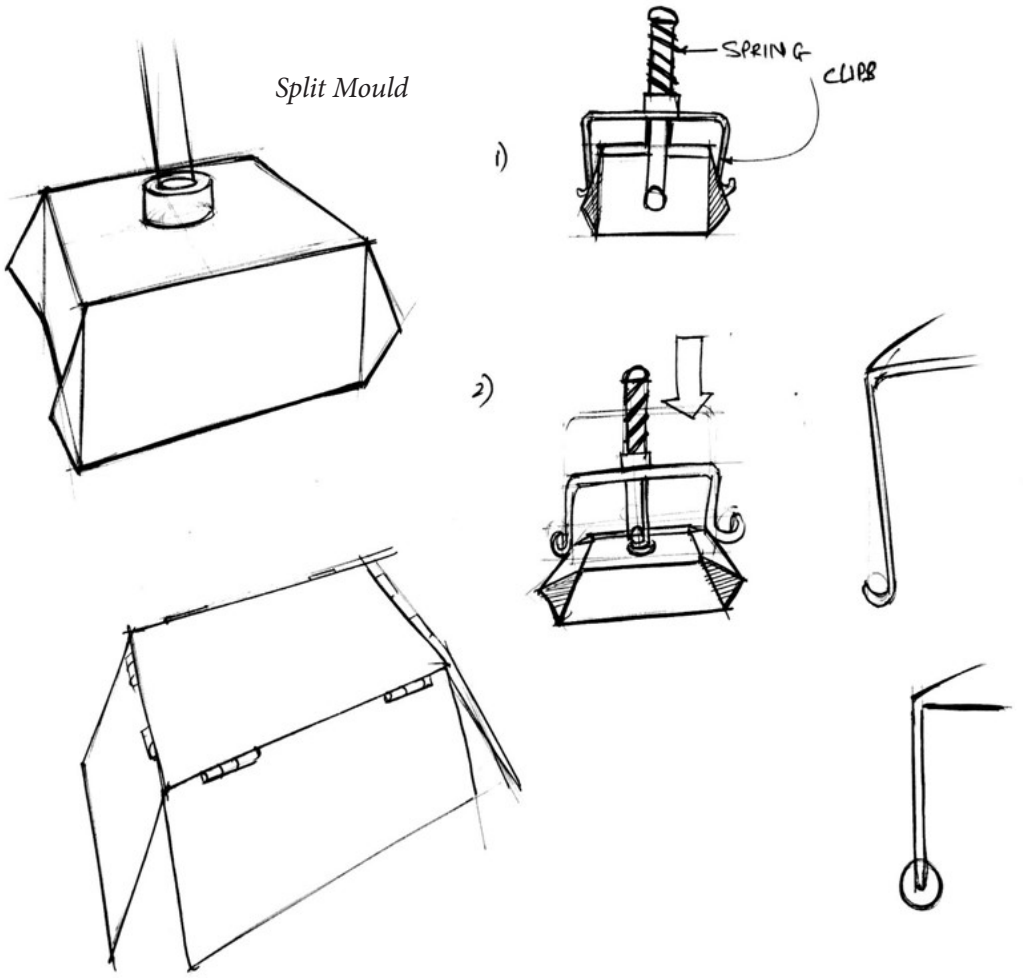


Fig : 23 (Ideation of exploration of moulds)

This type of mould can give a possibility of eliminating the the piston type mould and give better access for cleaning and lubrication.

The mould consists of five faces which are connected by hinge and a spring for each face the upper face has a connecting rod which is spring loaded (fig : 23).

The whole assembly goes into the frame. The faces are closed by the frame body.

When the rod is actuated the box is pushed outward which is are hold by the springs situated on the joins of the box. When the box is released from the frame it tends to open like a flower and origami gift box. At this time, the box can be lubricated and cleaned and send towards the moulding area.

Concept Modification 2

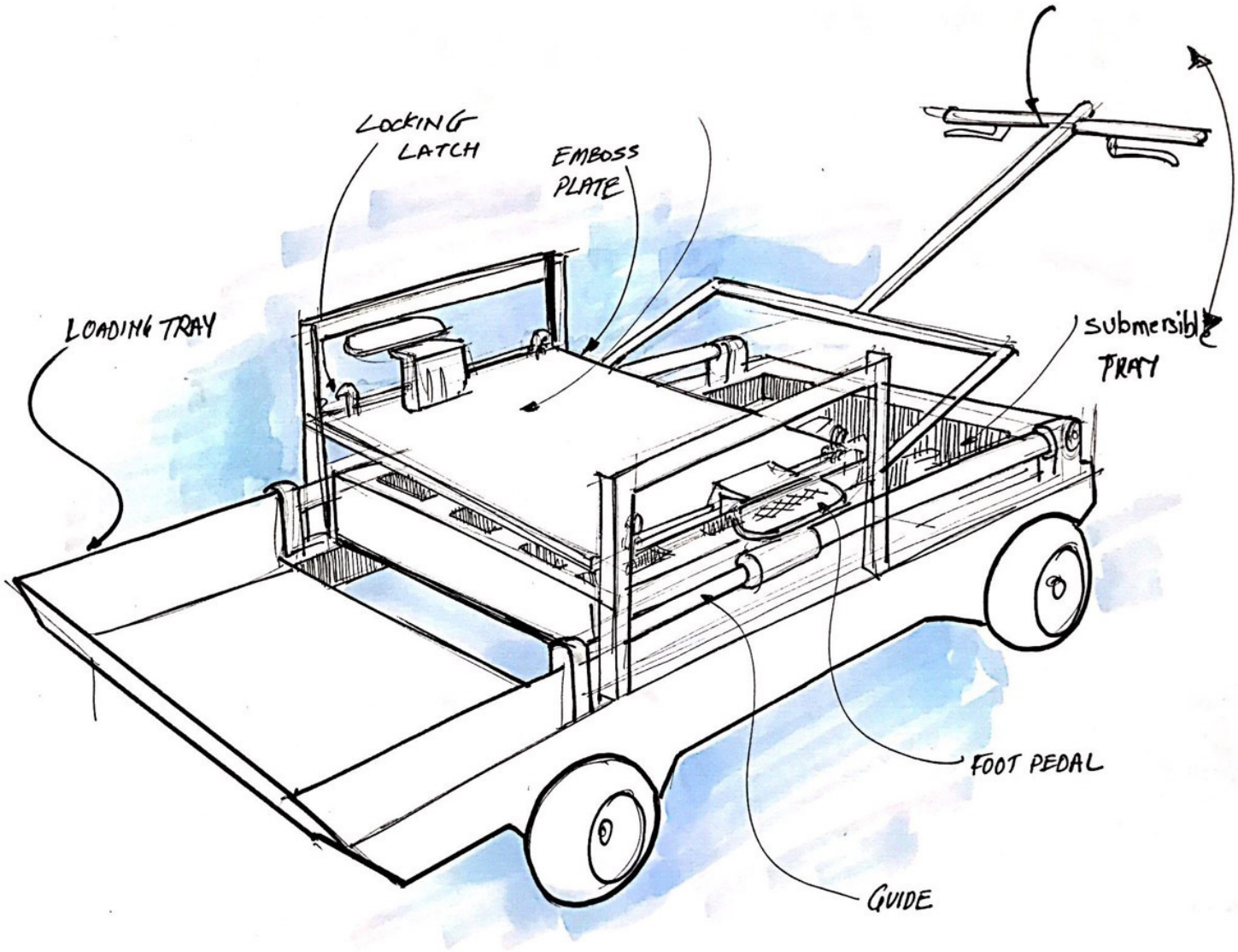


Fig : 24 (Ideation of modified cart type brick moulding machine)

Concept 2 and types of compression options

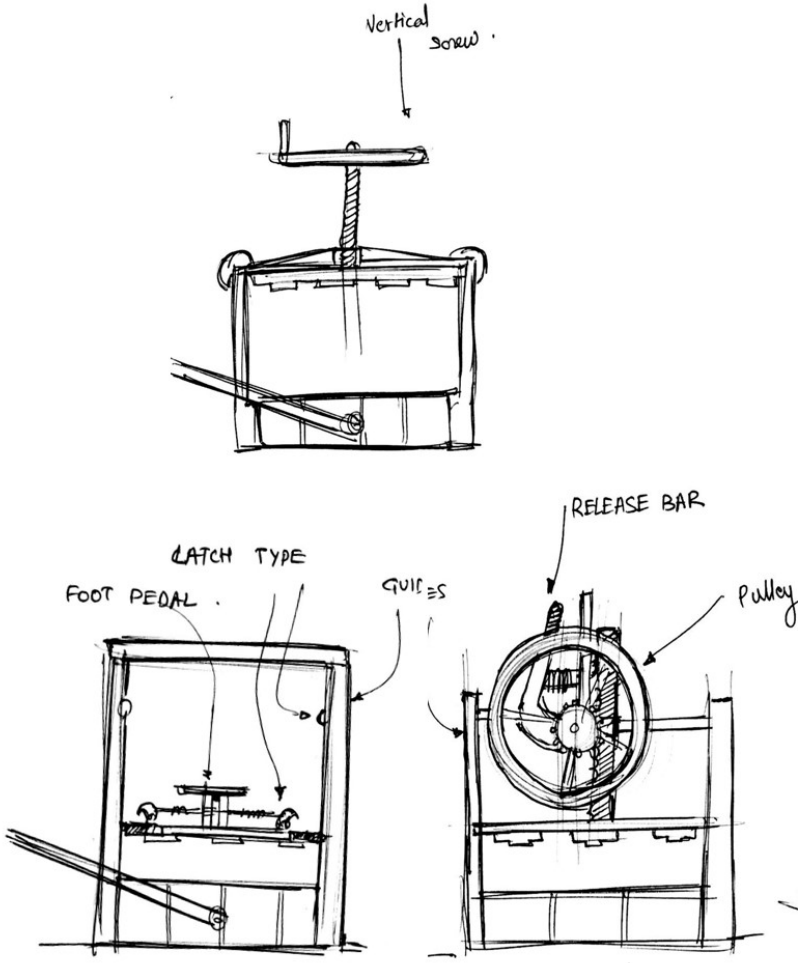


Fig : 25 (Different mechanisms to show the ejection of bricks)

The concept has been made for directly by laying a batch of bricks on the ground instead of continuous laying which gives more control over the process.

The machine consist of a mould of 10 bricks which is lifted by lever and slides over the guide provided on the sides. The machine also has a water tank for lubrication of the mould.

Once the mould is lubricated in the water it is brought back on the ground with the help of the lever and the guides. The person associated with this job brings the mud in the cart and feeds the loading tray once the loading tray is filled with mud ,its is slided so that the mud can fall on the mould. Once the mud is loaded on the mould, it is compressd by the emboss plate above it by means of motor or my screw mechanism.

Once the bricks are comrpessed the emboss plate is released and the mould is brought back to the the water tank hence laying the bricks on the ground and the cart is moved forward to lay fresh batch of bricks.

Concept Modification 3 (P2)

Taking the consideration of th table top moulding unit from the P2 ideationst (fig: 26) .

This type of moulding is suitable for the brahmani brick kiln because they are already introduced to brick moulding on the table which is better for their posture and eliminates the bending action

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 10mm 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.

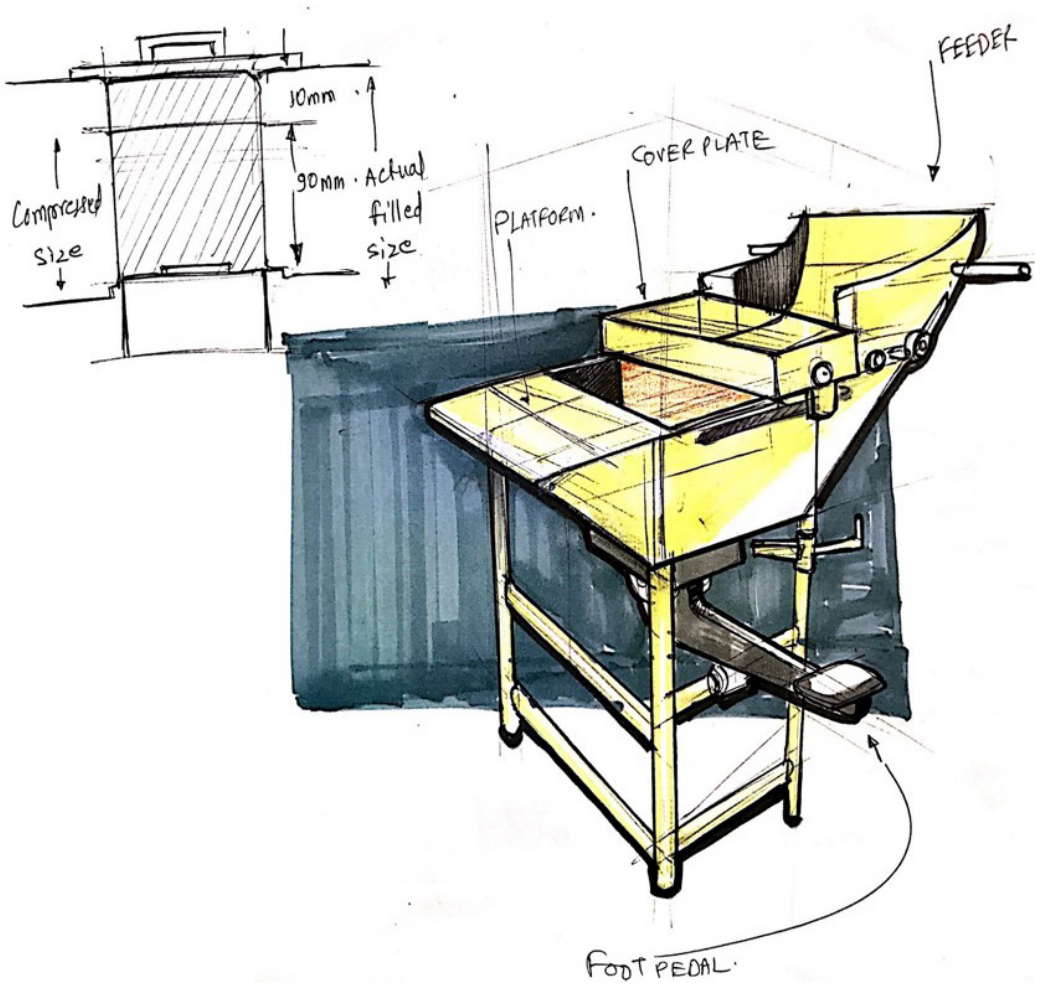


Fig : 26(Ideation of table type brick moulding machine)

Concept Modification 3 : Side View

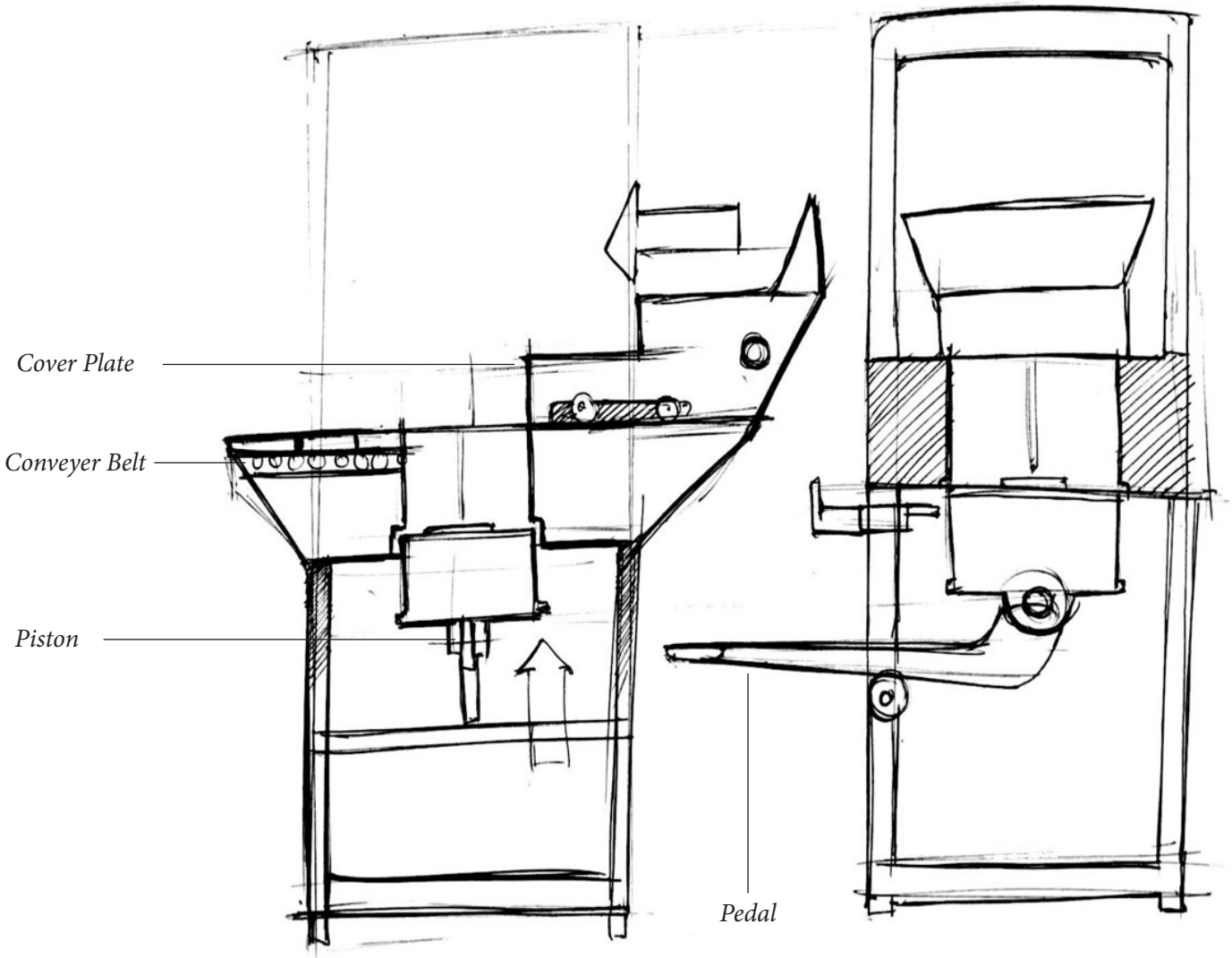


Fig : 27 (figure showing side view pedal type brick moulding machine)

Concept Modification 3A: Ejection of bricks

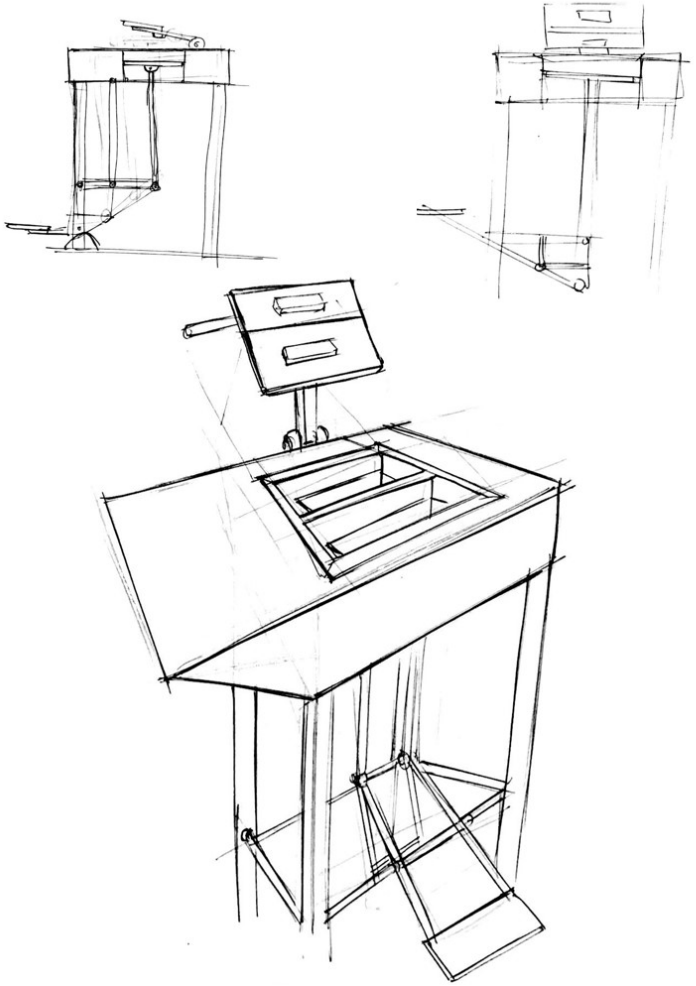


Fig : 28(Modification of table type brick muolding type concept)

The table top foot pedal actuated moulding machine is further optimised for better usability

Different types of mechanism and table structures can be seen in the figures 28

Concept Modification 3B

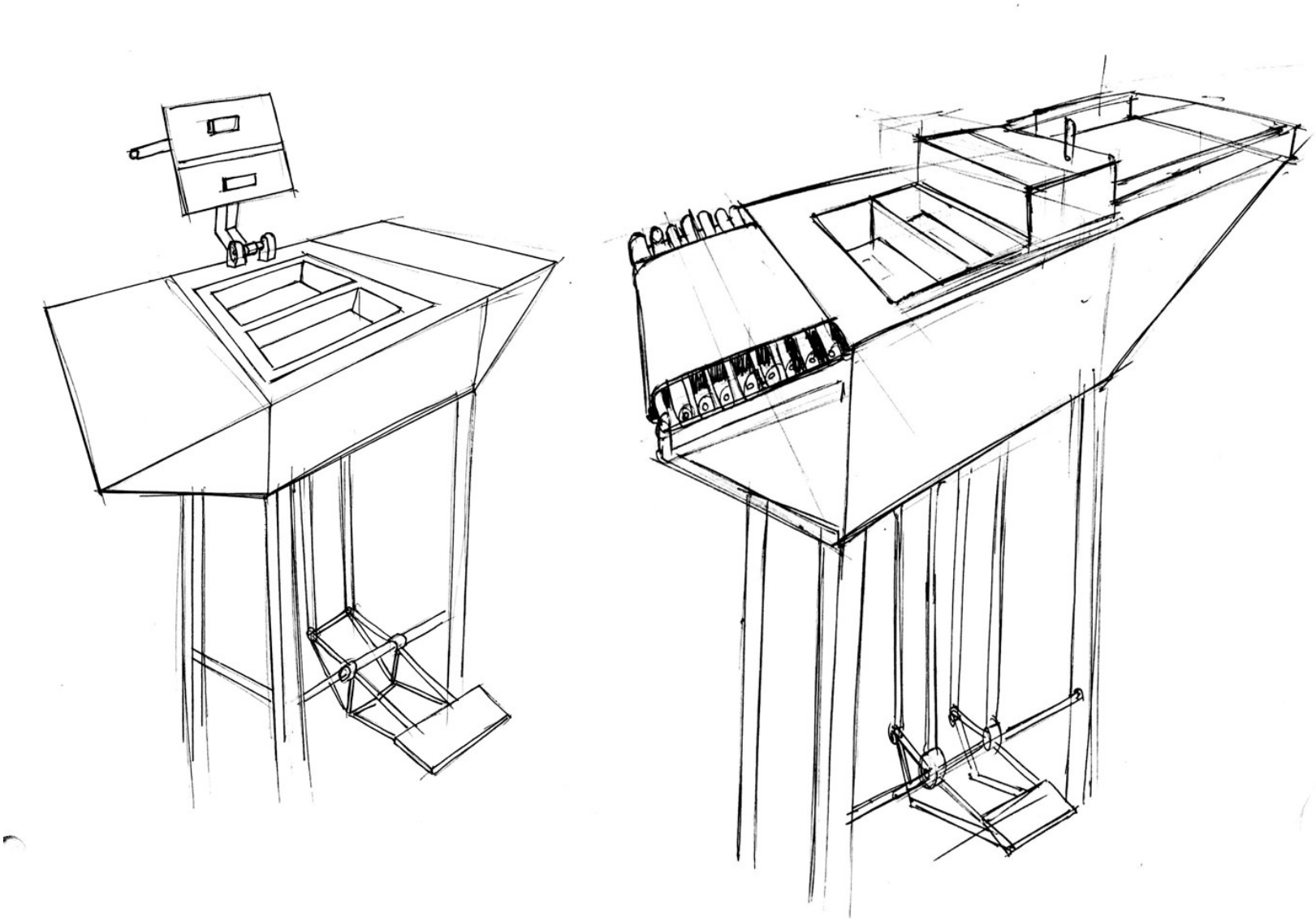


Fig : 29(Modification of table type brick muolding type concept)

The concept of this machine is based on workstation type set-up. It consists of a workstation which has two moulds, which are pedal pushed from below for ejection and compression.

The machine has a mud bay on which the mud is loaded the person operating the machine fills the mould with the mud and closes the top cover which has sliders on both the sides. Once the mould is closed the person presses the foot pedal which with relative action, pushes the plunger up by means of lever.

The mud gets compressed and the foot pedal is released. the top cover is slided back to its position and the person presses the pedal again hence ejecting the bricks out of the mould.

A roller bed is provided to transfer the brick for drying. Since the bricks are compressed, it makes its easier to transfer without causing any deformity.

Issues

- The issues related to this concept is the repetitive action involved in actuating the foot pedal
- The compression requirs lot of force which can create drudgery on legs
- The person responsoible to bring mud has to bend and load the loading bay.

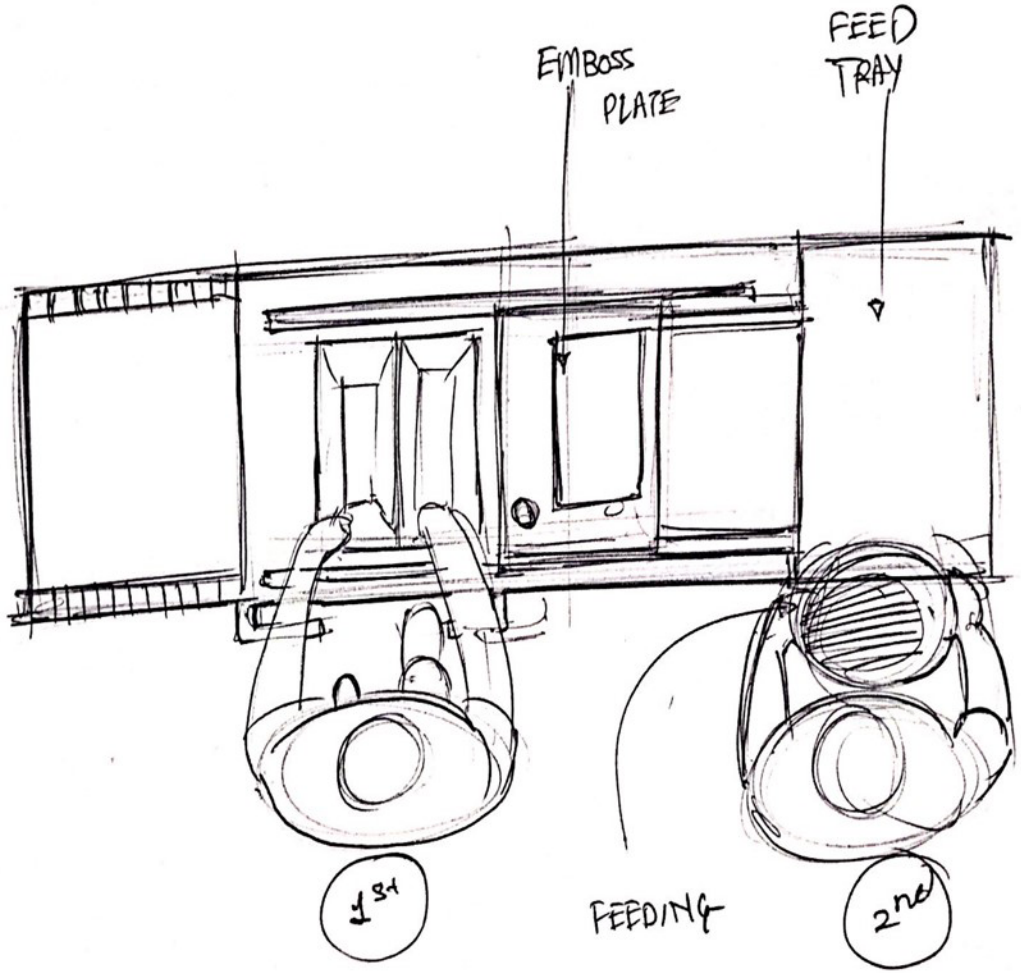


Fig : 30(Top view of the moudling machine)

Concept Modification 3B : Issues

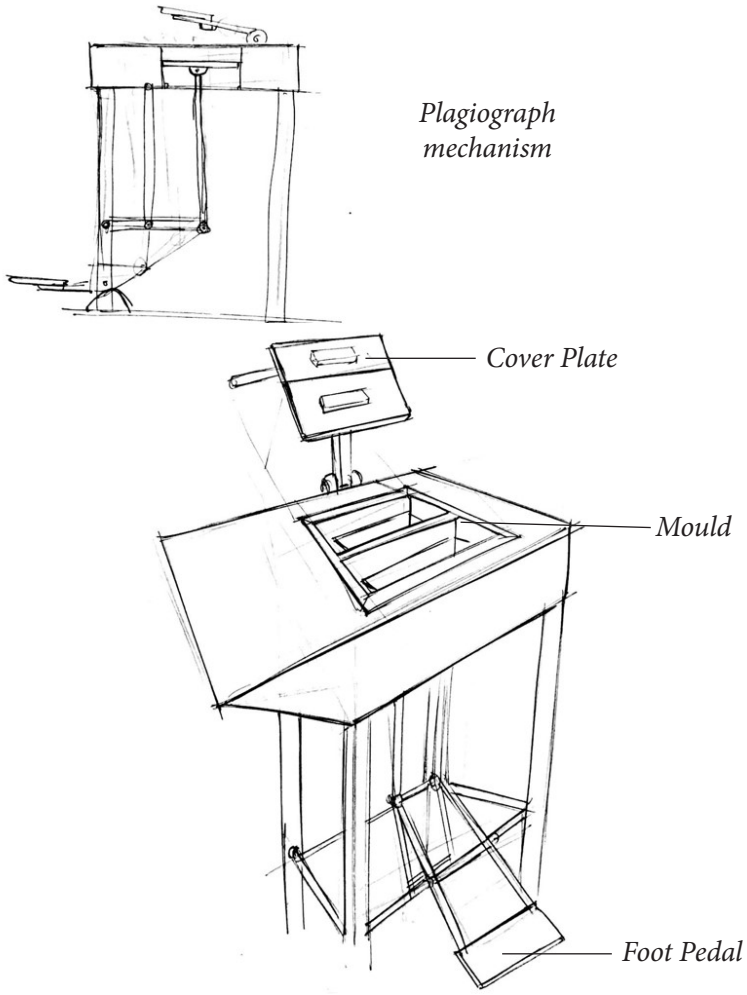


Fig : 31 Ideation of the modified brick moudling machine)

Issues:

- The foot forced required by the person to operate the machine may cause fatigue and muscular pain since its a repetitive action.
- The consistency of the mud is semi wet which is undesirable for compression of mud.
- The machine's output is lesser than the traditional method.
- The person who is supplying the mud needs to bend frequently

Concept Modification 4

The concept 4 (fig:33)is a variation of the pull cart type concept in which extruder with two embossement drums can be used for for ejecting a slab of brick out with the logo embossed over it.

An external wire cutter is used for cutting bricks from the extruded brick slab. Since the cart is being pulled the bricks are directly laid on the ground without
requiring any person to bend or squat in order to lay bricks.

The concept will require three people to operate it ,two people will be pulling it and the third person will operate the wire cutter to cut the slab into bricks.

Top view of the machine shows us the people involved with the operation of the machine

One person pulls the cart and controls the on/off the extruder.when the cart is loaded witht the mud the cart is pulled and the extruder ,ejects a continuous slab of mud which passes through the two rollers in tension against each other.this rollersa embosses the brick logo on the slab .the slab moves forward and is cut into smaller brick pieces by means of a wires cutter which is actuated by another person .

Then bricks then slide through the ramp onto the ground which are lay for drying.

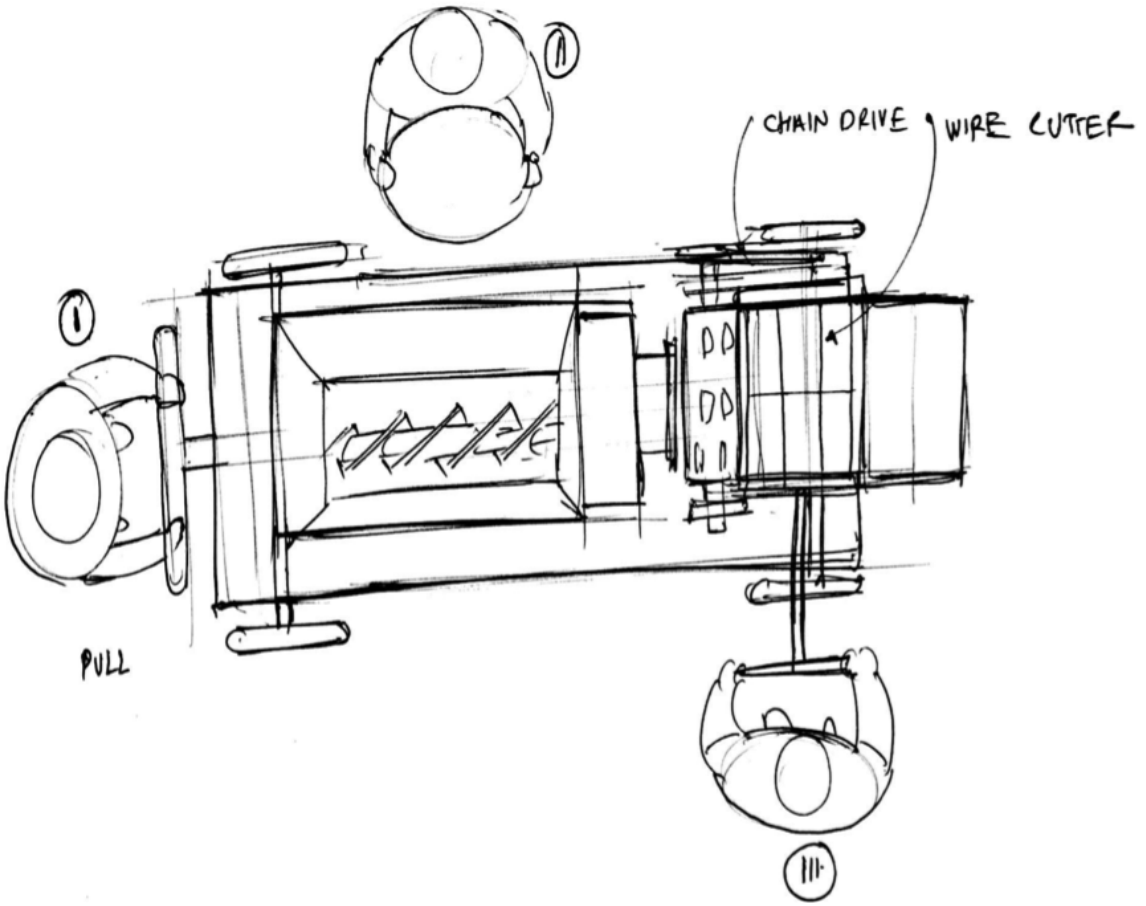


Fig : 33 (Top view of modified extruder type brick moulding machine)

Concept Modification 5

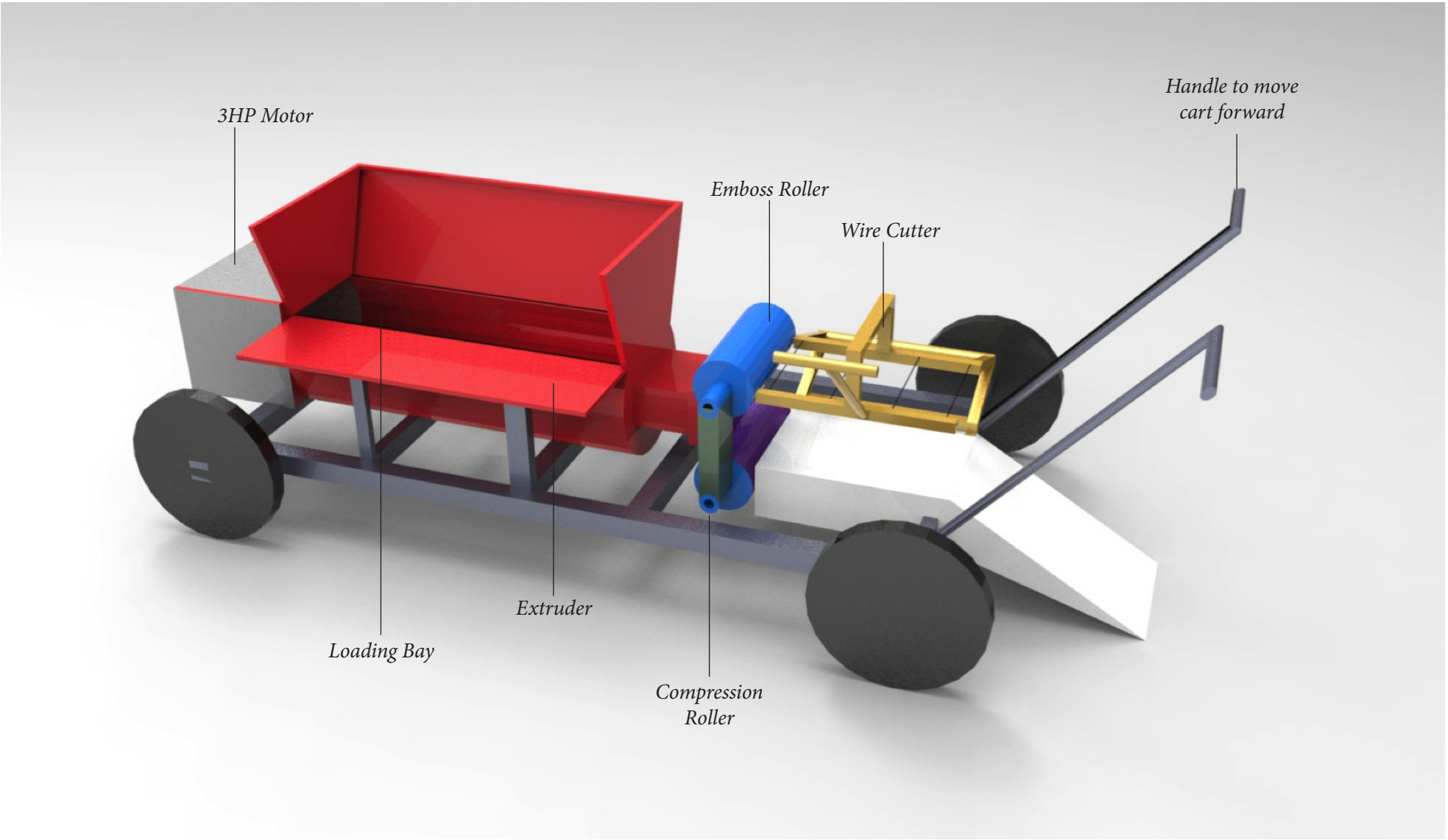


Fig : 34 Fig : 28(CAD model of the modified extruder type concept)

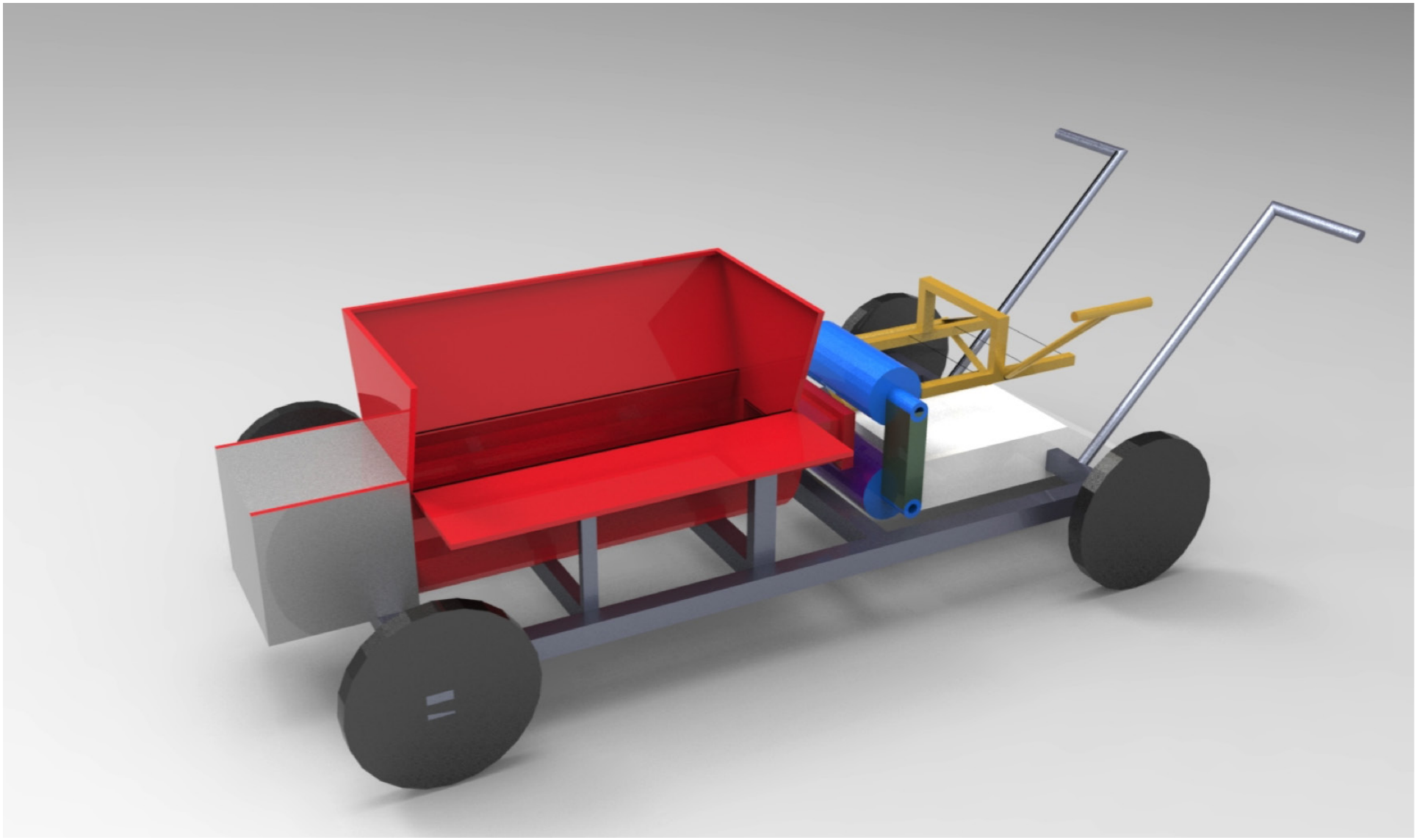


Fig : 35 (CAD model of the modified extruder type concept)

Concept Modification 5 : Variants

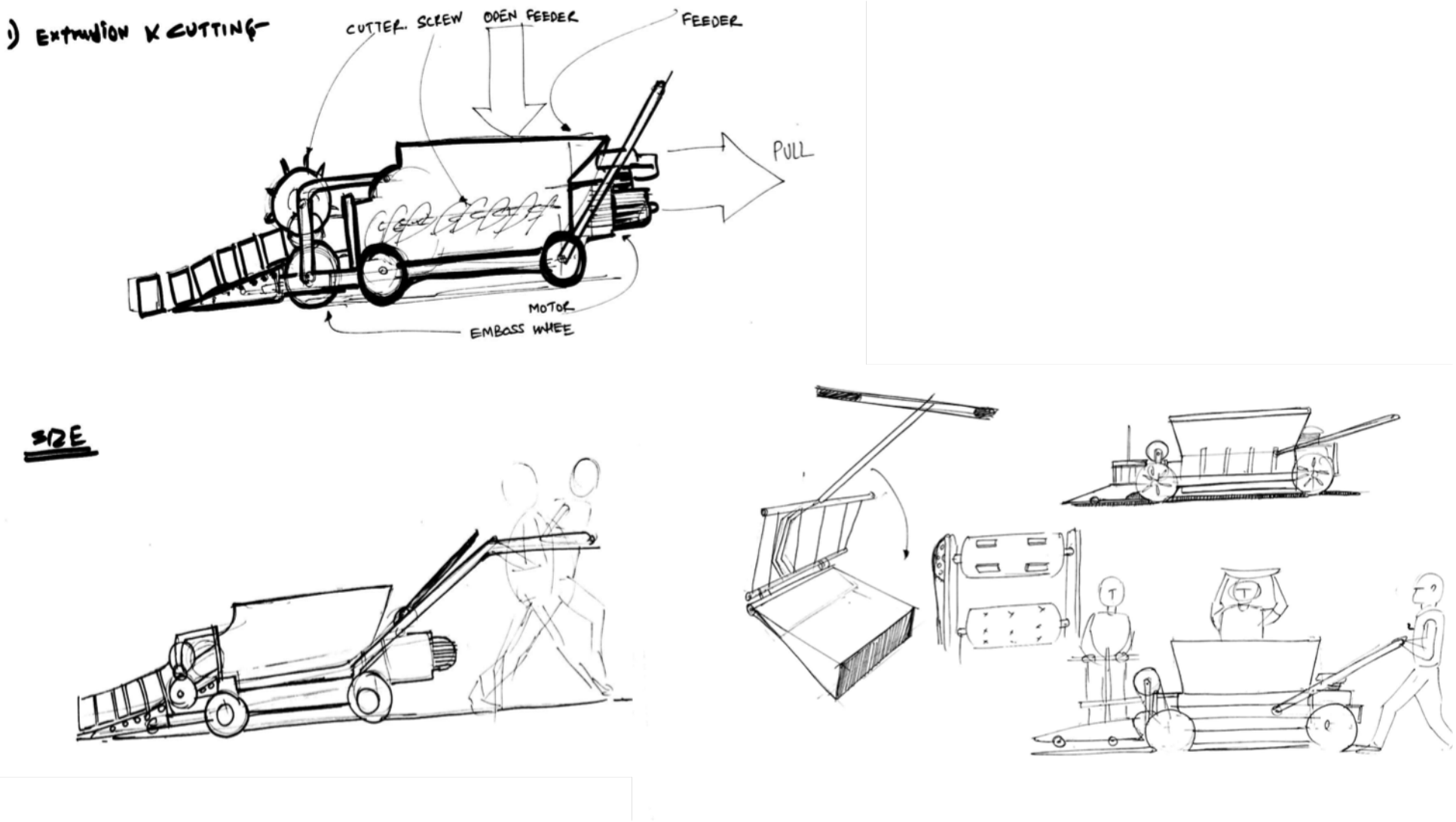


Fig : 36 (Ideations of the extruder type moulding machine mechanism)

Concept Modification 6

This particular concept is the final modification of all the drum roll concepts (fig:37).

It is a push cart type moulding machine, rather than a pull cart which gives better visibility to the person who is pushing the cart.

It consist of a motor which drives the extruder and the drum wheel as well.

The drum is not in the contact with the ground which provides better mobility of the cart.

The person pushing the cart has the controls to stop or start the extruder.

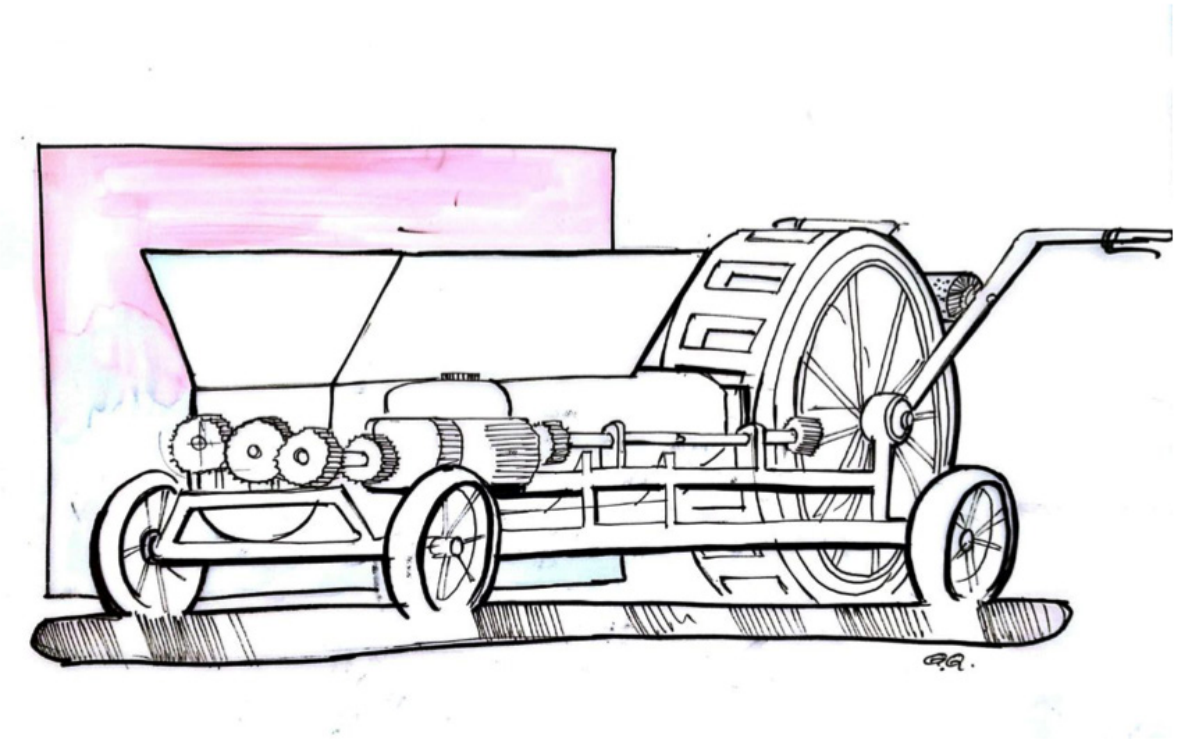


Fig : 37 (Ideation of modified cart type brick mouldign machine)

Concept Modification 6 : Issues

The issues with the drum roll concepts:

- Skills of the people associated with brick making process is getting killed by introduction of a fully mechanised machine.
- The initial cost of the machine and the running cost is high, so the people might not be in favor of purchasing the machine.
- The repairing and and maintenance of the machine will be difficult for the workers.
- Frequent filling of the machine will be difficult, and efforts will increase.
- The weight of the machine is heavy to pull even by two workers.
- For flipping the bricks for drying it from the wet side the person has to bend for each brick hence the bending action is not being removed.
- Even picking the brick for stacking will be having bending action.
- High torque is needed to make the machine work.

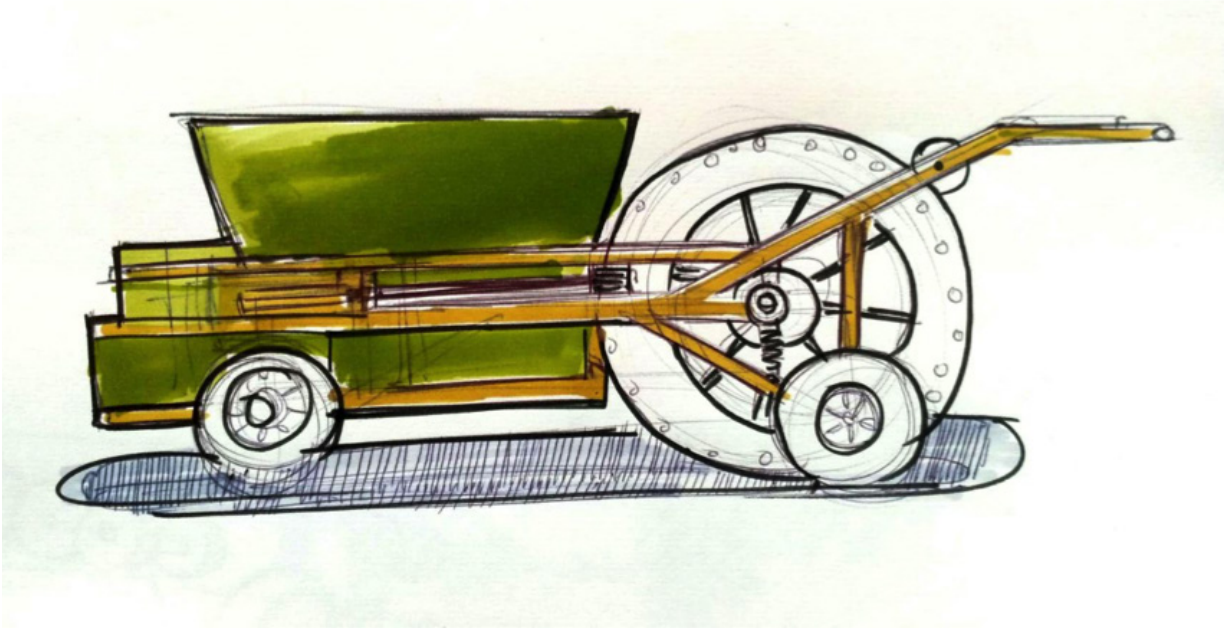
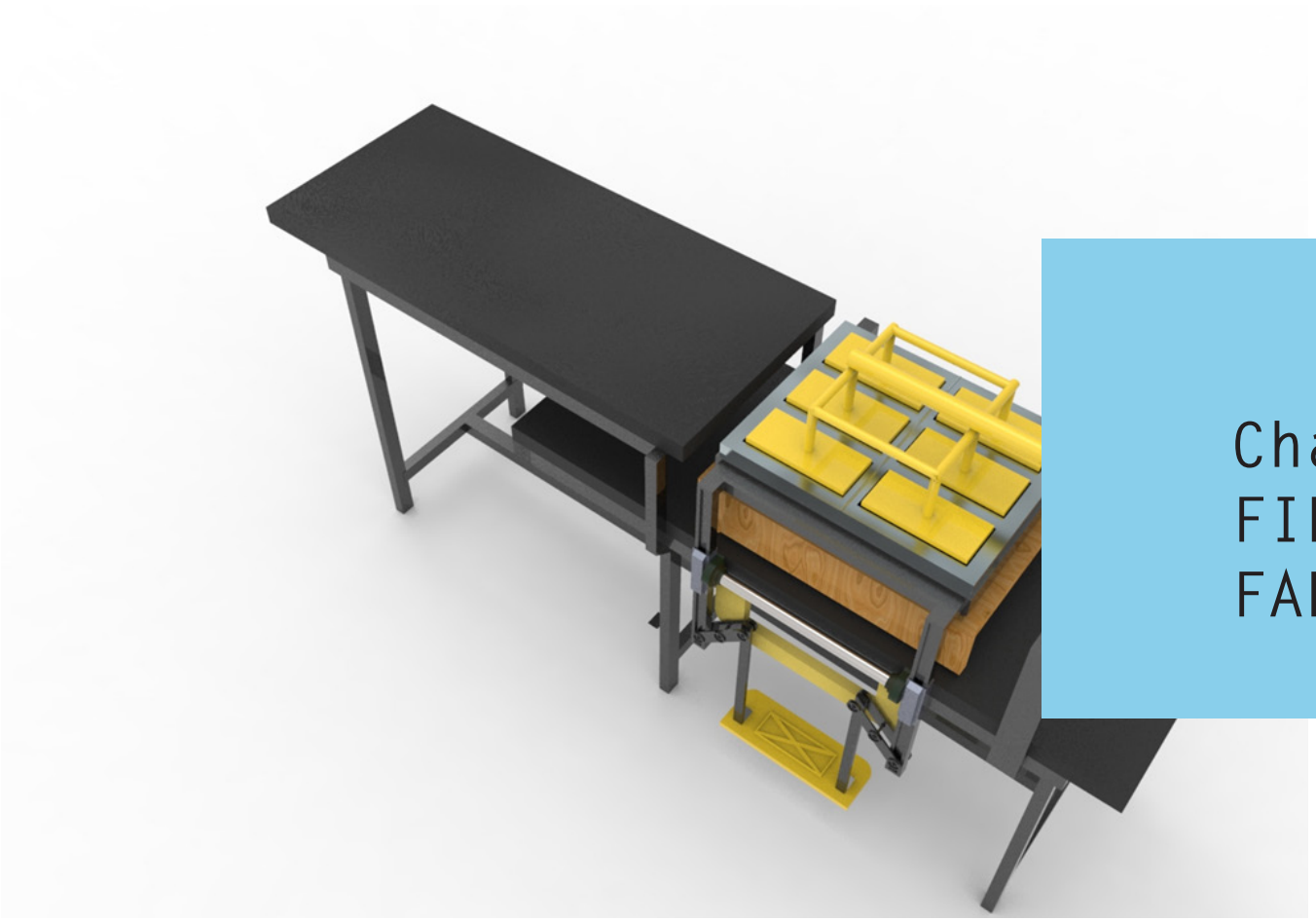


Fig : 38 (Ideation of side view of modified cart type brick moulding machine)



Chapter 3:
FINAL CONCEPT and FABRICATION

Final Concept

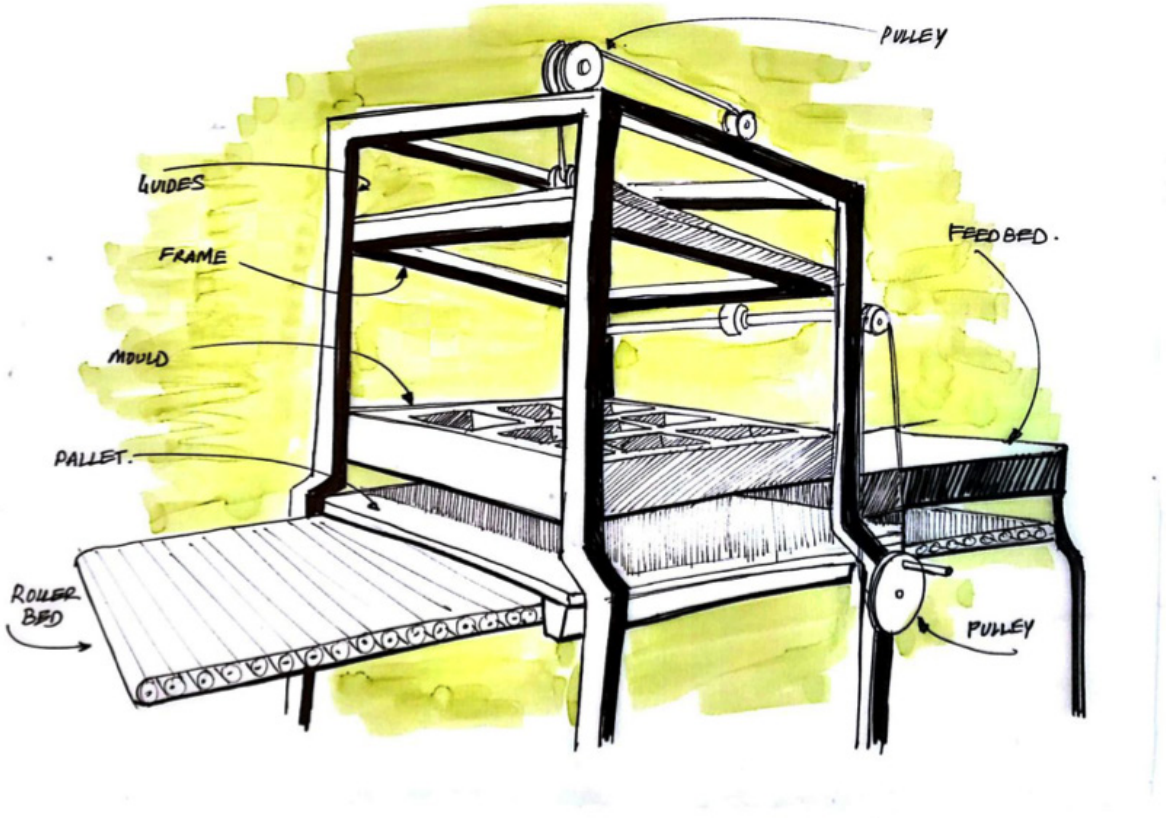


Fig : 39 (Ideation of workstation type brick moulding machine)

This concept consists of 40 brick moulds with 5x8 distribution. The mould should be able to make 40 bricks in a batch directly on the pallet provided underneath.

The pallets are supplied by an another person through the roller roller bed situated underneath the feed table.

The mould is place once the pallet is secured at the moulding area and mud is dragged over the mould by the people associated with the moulding activity. The mud is supplied by another person whose duty is to load the mud from ground to the table.

The mould is sprayed with water and one by one each mould is filled by hands.

Once every mould is filled and evened a roller or a stamp plate is used to stamp the logo on the bricks.

After stamping th roller is taken away and the mould is lifted by pulley action,na the tray is slided towards the trolley loading area where a person is ready to shift the pallet on trolley and take it away for drying.

Pros and Cons

Pros:

- This concept is an extension of the table concept which they are already familiar with, so adaptation is not a big challenge.
- This method does not kills their skills.
- It provides better posture for work and safe working conditions.
- The women gets to play a wider role in process of brick moulding operation.
- The person gets the freedom to switch the roles.
- The design in frugal and minimal
- It is easy to maintain, service and construct.

Cons:

- Initial investment is high
- The feeding of mud to the table is still carried out by the traditional method.
- The weight of the pallet with bricks moulded is heavy.

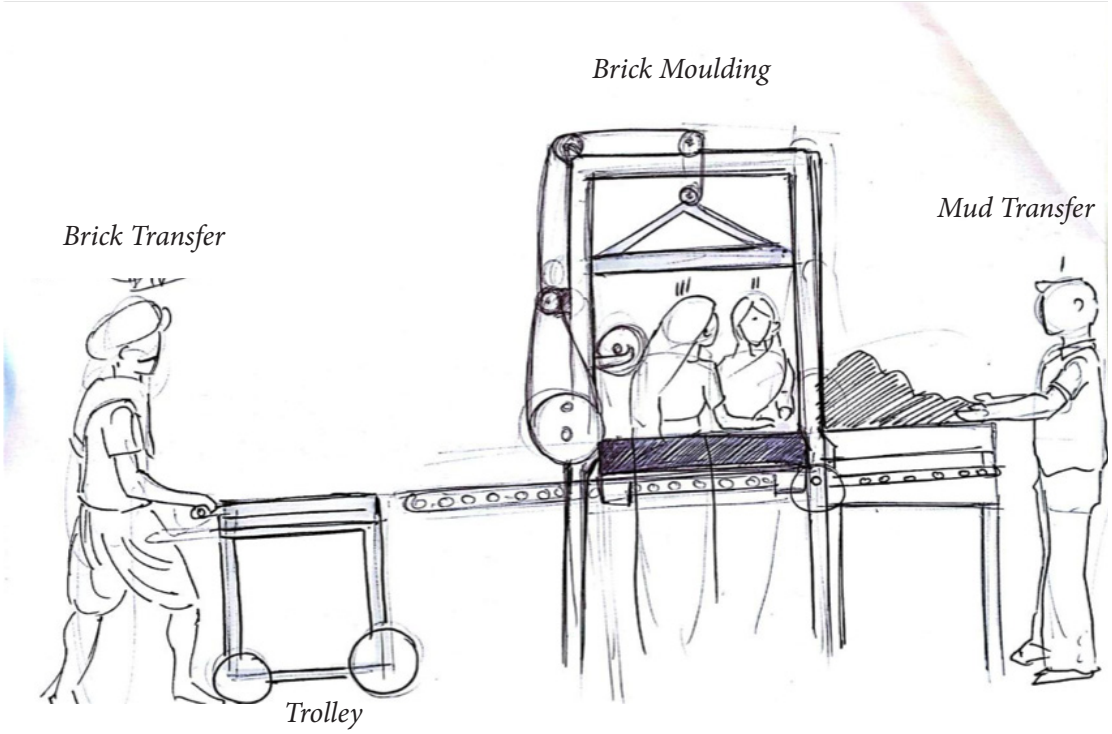
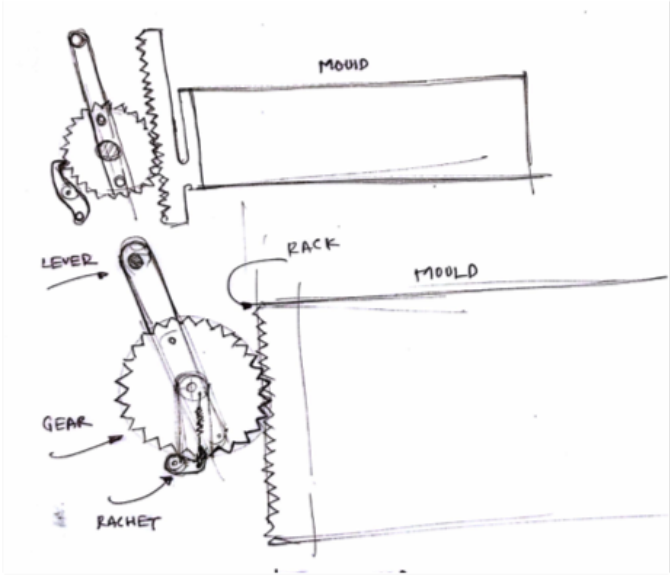


Fig : 40 (Figure showing human interaction with the machine)

Mechanisms



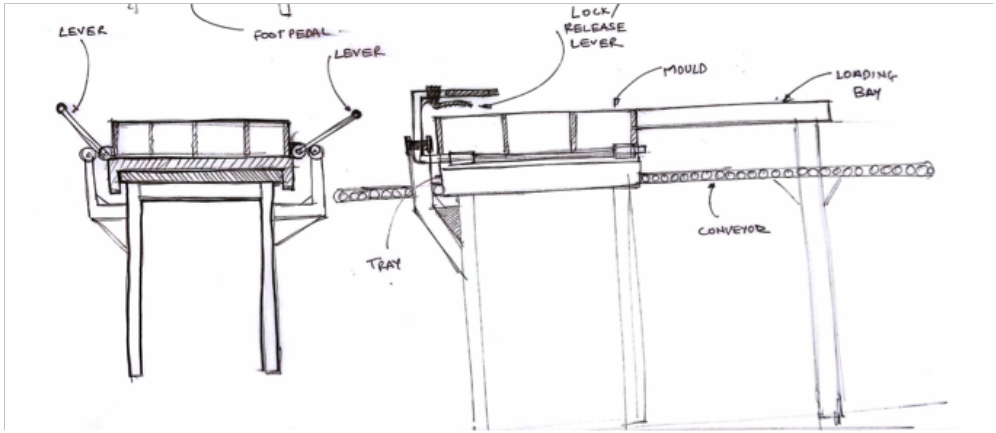


Fig : 41 (Ideation showing the mechanisms for the machine)

Material:

- The mechanisms serve as the key element in lifting the mould upwards in order to mould bricks on the table by use of gravitational force.
- The mould is open ended so that its easier for the person to fill the mould and de-mould the brick on the tray directly.

Mechanism:

- The type of mechanisms which can be used are based on the type of load bearing capacity, load output, motion of the load, continuous or intermittent motion ,
- Gear or pulleys, hand operated of foot operated etc.
- The first figure shows the gear type mechanism

Mechanism

This type of mechanism can be used for actuating the mould up and down by using foot , since leg has more muscles compared to the hands and even body weight can be applied to push the pedal downs it makes it lot more easier for the person to operate the machine and gives more freedm to its hands so that he can perform other works simultaneaously.

The machine consist of pulleys and wire which are pulled by means of foot pedal which in relation lifts the mould up.

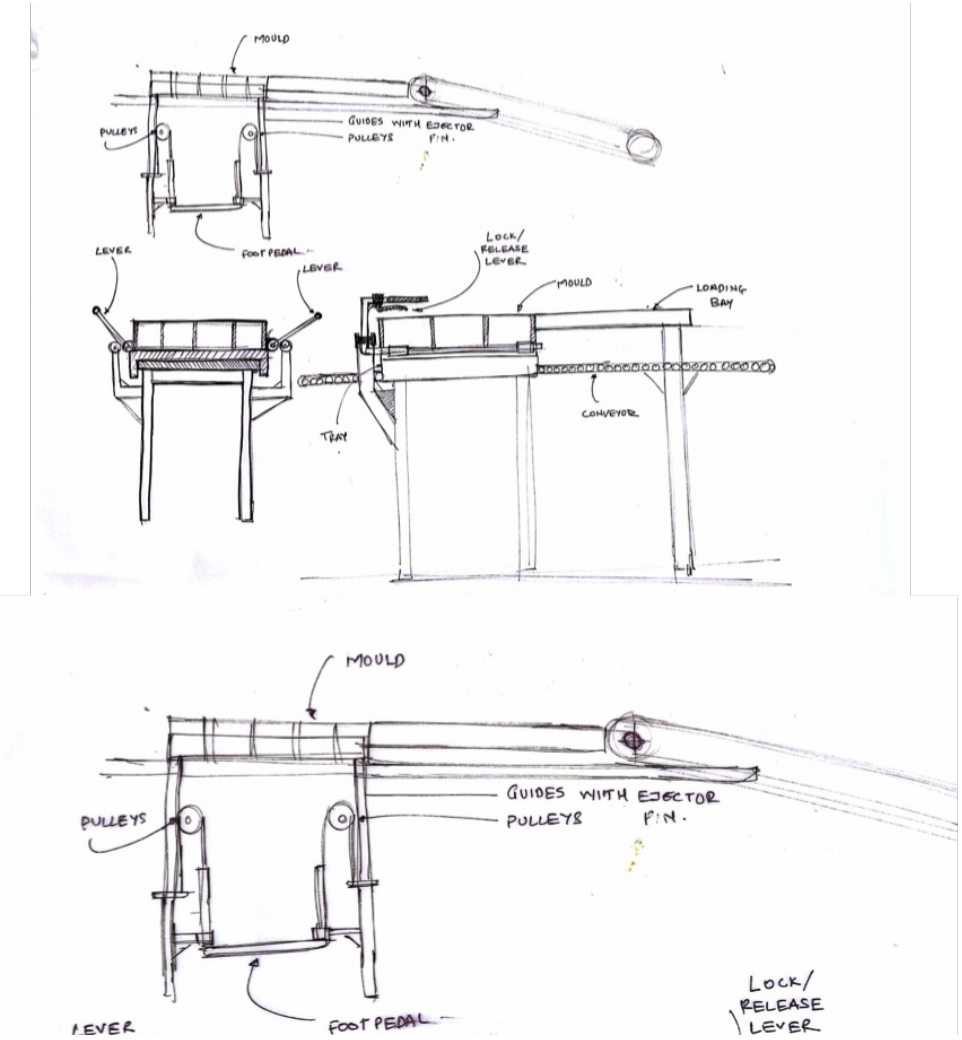


Fig : 42(Ideation of the mechanisms of machine)

Pulley Mechanism

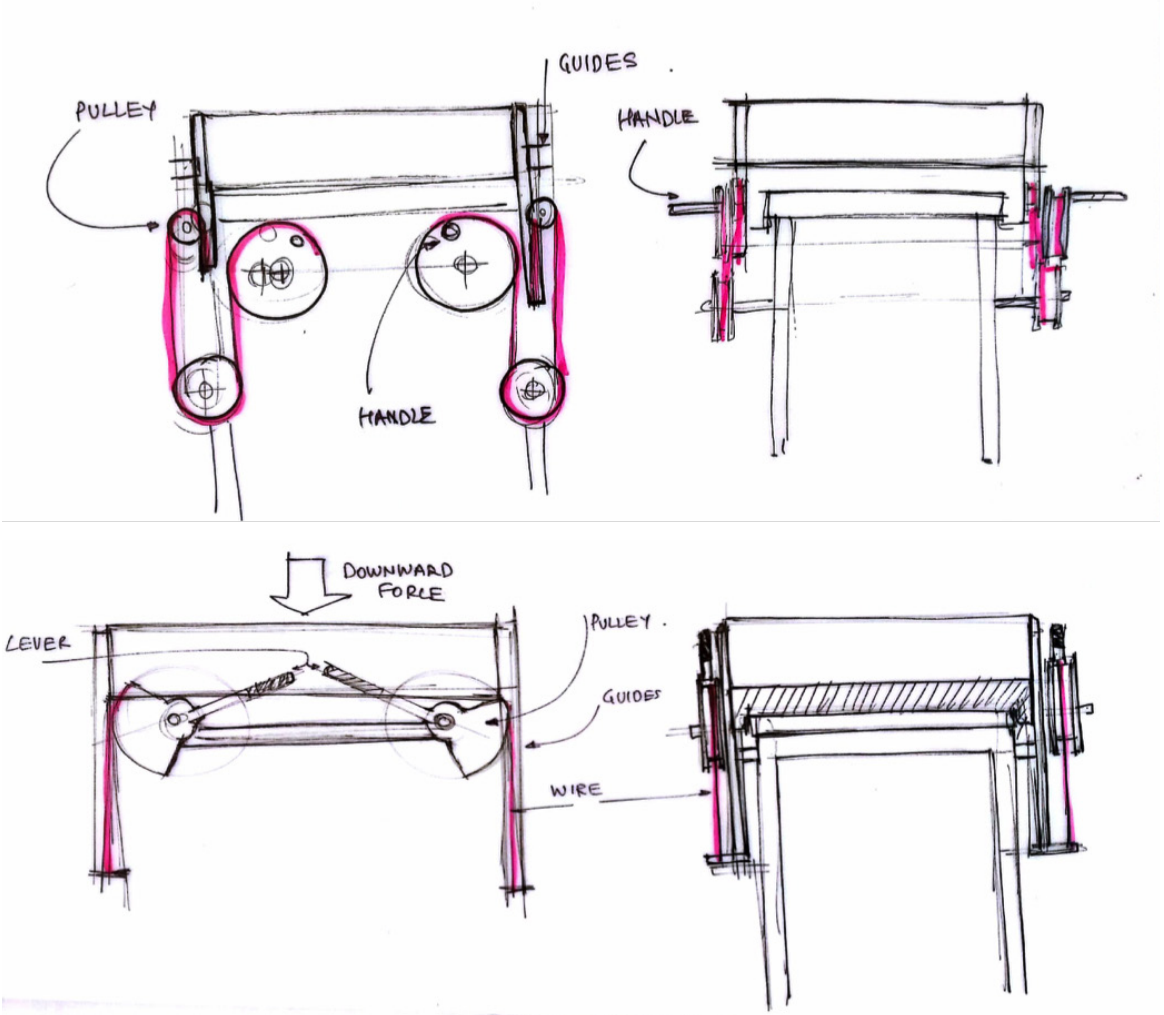


Fig : 43 (Ideation shwoing the mechanism for lifting the mould)

Using direct muscular motion to lift the tray cause drudgery hence to avoid that mechanisms can be used for lifting the mould.

The first figure shows different types of lifting mechanisms. It shows the use of wire and pulley type mechanism which can lift the mould up by roatation of the pulley by hands

The second figure shows the pulley wheels are elimintated and lever and wire combination is used for lifting the mould. hence simplyfying the fabrication.

Mechanism

The lever type mechanism is more suitable since it doesn't slack unlike the wire mechanims and has zero slip chances.

The mechansim consist of bar linkages which are pivoted at amid point which acts as a lever for both mould and the foot pedal.
The linkage also has a air psiton to slow doen the downward action to avoid accidents by rapid travel of the links.
When the peddal is pressed the mould is lifted upwatds via links and when the pedal is released the mould comes back to the original position.

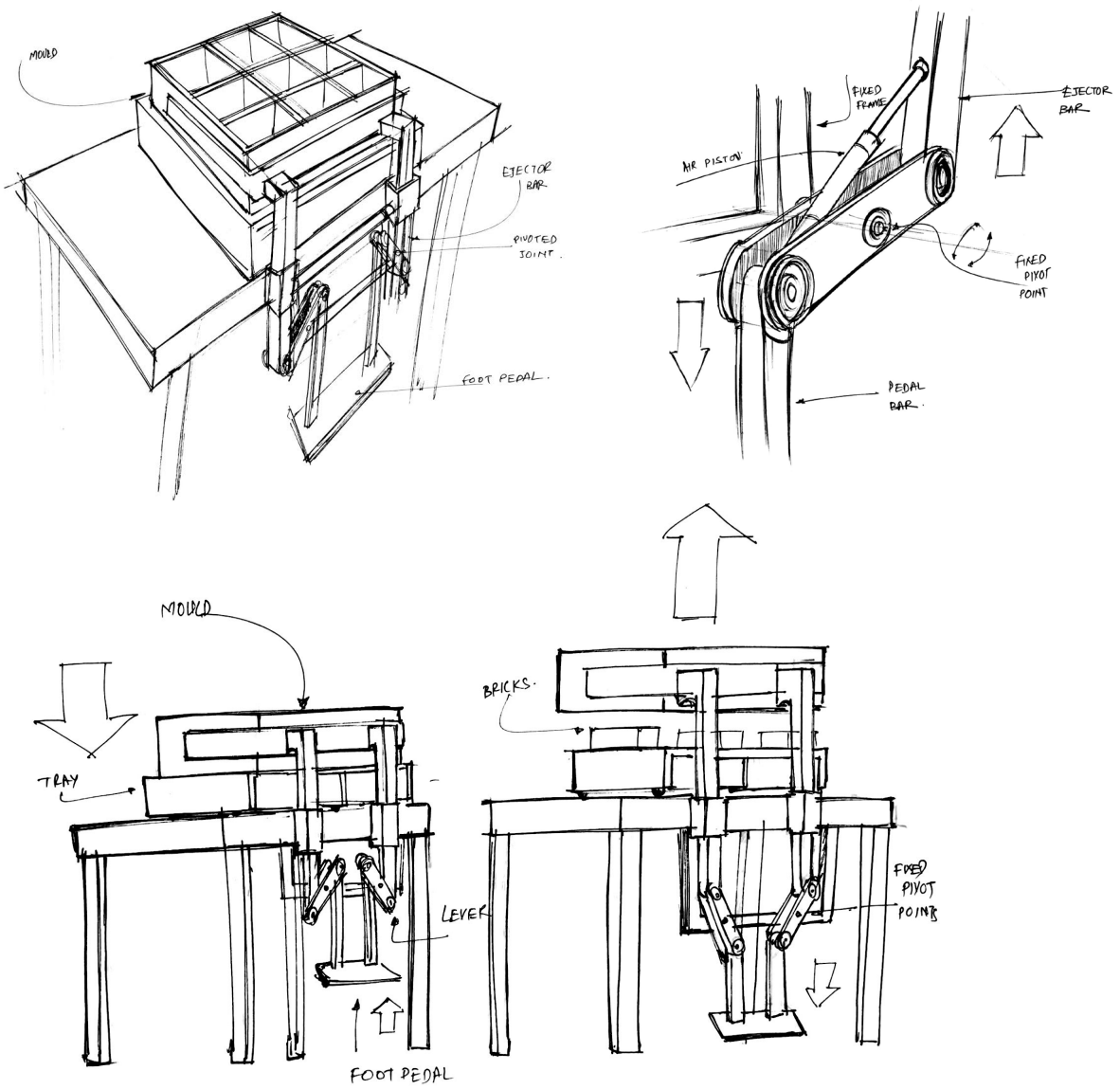


Fig : 44(Detailing of the mechanisms)

System Level Design Layout

The graphical representation (*fig.41*) shows the plan of the process carried out for making bricks by using the new pit type brick moulding setup.

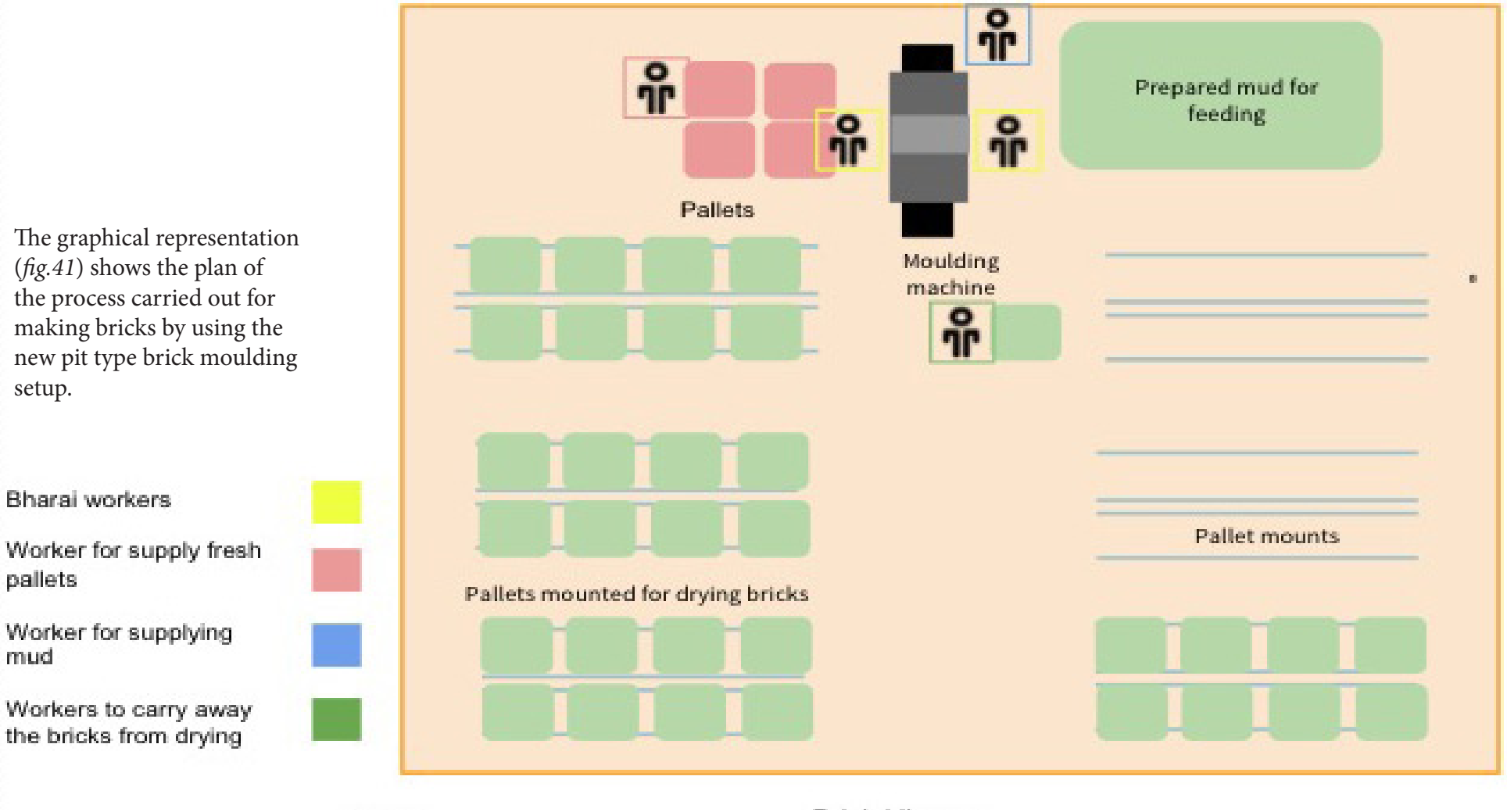


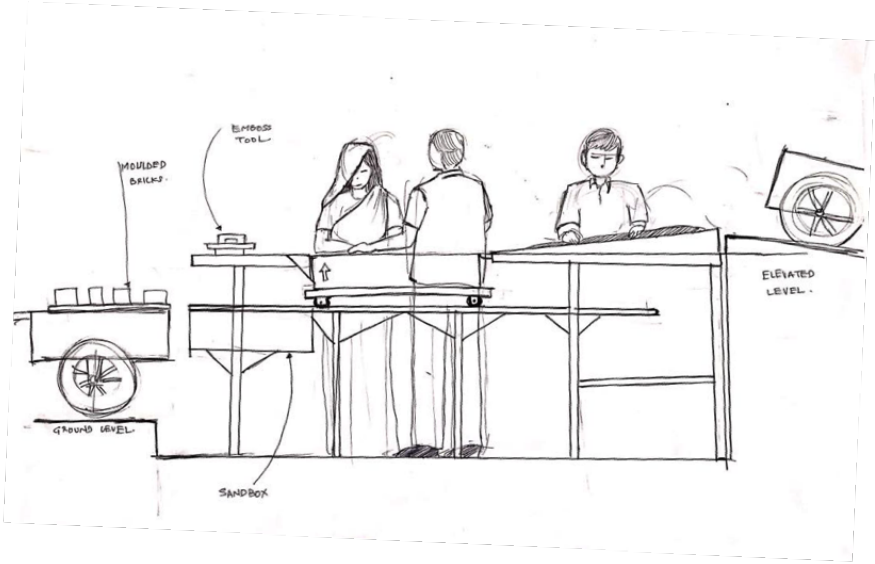
Fig : 45 (Top view layout plan for the brick moulding process)

Process Flow

The figure shows the side layout of the proposed concept. The whole setup is supposed to sit inside a pit, which gives an ex-ellent working height to the people moulding bricks as well as to the person bringing the the mud and transfering th e bricks.

Five people are involved in this process, as shown in the il-lustration. Two people are involved with the moulding work wheareas the the third person in loading the trays for laying th e bricks. Two additional workers are required to transfer the mud and bricks into the machine.

The person brings the mud and loads it on the loading area. The people responsible for brick moulding job drags the mud forward the mould is lifted up by one person and the worker and the tray is slided under the mould.
The foot pedal is released and the mould sits on the tray, after which the worker dust it with dirt.
When this process is done the workers start making lumps of mud and start filling the mould with it. When the mould are filled and evened out, they stamp it with a stamping plate to engrave the logo on it.
After that, the mould is lifted up by means of foot pedal hence laying the bricks on the tray. Once the bricks are layed, the tray is transfered to the other person for drying. Meanwhile, a new set of tray is supplied from underneath the moulding ares and hence the process repeats.



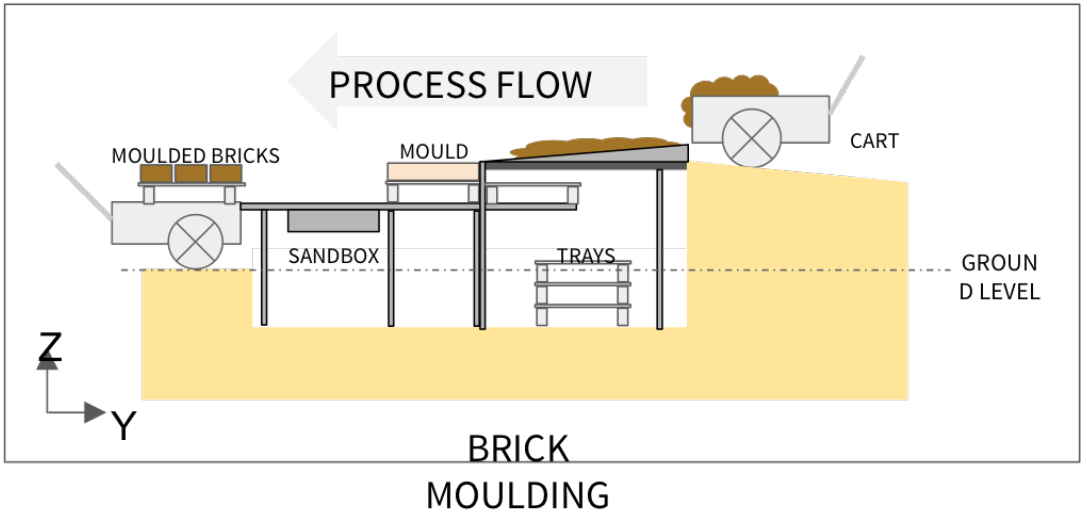


Fig : 46 (Front view of the layout of the brick moudling process)

CAD Model

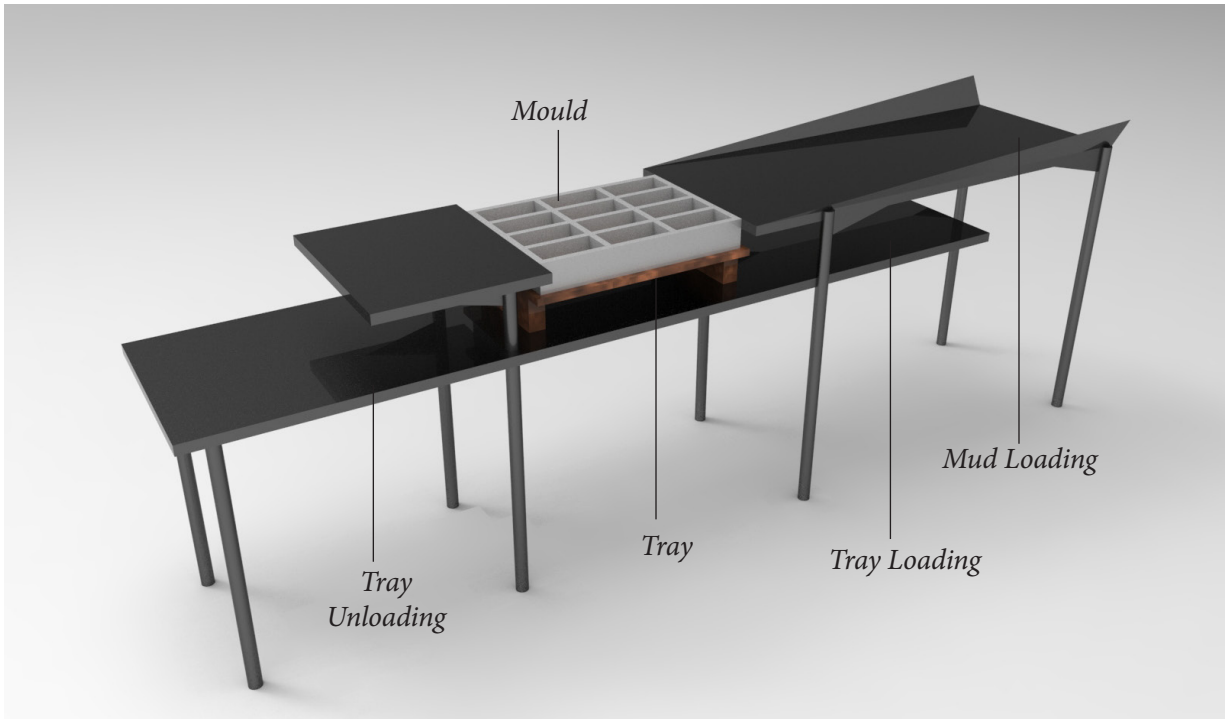
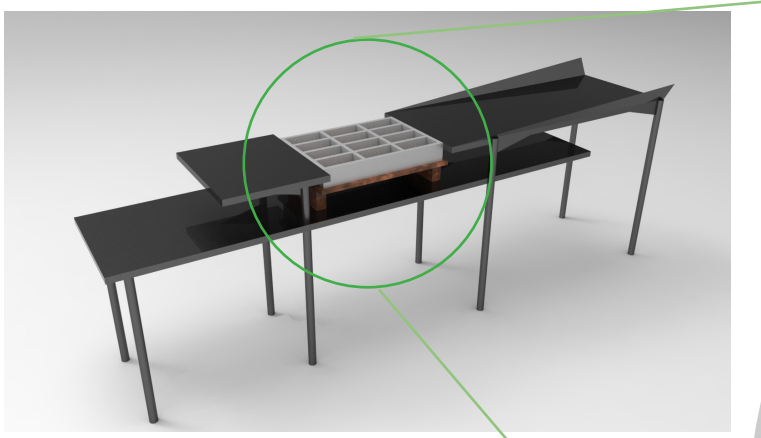


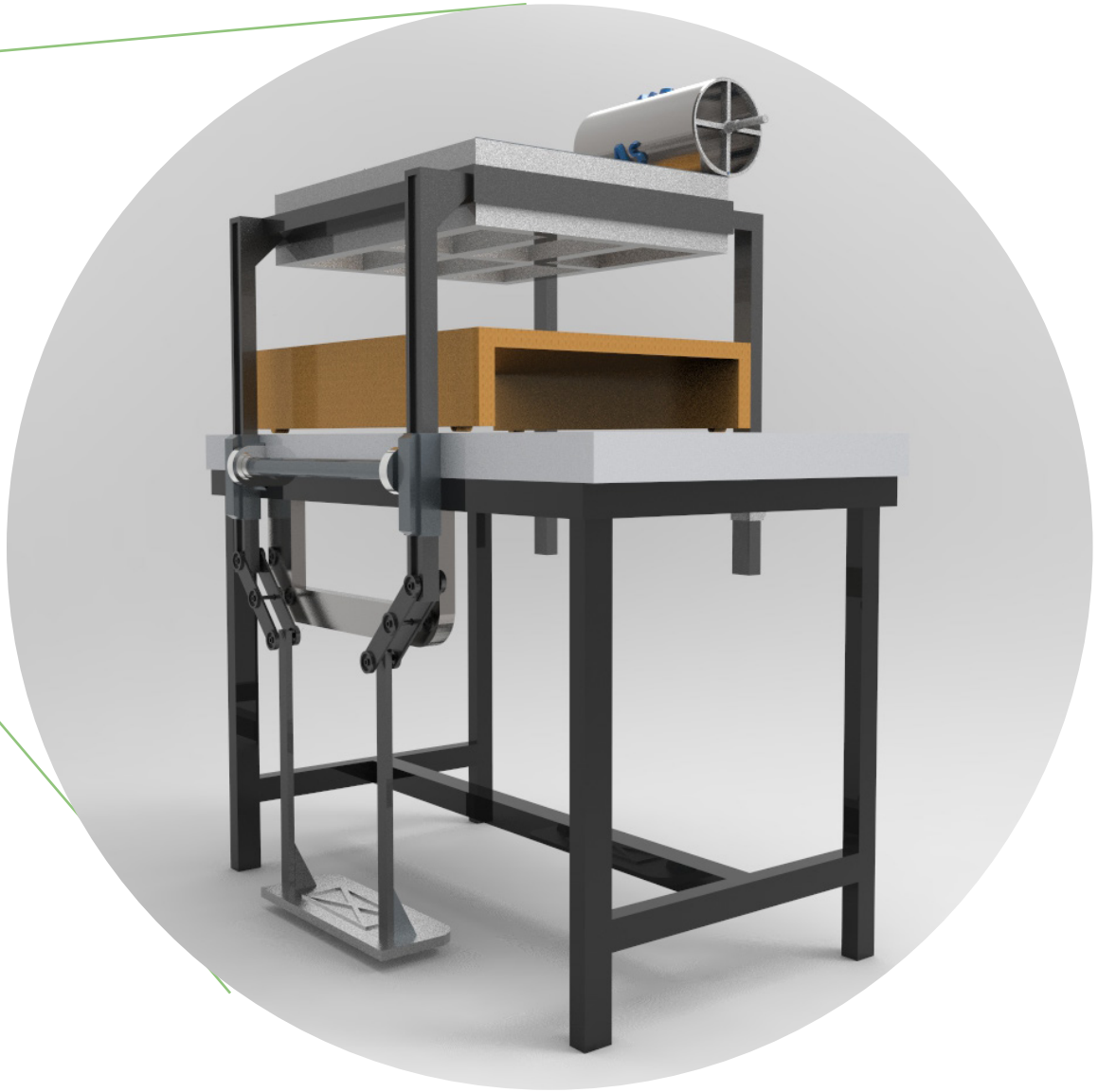
Fig : 47 (CAD model of the workstation type brick moudling machine)

The CAD model shows the various components in the brick moulding workstation.

The machine consists of two levels, of which the upper level has the mud loading bay on which the mud is loaded by means of a hand pushed cart, since the whole setup is supposed to be used in a pit the lower lever is fro transfering an loading trays

Brick Moulding Machine

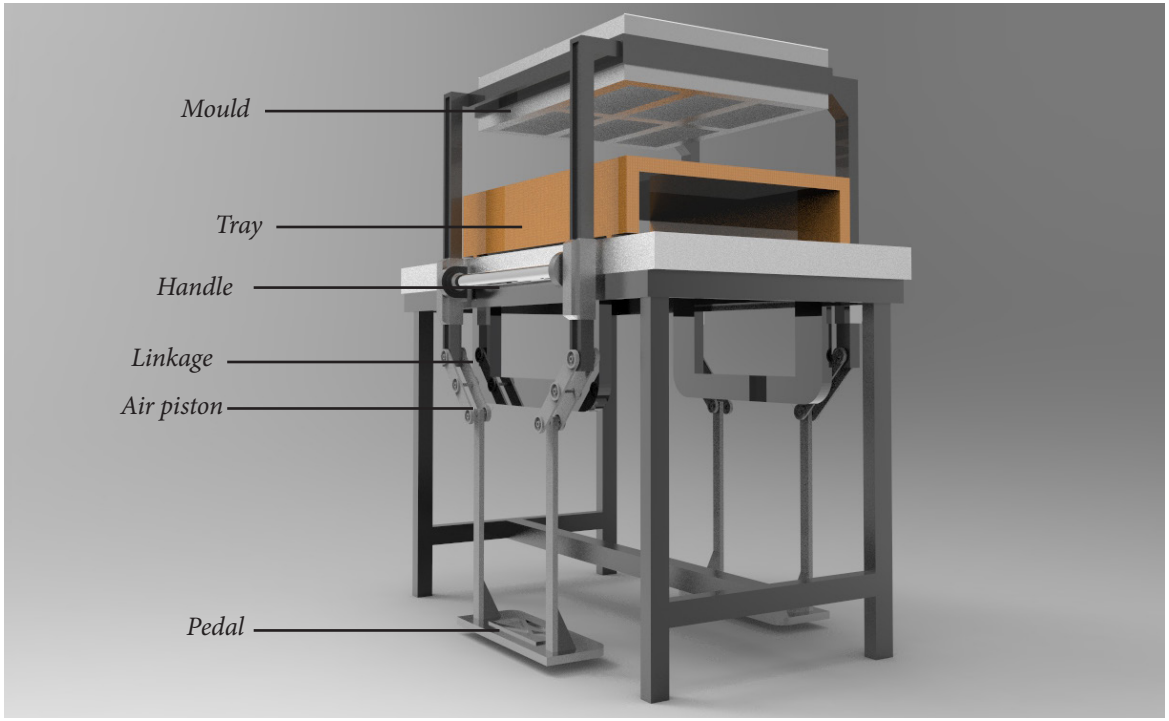


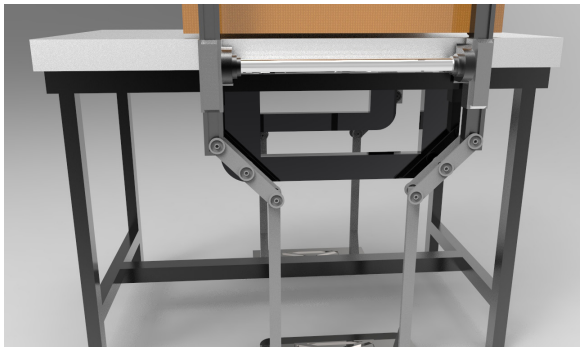


The brick moulding machine is one of the main component of the whole workstation, which is installed in between the mud transfer bay and brick transfer bay.
The mechanical linkages provide better and effortless brick moulding by use of foot muscular power and body weight. When the foot pedal is pressed, the mould is lifted up by means of levers.
A external drum is provided for embossing logo on the bricks

Fig : 48 (CAD model of the workstation type brick moudling machine)

Brick Moulding machine With Double Pedal





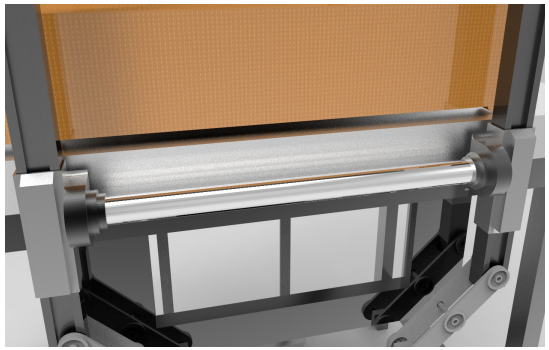


Fig : 49 (Details of the brick moudling machine)

The double pedal type moulding machine allows the workers to press the pedal simultaneously which reduces the effort to push the mould up and to hold it.

The machine also consist of handle to give support to the person pressing the pedal.

The double pedals are provided so that the embossment can be done if a metal flat plate stamp is useed for pushing the bricks out.

The problem with this particular design the problem of syncronization of pedal pressed simultaneously.

Brick Moulding Machine With Single Pedal

The double pedal type moulding machine allows the workers to press the pedal simultaneously which reduces the effort to push the mould up and to hold it.

The machine consist of a single pedal operated brick mouldi which is ejected upwards when the foot pedal is pressed.

The single foot pedal is provided to give more control on to the person operating the machine and providing freedom to the other person in opposite to carry out other tasks such as transfer of tray etc.

A secondary guide is provided as a support to avoid cantilever bending of the mould

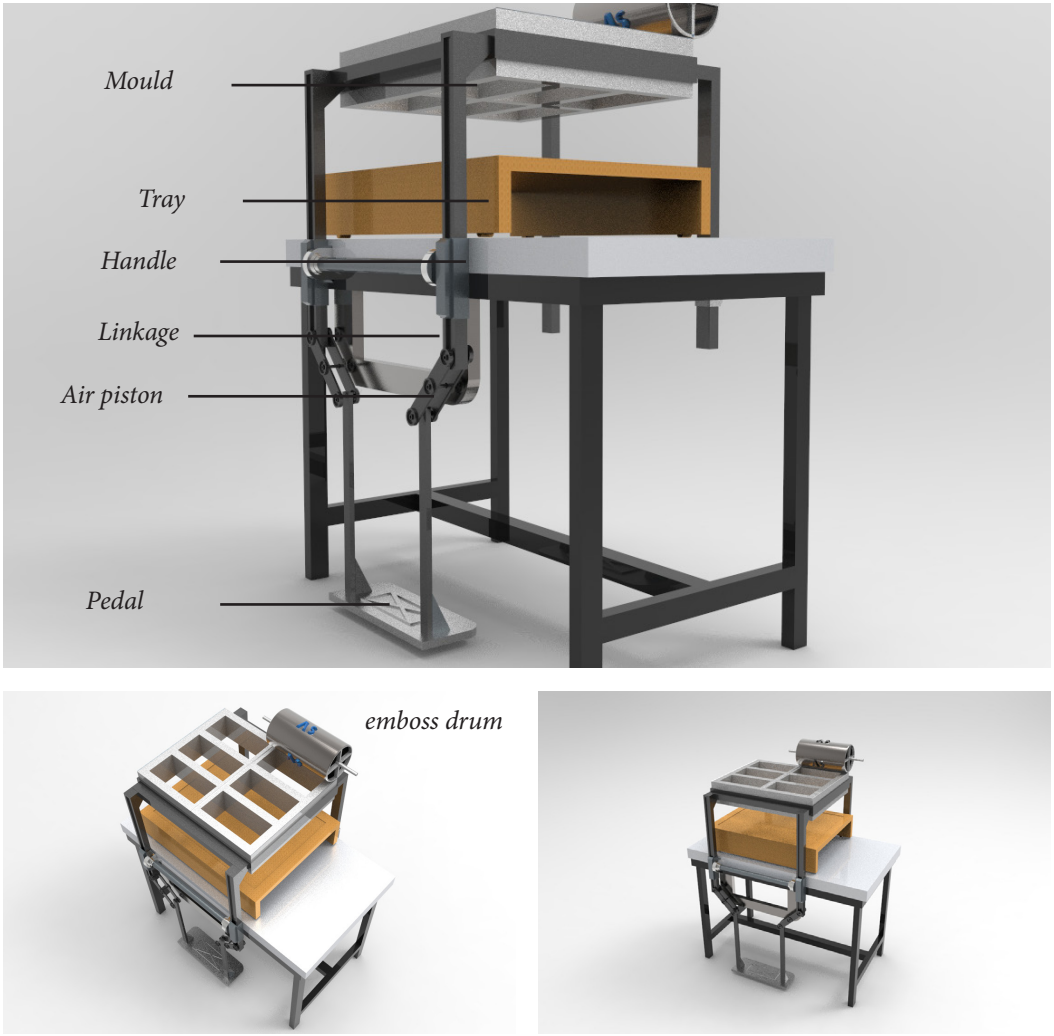
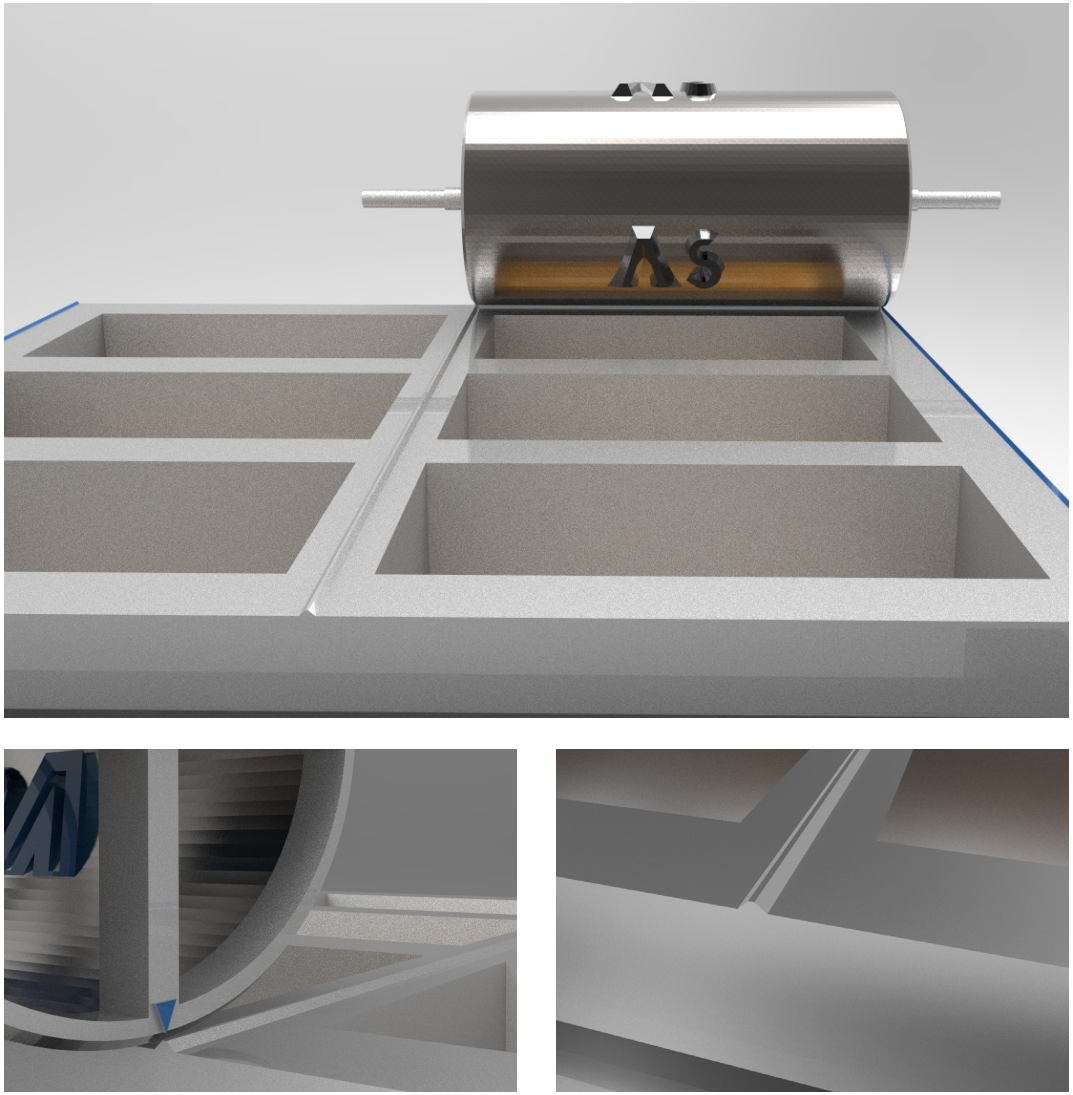
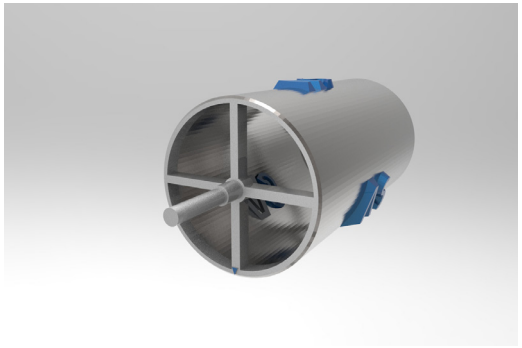


Fig : 50 (CAD model of the Single pedal brick moudling machine)

Embossment Plate





The drum type : logo embossment drum is provided for embossing logo directly on the brick by rolling the pin on the brick. The idea is inspired from rolling pin concept.

The logos are made up of silicone which avoid sticking it into the mud of the brick. The cross section of the logo is in tapered shape so that the mud is not removed from the brick with embossing and the logo easily comes out once the embossing is done without damaging the brick.

A raised triangular guide provides a path to the pin, so that the pin doesn't slips away from the position and the logo is embossed directly on the centre of the brick.

A arrow is provided to mark the starting point, or magnets can be provided so that the magnets adhere to the frame of the mould and aligns the logo on the brick by itself.

Fig : 51 (Roller for embossing the logo)

Anthropometric Data Considerations

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

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.
When a load has to be manually handled, it should be held or manipulated as close to the body as possible.

Anthropometric Data Considerations

1. Standing height selected is 5th percentile combined i.e 143 For the overall machine height
2. Abdominal extension selected is 5th percentile combined 881 for the working platform for moulding.
3. Maximum breadth of the body (relaxed) selected is 75th percentile is 849
4. The span is selected for 50th percentile combined i.e. 1659 for spacing among the people for free roam and comfortable working condition.
5. Length of arm for the lower position is selected 5th percentile for combined 439
6. Considering the 30% of total arm reach for the moulding process.

Fig : 51 (Roller for embossing the logo)

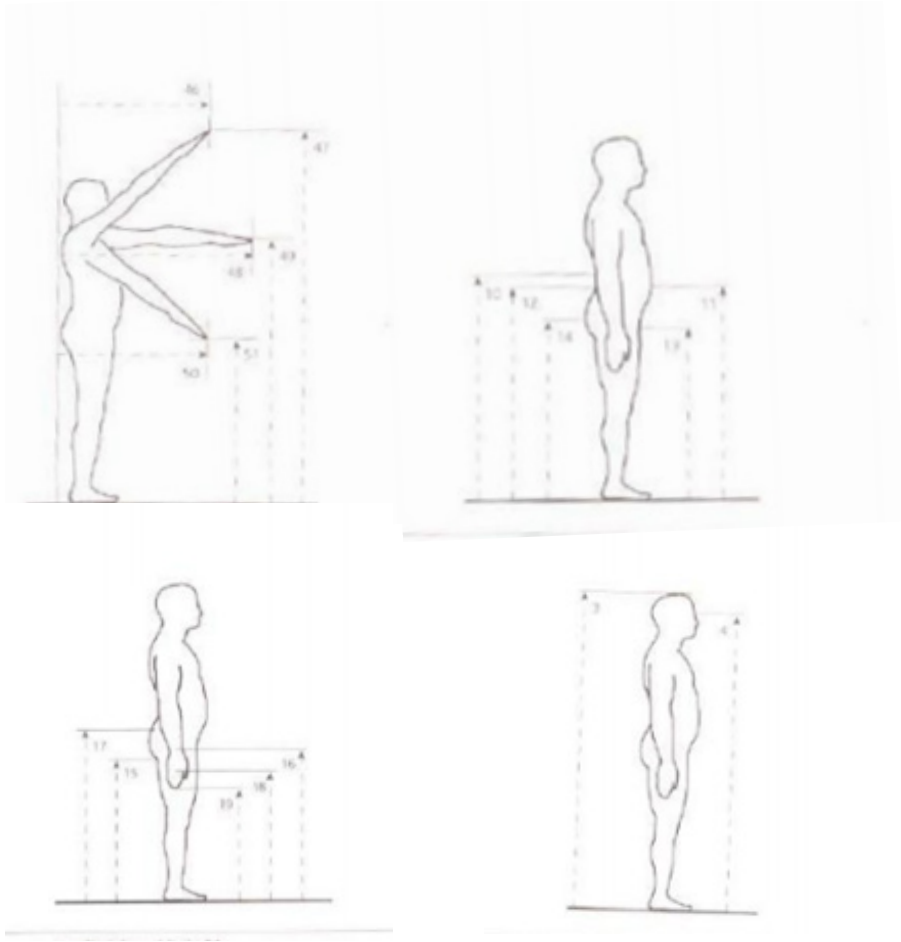


Fig : 52 (Anthropometric data representation)

Scale Model

Scale model of 1:5 scale (fig:53) was made to Study the brick making concept of workstation. After evaluation of the scale model ,few conclusions came out regarding the structure and the mechanism.
The mechanism or the linkages of the model were fixed hence not allowing the degree of freedom for the movement,hence slotted linkages were suggested with guides,also the structure had too many legs which were needed to be removed and simplified for better rigidity and stability with minimal approach.

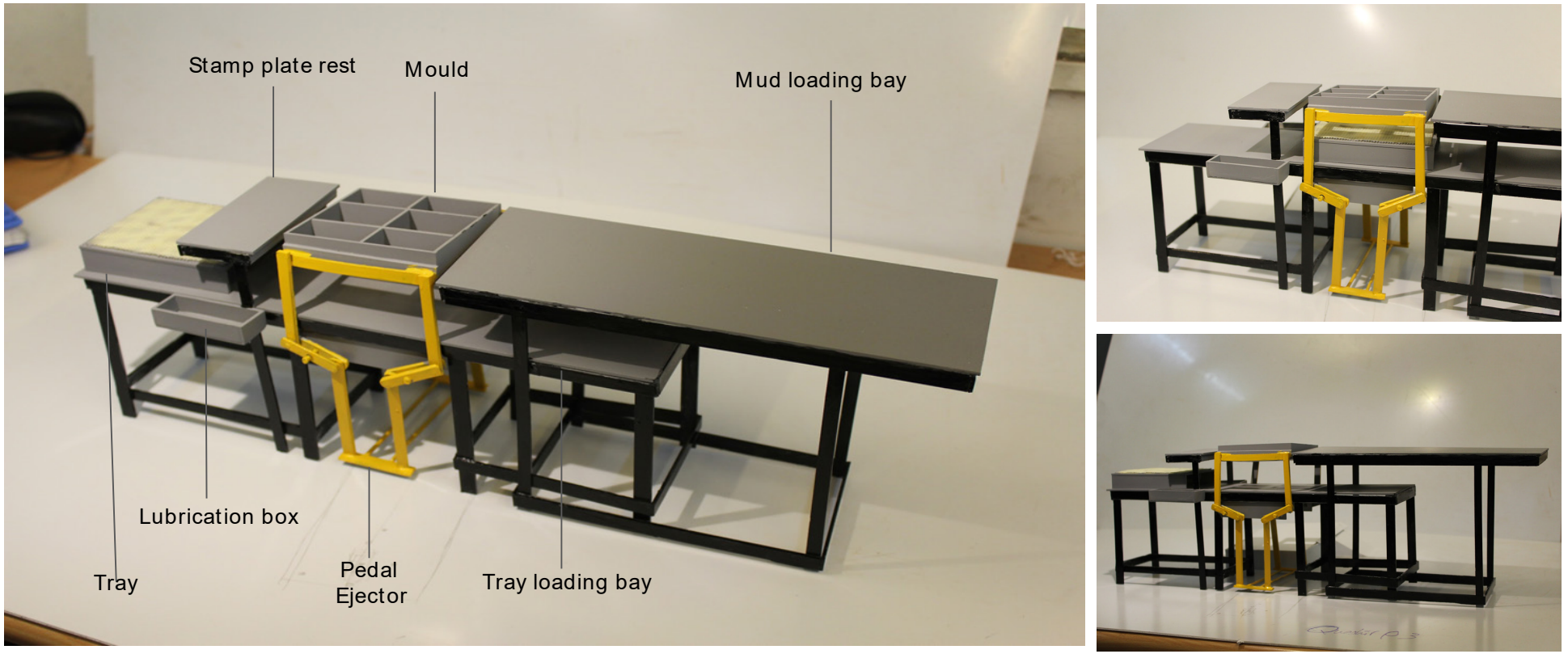


Fig : 53 (Scale model of the Final concept)

Layout Model

To study and understand the system and the workflow of the whole brick moudling concept with the new brick moulding workstations it was necessary to create a scale model of the whole layout of the brick making kiln so that the human interaction with the system and the placement of the machine can be studied as shown in (fig:54)
The layout showcases the number of the people appointed with different task to carry out the brick moulding process.

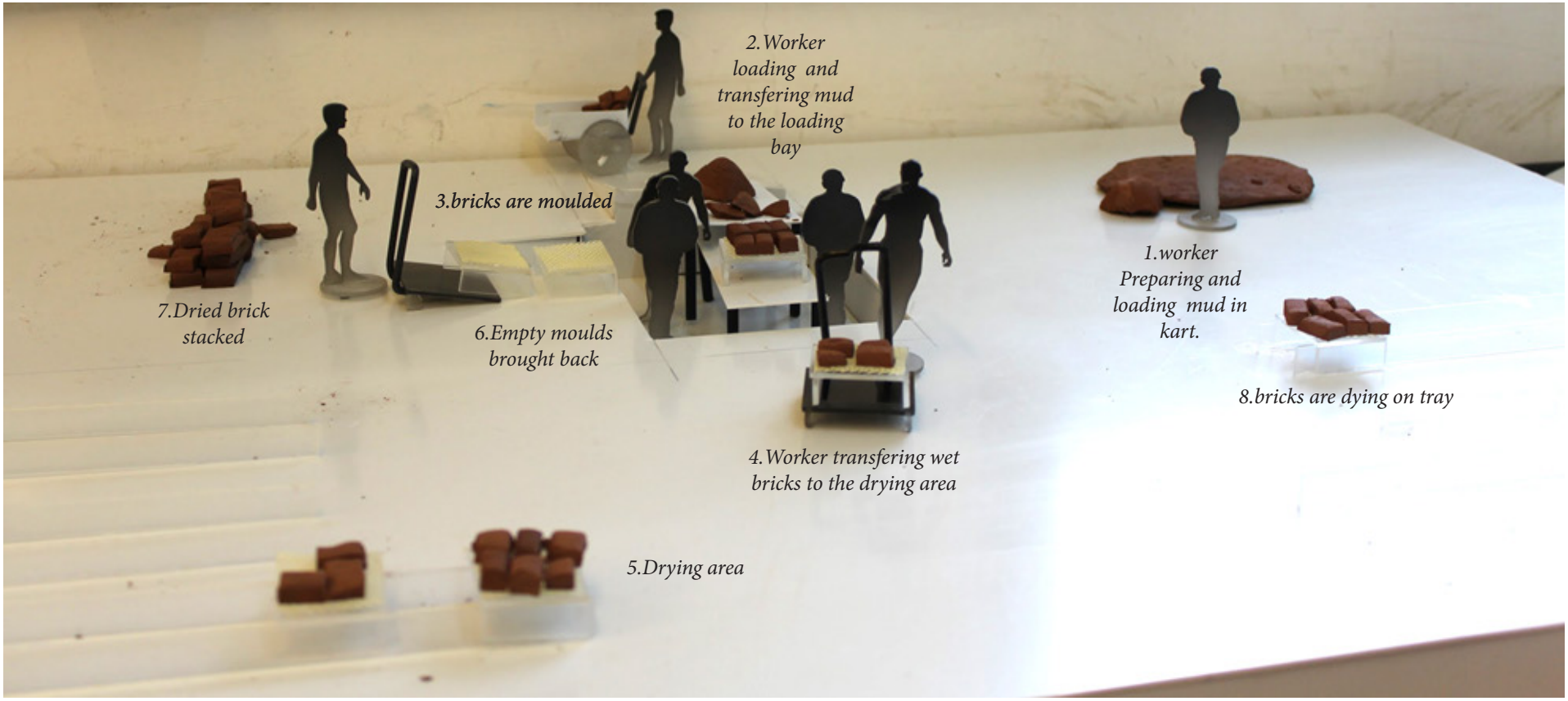


Fig : 54 (3D Layout Model)

layout Model

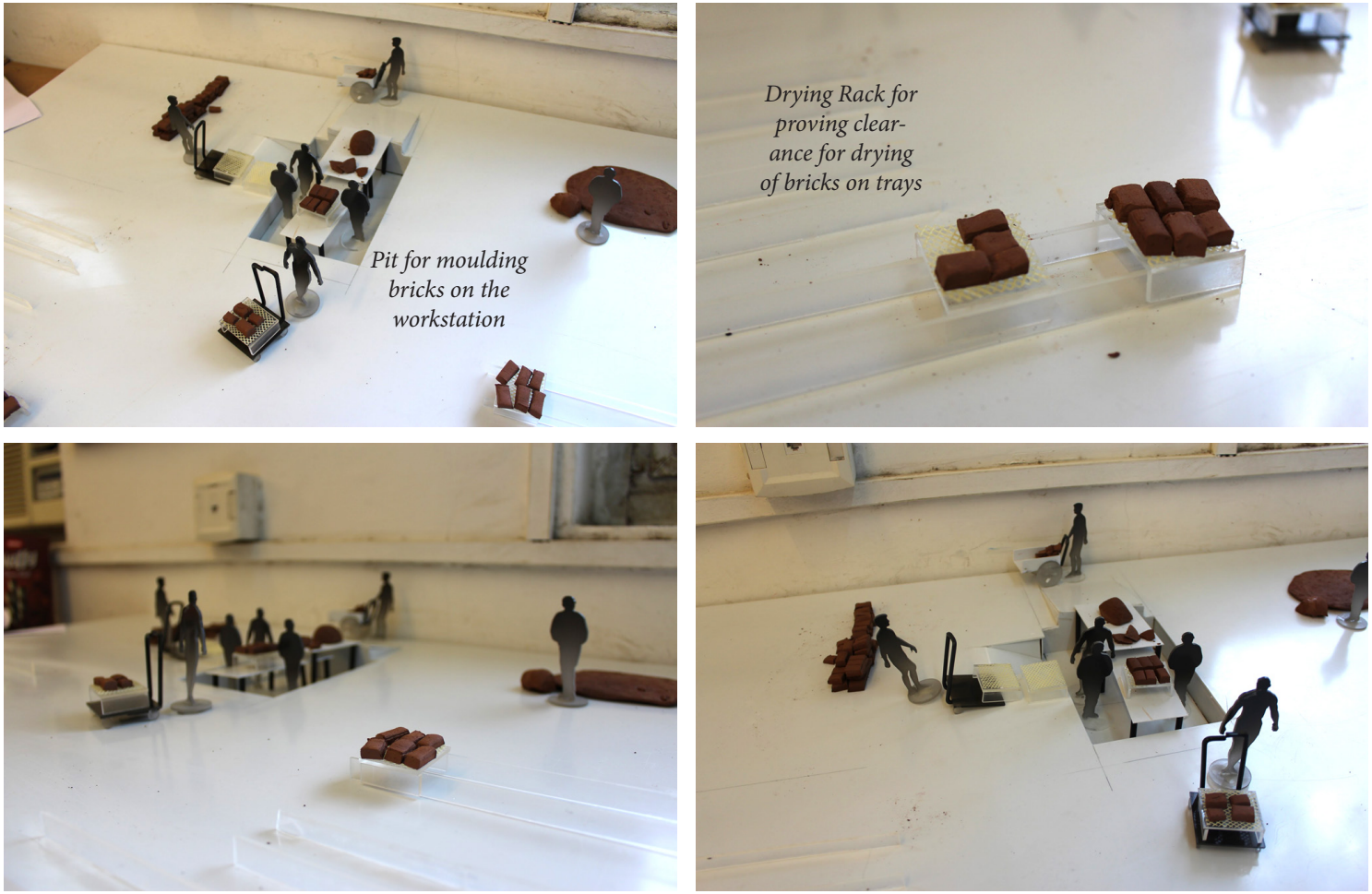


Fig : 54 (Different angle views of Layout model of the brick making system System)

Rig Testing

Rig testing was conducted to understand the human factor involved in using the work-station type brick moulding setup as shown in (fig : 55).
The Testing of the setup was condusted to understand the body movement and actions which will be associated with job keeping the size of the setup following the dimensions considered from the anthropometric Data book. so that minimum stress must caused on the human body with most effecient workflow.

Requirements:

Max Length of the rig : 250 cm
Max Height of the rig : 120 cm
Number of people : required for testing : 5
Time taken for one trial : 8 mins
Number of trials : 5

Fig : 55 (Rig Testting of the Final Concept)

Loading of the mud

Tray Loading

Mounting the mould on the tray

Breaking the mud into batch

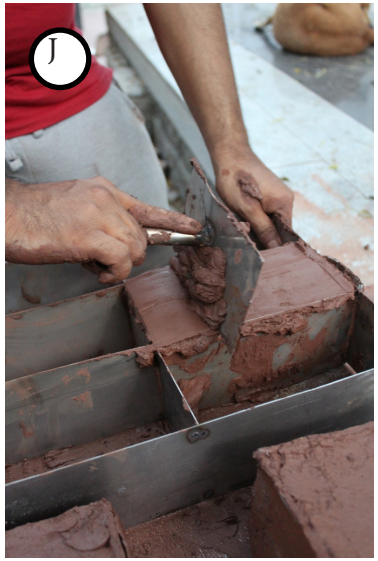
Aligning or lubricating the mould

Making the mud into smaller lumps

Throwing the mud into mould

Pressing the excess mud

Pressing it further



Scraping out the excess mud

Stamping logo

Lifting the mould up

Using two persons to lift the mould

Brick made

Transfer of tray

Tray is taken away for drying

Time taken to make six bricks
Mud loading time = 2 mins
Lumps preparation= 2 - 3 mins
2.5-3.5 mins
Brick moulding = 2-3 mins
Brick transfer = 1 min

Learning from the experiment were :

The person bringing the mud needs to push cart on the elevated platform.
The posture of the person loading the tray is inappropriate and visibility of the tray platform is poor.
The tray does not stay locked at one place when the mud is poured into the mould.

Testing of Mould and Trays

The photographs shows (fig:56) the step by step tasked involved in moulding of the brick for testing different types of tray for selecting the best material for the job.

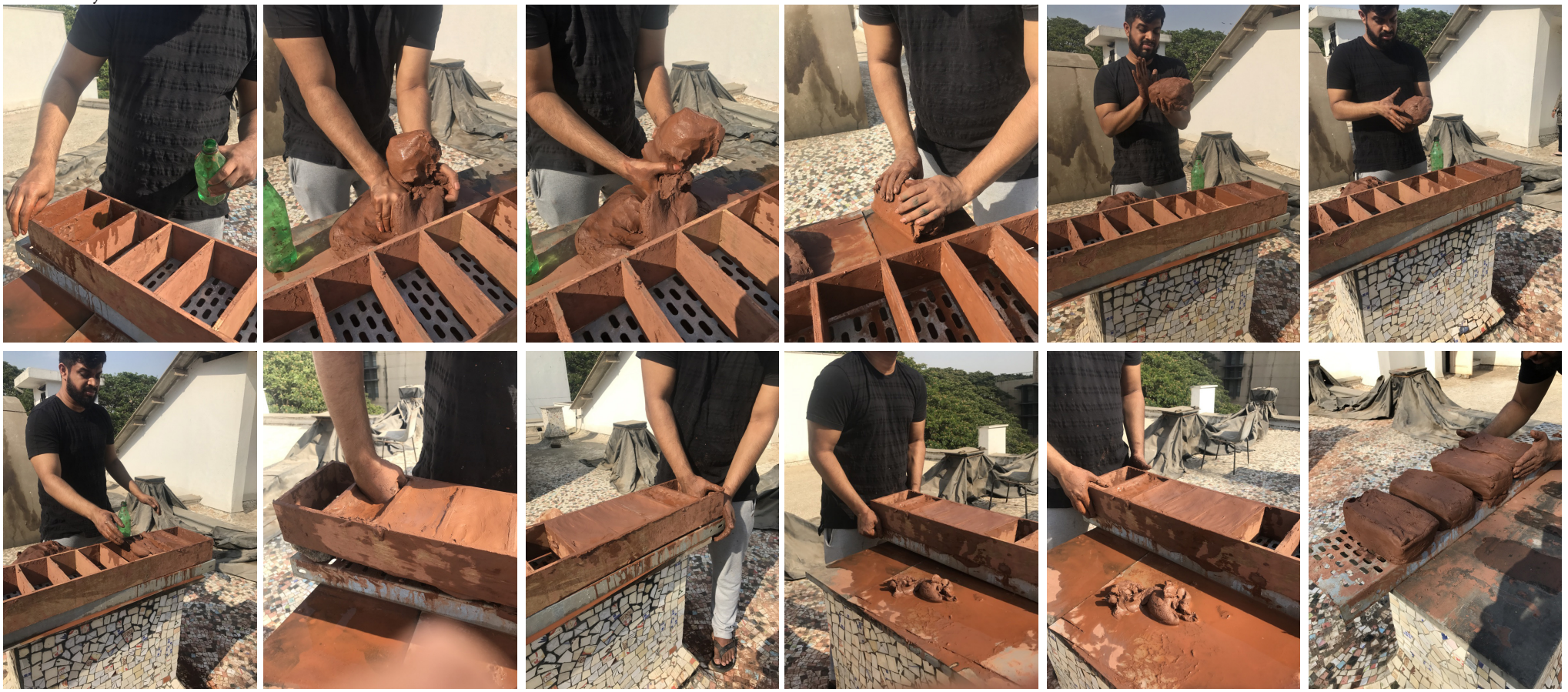


Fig : 56 (Rig testing of the Drying tray for the bricks)

Testing Different Types of Trays for Drying Bricks

Fig : 57 (Nylon and metal mesh backed tray)

Material:
Nylon mesh backed with metal wire

Observations :
- Gives good texture to the brick
- Sagging of the wire mesh due to heavy weight
- The brings get deformed due to sagging
- Impact mould filling also stretches the mesh.
- Good air flow from bottom
- The bricks are evenly dried
- The frame can withstand repetitive impact.

Fig : 58 (wooden pallet)

Material:
Packing wood pallet

Observations :
- Good strength
- Weight bearing capacity around 700 kgs
- No sagging of bricks
- The gaps between the planks creates non-uniformity in the bricks
- The wood however is not a good material for drying the bricks.
- But packing wood is still better than plywood in terms of absorption of water.
- Different types of powder materials can be used to dust the pallet for efficient drying of the brick

Fig : 59 (Fine wire mesh)

Material:
Fine metal wire mesh

Observations :
- Starts sagging after repetitive use.
- The the texture on the brick is fine and the material does not comes out of the mesh.
- The bricks gets deformed due to sagging of the mesh.
- The airflow is good in this type of tray

Fig : 60 (flat wooden tray)

Material:
Flat wooden plank

Result :
- Gives flat surface
- No bending or deformation of brick
- The mud adheres to the tray while demoulding
- The bottom surface is dryer than the top surface.
- Minor cracks on the bottom surface

Fig : 61 (perforated metal plate)

Material:
Perforated steel plate

Observations :
- The clay gets extruded from the holes.
- Need extra layer of fine mesh.
- Good air ventilation at bottom
- Steel conducts the heat to the brick
- Straight brick surface
- The texture embossed on the is quite big from removing brick from tray.

Fig : 62 (SS metal plate)

Material:
SS metal plate

Observations :
- The shiny metal plate act as good conductor of solar heat
- The heat is evenly distributed underneath the surface of the brick.
- The result is that the surface of the brick gets heated up faster.
- The surface is smooth and flat
- However the sheet also tends to bend if no support is provided from the bottom.
- Black coating of the steel surface can result into better heat absorption by the plate

Conclusion of tests

Fig : 63 (combination of different table)

Fig : 64 (modification of mesh tray)

Based on the trial testing of different types of tray and materials various observations were made on all trays created and direct or indirect effect on the texture, shape and composition of the brick being dried on it.

From the obseravations made on perforated steel plate in Fig. 58 and packing wood pallet Fig. 55, it has been seen that these two test specimens possesed good structural strength and they did not slack at the time of moulding due to impact mould filling. Hence, it made them most suitable for brick drying. Since, the wooden pallet does not has perforation, a combination of wooden pallet structure along with the steel perforated plates was considered as the potential concept.

It can provide good strength as well as good airflow for uniform drying of brick without deforming.

The specimen testing of the tray with wire mesh and wooden frame in Fig. 54 showed that the tray failed while moulding because of the slacking caused by impact of mud filling which resulted in deforming the shape of the brick.

The main reason of failure of this tray was the absence of a central supporting member for the mesh. If provided this type of tray can posses a better ventilation to the bricks while keepng the cost low.

The tray also consists of wheels which give better mobility for manual load handling of the tray.

Hence this mould was finalised for the prototyping

CAD Model of Final Tray Concept

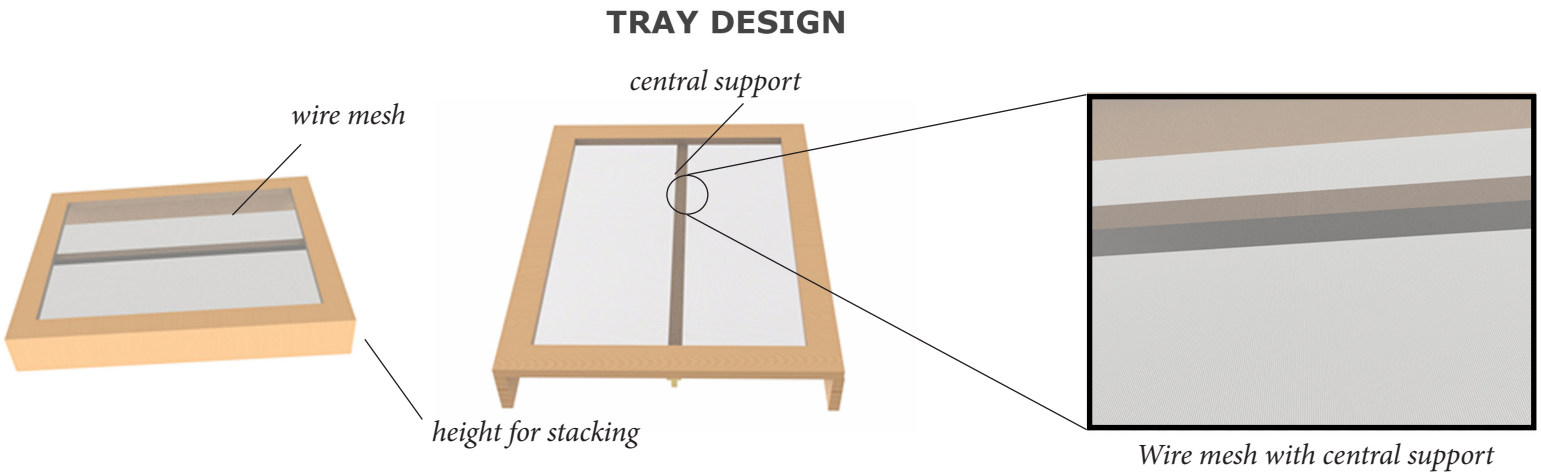


Fig : 65 (CAD of tray model)

The CAD model shows the finalised concept fro the tray to dry the bricks. The model is based on testing dome previously.

Pros:

- Good ventilation
- Better central support to reduce sleacking of the mesh
- More height gives ability to stack the trays with bricks allowing to reduce the occupied area for drying.

Cons:

- Cost can be higher that the previously tried trays.

Mock Up Model

Mock up of the concept to show the functionality and issues related with the concept

Issues

- Length of the overall design.
- Mechanism.
- Size of mould.
- No. of people which will be associated with the job.
- Syncronization of mould ejection

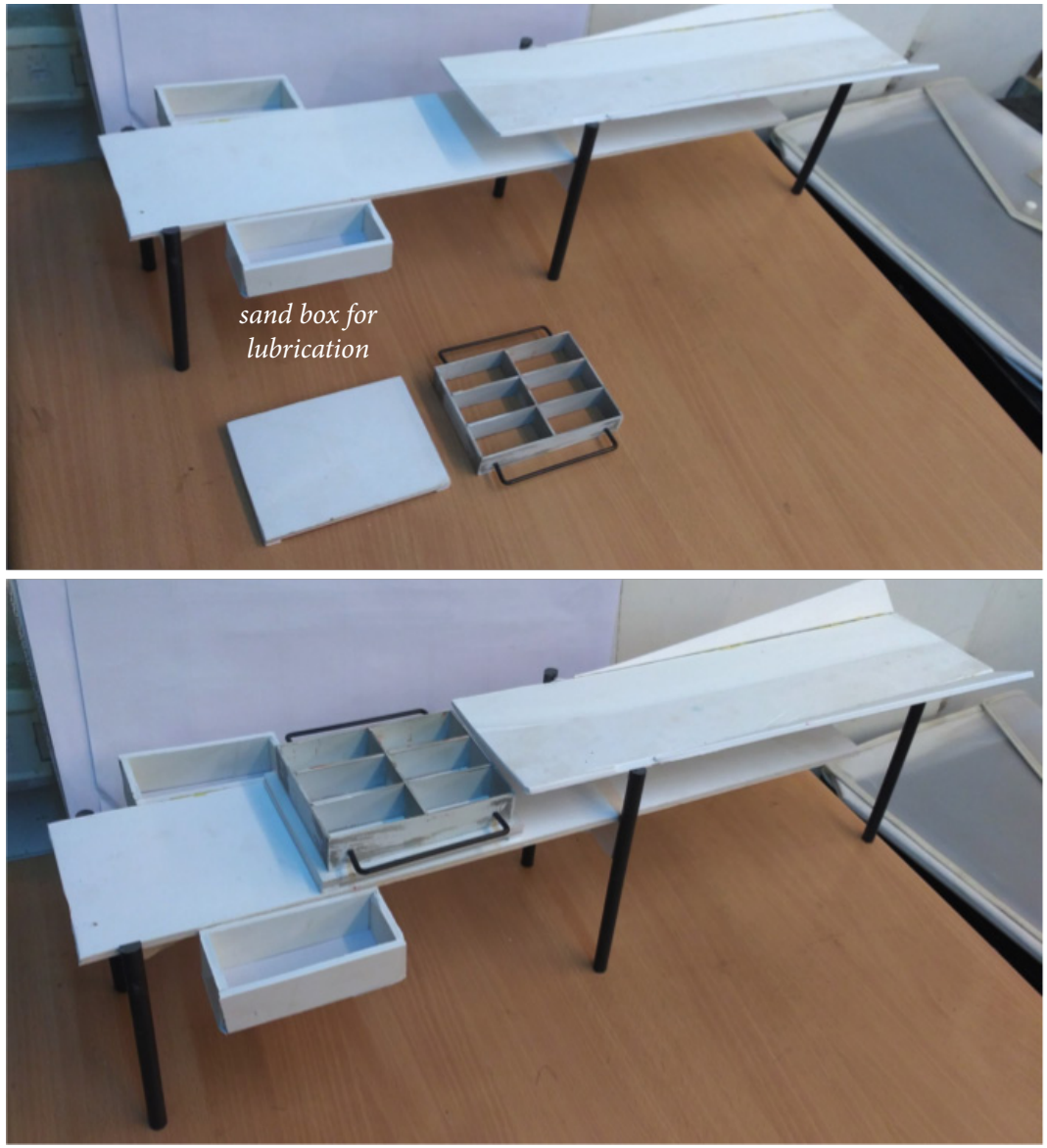


Fig : 66 (Mock model of the concept)

Modified Final Model

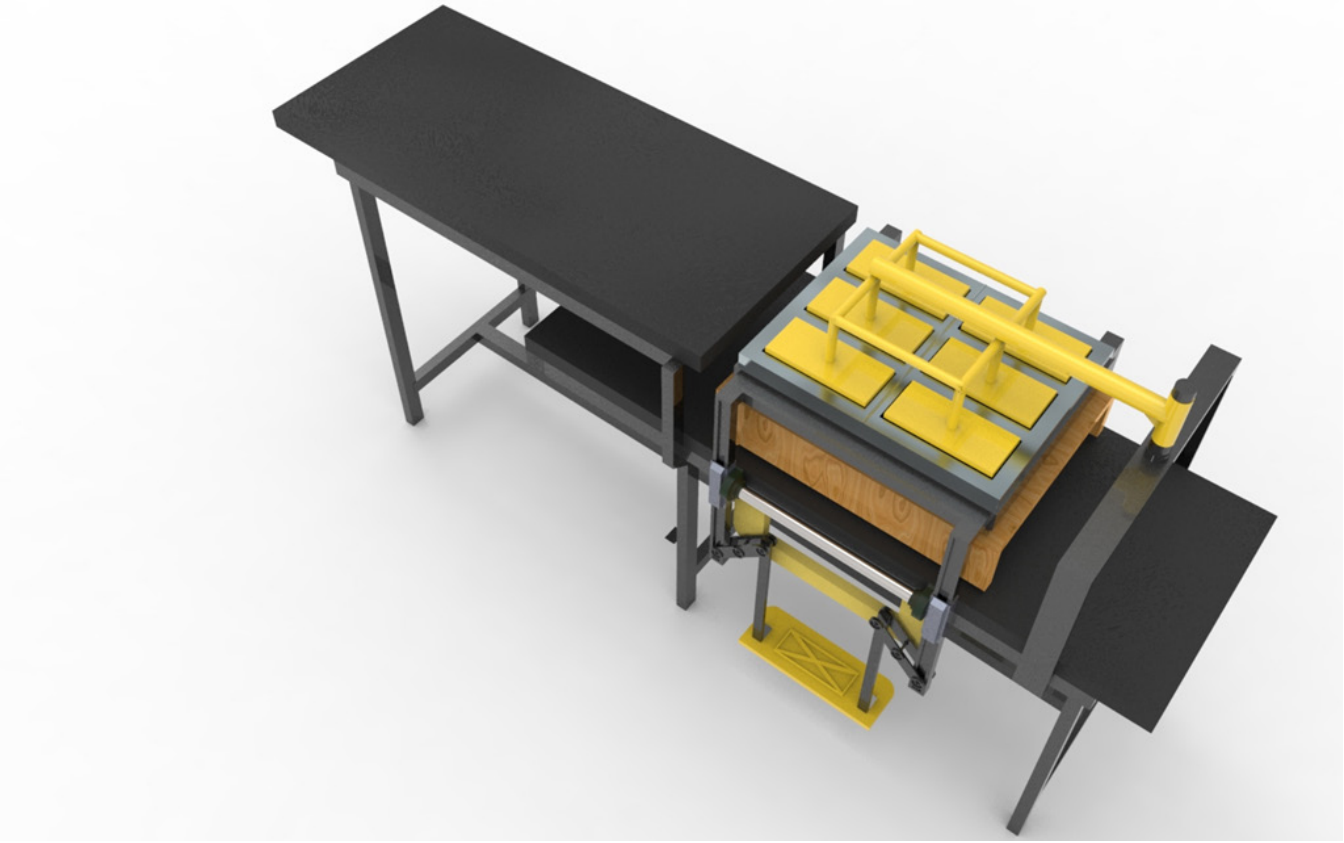


Fig : 67 (CAD model of the modified final brick moulding Concept)

By studying the mockup model *(fig:52)* and the cad model various issues were discovered with the design,hence the model and dimensions of the concept model were further modified to design the feasible brick making machine/

The CAD model shows the various components in the brick moulding workstation.

The machine consist of two level, of which the upper level has the mud loading bay on which the mud is loaded by means of a hand pushed cart, since the whole setup is supposed to be used in a pit the lower lever is from transferring a loading trays

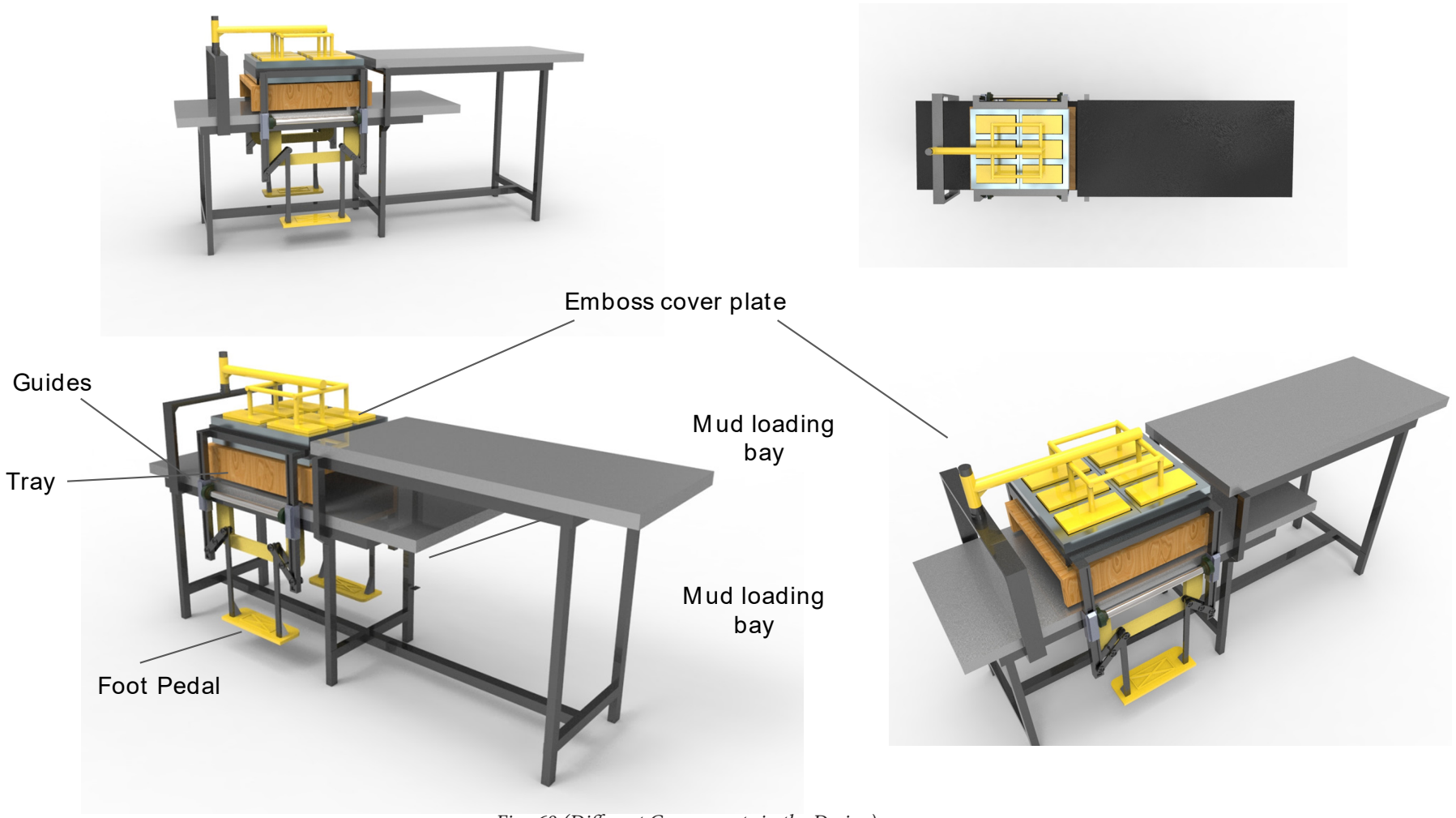
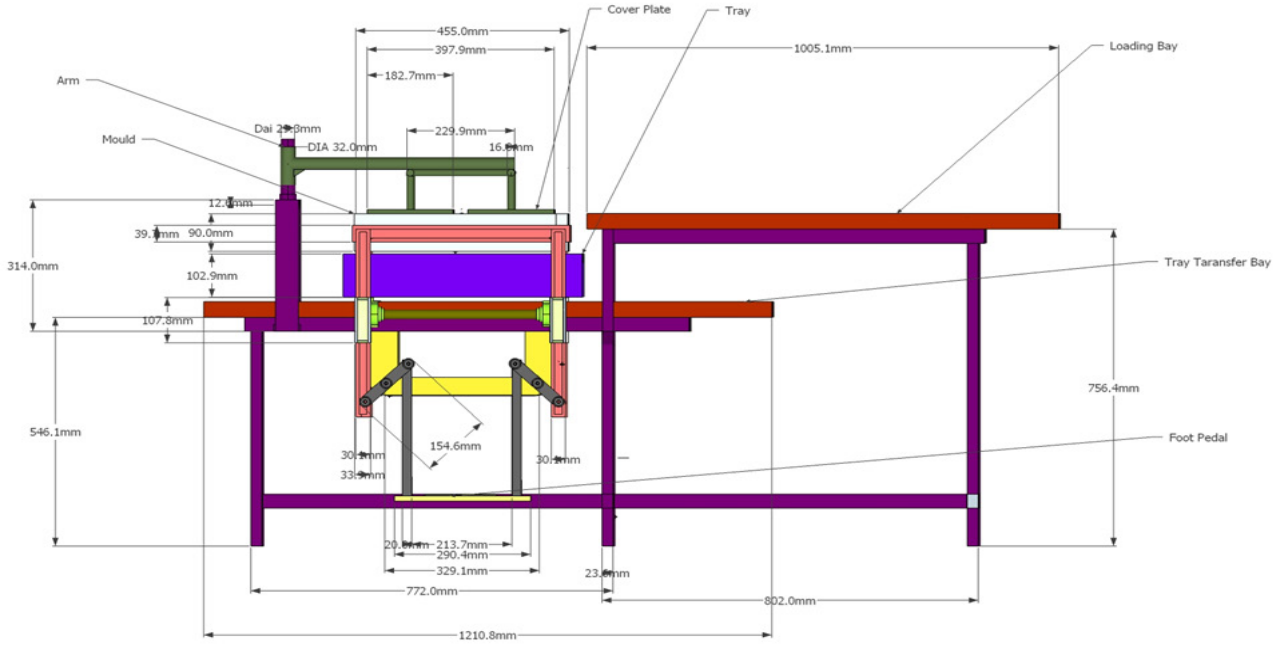


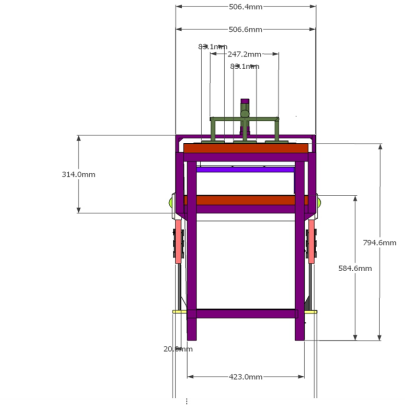
Fig : 68 (Different Components in the Design)

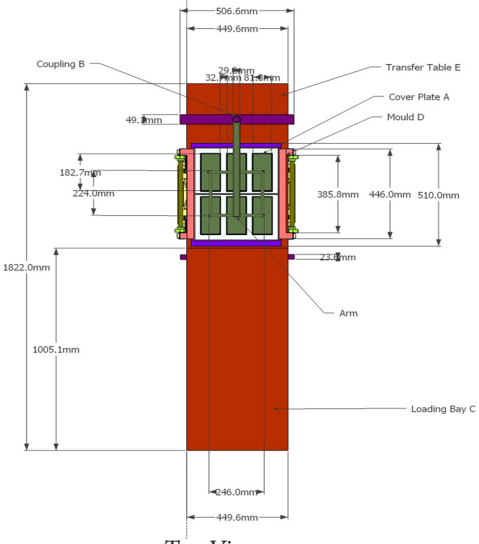
Portable Brick Moulding Workstation

Side View



Front View





Top View

Fig : 69 (Engineering Drawing of the Final concept)

Fixed Brick Station Type Brick Moulding Machine

During the discussions with the guides it was suggested that usage of already available bricks and the concrete to build the workstation platform can cut overall cost of the machine drastically. hence workstation made up of bricks was also one consideration for the furgal concept.
But acheiving precise dimensions to install the moulding mechanisms in the workstation is difficult in brick construction.

The fixed brick station type brick moulding machine is a one time constructed workstation which is made by the bricks available at the brick kiln.
The mould and mechanism are pre-fabricated and installed at the construction site.

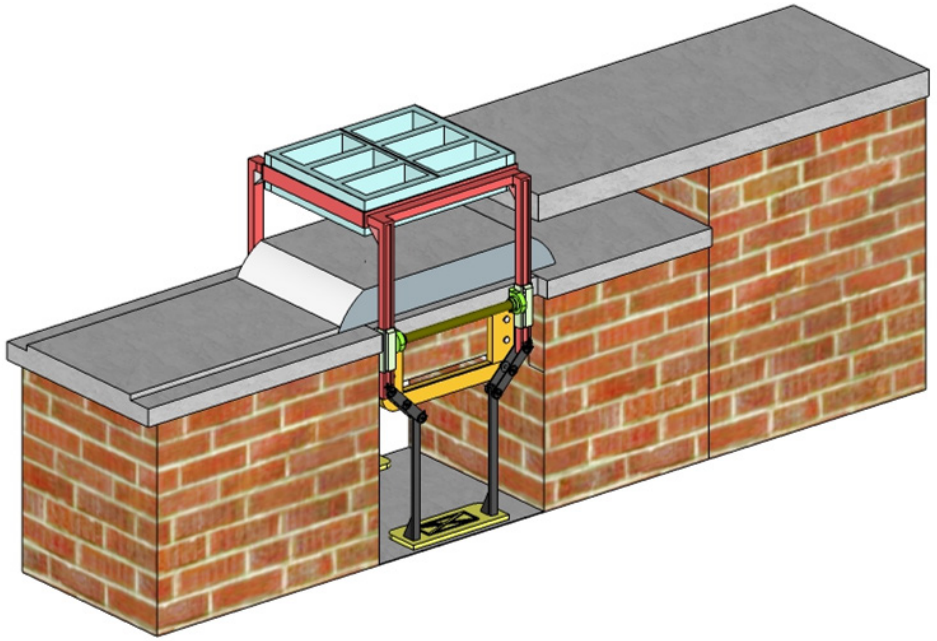


Fig : 70 (Fixed brick station type brick moulding machine)

Fixed Brick Station Dimensions

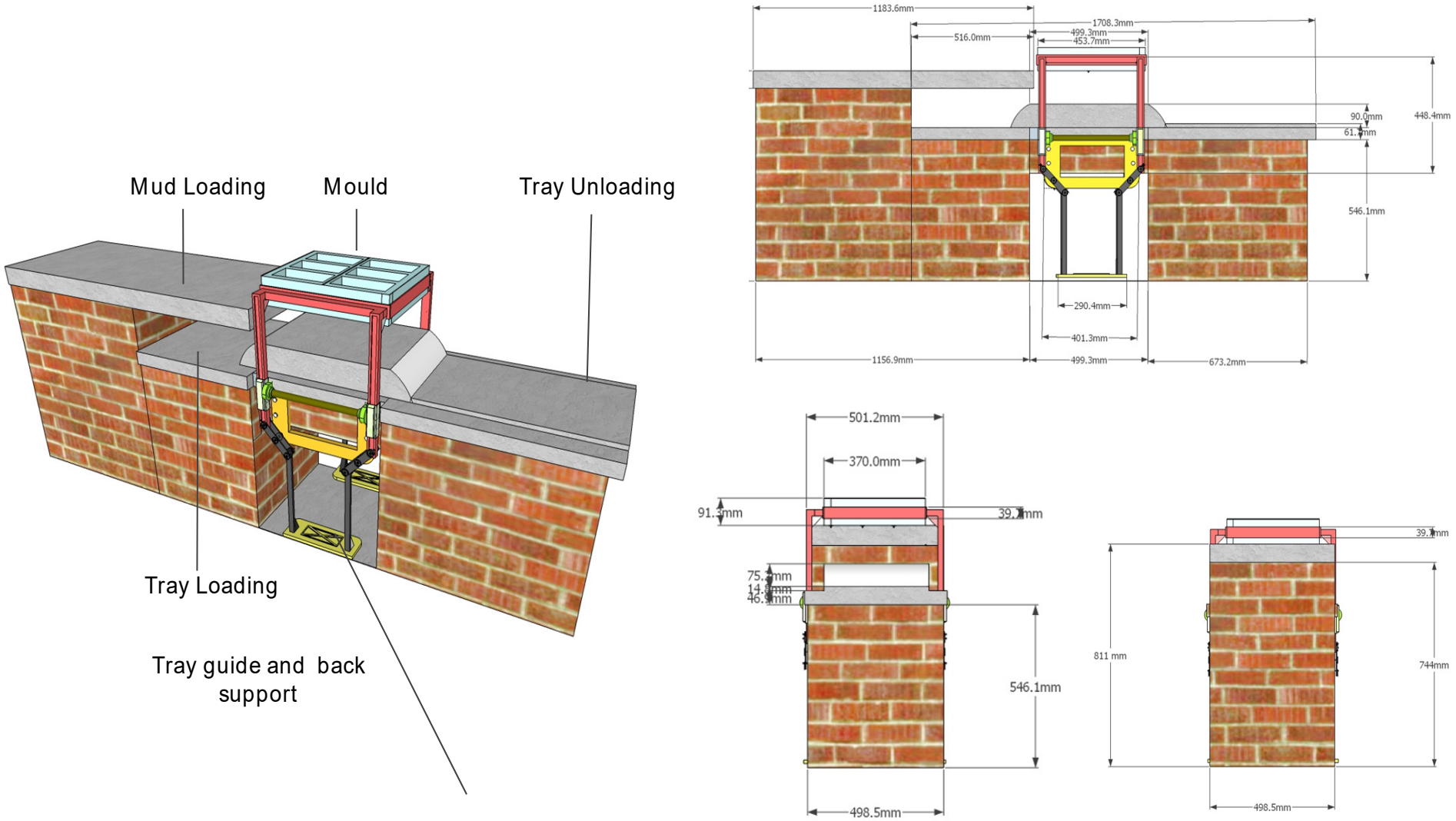


Fig : 71 (Engineering Drawing For the Fixed Brick type brick moulding machine)

Fabrication

Processes followed:
1. Sheet cutting
2. laser cutting and CNC milling
3. Sheet bending
4. Tig welding
5. Arc welding
6. Drilling
7. Grinding
8. Buffing

Bill of Materials:
Sheet metal - 4x5ft
SS Sheet - 6x5 ft 3mm thickness
MS Hollow rectangular pipes 2”x1” 20ftx2
Flat MS Strip 25mmx3mm 20ftx2
Plywood 2”x6ftx4ft
Round pipe 18mm x 20ft
Total cost = approx 5000 INR

Fig : 72 (Fabrication of the prototype)

Final Prototype

Final Prototype was made by carrying out different machining processes. one of the main criteria which was followed was of keeping the contruction frugal. however the mould and linkages design needs to be precise hence high accuracy of machining like CNC was required for it.
The overall cost of the machine with the material was Rs.7000 approx.

Fig : 73(Final Prototype of the brick moulding machine without the mud loading bay)

Fig : 74 (Drying Tray prototype)

Working

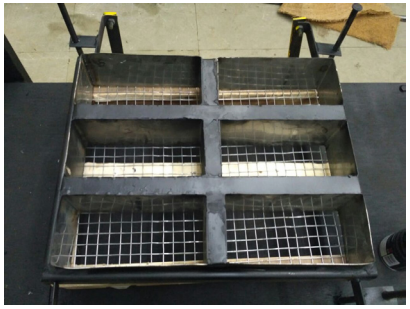
The working of the machine is as follows:

The pedal is is pressed lifting the mould upward so that the tray can be slided in. After resting the mould on the tray mud is loaded in the mould by throwing action or called as thapera action,the excess mud is removed and the cover plate is brought over the mould ,since the cover plate is overhanging ,it rotates for easy engaging and disengaging. once the cover plate is fixed the pedal is pressed again lifting the mould upwards ,since the cover plate is in contact with the mud ,it pushes the brick out of the mould easily.

The tray with the freshly made bricks is then slided and taken away and the mould is brought back to its original position after a fresh tray is provided under it. After which the cover plate is rotated back to its original position so that the mould refilling can take place.

1. Slide tray under the mould

2. Place the mould on tray



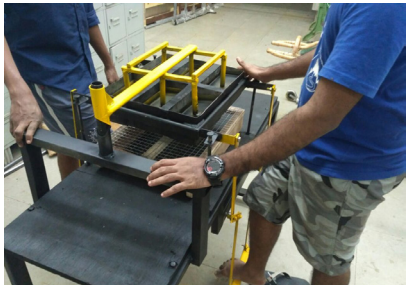
3. Mould placed

4. Rotate the cover on the mould

5. Press the foot pedal to lift the mould

6. Connecting shaft turns both linkages together

7. The linkages lifts the mould up in synchronization



8. Bricks get moulded on tray

9. Tray is transferred for drying

10. The cover plate arm is retracted back

Fig : 75 (Working of the brick moudling machine)

Elements

The Prototype comprises of different unique parts in which includes elements like the cover plate arm (fig:76) which has a slope slot made on it to allow the plate to rotated and sit on the mould. similarly slotted mechanism is given on the linkages (fig:82) to allow maximum degree of linear movement which was not present in the earlier model. Guides (fig:80) are provided restricting the movement to anywhere else other than upward and downward. A pair of connecting shafts (fig:78) is present under the bottom of the table joint with the two linkages to provide synchronised movement of the mould when the pedal is pressed.

Fig : 76 (Retractable Cover Plate Arm)

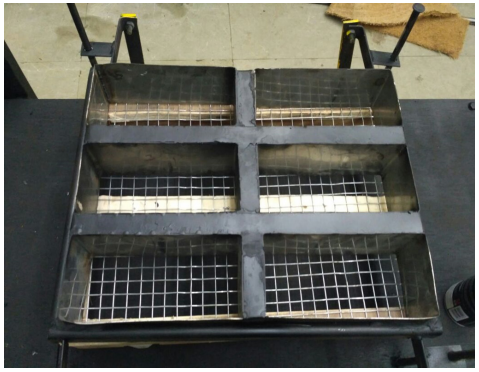


Fig : 77(Mould)

Figure :78 (Connecting shaft)

Fig : 79 (Slotted Rotating Bar)

Fig : 80 (Guide)

Fig : 81 (Slotted linkages)

Fig : 82 (Different Components of the prototype

Reference

Name and link	Date
Manual Brick blocking machine https://www.youtube.com/watch?v=jQVCwZnwWtA&index=1&list=PL_xVOZvkNPWm0kjgPW9B0zU-pTSvEjsCX	2/1/2017
manual block making machine price https://www.youtube.com/watch?v=kuSjFSoFFmw&index=2&list=PL_xVOZvkNPWm0kjgPW9B0zU-pTSvEjsCX	2/1/2017
clay brick making process, lakshmi and co-coimbatore https://www.youtube.com/watch?v=t_XqrvUBjQU&list=PL_xVOZvkNPWm0kjgPW9B0zU-pTSvEjsCX&index=3	12/3/2017
Small Brick Making Machine https://www.youtube.com/watch?v=4nOAlv-4Me4&index=4&list=PL_xVOZvkNPWm0kjgPW9B0zU-pTSvEjsCX	13/3/2017
Brick Making Machine LOGO - RAMESH MAHARJAN https://www.youtube.com/watch?v=9bIUNxQTp54&index=5&list=PL_xVOZvkNPWm0kjgPW9B0zU-pTSvEjsCX	15/4/2017
Brick Making Machine By RAMESH MAHARJAN https://www.youtube.com/watch?v=Fd2VVAHFPDg&index=6&list=PL_xVOZvkNPWm0kjgPW9B0zU-pTSvEjsCX	15/4/2017
QTS2-10A Interlocking clay brick making machine, lego cement clay block making machine https://www.youtube.com/watch?v=tCUnxE1sGos&index=7&list=PL_xVOZvkNPWm0kjgPW9B0zU-pTSvEjsCX	16/4/2017
shri keshav clay bricks making machine https://www.youtube.com/watch?v=5iBELrHqamU&index=8&list=PL_xVOZvkNPWm0kjgPW9B0zU-pTSvEjsCX	16/4/2017

Engineering Drawing

Fig : 77 (Manufacturing Drawings)