DEP 702 - Project II

Design of a squatting aide with Haptic feedback for seat type commodes

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Introduction

The process of defecation is man's one of the most inherent requirements of daily life. The scene around the excretion has shown us that there are most commonly two main ways in which people have always defecated, the sitting and the squatting positions. And there are very serious problems that revolve around both these methods of defecation. The action of defecation is something that is common to all people; the children, the adolescents, the middle aged and the old people alike and each of them face very unique problems during this process.
The process of defecation is something that touches upon several different topics of study as well. This includes health & hygiene, posture & human ergonomics, diseases that revolve around the process of defecation, the differences in ethnic behaviour when it comes to the same natural process, the accessories revolving around the process of defecation and the design of the toilet itself makes it a very complex topic of intervention.

My Interest in the project

The process of defecation was something that people usually don't concern themselves with. The process and everything around it has been considered a topic of taboo or disgust by many Indian households. There are several perspectives and problems that revolve around such an essential part of our lives. One of the main observations made by me regarding this was that the toilet and the manner in which I have defecated has been the same from the time I can remember. And it has been the same for 4 to 5 generations before me too. And the thought that something so essential to our lives has remained insubstantially changed provided motivation for a broad scope of intervention in this topic.
The project had initially started off as an exploration towards identifying the various problems around the process of defecation and moved towards addressing the problems revolving around the seating and posture while defecating.

02
Research
Phase 1

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Historical Study of Toilets

To identify issues that revolve around any topic of concern, it becomes important to study the many different solutions that people have come up with to address similar problems. In such a scenario, a complete understanding of its History becomes very essential.
Since the process of defecation is common to different regions of the world, and the same process has been addressed differently, it becomes important to start with a culture-based Historical study.

The Historical study of toilets takes into account the History of evolution of the toilets from the very beginning of recorded history to the toilets that we use today in our homes. **In this study, we try to point out the key developments in the sitting type and squatting type toilets around the world.**
The main regions of the focus of this study would be **Europe, China, Japan & India.**
These regions broadly represent the Western and the Eastern cultures where the type of toilets was the sitting and the squatting types, respectively. This could not only give us a view into the two cultures, but also a view into how the sitting and the squatting type toilets had developed individually and how their histories had intersected.

Europe - History of Toilets

Prehistoric times
(CA. 3200–1100 BC)

MINOAN ERA

Archaic, classical and hellenistic periods
(CA. 600–67BC)

HELLENISTIC ERA

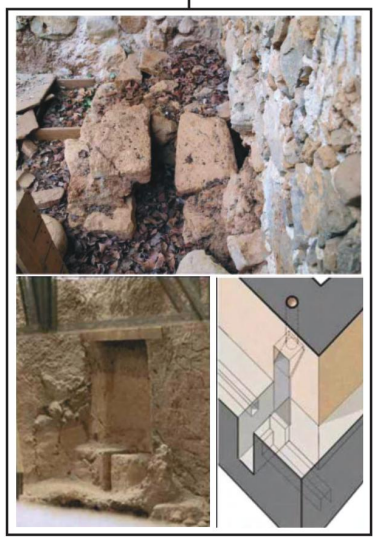


Fig.1. Knossos Prehistoric flush toilet

The first known flush toilet (of sorts) was in the Royal Palace at Knossos on Crete (circa 1700 BCE). It had a latrine on the ground floor with a rooftop water reservoir that collected rainwater for flushing

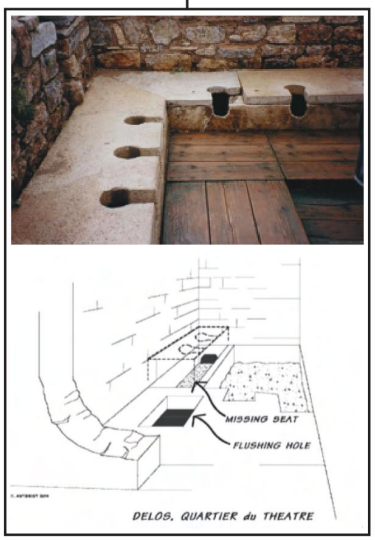


Fig.2. Roman - Crete Gymnasium toilet system

In ancient Rome, the public toilets had side-by-side seats without any partition. Archaeologists have confirmed the existence of the same toilet system in the Egyptian Civilization, too.

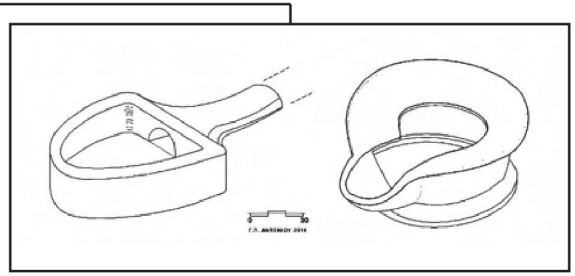


Fig.3. Axonometric sketches of clay defecation and toilet seat vessels.

Mainland, Asia Minor, and colonies - Megara, zhodes, Olynthos, Miletos, all of Hippodamia

Roman period
(CA.67BC–AD 330)

HELLENISTIC ERA

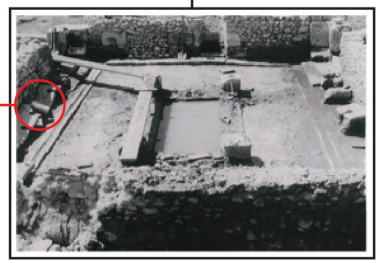
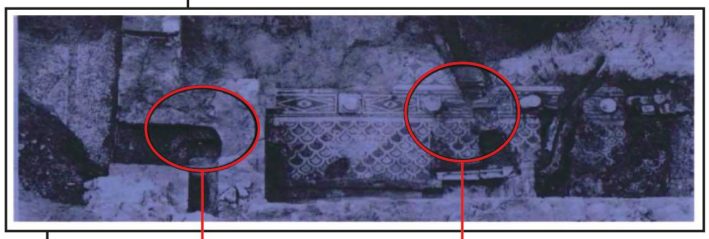


Fig.4. Standalone public toilets in Dion with impluvium at the centre.

Broken toilet structures made of stone along the periphery of the wall.

Byzantine period
(CA. 330– 1500 AD)



Bird's eye view of the seated stone toilets

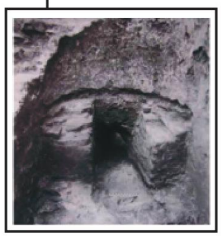


Fig.5. Byzantine toilets

1596

ELIZEBETHAN ERA

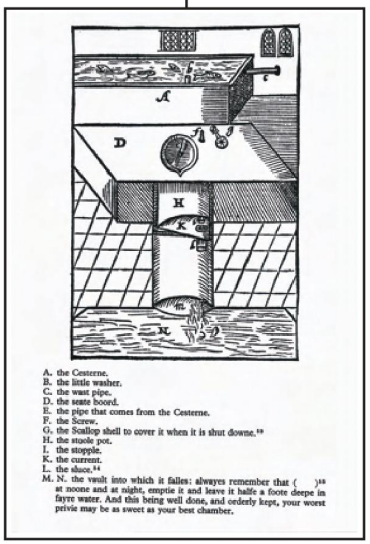


Fig.6. The first modern flushable toilet was described by Sir John Harington, an English courtier and the godson of Queen Elizabeth I.

It required 7.5 gallons of water per flush. But, water was scarce and thus, it could be flushed only once in 20 uses. It was an utter failure due to the unbearable smell.

1643 -1715

VICTORIAN ERA

1775

Fig.7. A replica of King Louis XIV Throne

He had made a throne for himself that also served as a toilet as he used to suffer from constipation.

Chamber pot with floral decorations

A decorative Austrian Toilet

Table-top type toilet from medieval Europe, carried by the affluent section while out on hunting.

Book Shelf Type French Toilet and colourfully Decorated Victorian period toilet

An Ornate Victorian Toilet

Fig.8. Ornate Victorian era toilets

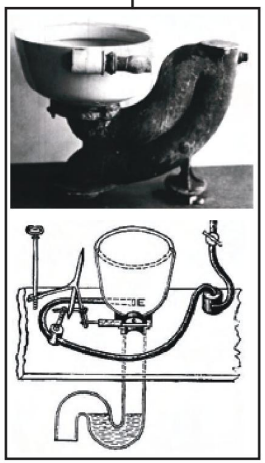


Fig.9. Alexander Cumming Flush Toilet

English inventor Alexander Cumming was granted the first patent for a flush toilet.

His greatest innovation was the S-shaped pipe below the bowl that used water to create a seal preventing sewer gas from entering through the toilet.

1778 to early 1800s

VICTORIAN ERA

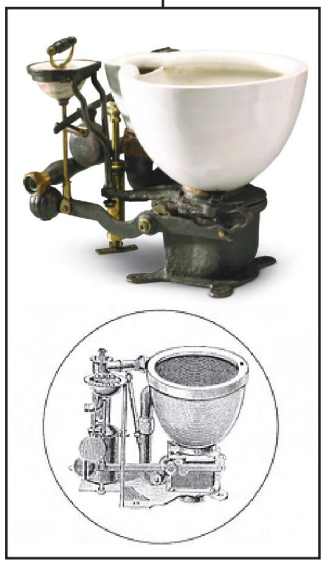


Fig.13. Denmark-based Joseph Bramah's water closets with float valve system

His design were based on **Alexander Cumming's** patented design. He developed a float valve system for the flush tank. It was the first practical non-manual flush toilet.

1852

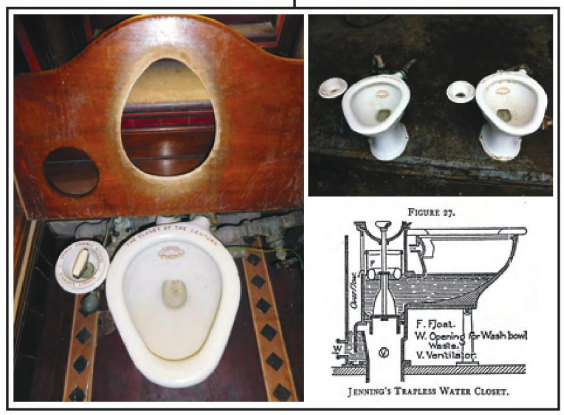


Fig.14. George Jennings' first public flush-out toilets.

George Jennings was an English sanitary engineer and plumber who invented the first public flush-out toilets.

1880-1885

Fig.15. Thomas Crapper flush toilets.

Thomas Crapper manufactured one of the first widely successful lines of flush toilets.
Crapper did not invent the toilet, but he did develop :

1. The ballcock
2. Improved the tank-filling mechanism still used in toilets today.
3. Crapper popularized the siphon system for emptying the tank

MODERN ERA

1906

Fig.16. William Elvis Sloan's Flushometer

The Flushometer used pressurized water directly from the water supply line for faster recycle time between flushes.

The Flushometer is still in use today in public restrooms worldwide.

1907

Fig.17. Thomas MacAvity Stewart's vortex-flushing toilets

Thomas MacAvity Stewart of England patented the vortex-flushing toilet bowl, which creates a self-cleansing effect.

1910

Fig.18. Coupled toilets.

Change from the elevated water tank into the modern toilet with a tank coupled to the bowl.

1911

PRESENT

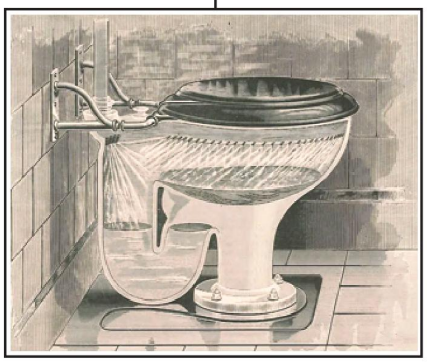


Fig.19. Philip Hass - Flush Rim toilets

Philip Haas of Ohio, developed and received a patent for the flush rim toilet, which depended on multiple jets of water from a ring with downward-pointing perforations to thoroughly wash every portion of the bowl

China - History of Toilets

(202 B.C. - 220 A.D)

Fig.20. A grey pottery 'pigsty' from the Han

People used the toilets where the excreta is then left in the pigsty for the pigs to consume.

(Upto 1990s)

Fig.21. Chinese Matong portable toilet bowls

Pit toilets and wooden matong were widely used in China. Even today, pit toilets in many rural areas in the north have yet to be replaced by flushing toilets, largely due to unresolved water scarcity issues.

(Present)

Fig.22. Chinese Squat Toilets

Today, a majority of public toilets in China — both in the north and in the south — are squat toilets. This is mainly because squatting toilets cost less to build and maintain than seated ones.

Japan - History of Toilets

700 A.D.

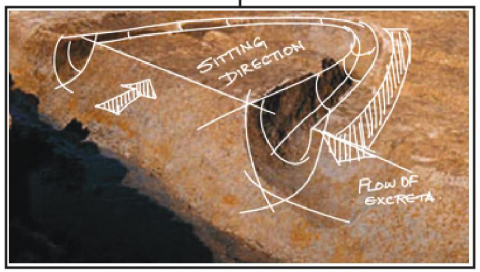


Fig.23. Primitive japanese flush toilets.

Since ancient times, there also existed toilets built over running streams. These types can be considered a primitive form of flush toilets..

1333–1568

Fig.24. Tōfukuji's tōsu - Hole type toilets

Tōfukuji's tōsu was constructed in the early Muromachi period.

Inside the tōsu are long lines of primitive, evenly spaced holes running the length of the building on both sides. There are two types of holes, deep ones for solid waste and shallower pits for urine.

1200 AD to present.

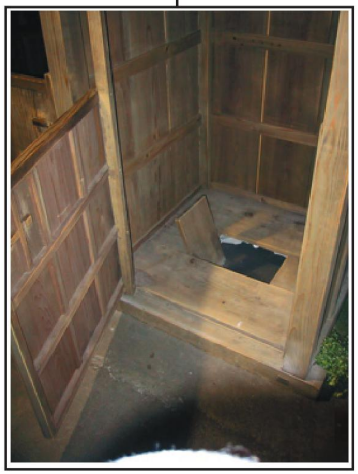


Fig.25. Japanese pit toilets

Pit toilets came into widespread use over the following centuries. In the 13th century the Japanese, who were largely a farming people, began to use the waste taken out of these toilets as fertilizer

1200 A.D. to present

1977 A.D to present.

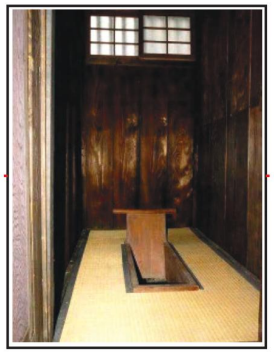


Fig.31. Japanese TOTO Toilets

In 1977 the number of Western-style toilets marketed in Japan surpassed that of Japanese-style toilets.

One of the most popular brands today is the Washlet, which was introduced in 1980 by Toto

In the evolution of the Japanese squat toilets we observe that the formal aspect of the medivial and the histroric Japanese toilets were maintained.

Fig.26-30. Evolution of Japanese Squat toilets to present era

India - History of Toilets

3300-1300 BCE

Fig.31. Flush toilets.

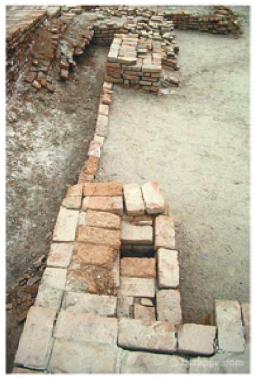


Fig.32. Squat Toilets

Fig.33. Bathroom with toilets

The Indus Valley Civilisations - The Harappa and the Mohendo-Jaro Had extremely advanced sewage systems, offered both sitting and Squatting type Toilets along with an integrated toilet and bathroom setup as well.

1377- 1404 A.D

Fig.34. The palace squatting toilets in Vijayanagara, Karnataka.

The **Vijayanagara Empire** had a very advanced squatting toilet system & a drainage system for waste disposal.

1601 - 1750 A.D

Fig.35. Squatting toilets with foot rests in Kanyakumari, Tamilnadu

Squatting toilets with foot rests were found in the **Venad Kingdom of Kanyakumari, Tamilnadu.** These toilets were built over an enclosed space with an invisible drainage system.

1526 – 1827 A.D

MUGHAL ERA

Fig.36. The tiled pit toilets of the Mughal empire.

The Mughal Culture also embraced the concept of squatting on the toilet.

Fig.37. The porcelain Mughal squatting toilets.

The Mughals had extremely ornamented squatting toilets like the Victorean era had the ornamented seated toilets.

1800s to Present

BRITISH ERA

Fig.38. Thomas Crapper toilets in India

Due to the influence of the British empire in India, several types of toilets such as the porcelain squatting toilets, the Anglo Indian toilets, and the modern western toilets were introduced.

Fig.39. Anglo Indian toilet

Fig.40. Western Seating toilets

Fig.41. Porcelain Squatting toilets

History of Toilets - Key Inferences

General Observations

Some of the general observations that were made while studying the History of toilets were :

- There are 2 basic types of toilets that are found in the regions studied - **The Sitting type and the Squatting type.**
- The Western region (The European And the American regions) placed comfort of the human body as the main factor of importance and hence had started developing seat type toilets that catered to that need.
- Most of the Eastern countries Such as Japan, China and India had mostly used the squatting type toilets and had recognised that as the most natural way of excreting.

Europe

- The main type of toilets that were used in the European regions were the seat type toilets that were prevalant from the times of Knossos and Ancient Rome.
- Most of the developments of their toilets were done on the premise of seating. It started with the use of wood to make the toilet body and cover and led to the use of Ceramic as a material for toilet bowls in the Victorian Era.
- After the Invention of the Alexander Cummings toilets, the shape of the seated toilet bowl has hardly changed. Several additions were made to the flushing technology, but the mode of seating on the toilet remained the same over the years.

China

- In China, the squatting toilets were, and are very common. The material that was used to build these toilets has changed from Stone to Wood to Porcelain. But the mode of seating has remained constant over the years.

Japan

- The Japanese too, had traditionally followed the squatting type toilets for a very long time.
- Their squatting toilets were differently built than the ones seen in other countries in Asia, but the posture of seating was predominantly squatting.
- From the 1970s, Japan had moved on from the squatting toilets with the advent of TOTO and the influence of western culture, but the squatting toilets remain their primary mode in all public spaces.

History of Toilets - Key Inferences

India

- India, being a country of wide diversity had Cultural Influences from various regions of the world.
- The Harappa and the Mohendo Jaro settlements saw the use of both sitting and squatting type of toilets along with very advanced drainage systems for the period.
- The South of India saw the use of Squatting toilets aided with footrests and Invisible Drainages.
- The Mughals who had entered India from the Afghan and the Mongol regions also brought with them, the squatting type toilets embellished with Islamic Patterns and Architectures.
- The British Era in India, however, reduced the usage of squatting toilets and seating toilets were deemed an item of luxury which later made its way into several Indian households.
- The toilet patterns seen in Victorian Europe, can be seen in Indian households even today.

Inferences

- Culture has played an Important role in the development of the mode of Defecation.
- The seating posture has been a factor of great Importance in the developement of toilets. And the two kinds of postures have remained unchanged over the years.
- **The seating posture/toilets is considered an item of comfort and along with the propogation of the western culture, the seated toilets has been adopted in many parts of the world, and is preffered by many.**
- **Hence, the next step in the design process would be to analyse the toilets with different postures and map out the key advantages and disadvantages of each.**

Sitting vs Squatting during Defecation

A thorough comparative study is required to compare the two types of postures that are widely used for defecation. Each posture has its own merits and demerits. By studying and understanding them, it would be possible to determine the aspects of each that can be used for further applications.

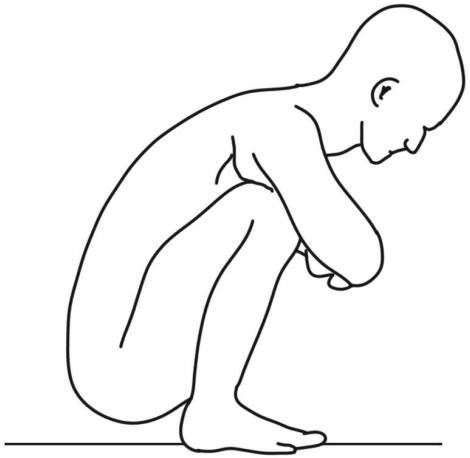
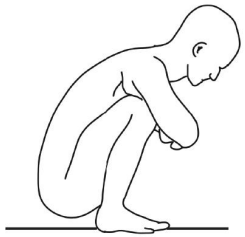


Fig.42. Natural Squatting posture during defecation

Fig.43. Common Sitting posture in pedestal Latrines

Posture Study - Sitting vs Squatting during Defecation



Posture

- The squat toilets use the natural squatting posture for the process of Defecation.
- This posture requires leaning forward to shift the centre of gravity and balance oneself.

- The pedestal latrines or water closets require a natural sitting posture for the process of defecation.
- Balancing oneself is not required since the seat of the toilet supports the weight of the user.

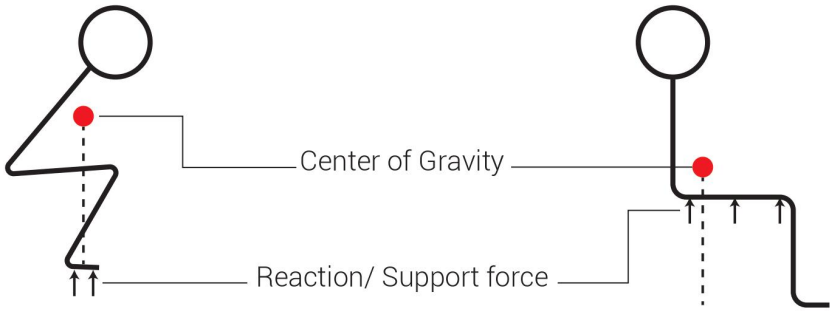
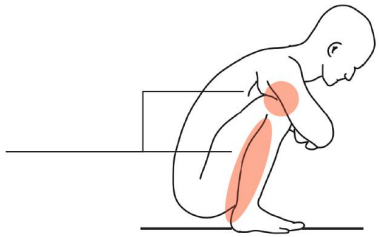


Fig.44. Center of gravity in different sitting postures

Posture Study - Sitting vs Squatting during Defecation

Physical pain points while squatting



Comfort

- The degree of comfort that the squatting posture provides is much lower than that of the sitting posture.
- **Users who suffer from ailments such as osteoarthritis, injuries in lower appendages and those with knee pain, especially the older users find it extremely difficult to use the Squat toilets.** It is also known to cause these diseases.[2]
- The Squat toilets also require a considerable amount of **practice** to use.

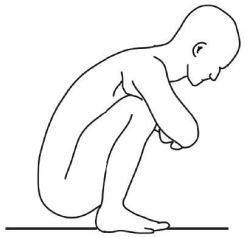
- One of the major advantages of the sitting posture is the factor of comfort that it provides.
- **The users find a high degree of comfort in terms of Thigh support from the seat; the users can also use the commode without fully taking off the bottom wear.**

Time taken to defecate

- As per [1] , subjects in the squatting posture take **less than 1 minute to defecate.**

- As per [1] , subjects in the sitting posture take **more than 1 minute to defecate and the amount of time increases with the increase in Height of the seat.**

Posture Study - Sitting vs Squatting during Defecation



Safety of Use

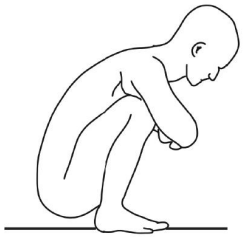
- The squat toilets are made of porcelain, which has a very low coefficient of friction. The feet come in direct contact with the porcelain surface. The surface may also be wet at times. This makes it extremely **prone to slipping and accidents.**

Fig.45. Slippage accidents in squat toilets

- The sitting type toilets are designed to act in a manner similar to that of seats, and unless the bowl is misused, **the probability of accidents in sitting toilets are low.** The wetness of the surface of the seat does not lead to accidents. However, the seat being loose may lead to Injuries.[3]

Fig.46. Warning sign not to squat on pedestal latrines

Posture Study - Sitting vs Squatting during Defecation



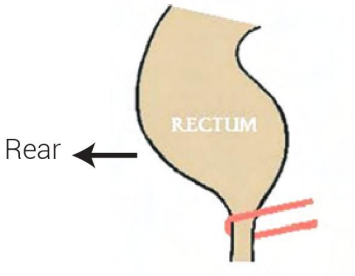


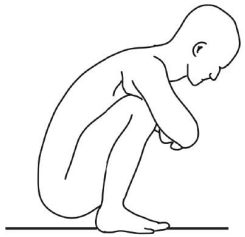
Fig.47. Relaxed Puborectalis muscle in the rectum

Health benefits of squatting

As per [4], **Advantages of Squatting** are :

- It makes evacuation faster and more convenient.
- It prevents "fecal stagnation," a causative factor for irritable bowel syndrome, inflammatory bowel disease, and appendicitis even colon cancer.
- It guards the pelvic nerves against becoming stretched and damaged which control the urogenital organs such as prostate, bladder, and uterus.
- It blocks the ileocecal valve temporarily, between the colon and the small intestine, and hence, there is a minimal or no chance of contaminating the small intestine.
- **It maintains continence by relaxing the puborectalis muscle (which usually chokes the rectum).**
- The colon is supported by the thighs which prevent straining which, in turn, prevent hernias and pelvic organ prolapse.
- It is a strongly recommended noninvasive treatment in the case of haemorrhoids.
- Regular squatting is beneficial for a natural delivery.
- Squatting is also useful for pregnant females by avoiding the pressure exerted on the uterus when using the toilet.

Posture Study - Sitting vs Squatting during Defecation



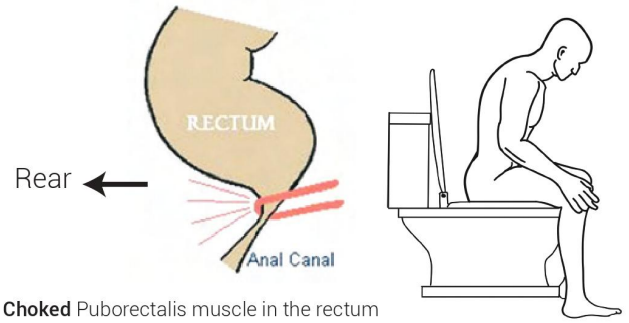


Fig.48. Choked Puborectalis muscle in the rectum

Health hazards of sitting posture

The sitting posture increases the amount of stress that is required to defecate. This is caused due to the "choked" puborectalis muscle that constricts the excretory passageway. This may lead to problems such as constipation, inflammatory bowel disease, appendicitis, and even colon cancer. [1][4]

Hygiene [4]

- Open toilets may cause the spread of pathogens.
- Only the feet touch the surface of the toilets, which is healthier than the entire surface of the persons back touching the toilet seat in sitting toilets.
- Easier to clean
- The seat may get soiled while urinating in the pedestal latrine. The users come in contact with the same seat while pulling the seat up and down and also while sitting, which is unhygienic.
- More unhygienic in the case of public toilets.

Process - Sitting vs Squatting during Defecation

Process of using a pedestal latrine

Fig.49. Operations performed while using pedestal latrines

Process of using a squat latrine

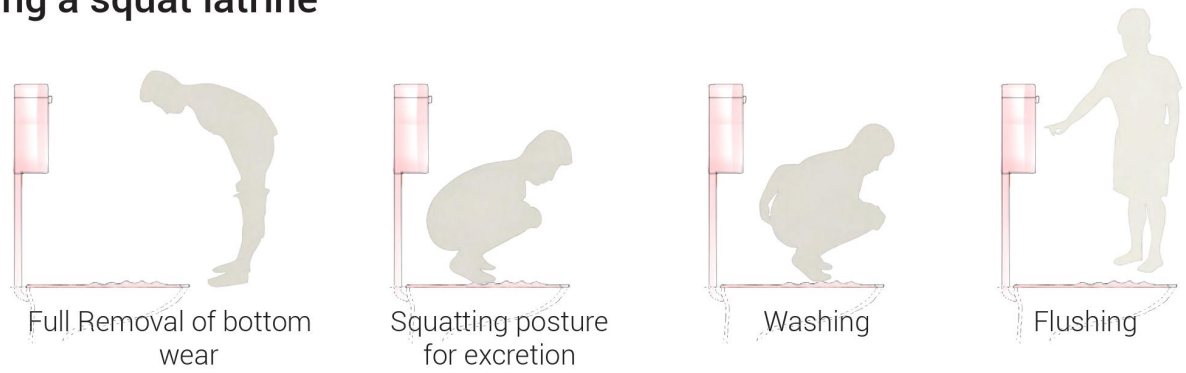


Fig.50. Operations performed while using squat latrines

Indian Market Trends for toilets

From Susana Forum

Collects data from verified experts or professional in a field.

https://forum.susana.org/141-other-types-of-toilets-and-sanitation-systems/12901-please-help-me-with-a-global-survey-how-common-are-squatting-toilets-in-your-country

(Statistical Market Surveys unavailable on free platforms)

Dr. Lucas Dengel

(Physician (Dr. med.) by educational qualification, working in public hygiene, environmental health and organic farming for the last >30 years. Running a company called EcoPro, based in Auroville in Tamil Nadu, India)

Percentage of squatting toilets in private homes:

Depends on socio-economic class (which, to some extent, reflects caste, but even more so reflects socio-cultural and educational background); upper class (the rich) seem to favour sitting toilets (increasingly); as private homes of the less wealthy often have no toilets at all, toilets in private homes might be more than 50% sitting types.

Any changes you are observing in this pattern over time:

Yes, the number of sitting toilets is on the increase. Don't know whether this has to do with the lack of physical fitness of the rich; or with the difference of status i.e. the sitting toilet being regarded as the more convenient toilet of the rich; or rather the combination of these two factors.

Percentage of squatting toilets in public buildings:

50% (i.e. both types are provided); in smaller towns and countryside rather 80-100%; in the context of upper-class clientele e.g. airports, 40-50%.

More than 50% of the private homes and public spaces in Urban India are moving toward sitting toilets and the number is continuously Increasing

Inferences - Sitting Vs Squatting Analysis

Inferences

Some of the inferences that can be drawn while comparing the sitting and the squatting toilets were :

- Both Sitting and the Squatting postures have their merits and demerits.

Sitting toilets

- The sitting posture has been preferred due to its factor of **comfort** and has been deemed a **luxury** product by many.
- It is also **preferred by Geriatric people and people with injuries** due to the added comfort that it provides in comparison to the squatting toilets.
- The sitting toilets are also **relatively safer than the squatting toilets** in terms of the probability of accidents when used properly.
- They pose a major **Health hazard in terms of hygiene**, especially in public spaces due to the high degree of contact that is required to use them.
- They also pose a major **health hazard in terms of posture** and the prolonged usage can lead to **health issues.**

Squatting toilets

- They are widely used in the country by the lower economic classes, in sub-urban and rural parts of India.
- It is proven to have extra health benefits in terms of posture and the degree of hygiene it provides due to minimum contact.
- It is more hazardous in terms of safety and can cause serious injuries due to slipping.
- It also remains open which can prove to be a health hazard.
- It requires practice and balance to use.

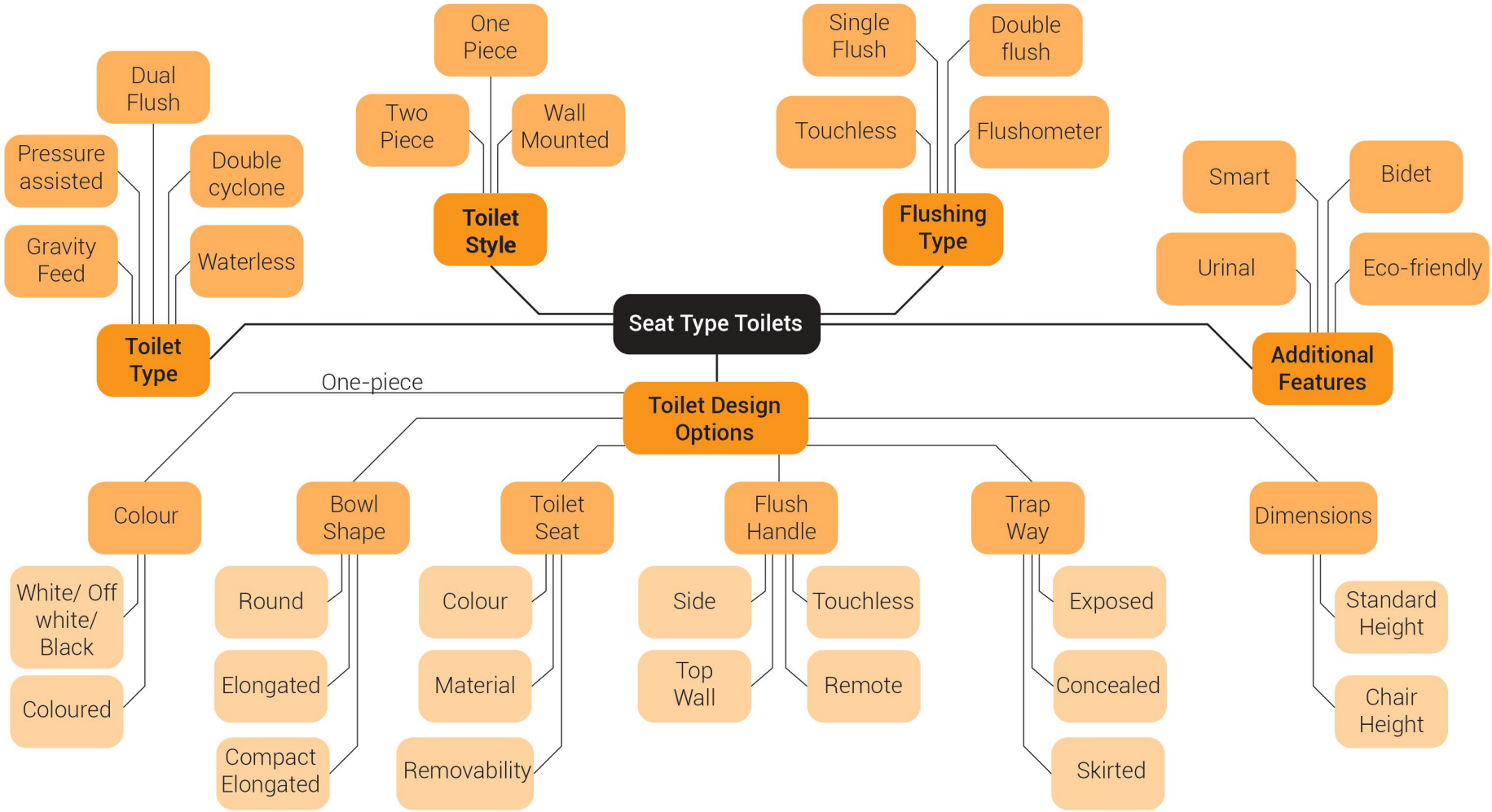
Market Trends [5], suggests that people are leaning more towards sitting toilets rather than squatting toilets and thus the focus of this project must be to facilitate the health benefits of squatting in sitting type toilets.

In order to understand the **seat type commodes** better, a complete **divergent study** needs to be conducted on them to identify the pain-points and the places where impactful changes can be made.

Types of commodes in the market

Fig.51. - Fig.62. Types of seat type commodes.

Classifcation of seat type commodes



Cross Sectional Study - Seat Type commode

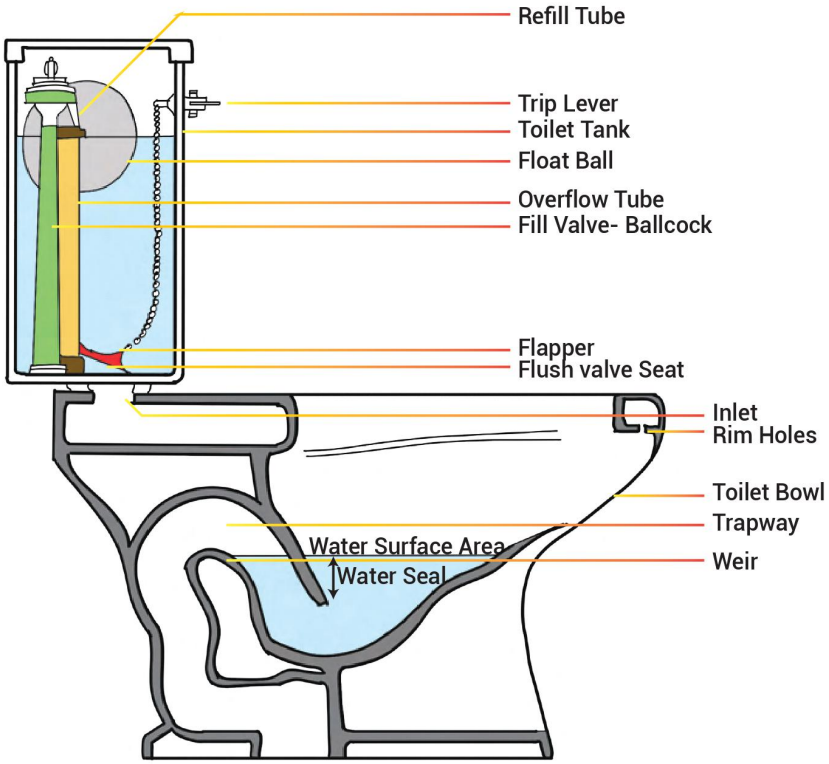


Fig.63. Cross section of a western closet

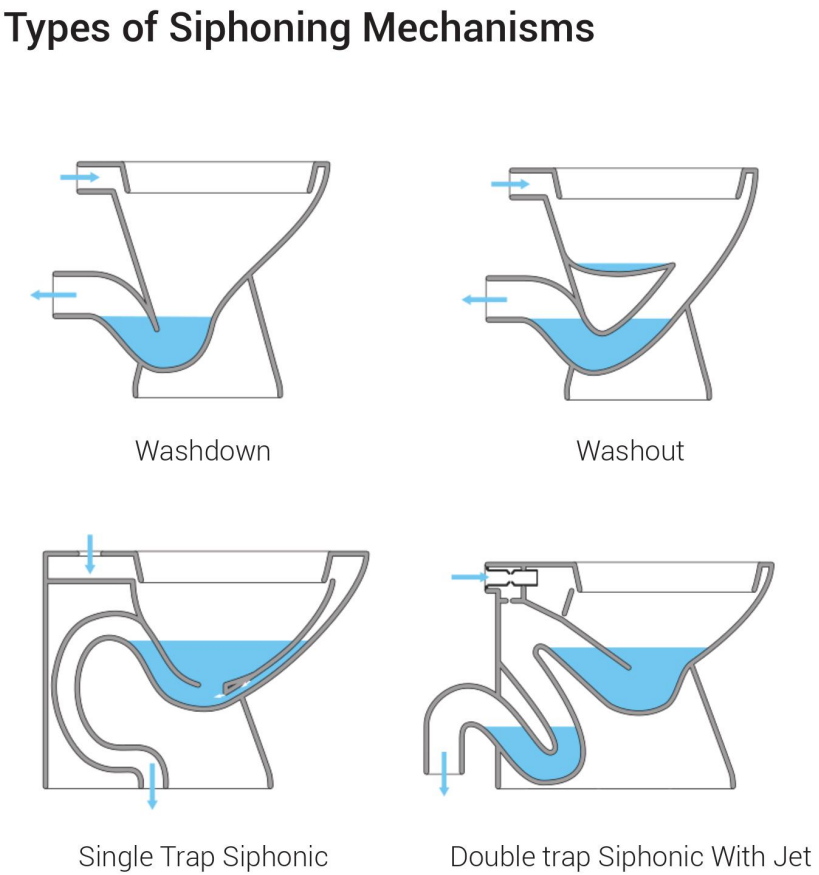


Fig.64. Types of Siphoning Mechanisms

Ergonomic Considerations - Body Posture & Defecation

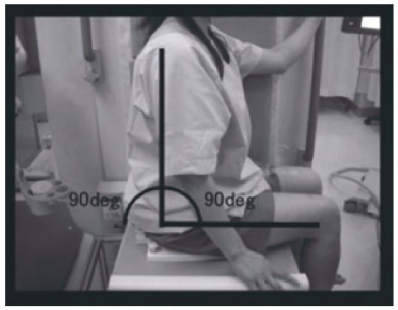
Influence of Body Position on Defecation in Humans

by Ryuji SAKAKIBARA, Kuniko TSUNOYAMA

Why this Study ?

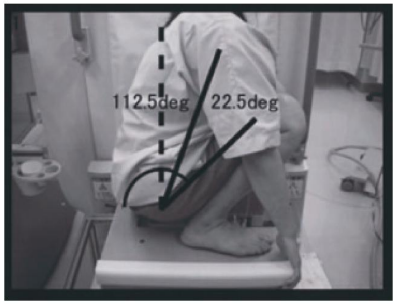
Once the outline study of the commodes was done and the process of usage of a commode has been analysed, a detailed study on the effect of different body postures on the process on the process of defecation needs to be done.

The results obtained from the Sitting Vs Squatting posture analysis had been Concluded to bring in the advantages of both the sitting and the squatting postures. **This study [6] compares the effect of simulating a squatting posture at different leg raise angles to the amount of abdominal pressure and anorectal angle required to defecate**



This image shows a proper sitting posture as simulated in a seat type commode.

This image shows a 60-degree flexion of the legs & 90-degrees (Ano-rectal angle) with the back kept straight.



This image shows a full squatting position with the greatest hip flexion and greatest anorectal angle.

Fig.65. The 3 Postures of defecation in [6]

What is the recommended ano-rectal angle for ease of excretion ?

Greater the hip flexion achieved by squatting the straighter the rectoanal canal will be, and accordingly, less strain will be required for defecation.

This means that, greater the amount of leg raise and greater the extent to which the hip is moved forward, lesser the strain that will be required to defecate.

Inferences - Study of Seat Type toilets

Some of the key inferences that can be drawn from the divergent study of commodes are that :

- There are at least 12 different types of commodes that can be identified from the above classifications.
- They have **similarities** in terms of :
    - Form
    - Shape
    - Usage
    - Similar mode of usage
    - Have a seat and cover.
- They have **Differences** in terms of :
    - Dimensions
    - Material
    - Color
    - Location in the toilet
    - Wall or Floor Mount
    - Technology Integrated
- **But most important of all is that all of these pedestal latrines are used in a similar manner and in a similar posture.**

From the study of the Ergonomic Factors in different seating postures [6] , we can say that the integration of the squatting posture is necessary with a maximum leg angle and the maximum possible hip flexure so that the process of defecation is done without any strain on the part of the user.

Thus, squatting aides can be introduced in the seat type toilets either as temporary or permanent fixtures.

Several solutions have already been proposed in order to aide this process.

Hence, we perform a market study to understand the products & solutions existing in the market and to map out their advantages and disadvantages.

Market Study - Squatting aides on seat type toilets

By doing the Market study of the various products, we would be able to understand the Advantages and Disadvantages of each product that aides in sqautting in a seat-type commode. This would then further enable us to arrive at an understanding of the various needs that the user expects from a product in the area.

Fig.66. Kurtzy Height Adjustable Bathroom step stool

Merits

- Easy to Manufacture
- Lightweight
- Height Adjustable
- Non Slip - Surface
- Freedom of choice

De-Merits

- Not Angle Adjustable
- Very Intrusive - Gets in the way while trying to sit on the commode
- Does not provide support while getting On & Off

Fig.67. Squatty Potty

Merits

- Easy to Manufacture
- Lightweight
- Non- Intrusive - Hidden under commode when not used.
- Non Slip - Surface
- Easy to clean

De-Merits

- Not Angle Adjustable
- Non- Height Adjustable
- Does not provide hand support while getting On & Off

Fig.68. Semi-Squat Toilet

Merits

- The squatting posture is integrated in the commode.
- Simple to use
- Aesthetically Pleasing

De-Merits

- Highly Uncomfortable posture
- Non-Ergonomic
- Expensive to recast the toilet bowl
- Very difficult for old people to sit and get back up.
- Cannot be used with existing set-up

Fig.69. Squat & Sit toilet

Merits

- Provides both sit & squat modes
- Gives a freedom of choice.
- Non-Slip surface while squatting
- Simple to use

De-Merits

- Users need to climb onto the pedestal to squat
- Expensive to mfg.
- Complex to mfg.
- Does not provide hand support while getting On & Off
- Cannot be used with existing set-up

Fig.70. Squat-Sit seat toilet

Merits

- Easy to Manufacture
- Low number of parts
- Easy to clean
- Both sit and squat provided to user as a choice

De-Merits

- Slippery Surfaces
- Very Intrusive - Gets in the way while trying to sit and stand on the commode
- Does not provide support while getting On & Off
- Cannot be used with existing set-up

Fig.71. Ergonomically correct Wellness Toilet

Merits

- Ergonomically perfect
- Adjustability of angle of sitting
- Aesthetically pleasing
- Easy to clean

De-Merits

- Users need to climb onto the pedestal to squat
- Very difficult to clean oneself while sitting
- Very difficult for kids and old users to use
- Slippery surfaces - accident prone

Fig.72. Anglo-Indian Toilet

Merits

- Easy to Manufacture - same as current toilet bowls
- Both sit and squat provided to user as a choice

De-Merits

- Users need to climb onto the pedestal to squat
- Very Intrusive - Gets in the way while trying to sit on the com-mode
- Does not provide support while getting On & Off
- Very difficult for kids and old users to use since they need to climb
- Accident prone

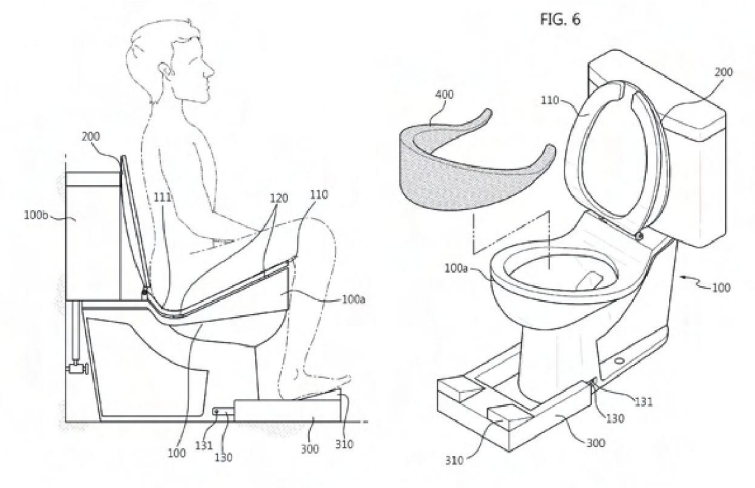


Fig.73. Squatting Fixture in seat-type toilets

Merits

- The squatting aide provided as a fixture to existing toilets
- Easy to Manufacture
- Easy to clean

De-Merits

- Bad posture - combination of footrest with elevated seat
- Non- Ergonomic squatting
- Does not provide hand support while getting On & Off
- Very difficult for old people to sit and get back up.

03 Design Brief

Contents

Formulating User Requirements

Requirement 1

From the above studies, we can conclude that most people in Urban Areas of India use Pedestal/seat type toilets. All the users currently using them as such face several problems :

• Bad posture while defecating [4]

• Defecating for longer periods of time [1]

• They impose more strain on the body while defecating [6]

• Following this posture of defecating over prolonged periods of time lead to several health problems & bowel disorders. [4]

But on the other hand, absolute squat toilets have several demerits too, including accidents, balance, age restrictions, hygiene and the ability to squat for long periods.

Therefore, a squatting aide to the current seating toilets is the main requirement of this project.

Requirement 2

In a home, people buy and install commodes or water closets only once, as a permanent fixture. The commode stays in the same home as long as people live there and is seldom changed. Thus, making drastic modifications to the shape of the toilet bowl, (like the ones seen in the market study) or the commode itself cannot be done.

Hence, the squatting aide must be installable/addable in existing toilets with minor or no modifications to the toilet bowl and tank itself.

Requirement 3

The added squatting aide must be able to provide users with an ergonomic and comfortable squatting posture.

Requirement 4

The squatting aide must not disrupt the existing processes on the commode such as sitting , standing up , reaching out to the bidet, washing oneself. And must be very safe to use. It must also be easy to clean.

Requirement 5

In a modern home, there may be people of all age groups - children, teenagers, working adults and old people. And since the commode is a permanent fixture, and not more than 1 or 2 toilets are installed in an average urban apartment, all the members of of the family use it. We have made it clear that the commode is an investment and people grow old with the commode.

A large section of the population develops joint pains, knee pains, arthritis and other musculo-skeletal problems in their middle ages which last till they grow old (from expert). This makes it very difficult to sit and get up from toilets and chairs in general.

Hence, (requirement of least priority) the squatting aide could be used to provide support for the geriatric and the ailing members of the family.

Design Brief

To design a squatting aide for seat type commodes that can be installed in existing toilets with minimum or no modification to the toilet bowl and tank set-up. The squatting aide must be able to provide the user with an ergonomic and comfortable squatting posture.

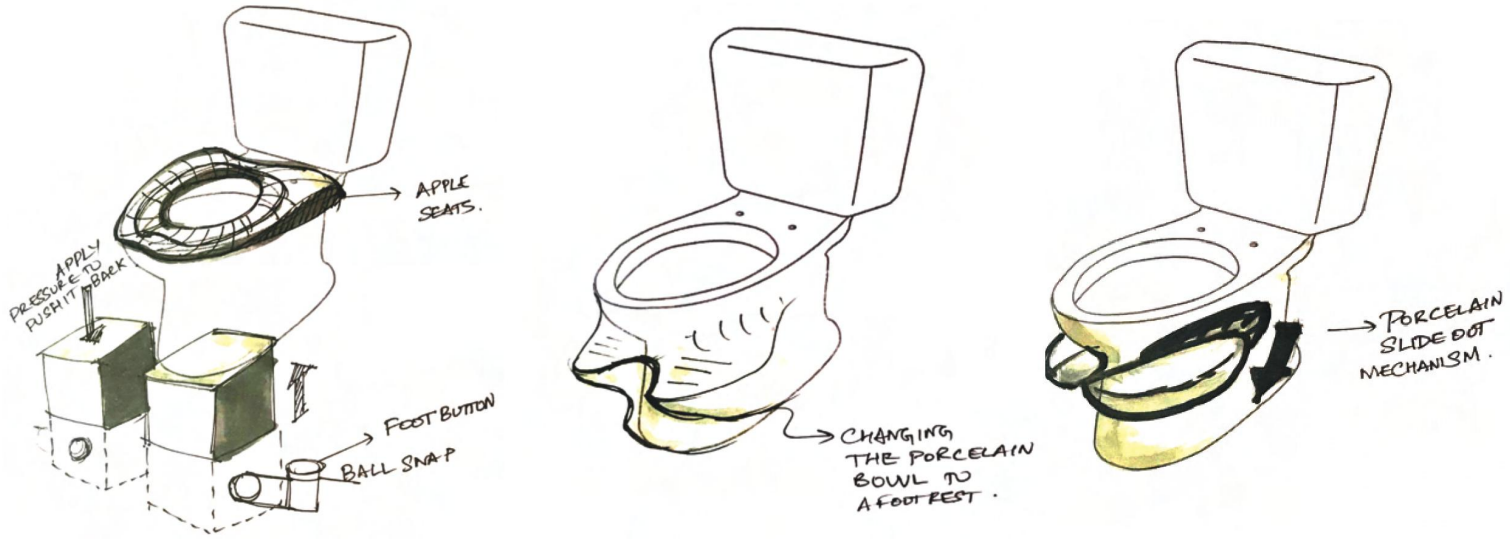
It must also not disrupt the existing process on the commode such as sitting, standing up, reaching out to the bidet, washing oneself. And must also be very safe to use & easy to clean.

The final requirement of the squatting aide is that it could provide be used as a support mechanism for sitting and standing up from the seat type toilet for the geriatric and ailing members of the family.

04
Initial Ideations

Contents

Ideation Cluster 1



Changes in Toilet Bowl & Commode Environment

This cluster of ideation mainly focuses on the changes that can be made in the toilet bowl and within the surrounding environment of the commode.

Cluster 1 - Ideation 1

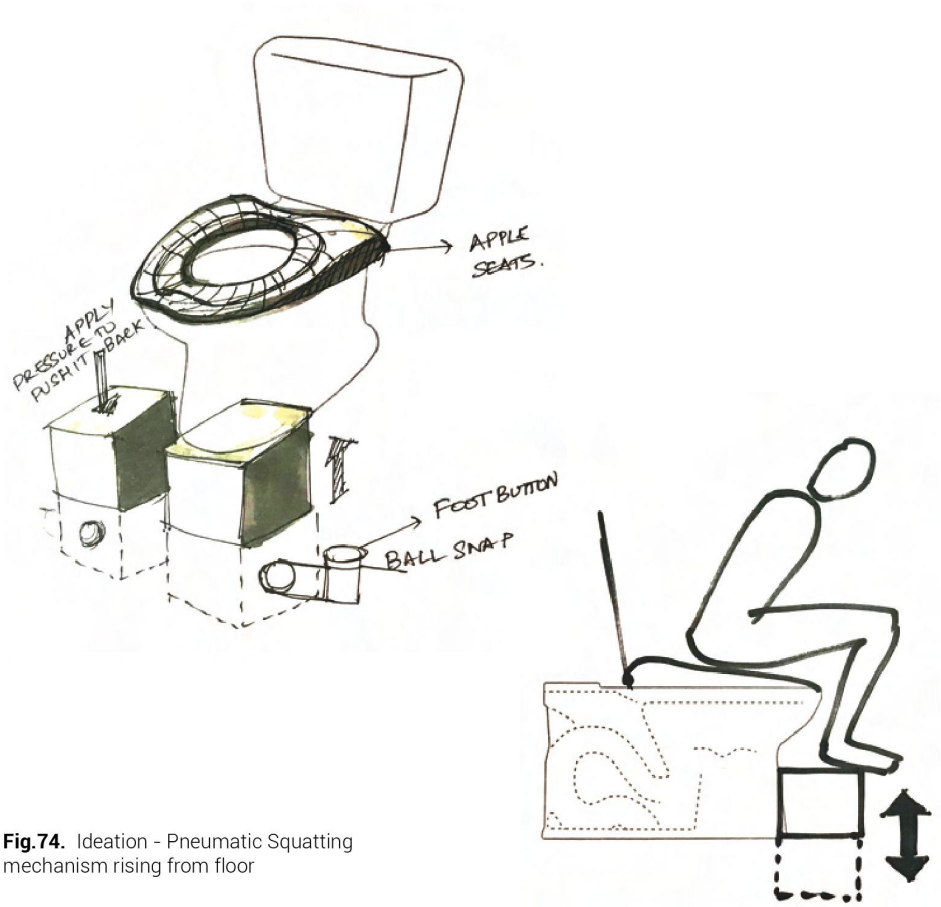


Fig.74. Ideation - Pneumatic Squatting mechanism rising from floor

Evaluation

This ideation consists of a pneumatic or electronically controlled block that can be pushed up and down from the floor of the toilet with a foot button. On the press of a button the leg rest rises up to provide a squatting mechanism. A more ergonomic seat shape was also considered.

Merits

- The leg rest is hidden under the floor.
- The entire mechanism is foot controlled
- Provides ergonomic squatting posture

Demerits

- Very Expensive to install, assemble & manufacture
- The mechanism makes it easy to accumulate dirt in gaps
- Clothes could get stuck in the gaps
- Does not provide geriatric support structures

Cluster 1 - Ideation 2

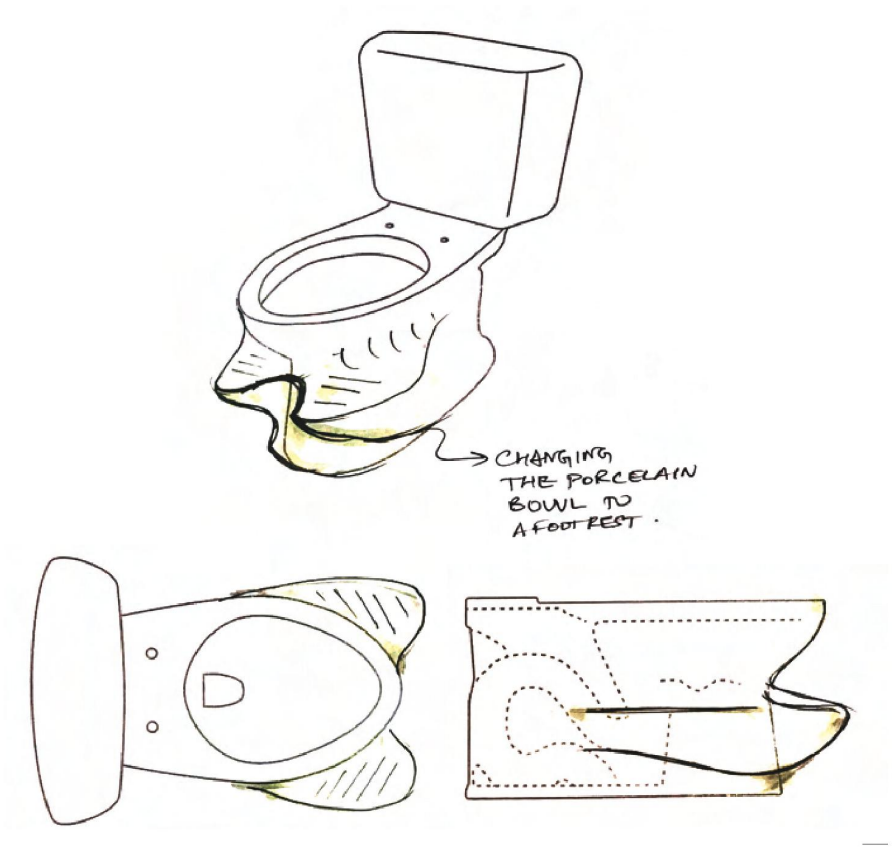


Fig.75. Ideation - Toilet bowl form modification for squatting

Evaluation

This ideation consists of a reshaped toilet bowl. Here, the toilet bowl is recast to form a foot rest like shape whihc could be used by the user to rest the feet on.

Merits

- Ease of cleaning
- The squatting mechanism is integrated into the toilet bowl
- Single cast structure

Demerits

- The squatting surface is also made of porcelain - slippery - unsafe
- Highly intrusive design - the user cannot sit without the structure obstructing them.
- Does not provide geriatric support structures
- The structure becomes very heavy to manufacture & install.

Cluster 1 - Ideation 3

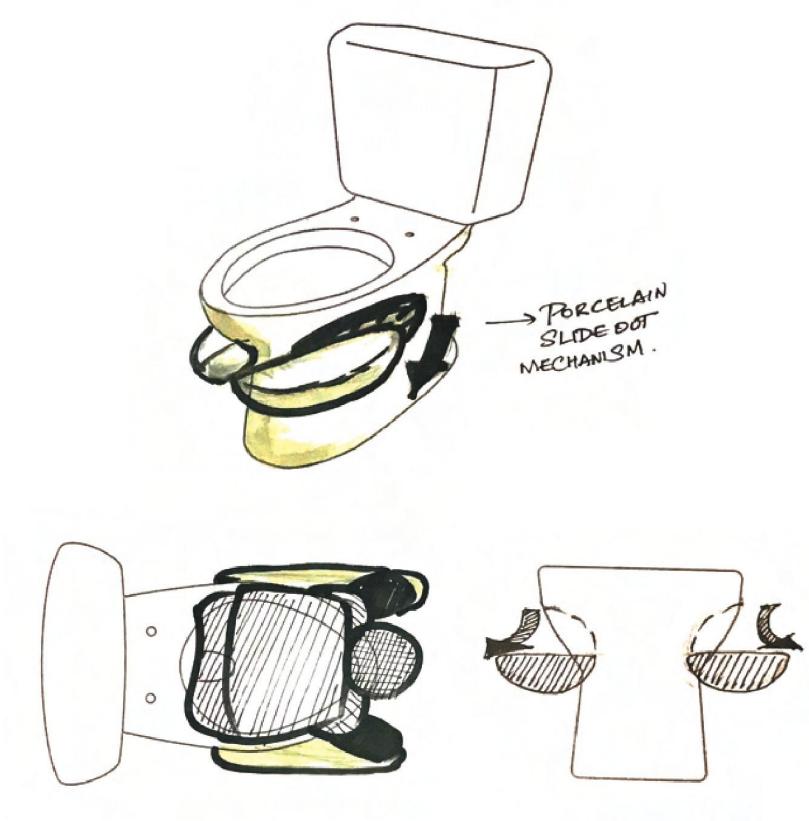


Fig.76. Ideation - Toilet bowl slide-out mechanism for squatting

Evaluation

This ideation consists of a pneumatic or electronically controlled foot rest that slides out of the toilet bowl when required.

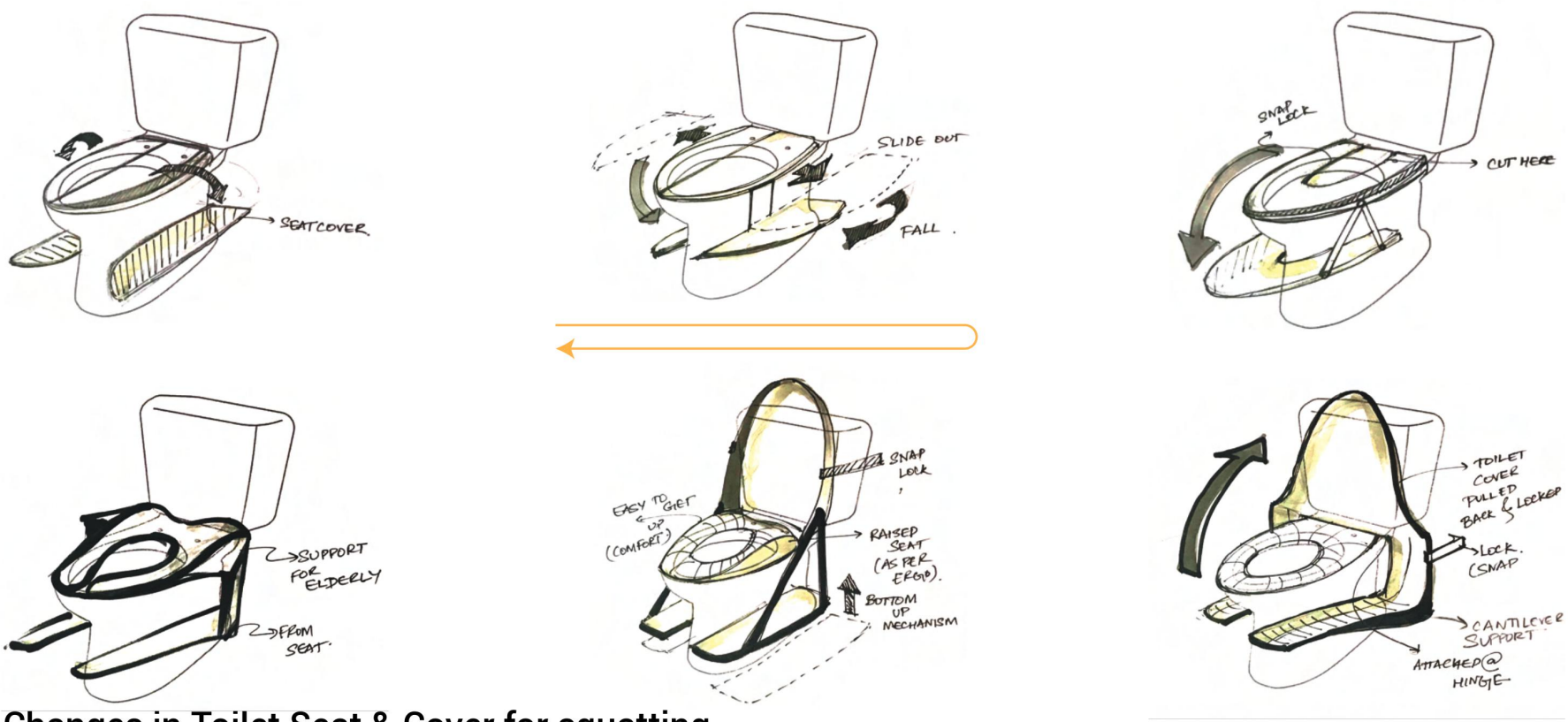
Merits

- The leg rest is hidden in the toilet bowl
- The entire mechanism is foot controlled or hand controlled
- Provides ergonomic squatting posture

Demerits

- Very Expensive to install, assemble & manufacture
- The mechanism makes it easy to accumulate dirt in gaps
- Clothes could get stuck in the gaps
- Does not provide geriatric support bars
- The squatting surface is also made of porcelain - slippery - unsafe
- The structure becomes very heavy to manufacture & install.

Ideation Cluster 2



Changes in Toilet Seat & Cover for squatting

The toilet cover is functionless apart from the fact that it covers the toilet when not in use (for maintaining hygeine). This cluster of ideation deals with morphing the toilet seat and cover to enable squatting in seat-type toilets.

Cluster 2 - Ideation 1

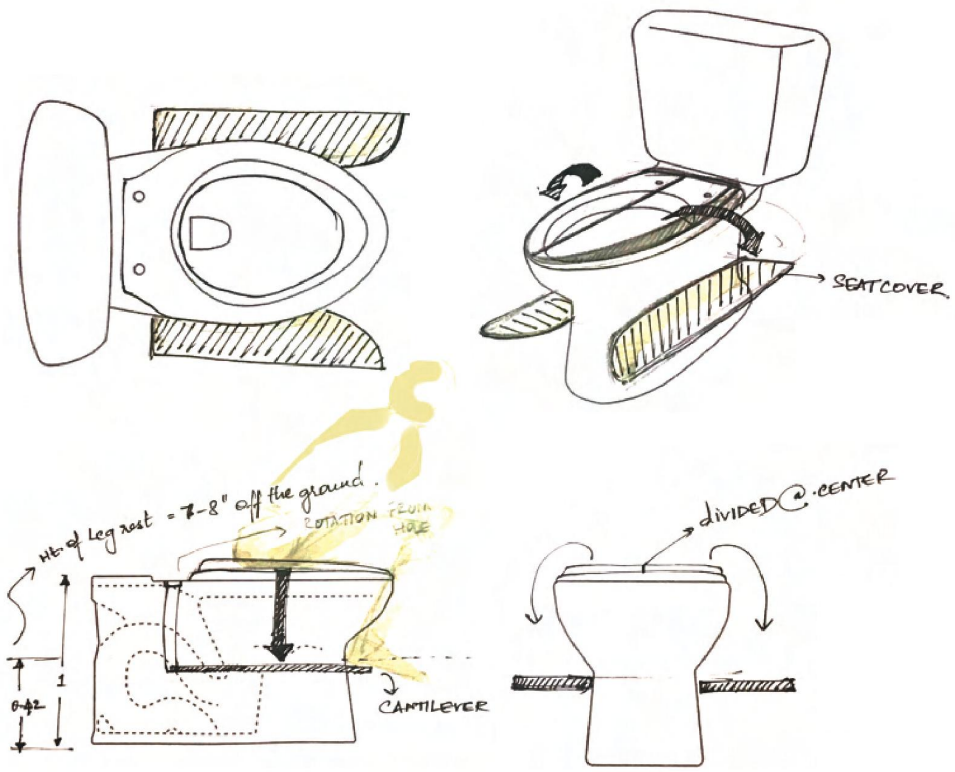


Fig.77. Ideation - Seat cover sideways-open mechanism

Evaluation

This ideation consists of a seat cover that is divided in half across the center and can be opened sideways via a hinge mechanism to form a foot rest. Once done, the user can fold the footrest back to a seat cover.

Merits

- The leg rest does not occupy any space seperately
- The product is easy to use
- Always maitains hygiene when done - by closing the cover.
- Medium cost of manufacturing

Demerits

- The seat cover will have to be redesigned to be a load bearing component.
- The mechanism makes it easy to accumulate dirt in gaps

The footrest surface is made of a smooth surface to maintain cleanability and hence, will not be safe to use.

- Does not provide geriatric support bars

Cluster 2 - Ideation 2

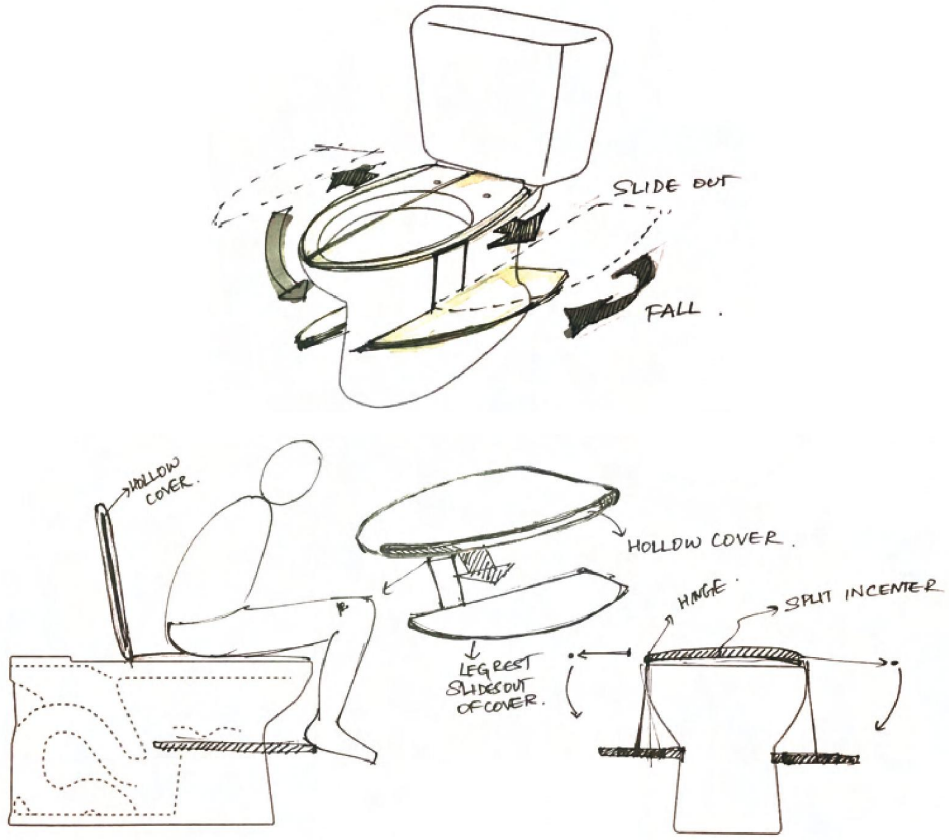


Fig.78. Ideation - Seat cover slide out & drop mechanism for leg rest

Evaluation

This ideation consists of a seat cover that is divided in half across the center and can be slid opened sideways from the cover to form a foot rest. Once done, the user can fold the footrest back intto the seat cover. While not in use, the footrest will be hidden within the seat cover.

Merits

- The leg rest does not occupy any space seperately
- The entire mechanism is foot controlled
- Provides ergonomic squatting posture
- Medium cost of manufacturing

Demerits

- The seat cover will have to be redesigned to be a load bearing component.
- The mechanism makes it easy to accumulate dirt in gaps
- Does not provide geriatric support bars.
- The system takes time to assemble and disassemble even during normal use.

Cluster 2 - Ideation 3

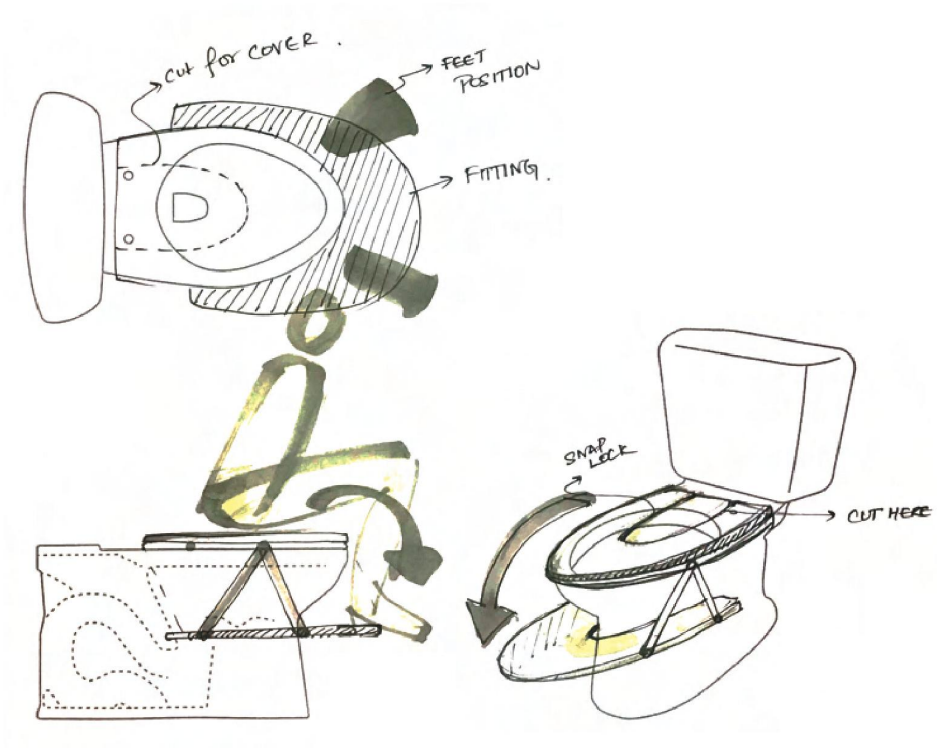


Fig.79. Ideation - Seat Cover Front Slide out mechanism

Evaluation

This ideation consists of a seat cover that is divided in a U-shape. During use, the U-Shaped sturcture can be slid towards the front and lowered to form a foot rest. Once done, the user can fold the footrest back unto the seat cover.

Merits

• This Ideation provides a full U-shaped sturcture to rest the legs on which gives the user , the flexibility to move their legs sidways based on comfort.

• The mechanism is easy to set-up

• Provides ergonomic squatting posture

• Medium cost of manufacturing

Demerits

• The seat cover will have to be redesigned to be a load bearing component.

• The mechanism makes it easy to accumulate dirt in gaps

• Clothes could get stuck in the gaps

• Does not provide geriatric support structures

• Highly intrusive design - the user cannot sit without the structure obstructing them.

Cluster 2 - Ideation 4

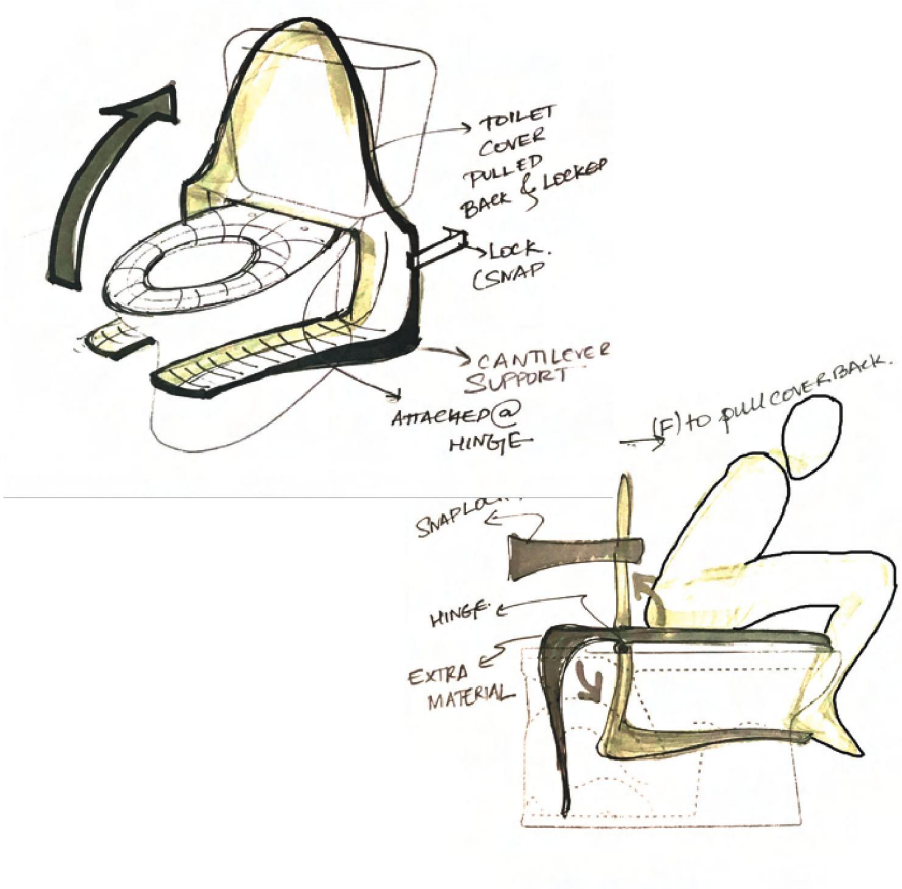


Fig.80. Ideation - Single cast seat cover cum leg rest for squatting

Evaluation

This ideation consists of a single cast seat cover that also acts as a foot-rest when open. The seat cover is opened and snaps onto a holder attached to the back wall . The user can then sit and raise the feet onto the footrest to achieve squatting. The footrest faces downward when not in use.

Merits

- Easy to use & Easy to clean
- Provides ergonomic squatting posture
- Low cost of manufacturing & easy to manufacture
- Single Cast structure of foot-rest and seat cover.

Demerits

- The snap-fit holding the seat cover would have to be very strong to take human load.
- The footrest cannot be adjusted in height or angle.
- Does not provide geriatric support structure.

Cluster 2 - Ideation 5

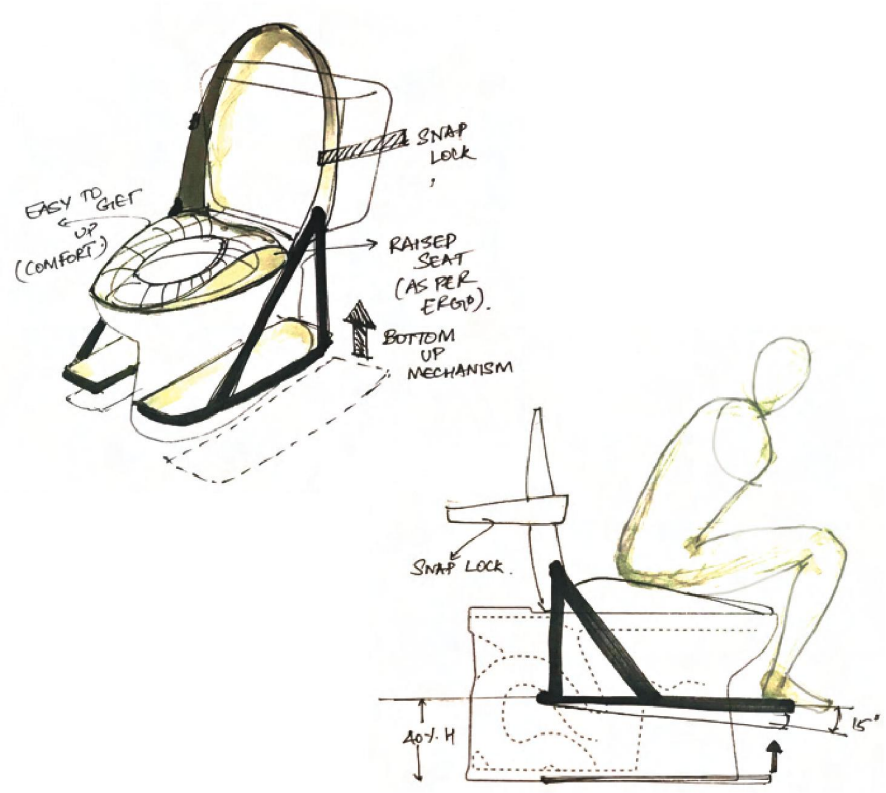


Fig.81. Ideation - Legrest mechanism attached to seat cover

Evaluation

This ideation consists of a footrest that is attached to the commode seat cover and stays on the floor when not in use. When the seat cover is lifted & snaps onto a holder attached to the back wall , the footrest rises into position, where the user can sit and lift their legs to attain squatting poture.

Merits

- The leg rest stays on the floor when not in use.
- Easy to use
- Provides ergonomic squatting posture
- Low cost of manufacturing & easy to manufacture

Demerits

- The mechanism makes it easy to accumulate dirt in gaps
- Clothes could get stuck in the gaps
- Does not provide geriatric support bars

Cluster 2 - Ideation 6

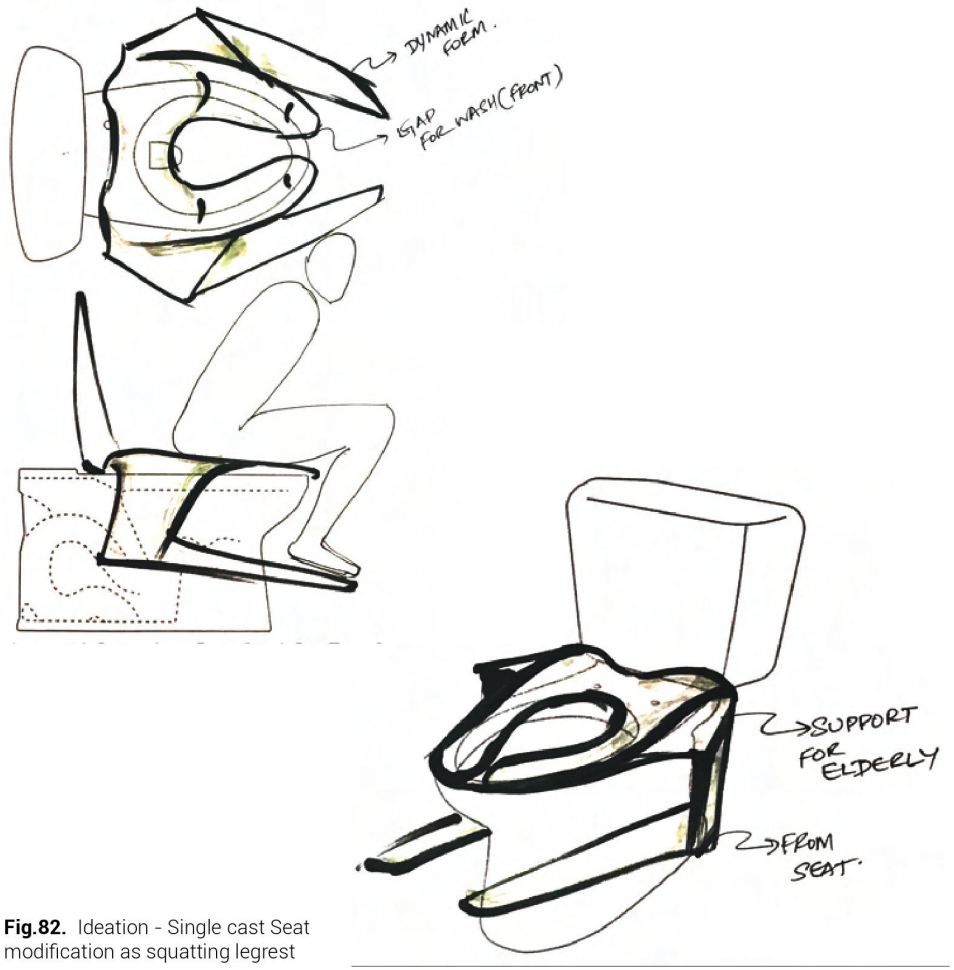


Fig.82. Ideation - Single cast Seat modification as squatting legrest

Evaluation

This ideation consists of a toilet seat morphed that doubles as a footrest for squatting when it is lowered. The seat and the footrest is a single cast structure

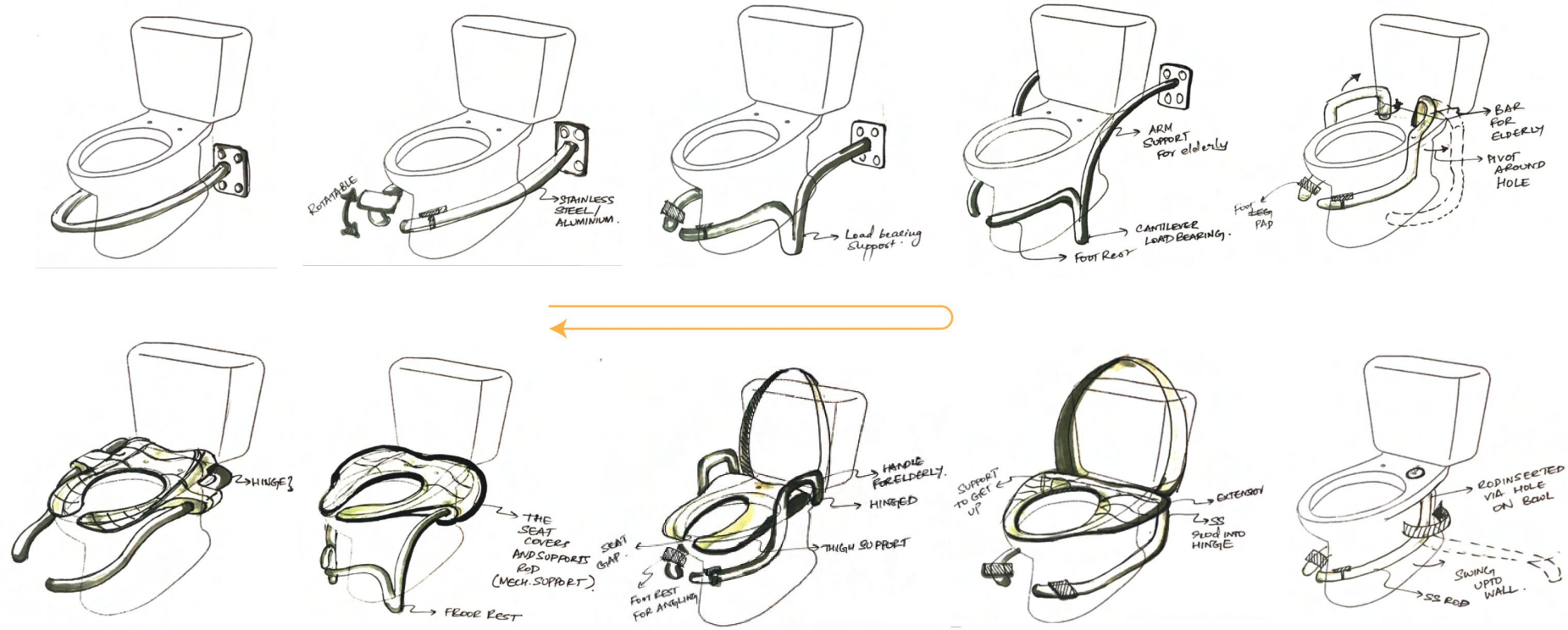
Merits

- Very simple to use & easy to clean
- The cost of manufacturing is low since the moulding of the seat and footrest can be done together.
- Provides ergonomic squatting posture
- No snap-fits required as the footrest is held in place when the body is seated.

Demerits

- When the seat needs to be raised up for urinating, the seat is very intrusive in nature. It may also cause accidents and hurt people while being lowered.
- Does not provide geriatric support structures.

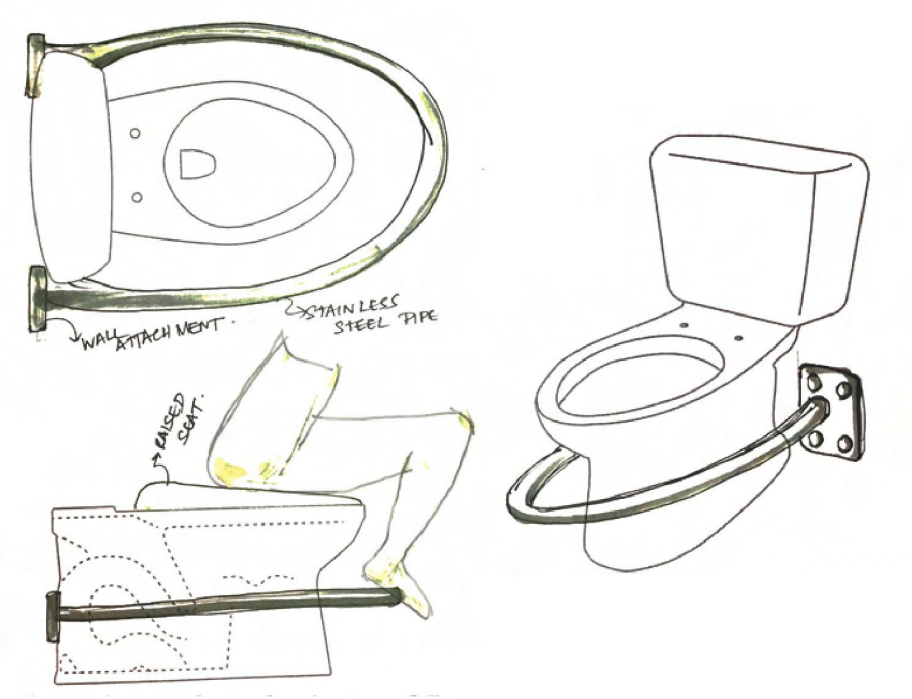
Ideation Cluster 3



Metal Bar based Leg rest for Squatting

One of the very simple type of leg rests for keeping our legs on while squatting is a simple rod. This cluster of ideation represents the various modes in which rods can be modified around the seat-type toilets to rest our feet on.

Cluster 3 - Ideation 1



Evaluation

This ideation consists of an elliptical stainless steel rod that is permanently fixed on the wall behind the commode. The bar is fixed such that it acts as a squatting contraption while defecating.

Merits

- Very simple to install, use & clean
- The position of the feet can be varied as per comfort.
- Provides ergonomic squatting posture
- Any choice of angle of feet as chosen by user

Demerits

- It is a permanent fixture
- It is very intrusive in nature - obstructs the sitting and standing up
- Users may trip from the bar
- Does not provide geriatric support system
- Cantilever
- Using a rod as foot rest is very uncomfortable.

Fig.83. Ideation - Elliptical rod attached to back wall

Cluster 3 - Ideation 2

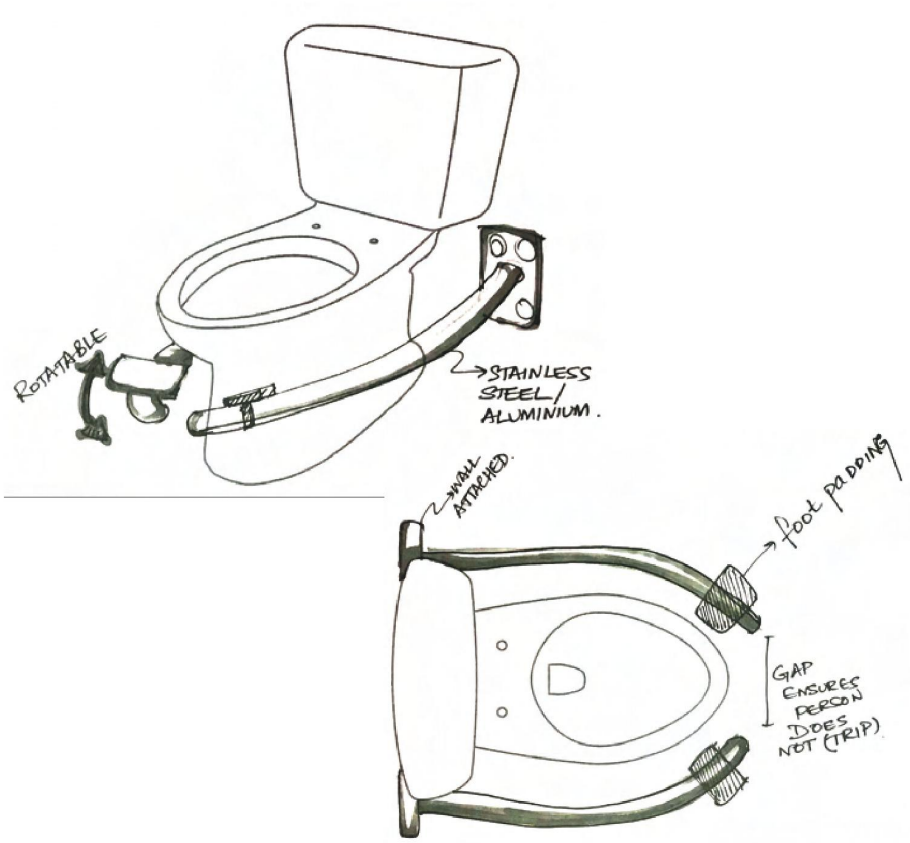


Fig.84. Ideation - Double rod legrest from back wall (with foot padding)

Evaluation

This ideation consists of two symmetrical steel bars that is permanently fixed on the wall behind the commode. It has a gap in between to enable the user to sit and stand up. It also has a pad to indicate the position of placement of feet while squatting - it has the ability to change its angle.

Merits

- Very simple to install, use & clean
- The angle of the feet can be varied as per comfort.
- Provides ergonomic squatting posture

Demerits

- It is a permanent fixture
- It is very intrusive in nature - obstructs the usage of the commode sideways - especially while urinating for men.
- Users may trip from the bar - lacks safety
- Does not provide geriatric support system
- Cantilever
- Using a rod as foot rest is very uncomfortable.

Cluster 3 - Ideation 3

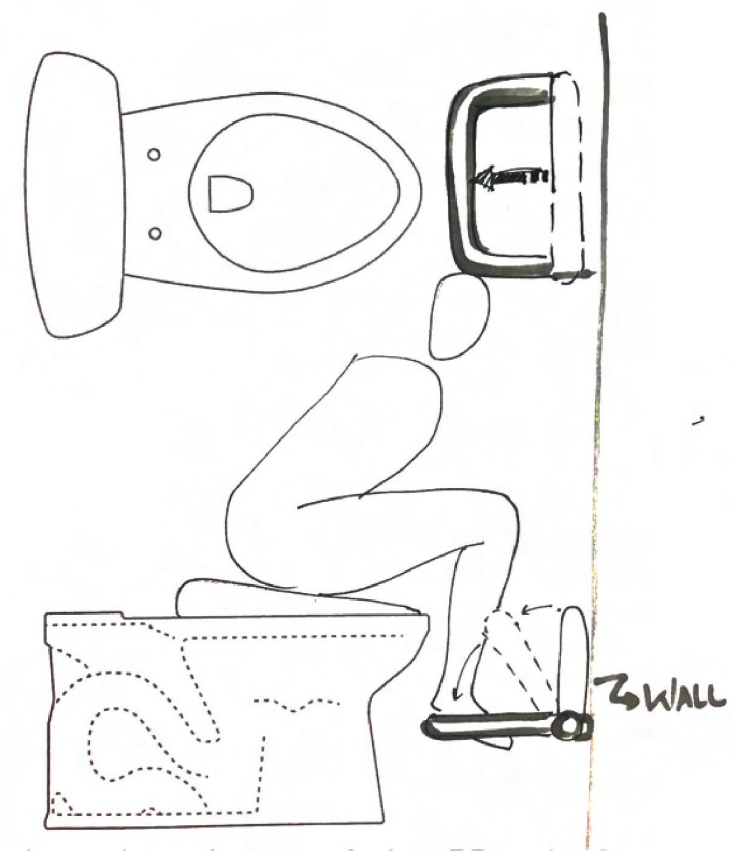


Fig.85. Ideation - Front wall pull swivel bar

Evaluation

This ideation consists U-shaped steel bar that is placed on the wall opposite to the commode. It can be swiveled down into place when the user needs to squat and can be pushed up against the wall when not in use.

Merits

- Very simple to install, use & clean
- The angle of the feet can be varied as per comfort.
- Provides ergonomic squatting posture

Demerits

- It is a permanent fixture
- The main disadvantage here is that this design depends on the position of the wall opposite to the commode, which differs from one toilet to another
- Does not provide geriatric support
- Cantilever
- Using a rod as foot rest is very uncomfortable.

Cluster 3 - Ideation 4

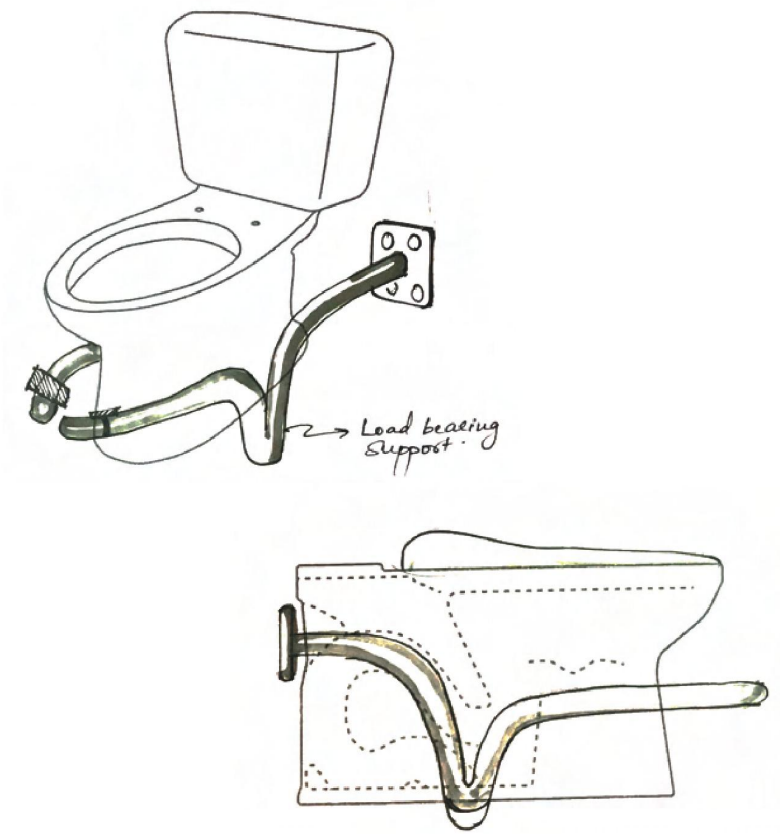


Fig.86. Ideation - Double bar from back wall with load bearing floor support.

Evaluation

This ideation is similar to that of the ideation 2 of cluster 3 apart from the fact that it the steel bar bends to touch the floor at a point before it is extended to the front to act as a footrest - It provides a better factor of safety.

Merits

- Very simple to install, use & clean
- The angle of the feet can be varied as per comfort.
- Provides ergonomic squatting posture

Demerits

- It is a permanent fixture
- It is very intrusive in nature - obstructs the usage of the commode sideways - especially while urinating for men.
- Users may trip from the bar - lacks safety
- Does not provide geriatric support
- Using a rod as foot rest is very uncomfortable.

Cluster 3 - Ideation 5

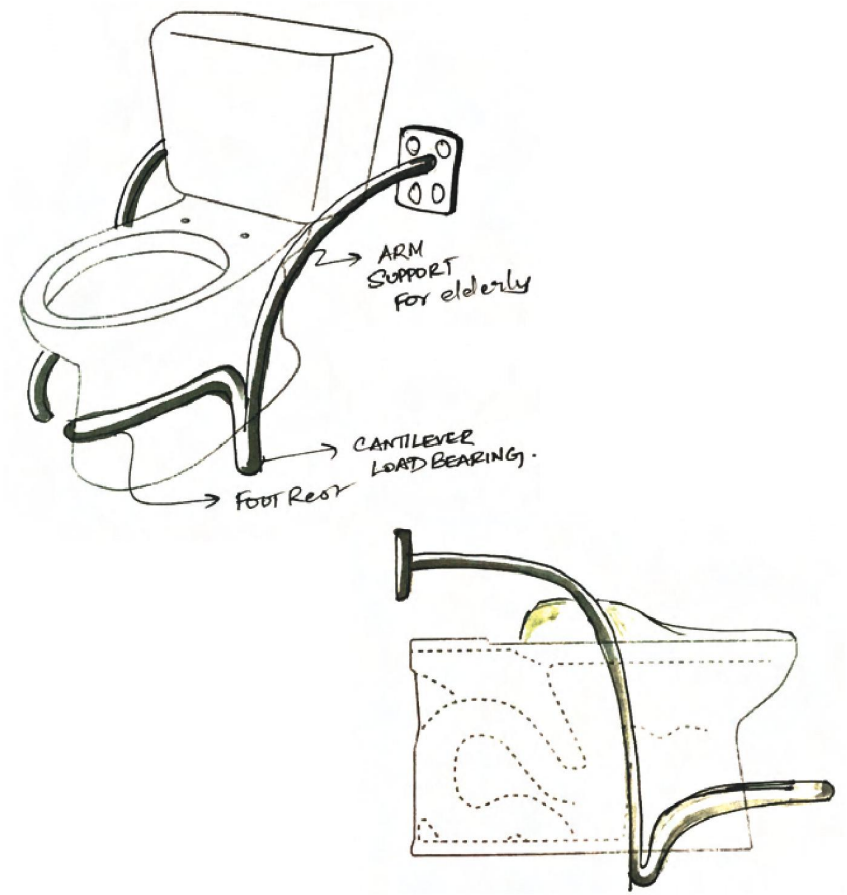


Fig.87. Ideation - Double bar from back wall with support handle & load bearing floor support

Evaluation

This ideation is similar to that of the ideation 4 of cluster 3 apart from the fact that the position at which the steel bar is attached to the wall is heightened so that the steel bar also acts as a support system for users while getting up.

Merits

- Very simple to install, use & clean
- The angle of the feet can be varied as per comfort.
- Provides ergonomic squatting posture
- It provides a support structure for users to sit down and stand up from the commode during defecation.

Demerits

- It is a permanent fixture
- It is very intrusive in nature - obstructs the usage of the commode sideways - especially while urinating for men.
- Users may trip from the bar - lacks safety
- Using a rod as foot rest is very uncomfortable.

Cluster 3 - Ideation 6

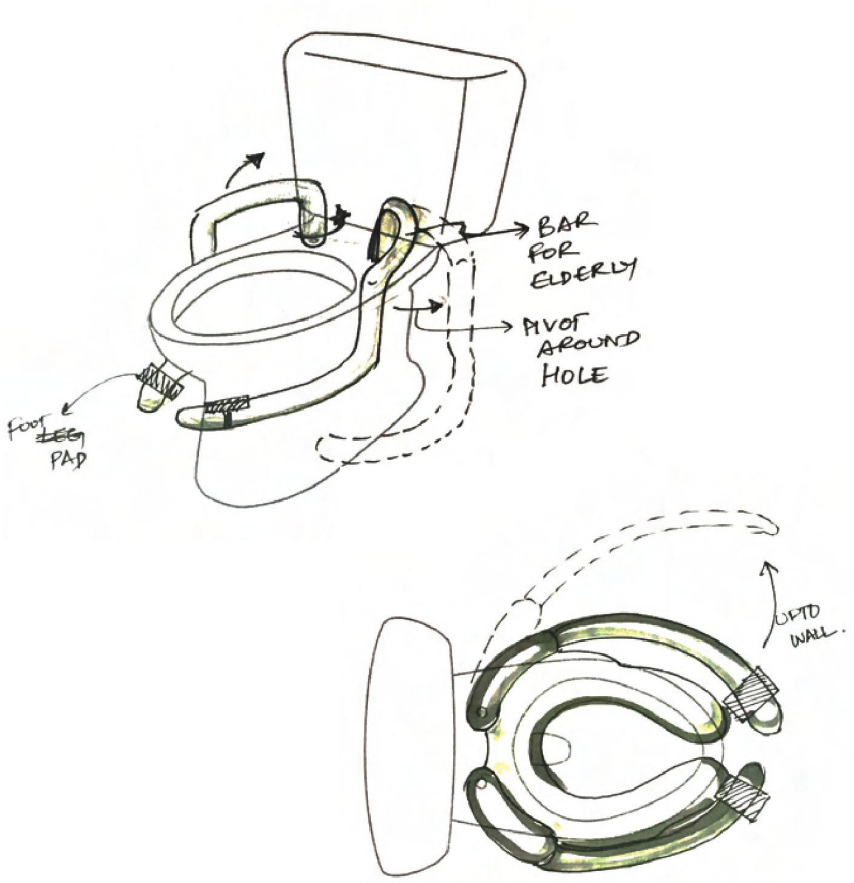


Fig.88. Ideation - Sideways swivel rod leg restwith hand support and leg pads

Evaluation

There are two holes on the toilet bowl that is used to fix the seat and cover onto the toilet bowl. These two holes can be leveraged to provide support to the contraptions. This ideation consists of two steel bars that use the seat fixture holes as swivel axes to swing sideways. When is use the swivel bars also act as handles to sit and stand up from the toilet seat.

Merits

- The complexity of installation is more than the previous ideations in cluster 3
- The angle of the feet can be varied as per comfort.
- Provides ergonomic squatting posture
- It provides a support structure for users to sit down and stand up from the commode during defecation.

Demerits

- The structure occupies a lot of space due to its swiveling action.
- The mechanism is veery intrusive in nature while using the commode and also while performing other actions in the restroom close to the commode.
- The load of the feet acts on the toilet bowl while squatting which may cause it to break
- Cantilever

Cluster 3 - Ideation 7

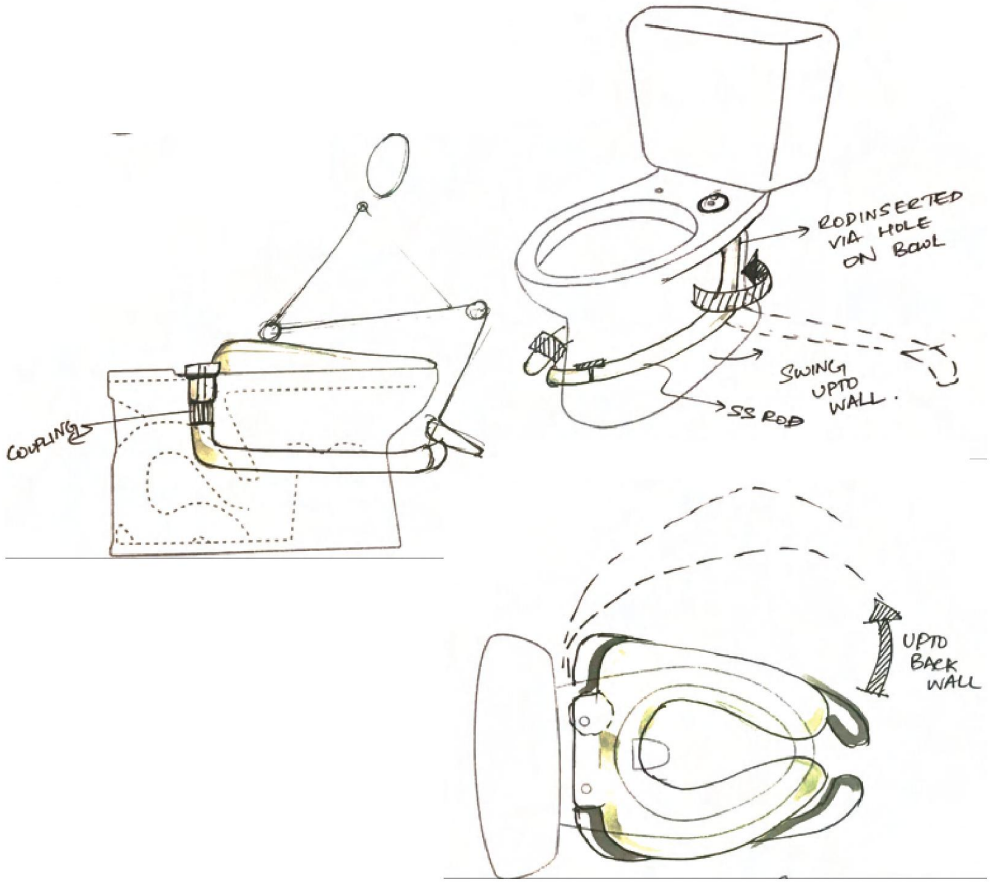


Fig.89. Ideation - Sideways swivel rod leg rest with leg pads

Evaluation

This ideation is similar to Cluster 3- Ideation 6 apart from the fact that the bar swivels from the bottom side of the commode.

Merits

• The complexity of installation is more than the previous ideations in cluster 3

• The angle of the feet can be varied as per comfort.

• Provides ergonomic squatting posture

Demerits

• The structure occupies a lot of space due to its swiveling action.

• The mechanism is veery intrusive in nature while using the commode and also while performing other actions in the restroom close to the commode.

• The load of the feet acts on the toilet bowl while squatting which may cause it to break

• Cantilever

• Does not provide geriatric support

Cluster 3 - Ideation 8

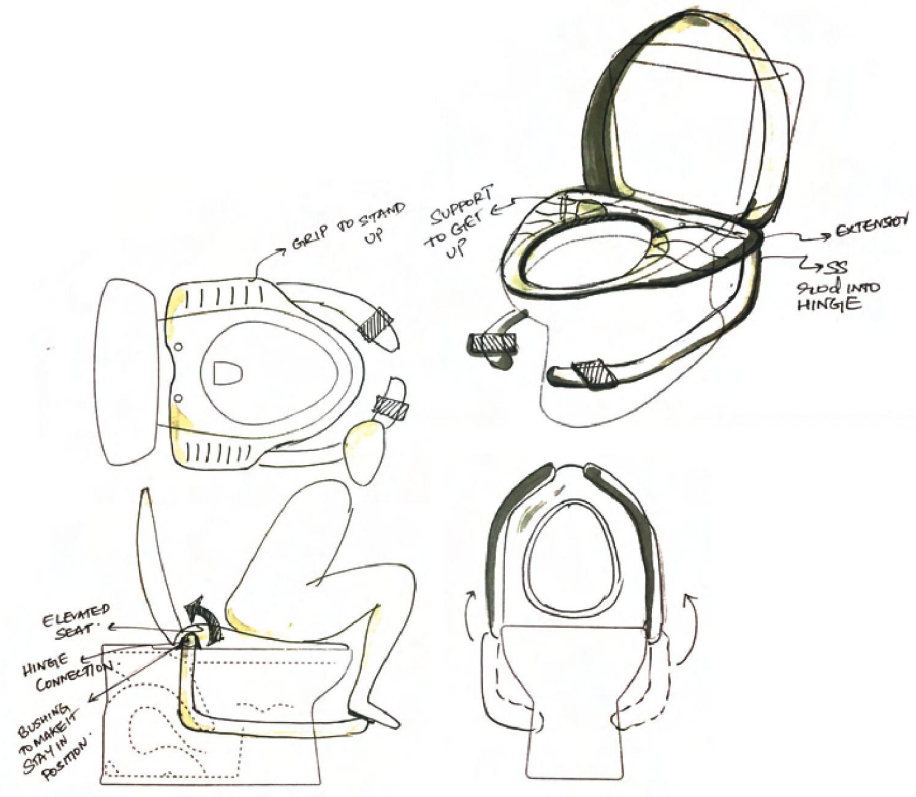


Fig.90. Ideation - Top-down swivel rod leg rest with seat modification for hand support

Evaluation

The toilet seat & cover are hinged which enables it to swivel up and down. This ideation consists of a modified toilet seat , cover and foot rest mechanism that all swivels about the hinge as its axis. The toilet seat is modified to provide support for users to sit sown and get up.

Merits

- The leg rest mechanism can be lifted up or down whenever required & acts as a seperate entity.
- The angle of the feet can be varied as per comfort.
- Provides ergonomic squatting posture

Demerits

- The existing seat and cover needs to be completely replaced in order to intall this mechanism
- The seat needs to be redesigned to bear the load of the feet on it
- Intrusive to approach the toilet
- Cantilever
- The steel bar may cause accidents while lowering

Cluster 3 - Ideation 9

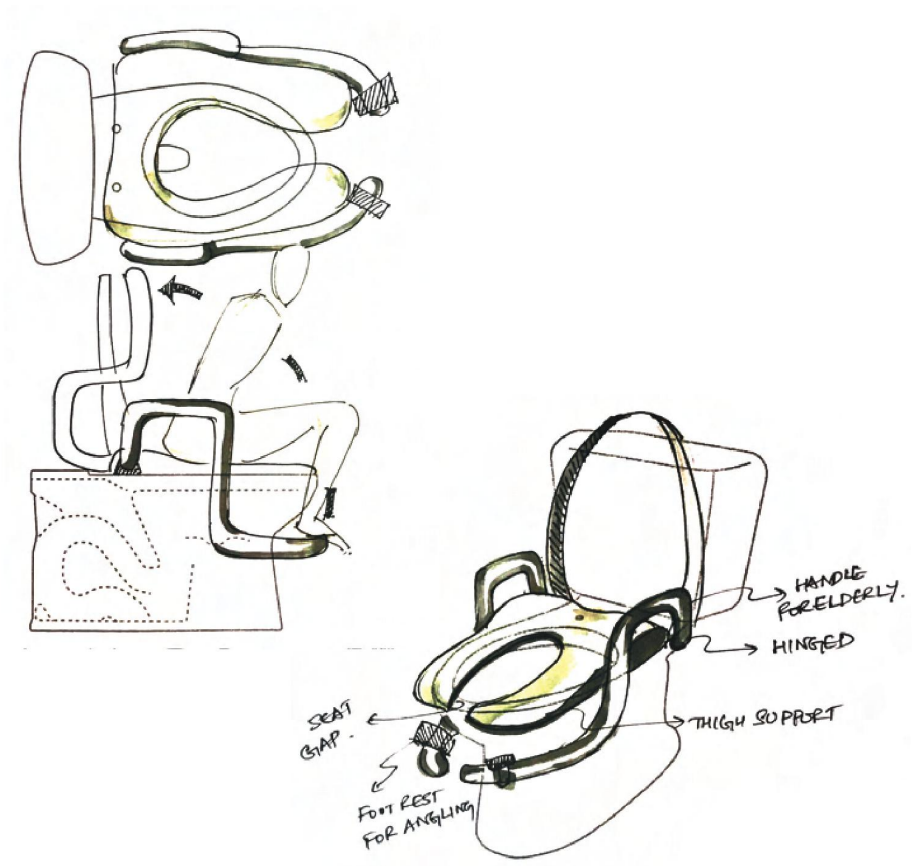


Fig.91. Ideation - Top-down swivel rod leg rest with handle modification for hand support

Evaluation

This ideation is similar to cluster 3 - ideation 8 apart from the modification of the steel bar to provide a handle support instead of changing the shape of the seat

Merits

• The leg rest mechanism can be lifted up or down whenever required & acts as a seperate entity.

• The angle of the feet can be varied as per comfort.

• Provides ergonomic squatting posture

Demerits

• The existing seat and cover needs to be completely replaced in order to install this mechanism

• The seat needs to be redesigned to bear the load of the feet on it

• Intrusive to approach the toilet

• Cantilever

• The steel bar may cause accidents while lowering

Cluster 3 - Ideation 10

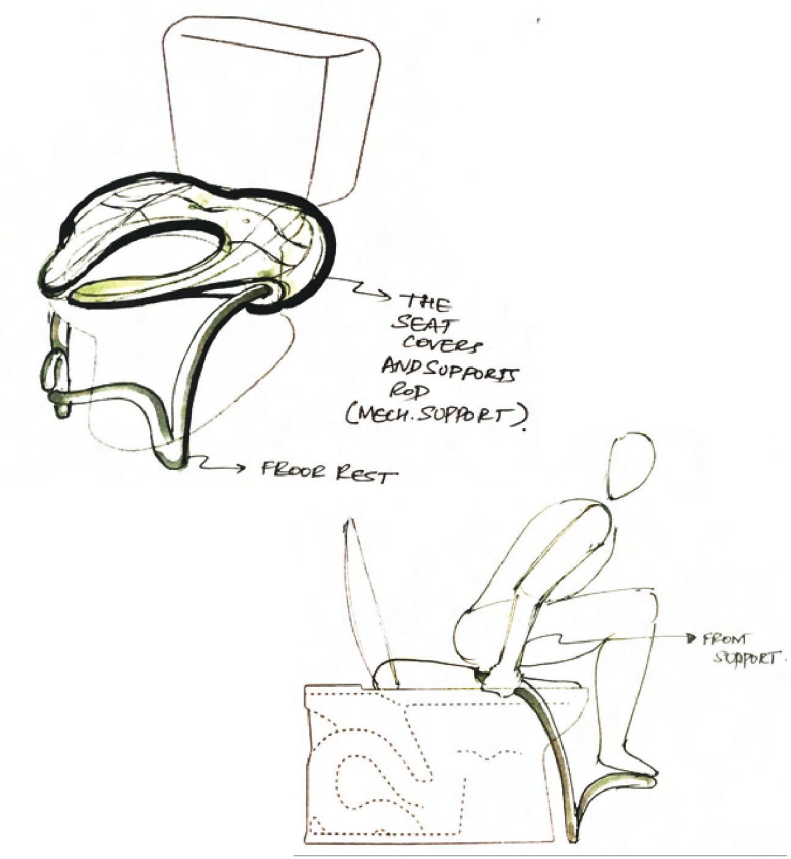


Fig.92. Ideation - Single Cast seat & rod with hand support

Evaluation

In this ideation , the steel bar is insert moulded into the seat of the toilet. It is shaped in a manner so as to provide a single point load on the floor before extending as a foot rest. The foot rest swivels along with the seat.

Merits

- The process of insert moulding makes it very easy to manufacture as a single mould.
- the steel bar itself can be used to sit and get up from the seat
- Provides ergonomic squatting posture

Demerits

- The existing seat and cover needs to be completely replaced in order to install this mechanism
- The seat needs to be redesigned to bear the load of the feet on it
- Intrusive to approach the toilet
- The steel bar may cause accidents while lowering
- Using a rod as foot rest is very uncomfortable.

Cluster 3 - Ideation 11

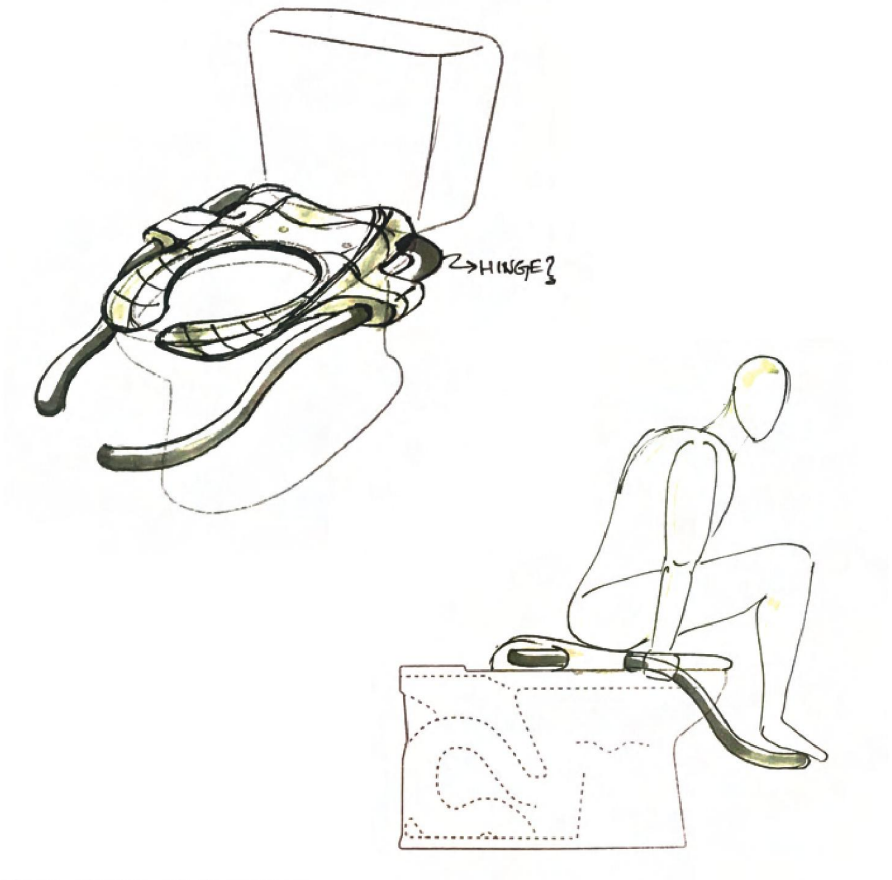


Fig.93. Ideation - Single Cast seat & rod with hand support (modified)

Evaluation

In this ideation , the steel bar is insert moulded into the seat of the toilet. The foot rest swivels up & down along with the seat.

Merits

• The process of insert moulding makes it very easy to manufacture as a single mould.

• the steel bar itself can be used to sit and get up from the seat

• Provides ergonomic squatting posture

• The seat itself is modified to provide a more ergonomic posture.

Demerits

• The existing seat and cover needs to be completely replaced in order to install this mechanism

• The seat needs to be redesigned to bear the load of the feet on it

• Intrusive to approach the toilet

• Cantilever

• The steel bar may cause accidents while lowering

• Using a rod as foot rest is very uncomfortable.

Evaluation of Ideations

Cluster / Ideation Number	Feasibility			Usability					Total Score (x / 56)
	Ease of Mfg.	Ease of Assy. / Install	Potential Cost	Intrusiveness during use	Adjustability	Cleanability	Safety	Ergonomic Comfort while sitting	
1.1	1	1	1	4	5	1	2	6	21
1.2	5	6	4	2	1	5	1	4	28
1.3	1	2	2	2	3	2	1	4	17
2.1	4	4	5	2	2	3	4	4	28
2.2	5	3	3	3	1	2	4	4	25
2.3	4	3	5	1	1	2	4	5	25
2.4	6	4	6	4	2	5	4	6	37
2.5	4	4	5	4	2	2	4	4	31
2.6	6	6	6	4	2	5	4	6	39
3.1	7	5	5	3	5	6	3	2	35
3.2	6	5	5	4	5	5	5	3	38
3.3	6	3	5	2	5	5	5	2	33
3.4	6	5	5	4	5	4	6	3	38
3.5	6	5	5	4	5	4	6	2	37
3.6	4	4	4	3	5	4	4	3	31
3.7	4	4	4	4	5	4	4	2	32
3.8	5	5	5	6	5	5	4	3	38
3.9	5	5	5	5	5	5	4	3	37
3.10	6	6	6	5	5	6	4	2	40
3.11	6	6	6	6	5	6	4	2	41

The various initial ideations were evaluated on a scale of 0-7 based on the legend given below. One iteration from each of the clusters 2 & 3 were chosen for further discussion. All scores were assigned based on the individual evaluations of each ideation as given above.

Legend

Feasibility

Most Difficult to Mfg. - Easiest to Mfg.

Most difficult to Assemble - Easiest to Assemble

Potentially Highest cost - Potentially Lowest cost

Usability

Most intrusive - Least Intrusive

Least Adjustable - Most Adjustable

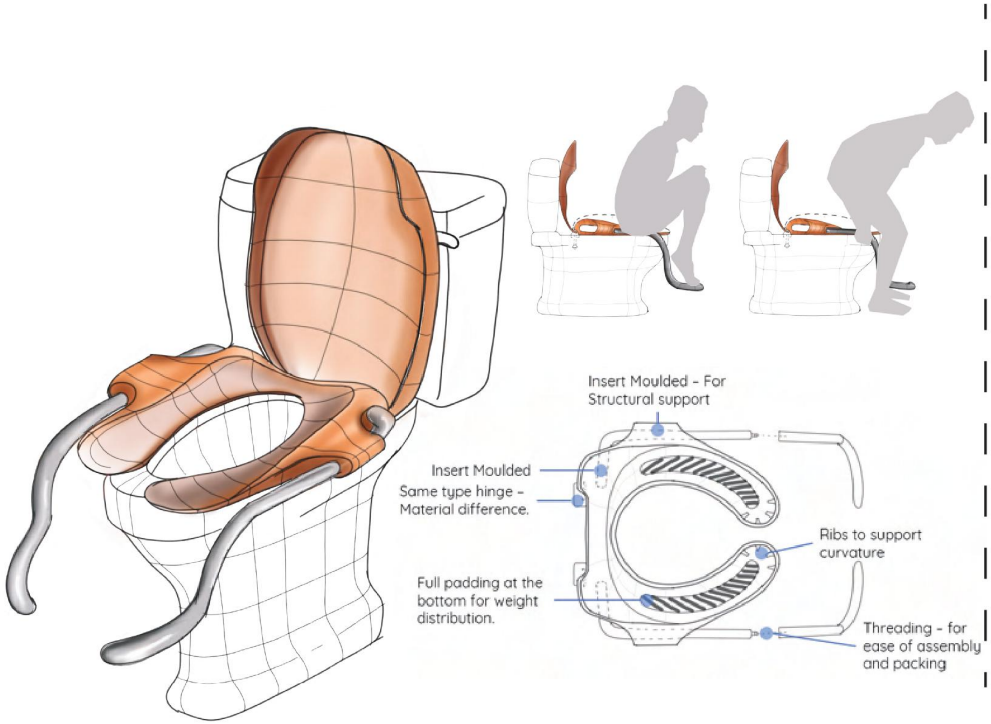
Difficult to clean - Easy to Clean

Lowest safety - Highest safety

Ergonomic Comfort while sitting (lowest - highest)

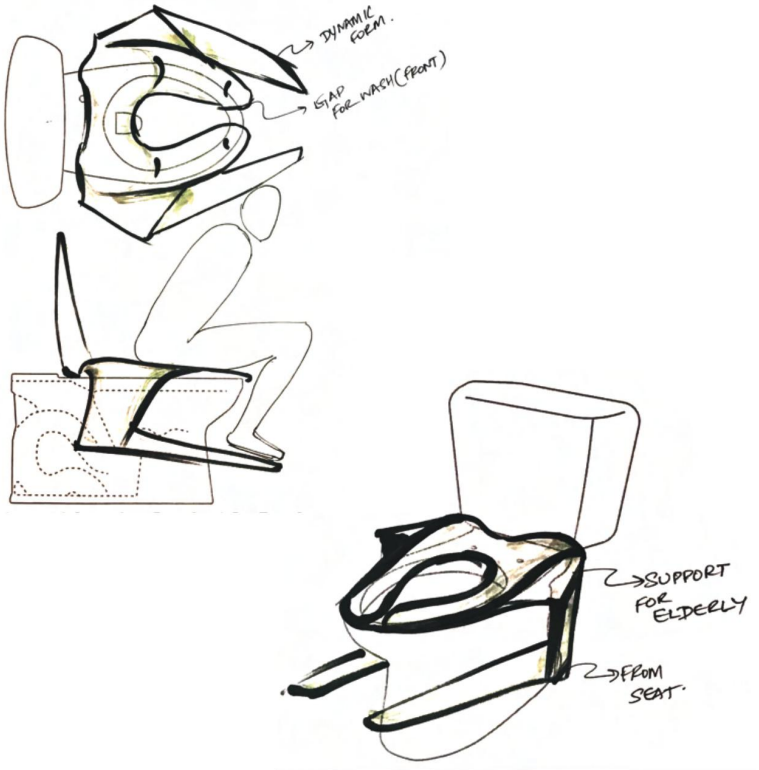
0-7

Comaparison of Ideations with Maximum scores



IDEATION A

Fig.94. Basic detailing of Ideation 11 - Cluster 3



IDEATION B

Fig.82. Ideation - Single cast Seat modification as squatting leg rest (copy)

Comaparison of Ideations with Maximum scores

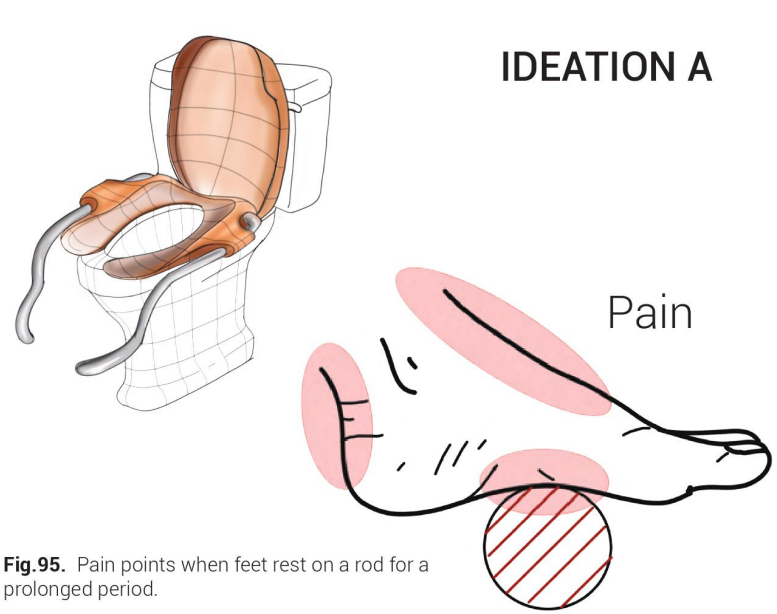


Fig.95. Pain points when feet rest on a rod for a prolonged period.

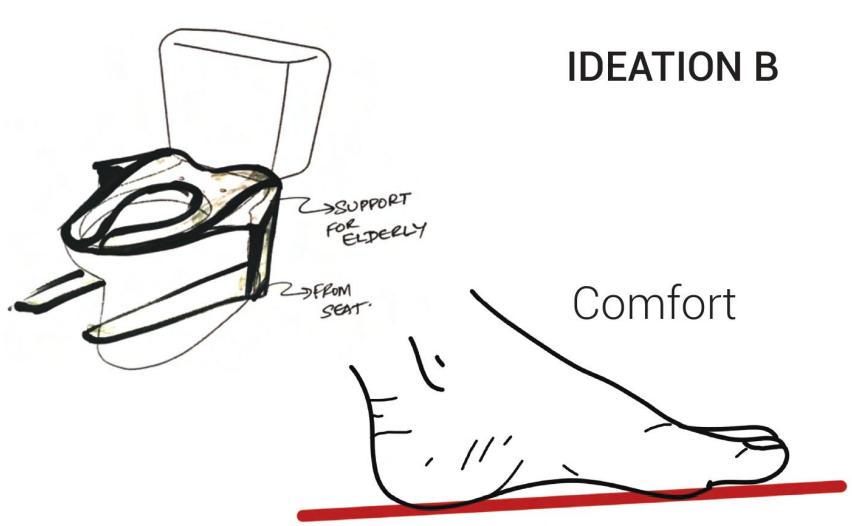


Fig.96. Painless feet resting on flat surface.

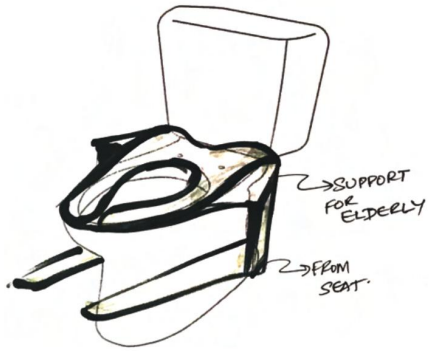
One of the main disadvantages of using a rod (**Ideation A**) as a foot rest is the amount of **pain and discomfort** that it causes when the feet rest on it for a prolonged period of time (**Point load**), especially while simulating the odd angles of squatting. (data from self-experimentation with 3 users)

But on the other hand, the flat surfaces (**Ideation B**) are **much more comfortable** to use since the entire load is being distributed throughout the entire feet.

From this, we understand that the surface quality of the surface under the feet is of utmost importance since that is the place where we get feedback from while squatting.

Conclusions from Initial Ideations

IDEATION A



IDEATION B

Commonalities of Ideation A & B

• Both these designs are **single cast structures.** - Ease of mfg.

• Both are **modifications of the seat** in which design A uses a steel rod for squatting whereas the design B uses an extended plastic moulded seat as a squatting foot rest.

• **Both provide an ergonomic squatting posture as a whole, but only design B provides comfort for the feet.**

• Both these designs are **extremely accident prone** when lifting and lowering down. They may hit the head or body of the user.

• Both these designs try to provide a support structure for the users to hold on to, while sitting and getting up.

• Both are **very intrusive to approach from the sides**. They need to be approached from the front and the gap between the foot rest is used to sit and stand up - causes a lot of discomfort.

• In both cases, **the seat and the cover need to be replaced** as a whole.

Conclusions

From the above ideations, we can gather that, users need to change to a squatting habit in order to lead a more healthier lifestyle. But, providing discomfort while squatting discourages them to use & buy the product. Hence the product must provide a factor of desirability and comfort along with enabling a squatting posture.

The product must also not be intrusive to any operation performed such as approaching from any direction, sitting, squatting, getting up, cleaning & urinating. And most important of all, the product must not cause accidents of any kind during use.

Taking these factors into consideration, regardless of the scores, both of these ideations are rejected. And the **design brief needs to be modified.**.

05 Literature Study

Contents

Ergonomic Anthropometric Dimensions - India

Ergonomic Anthropometric Dimensions - India

Measurement	Definition	Variable	Max (mm)	95th percentile	50th percentile
Foot length	-	A	302 mm	277 mm	-
Foot breadth	-	B	122 mm	104 mm	-
Hip breadth	maximum horizontal distance across the hips	C	550 mm	406 mm	326 mm
Thigh (middle) external breadth, single	maximum horizontal distance across the thigh (single) , midway gluteal distance across the knee.	D	204 mm	162 mm	125 mm
Mid- thigh to thigh breadth, relaxed	maximum horizontal distance across the mid thigh to thigh, most lateral surfaces, spreading external sideways, external position	E	530 mm	479 mm	369 mm
Buttock to popliteal length, normal sitting	Horizontal distance from the most posterior point on the uncompressed buttocks to the back of the lower leg at the knee, i.e. popliteal angle point (knee at right angle).	F	595 mm	509 mm	451 mm
Knee	Uppermost point on the knee (at lower thigh)	G	612 mm	563 mm	509 mm

Indian Anthropometric dimensions for Ergonomic Design Practice by DK Chakrabarti

These dimensions [7] are the recomended dimensional values for the Indian Population. They need to be taken into consideration while designing the squatting aide.

The height at which the foot rest is to be placed was calculated as 7 -8" from the ground for a 16" commode.

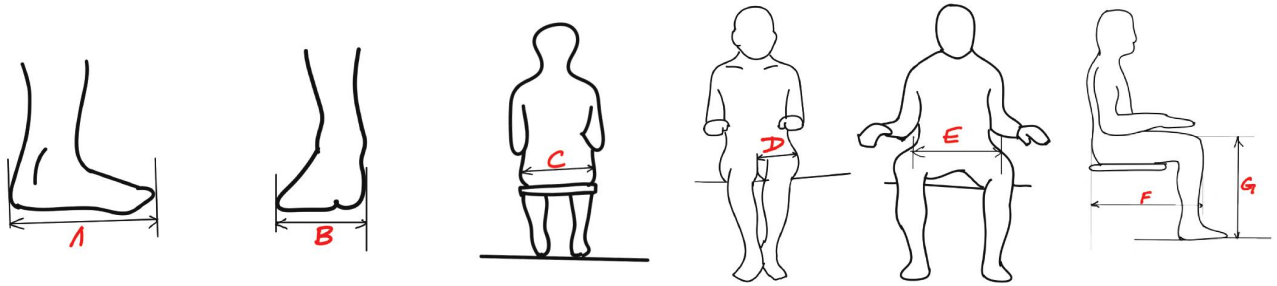


Fig.97. Anthropometric Dimensions for Indian population

Ergonomic Anthropometric Dimensions - India

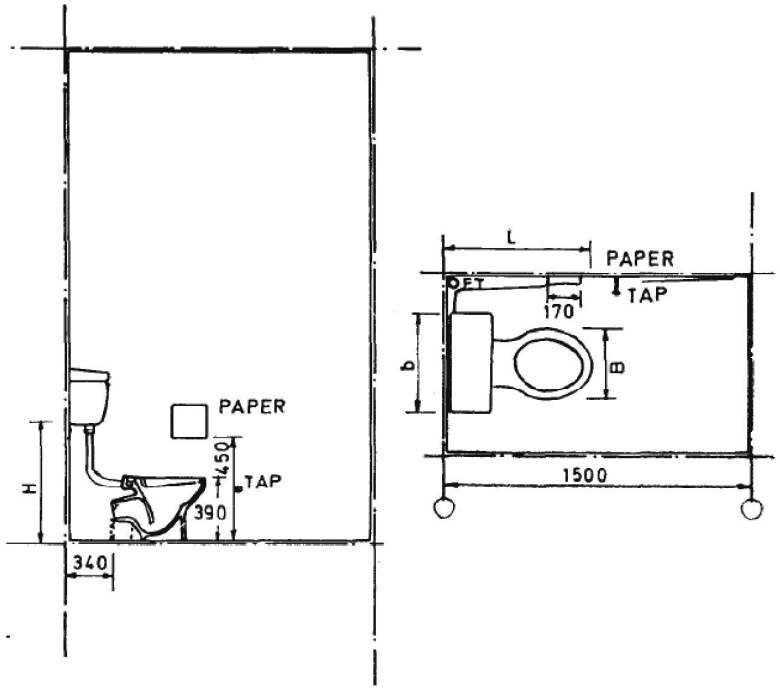


Fig.98. Indian Toilet Installation guidelines

What is the average height of toilets in India ? [8]

The toilet height (bowl) standard (as per indian code of installation) = **390 mm - 15.35" .**

Worldwide range = **15 -19 "**

Indian Range = **15 – 17 "**

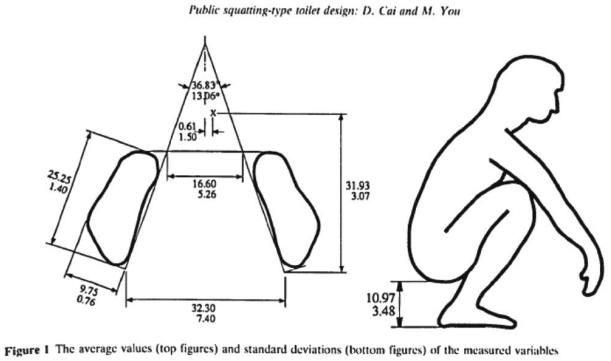


Fig.99. Comfort Angle between feet while squatting

Fig.100. Comfort angle of inclination while squatting

What is the most comfortable angle of leg spread while squatting ? [9]

Most comfortable angle between the 2 legs while squatting

= **36.83 degrees.**

The most comfortable angle of inclination = 0 or 15 degrees.

05
Revised Design Brief

Revised Design Brief

To design a squatting aide for seat type commodes that can be installed in existing toilets as an accessory to the existing commode.

The squatting aide (having a resting surface that can accomodate the entirity of the users feet) must be able to provide the user with an ergonomic and comfortable squatting posture with a squat height that ranges from 7 to 9 inches from the floor of the toilet.

The squatting aide must be able to provide a sense of desirabilty to the user.

It must not disrupt the existing process on the commode such as approaching the commode from any direction, sitting, standing up, reaching out to the faucet, washing oneself and urinating while standing up (for men).

It must also be very safe to use & easy to clean.

The final requirement of the squatting aide is that it could provide be used as a support mechanism for sitting and standing up from the seat type toilet for the geriatric and ailing members of the family.

07 Designing for Senses

Contents

Designing for the Senses

From the comparison of the two final concepts and our previous studies (including the market study of toilets in India), we got to understand that people are very sensitive to their level of comfort. And **they would use a product only if it provides them with a certain level of comfort rather than a health benefit.**

Hence, in order to provide comfort, Introducing pleasure into design is a key aspect. This pleasure can take any form.

In this Project, we aim to appeal to the senses of humans in order to appeal to their inner needs and pleasures.

The senses are unique to every person.[10] Everyone percieves a particular stimulus such as smell, taste, sound in a very different manner. For example, the same food is liked and disliked by people equally. This can only say that the same stimuli are percieved differently.

The senses trigger and amplify other senses.[10] Senses are not individual entities, for example we can percieve music in terms of colors or looking at a particular color has the ability to make a person hungry, angry, sad, or happy.

Sensory design knits together time and space.[10] We judge the scale of a building in relation to our own limbs and torsos. As we pass through a doorway, space hugs us tight and then lets us go. Air mutters through the HVAC system and ripples over our skin. Our feet pound against a building's floor, and our hands grasp its railings and knobs. Our daily routines—cooking, cleaning, smoking, bathing— produce an embedded brew of smells that make interiors memorable.

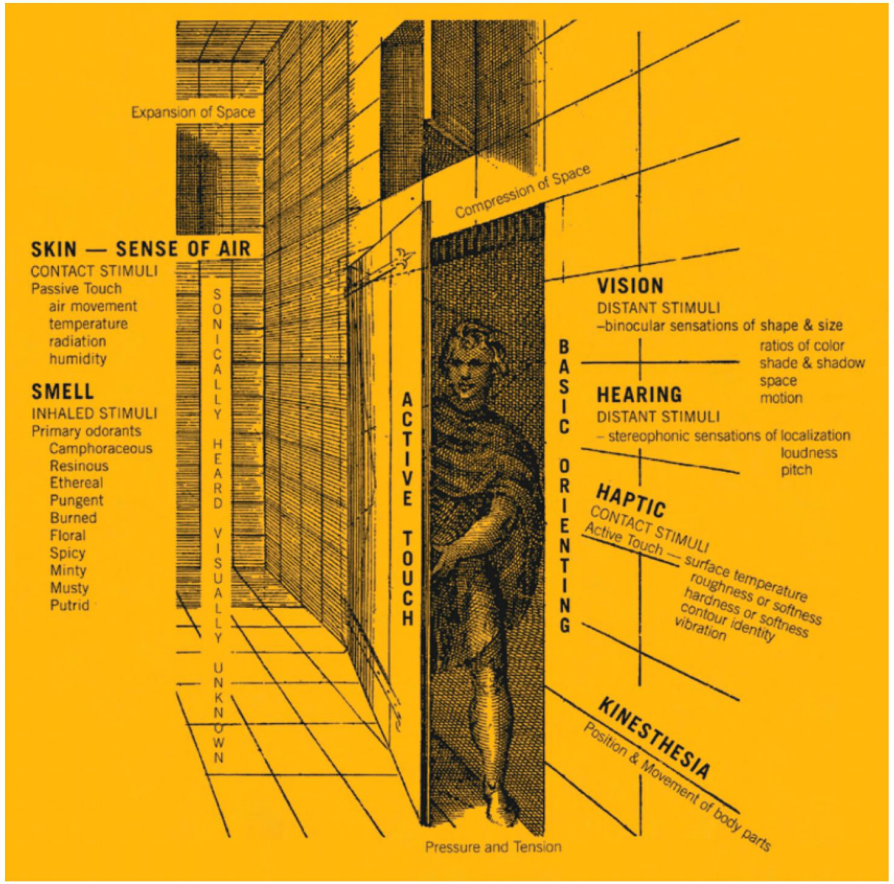


Fig.101. The various forms of Senses

Designing for the Senses

From Fig.101, we can see that humans experience a wide array of senses. And each of these senses are nothing but a response to some form of stimuli. Some of the senses are :

- **Smell - Inhaled Stimuli**
- **Vision - Distant Stimuli** of Shape, size, color, ratios, shade, space & motion .etc
- **Hearing - Distant Stimuli** of localization, pitch & loudness.
- **Kinesthesia - Position & Movement of body parts**
- **Skin - Passive Contact Stimuli** of air movement, temperature, radiation or humidity &
- **Haptic - Active Contact Stimuli** of surface temperature, roughness or softness, hardness, contour identity & vibration

We have allowed two of our sensory domains — sight and sound — to dominate our design imagination. In fact, when it comes to the culture of architecture and design, we create and produce almost exclusively for one sense— the visual.[10]

Since the process of squatting on the toilet primarily involves resting our feet on a surface, this involves the process of active contact stimuli or HAPTIC.

Haptic Design

What are Haptics ?

Haptics falls under the field of kinaesthetic communication, which focuses on tactile contact as a form of communication. Tactile feelings are salient and pervasive. Imagine holding a child for the first time, hugging a friend you haven't seen in awhile, or feeling your phone vibrate rapidly in your pocket. These sensations generate very real feelings that stick with us.[11]

How can haptics add to the pleasure or desirability of a product ?

A haptic design means " relating or pleasant to the sense of touch". A design that is made in order to "awaken the senses". A sense of pleasure is caused when a person experiences a pleasant stimulus after facing a lack of it.

For example, having a foot massage after a long day's work, or sitting next to a fireplace after getting back from a cold outing.

How can haptics contribute in designing squatting aides ?

Since the squatting aides are completely contact surfaces, the concept of haptic design helps in adding an element of pleasure to the design that can motivate users to use the squatting aide that leads to the betterment of their health.

Haptic Design-Examples

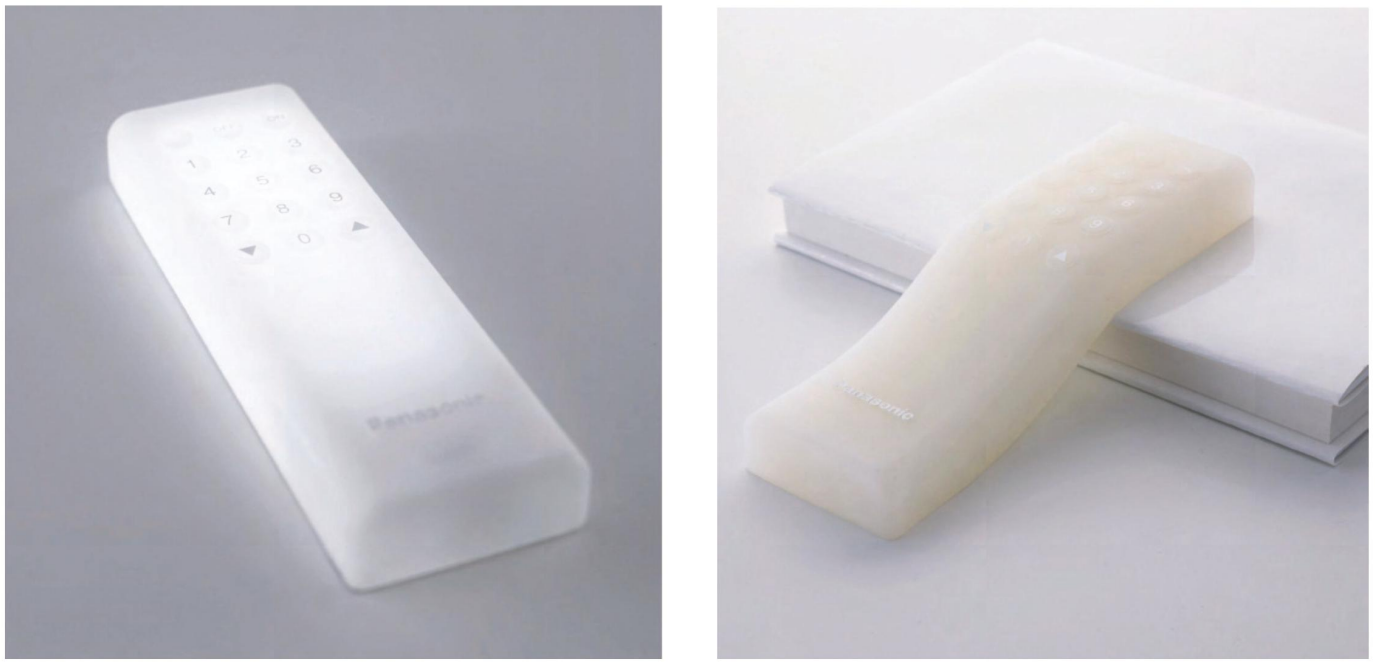


Fig.102. The Gel remote by Panasonic Design Company

In this case, the sense of touch is enabled by a remote that feels like a gel in your hand. It invokes the fluidity of the electronics that are placed inside. The design also enables the remote to light up, when touched which creates a sense of surprise and hence, happiness for the user.

Haptic Design-Examples

Fig.103. Juice Packaging by Naoto Fukasawa

One of the most famous haptic designs was the Fruit Juice Packaging by Naoto Fukasawa. In which he had enabled the users to experience the visual and the texture of the fruit itself on the outside of the packaging.

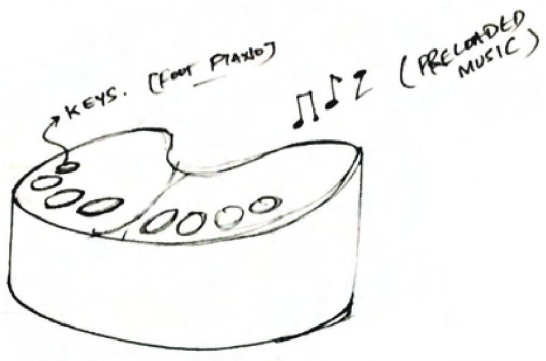
Haptic Design-Senses Ideations

From the market study of the various squatting aides, we can say that one of the only squatting aide that was an idependent accesory to the existing commodes were the squatting stools.

Hence, we begin with ideation on how to incorporate haptic designs on the variation of squatting stools.

Fig.66. Kurtzy Height Adjustable Bathroom step stool (copy)

Fig.67. Squatty Potty (copy)



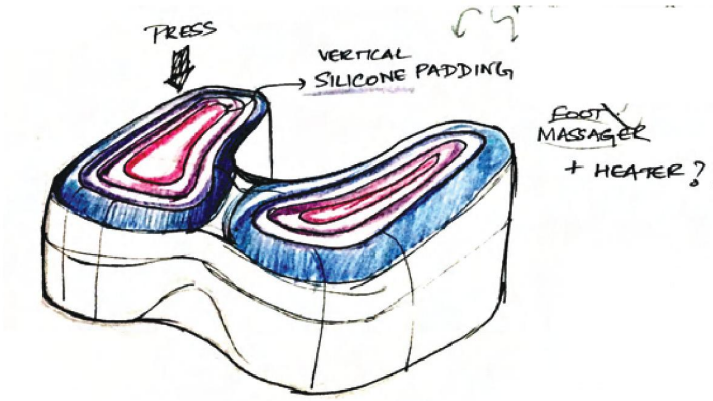


Fig.104. A squatting stool with a massager.

This ideation consists of a toilet stool with a soft silicone surface that vibrates and massages the users legs when placed on it. After a deep sleep, a deep foot massage provides a factor of haptic pleasure to the user.

Fig.105. A squatting stool that has musical keys to play music with feet

People often find themselves in the toilet bored, and hence develop habits of reading or going through the phone there. This ideation solves that by allowing the user to create their own music while on the toilet. It consists of a toilet stool with a rough surface on which there are buttons that also double as musical piano keys to create music.

Haptic Design- Senses Ideations

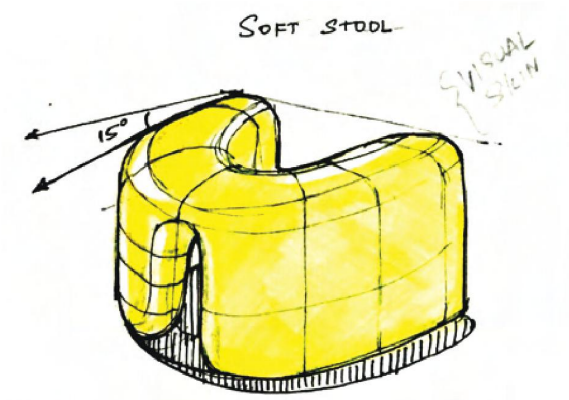


Fig.106. A squatting stool with a soft form and rough surface

This ideation consists of a simple toilet stool that creates an aesthetic soft form while creating an oxymoronic rough surface texture.

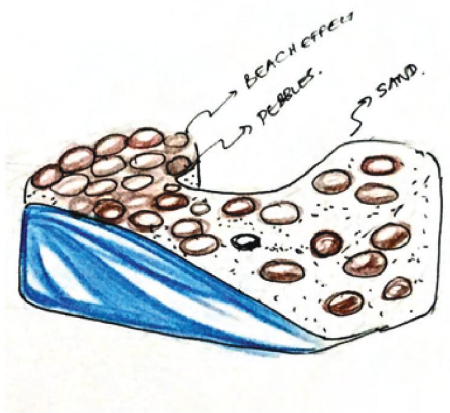


Fig.107. A squatting stool with pebbles and sand

We all love waddling through a riverside or by the beach to dip our feet in water. This ideation recreates that feeling on on the surface of our feet by being covered with pebbles and rough sand. The pebble covered stool also solves the medical need of activating nerve endings on the feet through accupressure/massage

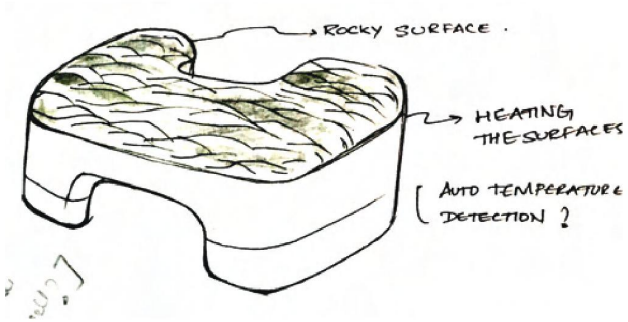


Fig.108. A squatting stool with a rocky surface & a heater.

On a cold morning, we would all love some warmth. This ideation consists of a squatting stool with an in-built heater that can warm the users legs. It also doubles the haptic feedback by providing a rough stony surface to place our legs on.

Haptic Design-Senses Ideations

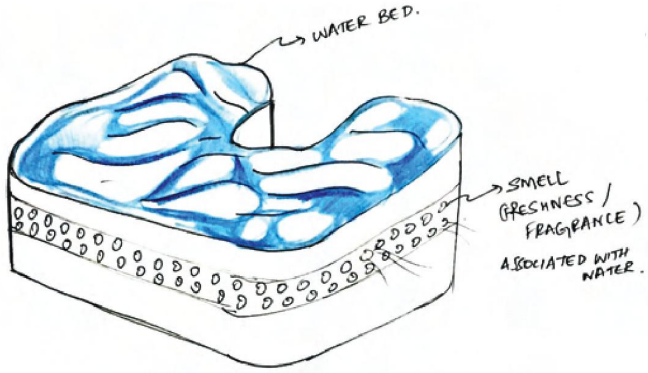


Fig.109. A squatting stool with a waterbed surafce

This ideation consists of a toilet stool with a waterbed surface that gives the user a feeling of standing on a liquid. The soft movement of the water creates a pleasurable haptic feedback. the ideation also consists of a the smell of freshness/ fragrance being released for Olfactory appeal

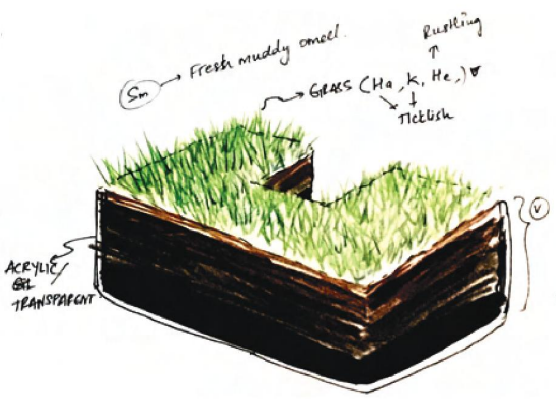


Fig.110. A squatting stool with a grass covered surface

This ideation consists of a toilet stool with a grass bed. Everyone loves to walk on grass barefeet surrounded by the smell of mud. This provides the fuzzy feedback of grass with the olfactory feedback of the smell of the mud itself.

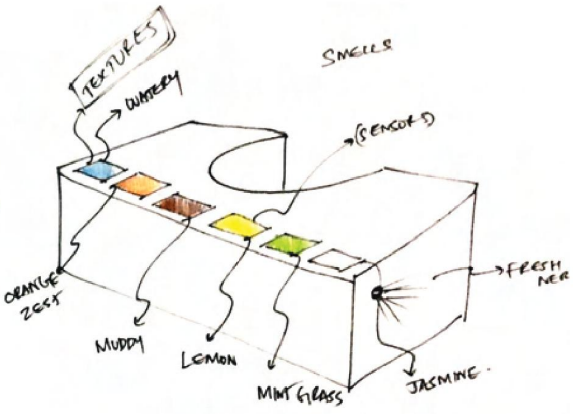
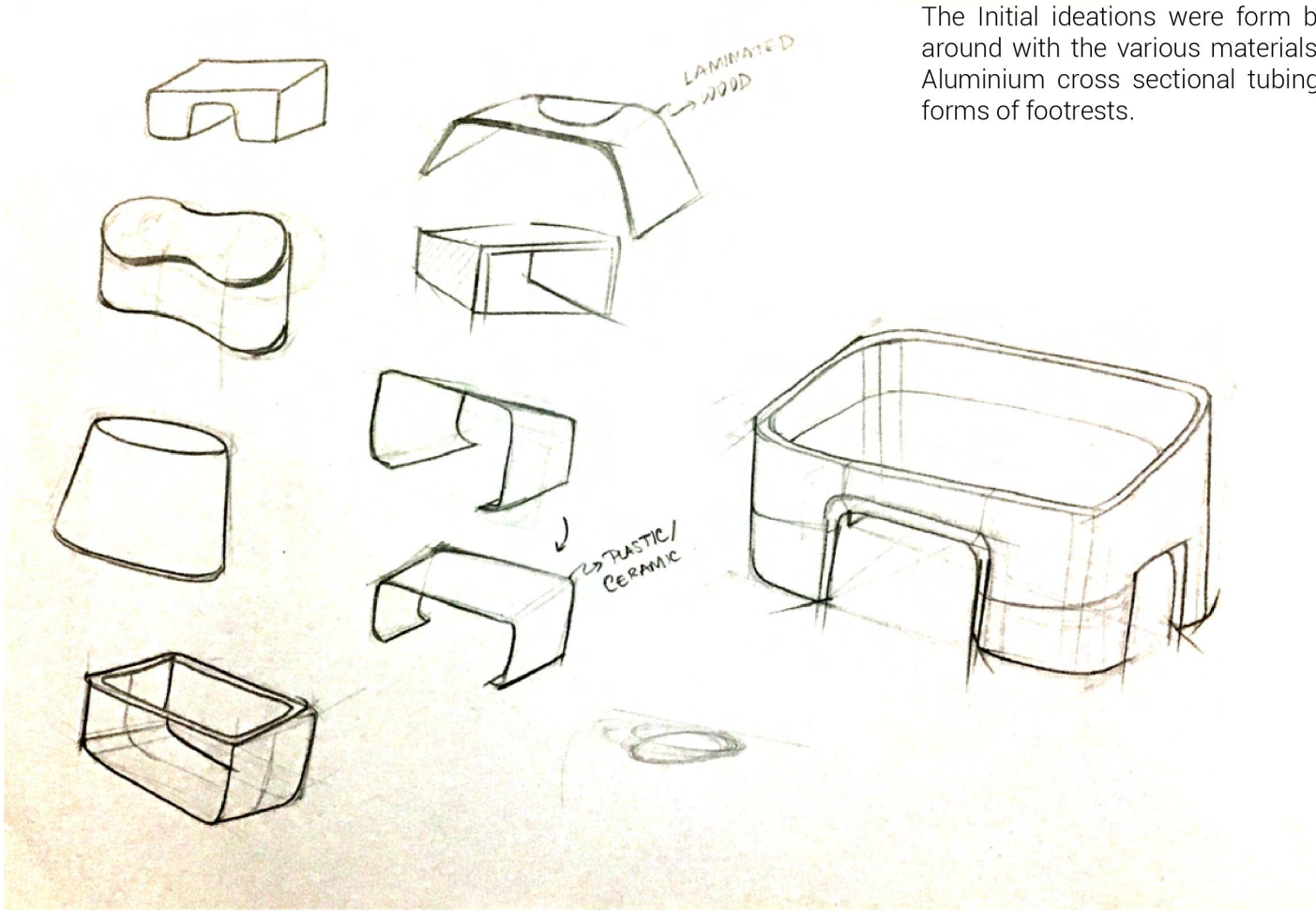


Fig.111. A squatting stool that blows out variuos scents.

This ideation consists of a toilet stool with 6 different panels each having its own texture. And each panel releases a scent corresponding to that texture. For example, the yellow panel with a lime skin like texture releases the scent of lemon.

Haptic Footrest - Initial Form Explorations & Ideations



The Initial ideations were form based, which involved playing around with the various materials such as pipes, sheet metal , Aluminium cross sectional tubing, molded plastic for creating forms of footrests.

Fig.112. Footrest form explorations

Haptic Footrest - Initial Form Explorations & Ideations

The next phase of ideations Involved creating Modular Replaceable trays which can provide a haptic feedback placed on a constant footrest as base.

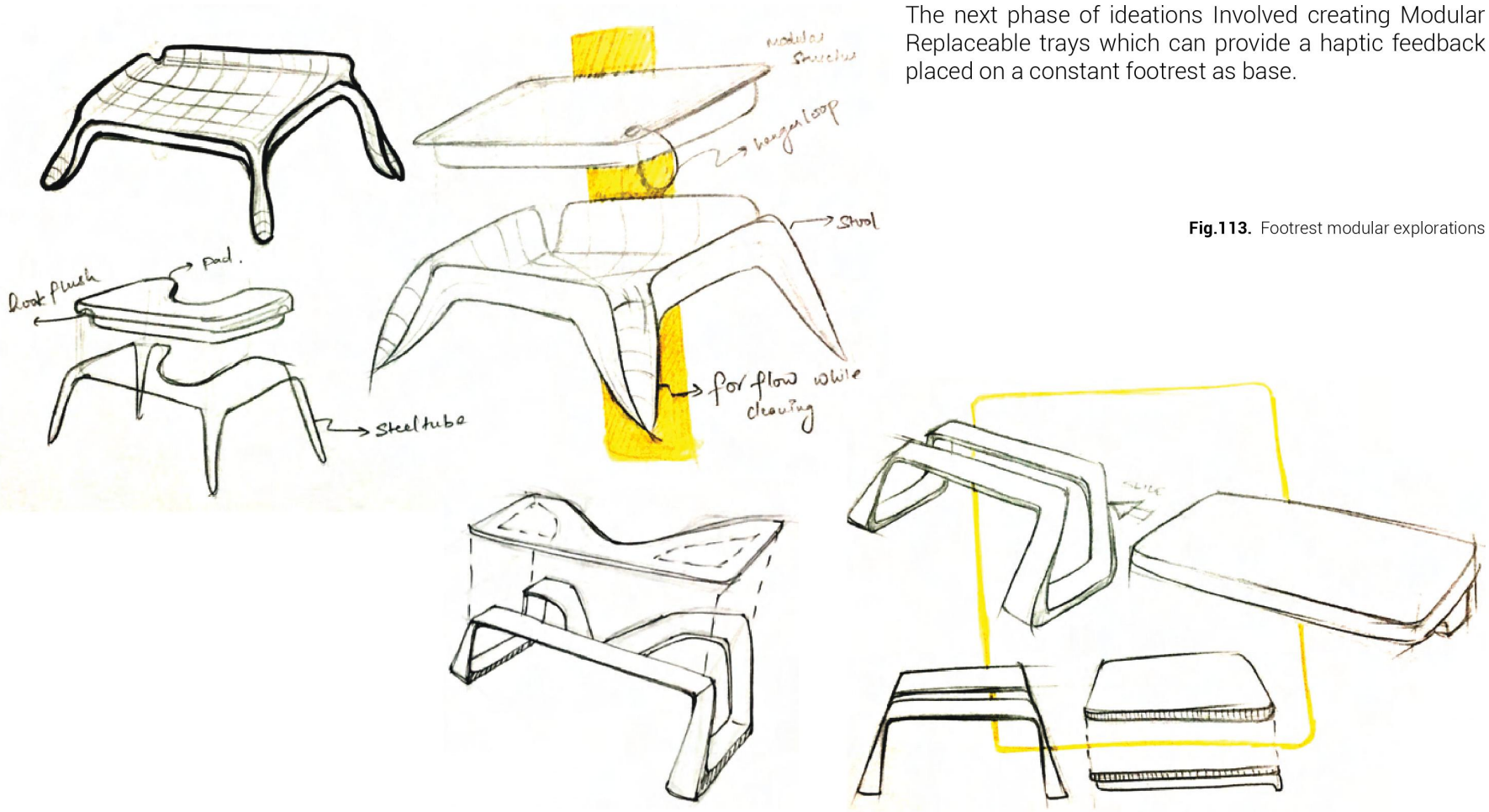


Fig.113. Footrest modular explorations

Haptic Footrest - Initial Form Explorations & Ideations

The next phase of ideations Involved creating Modular Replaceable trays which can provide a haptic feedback placed on a constant footrest as base.

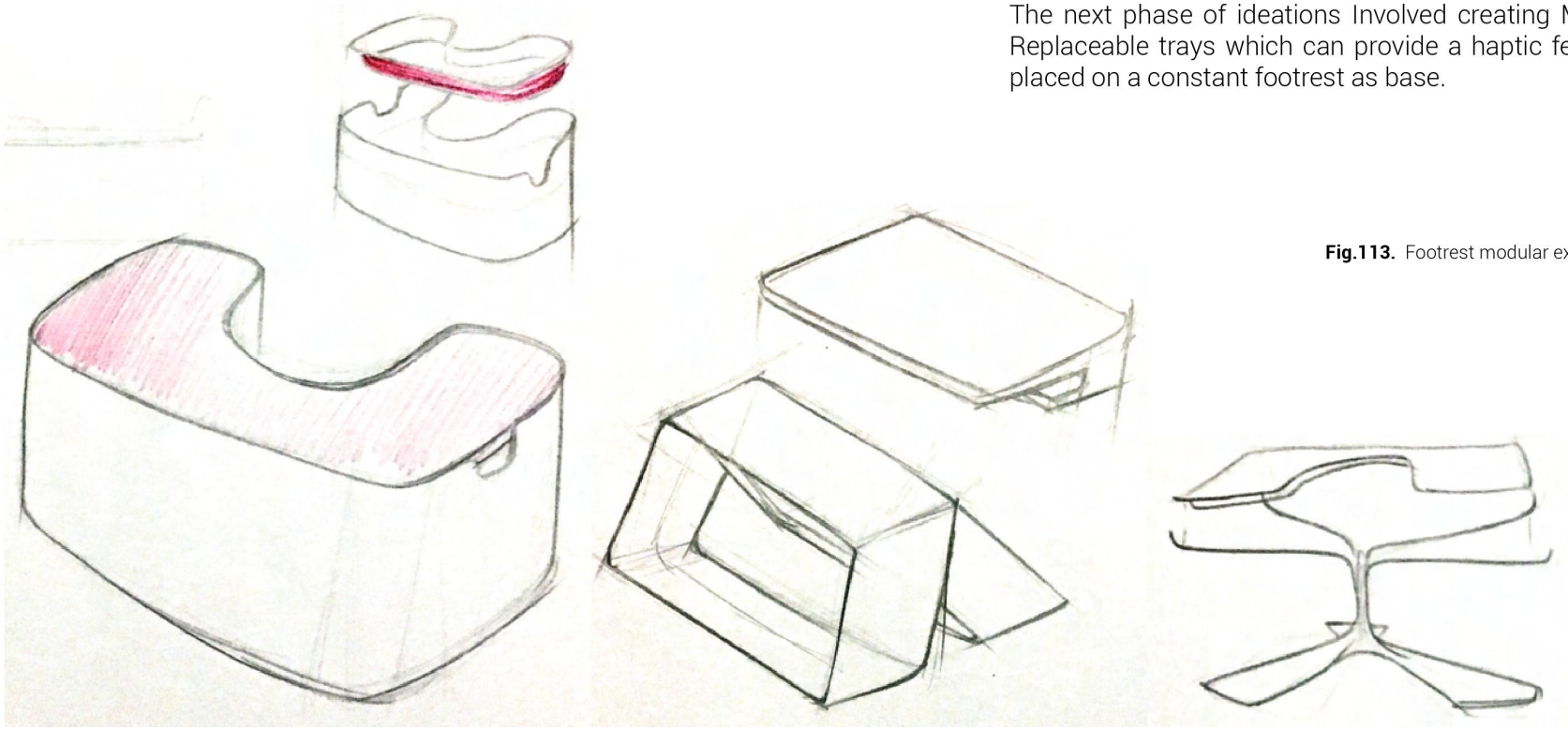


Fig.113. Footrest modular explorations

The above design was chosen as its a very simple form which consists of a plastic body, Trays in which each haptic feedback concept was placed in. It was inter-changeable.

Haptic Footrest - Concept

Radii Manipulation

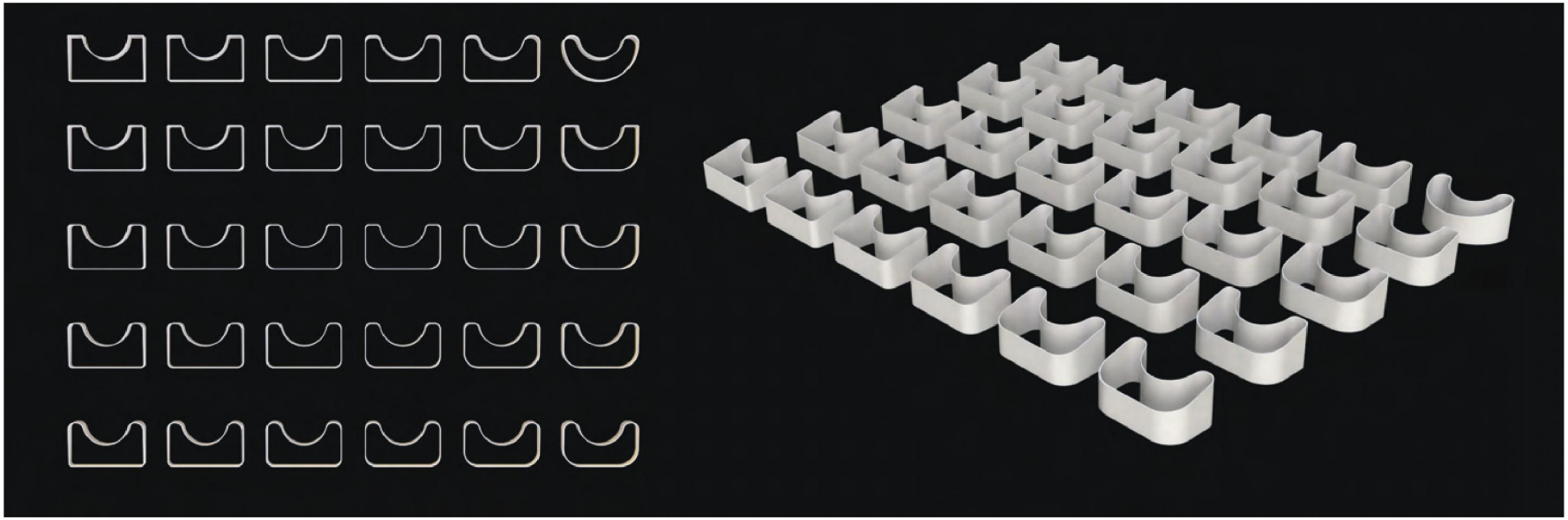


Fig.114. Radii Manipulation

Haptic Footrest - Concept

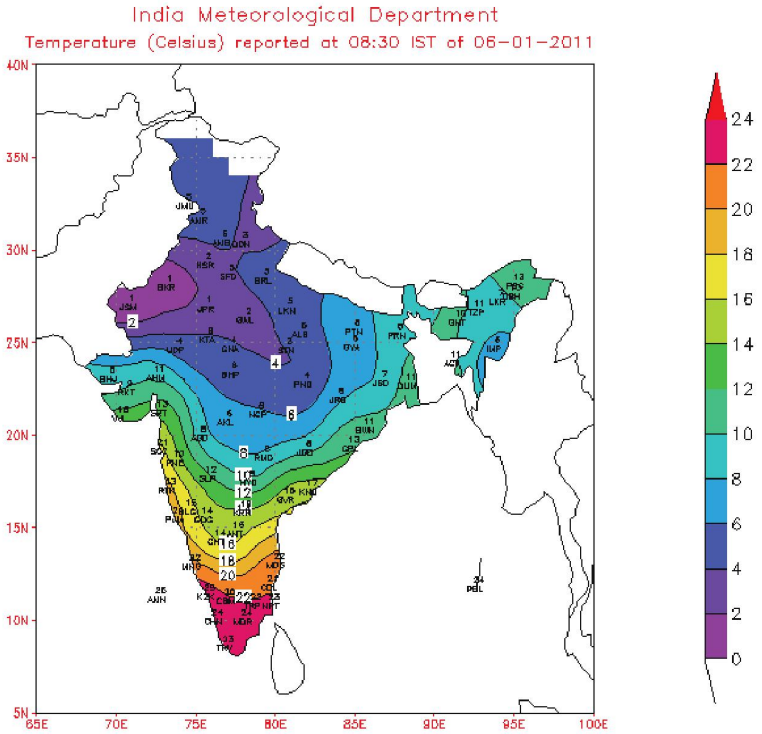


Fig.115. India - Temperature distribution by location

India has varying climates throughout its landmass. The temperatures are warmer in the southern parts of India. It gets colder as one moves up north.

In very cold places such as kashmir, Sikkim. etc. people leave the water heaters on throughout the day and night.This water can be used to attain that amount of heat even on the squatting footrest while defecating.

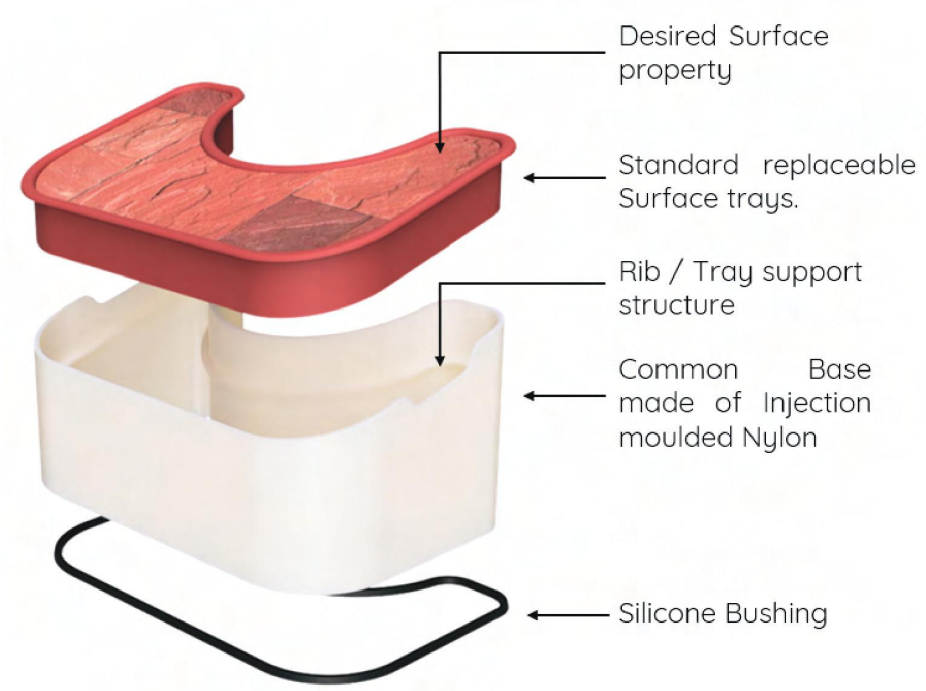
On the other hand, in hotter parts of the country, the people always seek a temporary relief from the extreme heat. In these parts the squatting fooyrests can be used to provide a sense of coolness to the feet.

These act as a haptic feedback to the feet surface that also provide pleasure to the body since the users are achieving a sense of relief in using the product.

Fig.116. Toilet stool concept.

This concept is a toilet stool with a clean and elegant design. It consists of modular replaceable trays that can be replaced as per season , or need.

Haptic Footrest - Concept



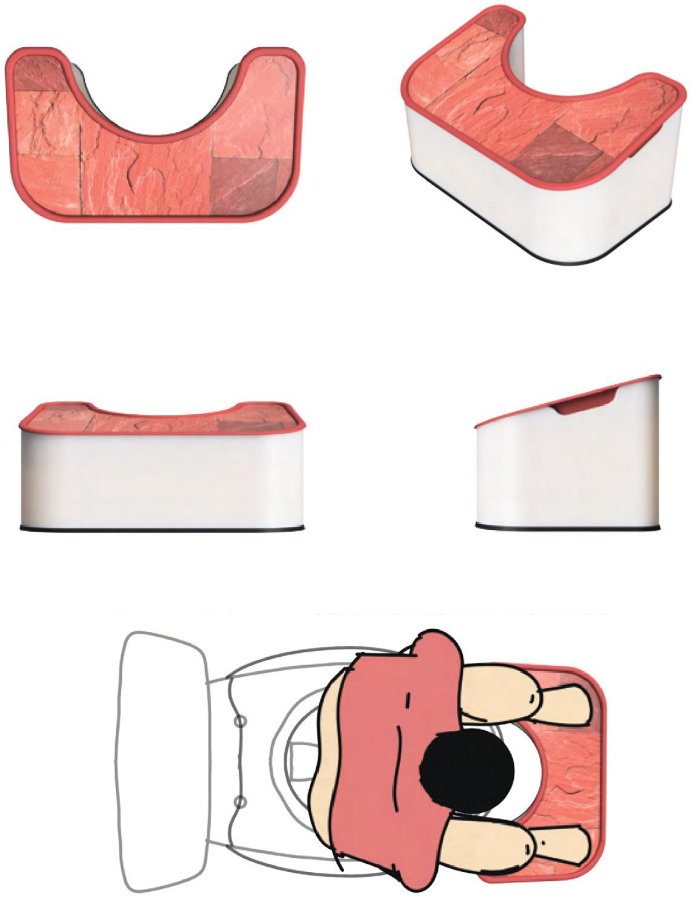
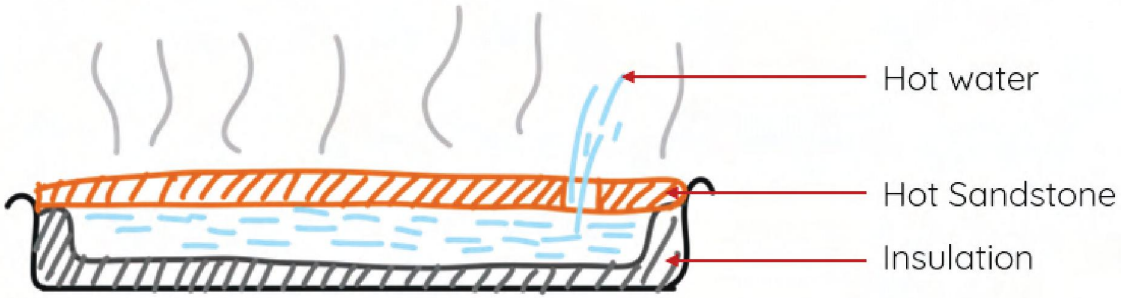


Fig.117. Assembly drawing & views - Footrest concept

Haptic Footrest - Concept

Sandstone Summer

Meant for very cold climates where hot water is readily available. The Red sandstone conducts the heat to provide warmth to the user's leg.

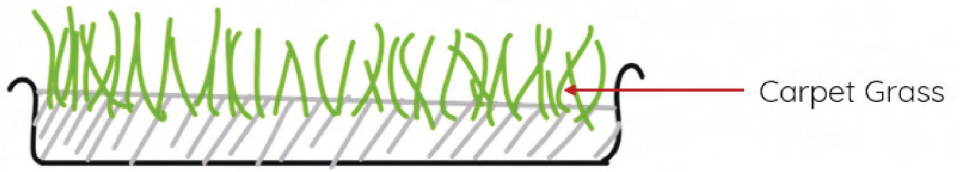


Haptic Footrest - Concept

Green Meadow

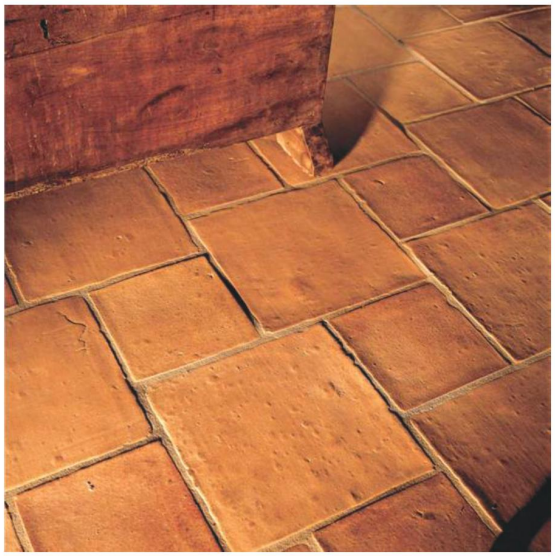
Everyone loves the touch of the cool green grass on their bare feet.

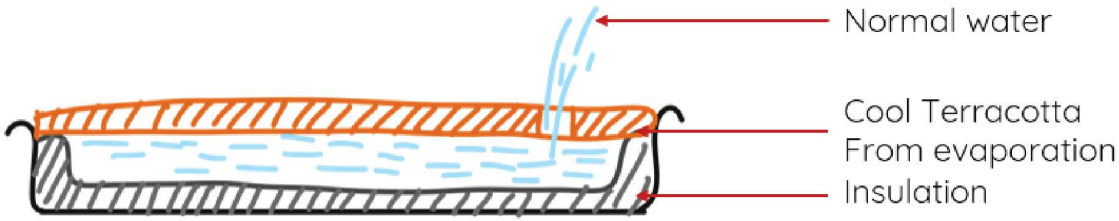
The Green Meadow provides the soothing experience while you unite as one with nature



Haptic Footrest - Concept

A Kiss of Clay



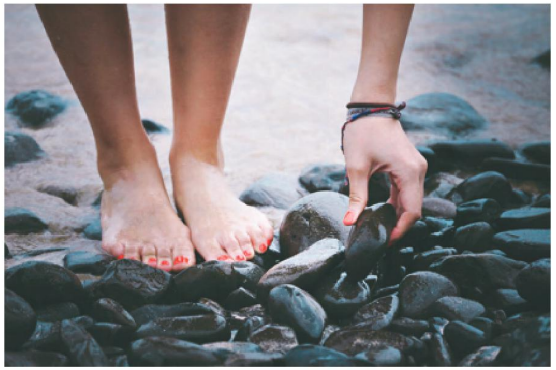


Meant for the warm summers brazen with the blazing hot sun.

The cool surface of terracotta and water provides a temporary relief.

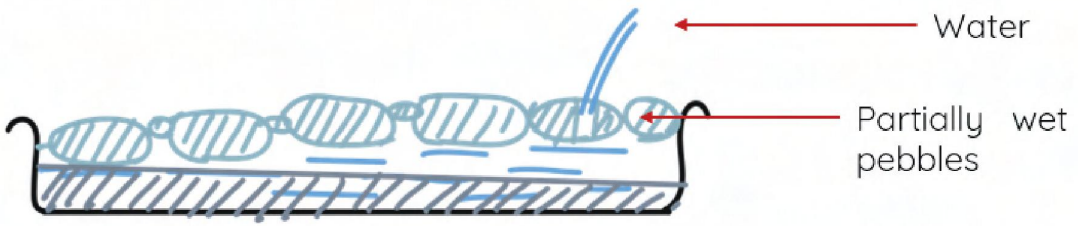
Haptic Footrest - Concept

Stony Creek



A subtle play of dry and wet, intertwined with a balance of pleasurable pain.

The stony creek leaves you with the feeling of a pleasurable massage by the creek



Conclusions

The above design has successfully implemented the features of Design for human sensory perception & a modular tray concept.

It has been able to provide an ergonomic squatting posture at the given height. This modular tray concept follows the pattern of a squatty potty stool. which enables it to be pushed under the commode when not in use. The design is also non-intrusive in nature.

But the only value addition this design provides over the squatting stool in the market is the haptic feedback and a clean formal aspect.

One of the requirements, that this design does not fulfil is the support handles as a part of the squatting aide.

Thus, more explorations in terms of redesigning the footrest in a formal aspect & including features of flexibility such as the height adjustments, angle adjustments needs to be done.

Market Study on Existing Footrests

Fig.116. Existing footrest products in the market

Inferences from footrest market study

The above design has successfully implemented the features of Design for human sensory perception & a modular tray concept.

It has been able to provide an ergonomic squatting posture at the given height. This modular tray concept follows the pattern of a squatty potty stool. which enables it to be pushed under the commode when not in use. The design is also non-intrusive in nature.

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Thus, more explorations in terms of redesigning the footrest in a formal aspect & including features of flexibility such as the height adjustments, angle adjustments needs to be done.

Final Concepts

After further Ideations on

- Adjustability Mechanisms
- Forms
- Materials

Three promising Concepts were finalised

Final Concept 1 - Sheet metal Bent Base

This concept consists of a bent sheet of Aluminium into which the modular leg rest board can slide into.

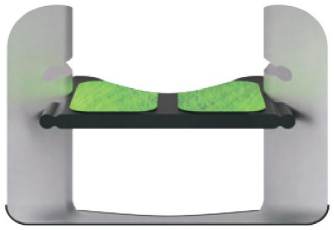
The other variations of this concept are as follows :

Sandstone summer

Green Meadow

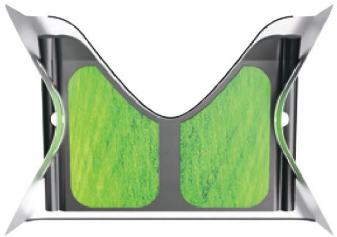
A kiss of clay

Final Concept 1 - Views

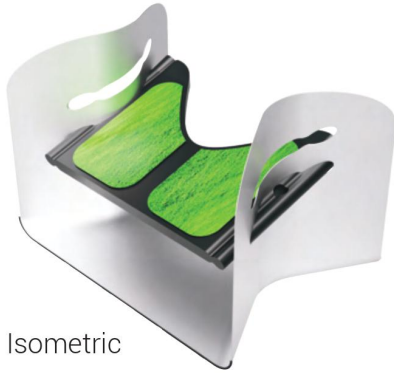


Front

Side



Top



Isometric

The setup can be moved under the commode when not in use. This enables it to become non intrusive in nature.

Final Concept 1 - Basic Details

Can be slid out and changed slot

The sheet metal is bend to provide a rib-like support on the sides to prevent buckling.

It can be placed at 2 heights, 7" & 9" from the floor.

Rubber Beading to ensure grip between the setup and the floor.

Sheet Cross section of the slot into which the leg rest is slid into.

The board has an outward conical draft so that it can lock itself into place inside the slot.

Final Concept 2 - Y-shape cast footrest

This concept consists of Y-shaped cast Aluminium structures that can slide into one another. They are locked onto one another via ball snaps. The footrest board can be slid on & off the structure.

The other variations of this concept are as follows :

Sandstone summer

Green Meadow

A kiss of clay

Final Concept 2 - Views

The setup can be moved under the commode when not in use. This enables it to become non intrusive in nature.

Front

Side

Top

Isometric

Final Concept 2- Basic Details

Can be slid out and changed slot

The Y-shaped structure is build such that the centre of gravity lies in the middle of the U area. This ensures that the model does not tip over when used.

It can be placed at 2 heights, 7" & 9" from the floor.

Slot on the footrest to insert into metal cast base

Slot to insert footrest into

Rubber Bushing to ensure grip to the floor

Rubber bushing base under the metal cast structure.

Final Concept 2 - Basic Details

It can be placed at 2 heights, 7" & 9" from the floor.

Ball snap lock for height adjustment

Sectional view detailing for ball joint

Final Concept 3 - Tubular sliding footrest

This concept consists of Bent Tubular Aluminium pipes onto which the flat footrest board can by slid into . This design can change in both angle (continuously) and in height. (7" & 9")

The other variations of this concept are as follows :

Sandstone summer

Green Meadow

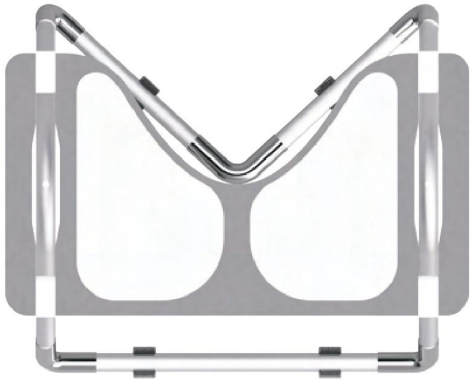
A kiss of clay

Final Concept 3 - Views

The setup can be moved under the commode when not in use. This enables it to become non intrusive in nature.

Front

Side



Top

Isometric

Final Concept 3 - Basic Details - Movement

Can be slid out & slid in easily vertically

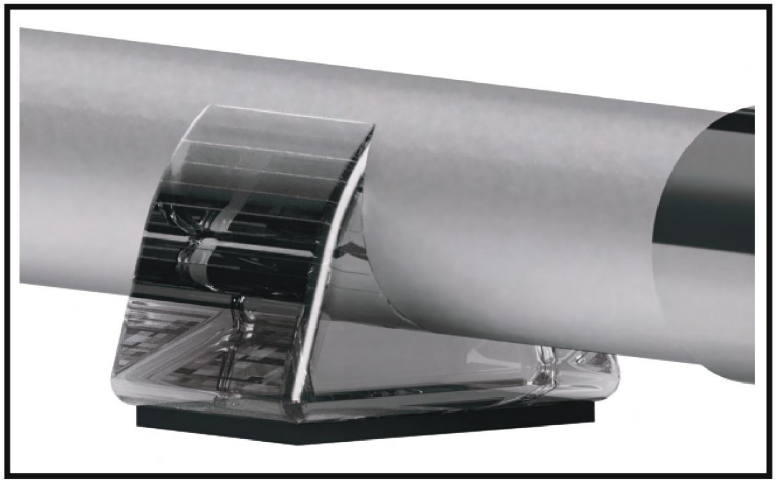
The Y-shaped structure is build such that the centre of gravity lies in the middle of the U area. This ensures that the model does not tip over when used.

It can be placed at 2 heights, 7" & 9" from the floor.

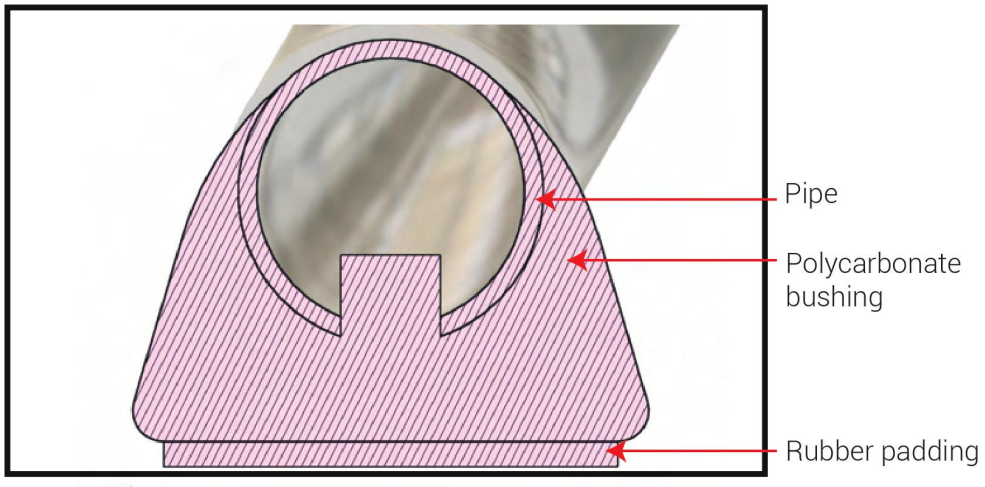
The rotational motion at 7" height of toilet

The rotational motion at 9" height of toilet

Final Concept 3 - Basic Details - Floor Bushing

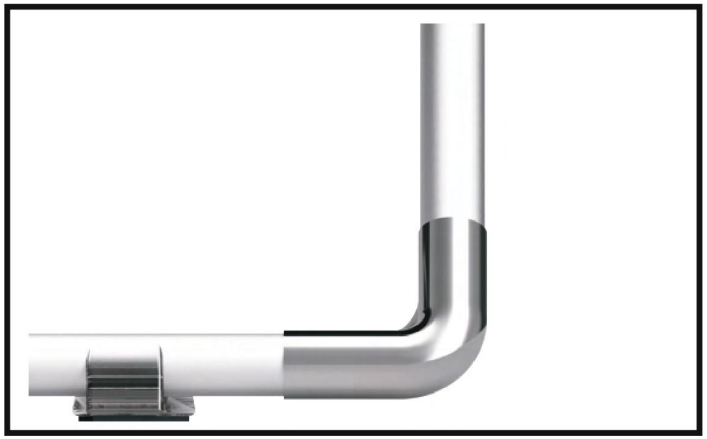


Polycarbonate snap fit bushing with a rubber padding stuck to the bottom for better flat grip.

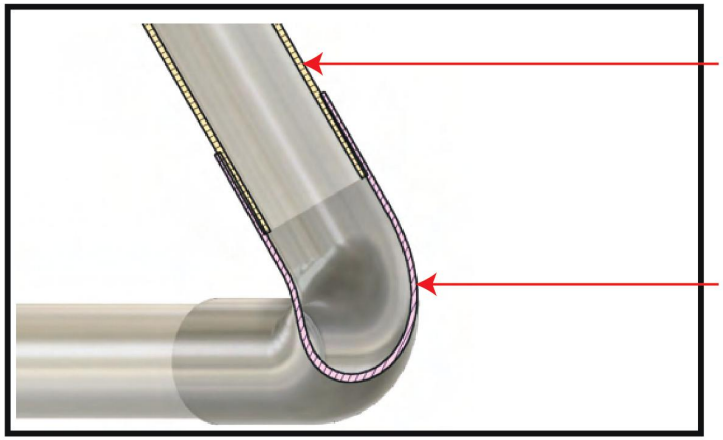


The PC bushing has an extrusion that runs into a hole on the pipe to hold it vertical.

Final Concept 3 - Basic Details - Corner Joints



90 degree corner joint that connects the bent tube to horizontal flat tube.

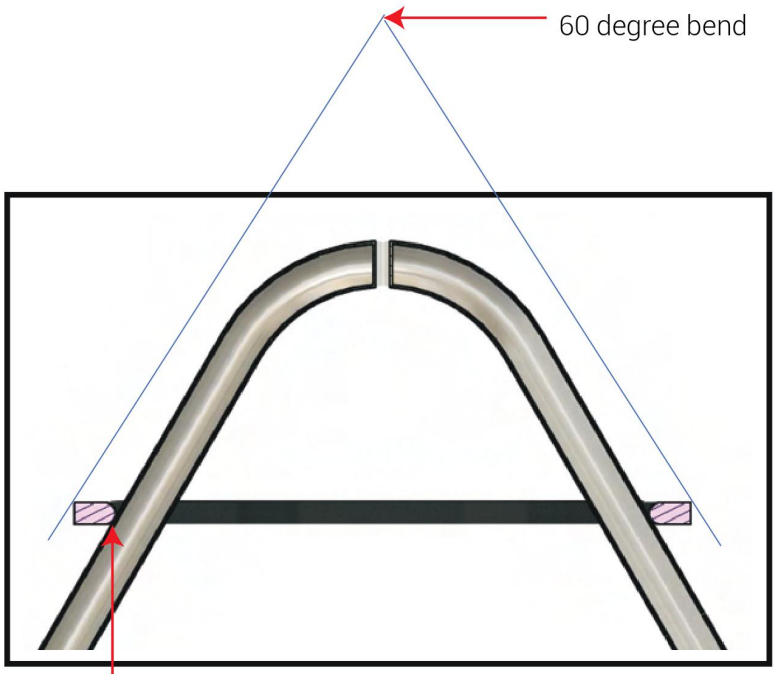


All the pipe fittings are tight fit with very close tolerances to their respective joints

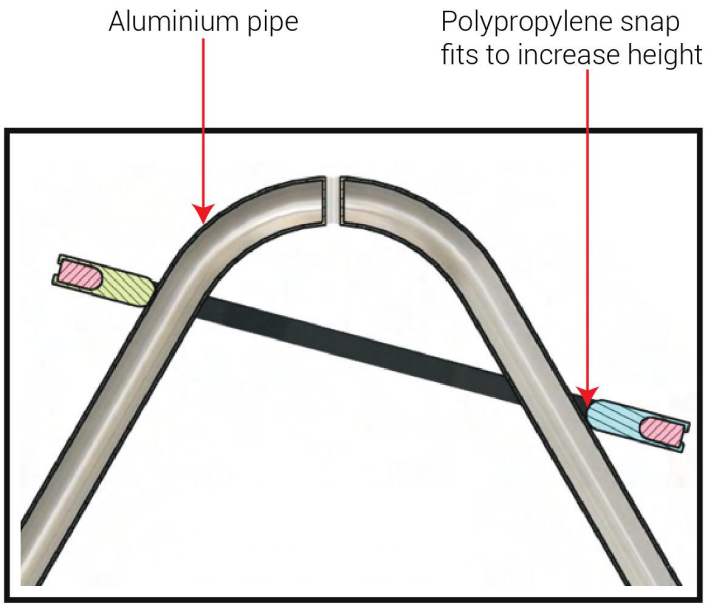
90 degree fitting for the V-joint

70 degree pipe fitting for U bend and V bend pipe.

Final Concept 3 - Basic Details - Board to Pipe contact



Round corners of the slot in the board (at 7")



Point contact at the board and U bend joint for free movement.

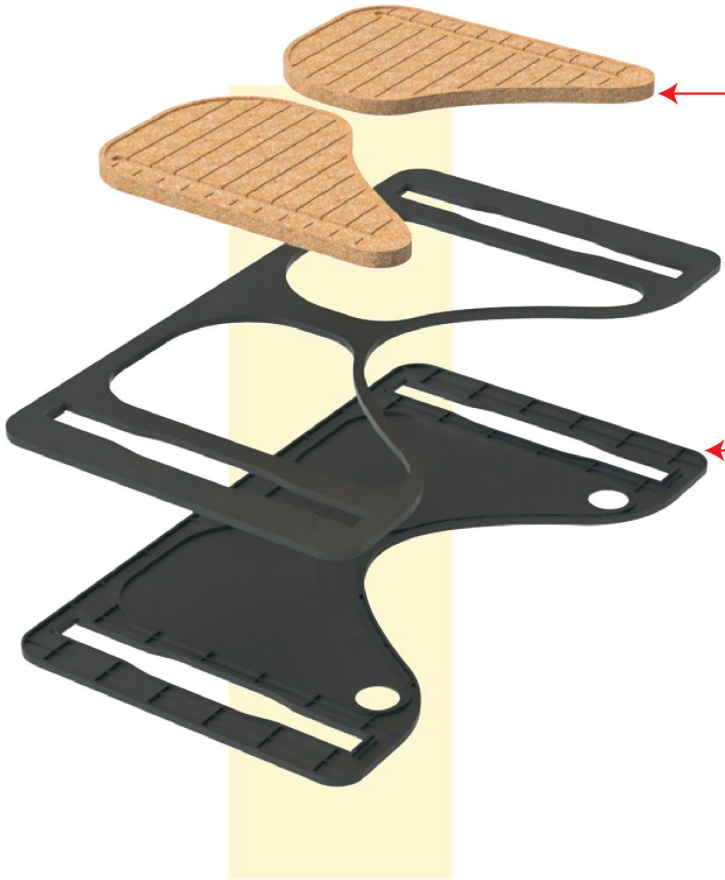
Analysis- Selection of final concept

Criteria	Final Concept 1	Final Concept 2	Final Concept 3
Angle Changeability	No	No	Yes
Height Changeability	Yes	Yes	Yes
Ability to add geriatric handle	Yes	No	Yes
No. of Components	5	8	16
Standard Parts	N/A	N/A	9
Potential Cost	Lowest	Highest	Medium
Potential Weight	Medium	Highest	Lowest

Hence Based on this evaluation, **Concept 3** has most features & uses the maximum number of standard parts, thus making the cost lowest. This concept is thus selected.

Final Concept 3 - More Details - Footrest Tray Design

The tray is the region on which the foot is placed. This component is to be manipulated in angle and in height. The tray consists of two parts. The modular tiles onto which the foot is placed. These tiles are interchangeable. And the Polycarbonate base onto which the tile is placed.

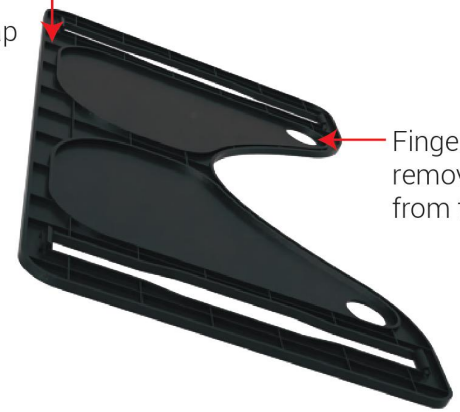


Modular Tiles made of materials like sandstone, marble, terracotta, wood veneer, grass .etc

Polycarbonate top snap fit to the bottom half of the tray

Bottom half of the tray snap fit to the top half

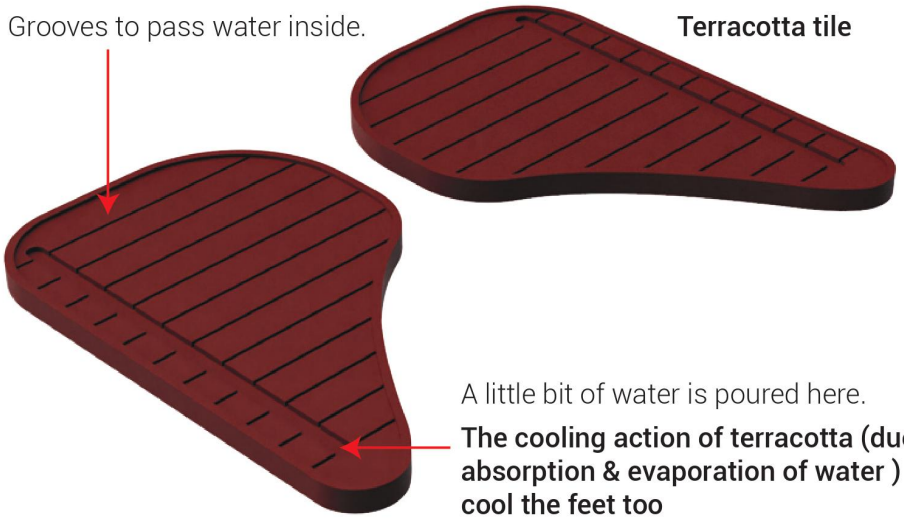
Cross ribs to support the flat region of the tray mould



Finger hole to remove the tile from the tray

Final Concept 3 - More Details - Tile Details

This is the detailing that is given to the heating type tray which can be used in hot or cold regions. Teracotta is used as the material in hot regions and sandstone is used as the material in cold regions. When cold and hot water respectively is poured on it. The water distributes itself across the span of the tile and cools or heats the users feet, respectively. They are replaceable with other tiles as per the user's desire.



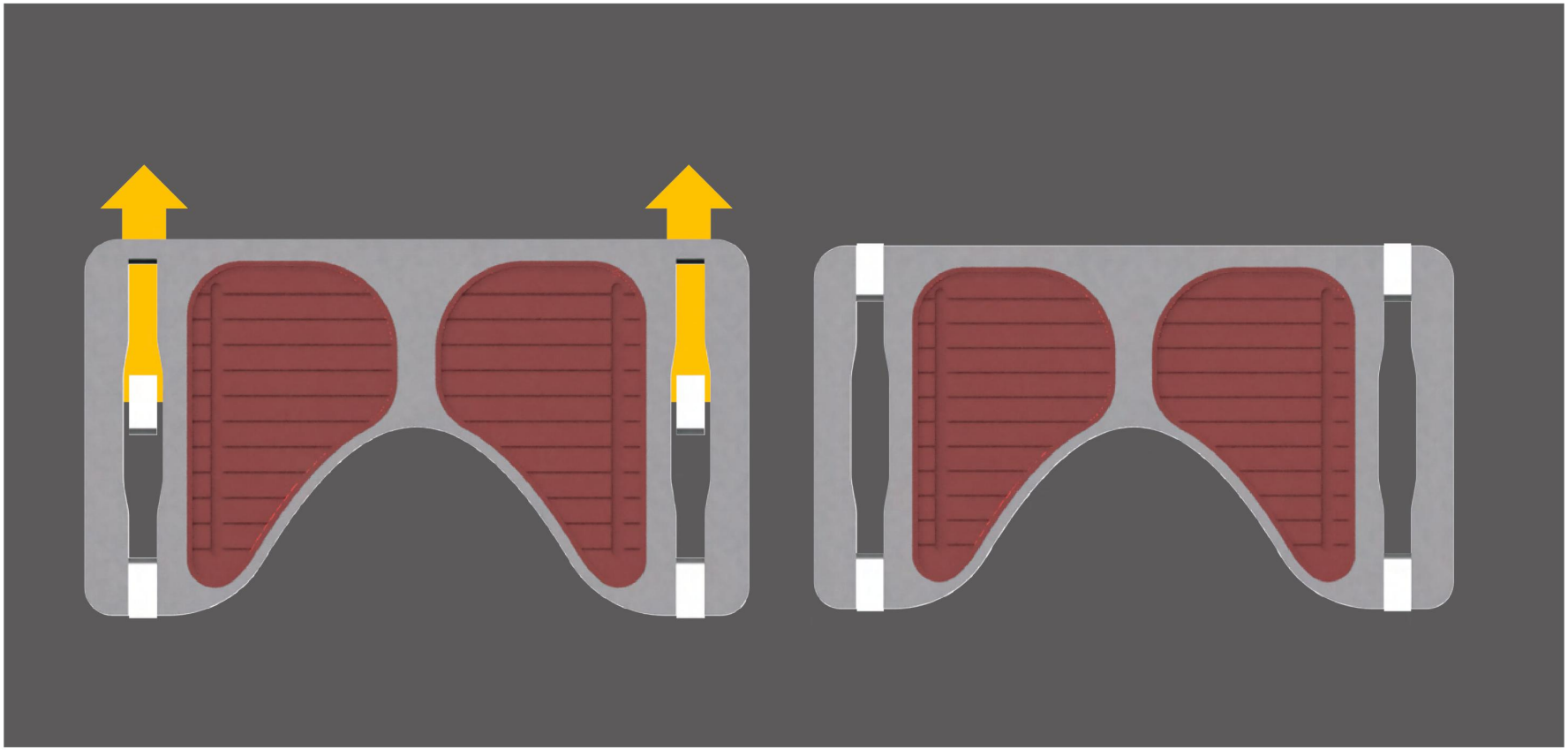
Grooves on the tile

Modular Tiles made of materials like sandstone, marble, terracotta, wood veneer, grass .etc

Wood – Veneer finish

Sandstone – Heating

Final Concept 3 - More Details - Snap Locks



Polycarbonate Snap Locks are used to increase the height of the tray on the U bend from 7" to 9"

Geriatric Handles – Market study

Since, the customization of the adjustable footrest for geriatric needs was also a part of the design brief, a brief market study on the types of geriatric handles (used in restrooms) that are used to support disbled/ elderly people was done.





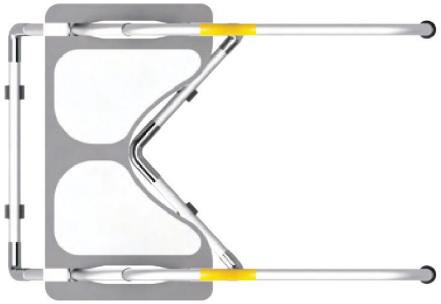



Final Concept with geriatric Handle

An ergonomic study was not done for the geriatric purposes.
Hence this model is purely an intuitive concept.

Front

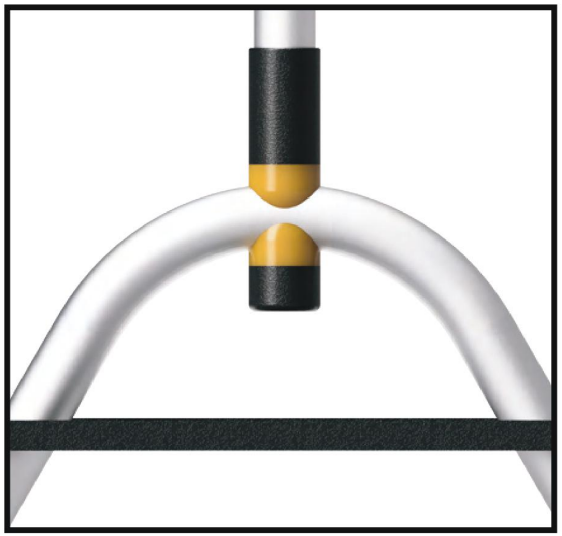
SIde



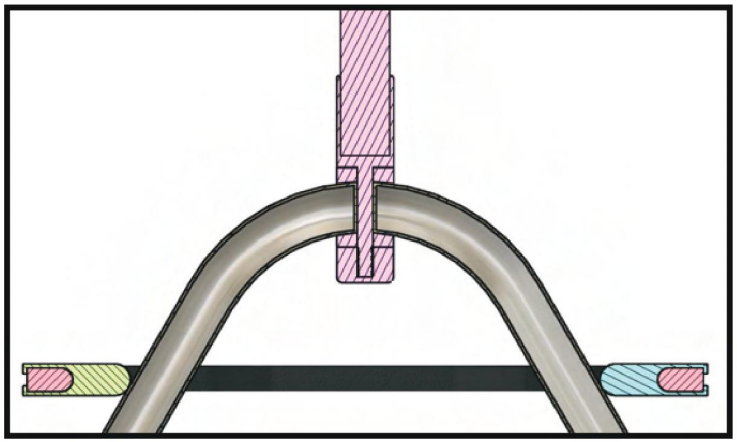
Top

Final Concept with geriatric Handle

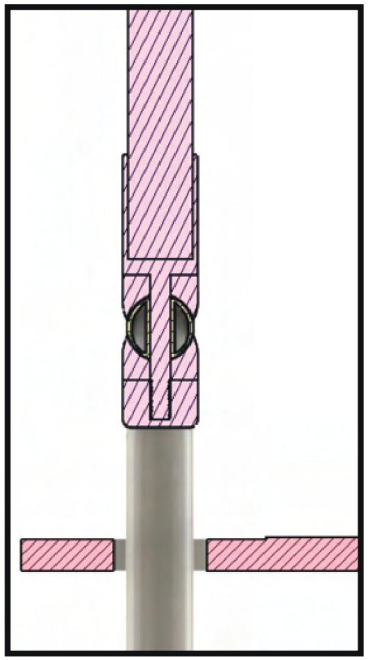
Final Concept 3 - Basic Details - Footrest to Pipe contact

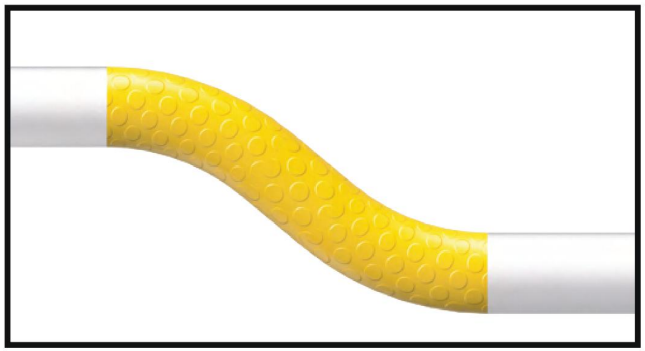


The handle end consists of a Polycarbonate screw. The Yellow washer is cast specially for this product to prevent the handle from swivelling sideways



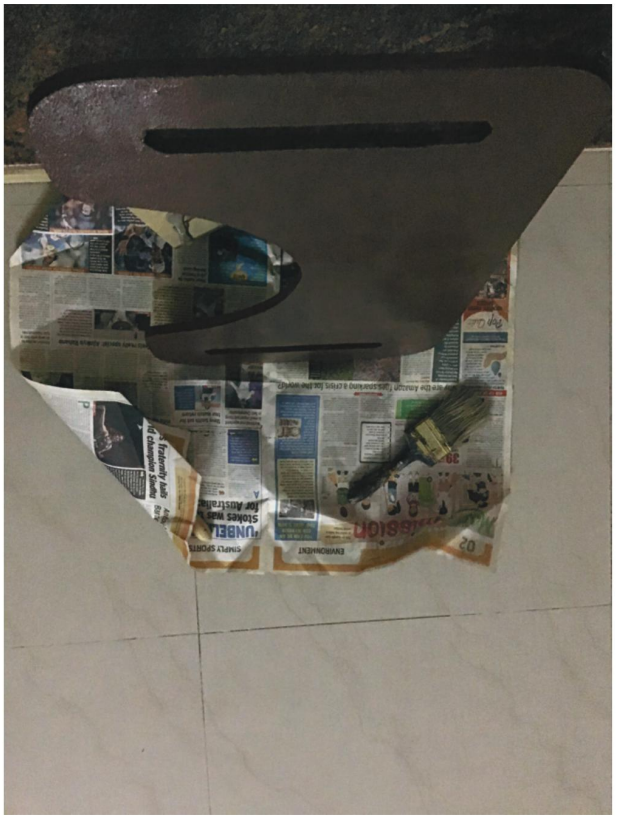
Handle to U bar of the footrest - Fixture details





A silicone grip is used to enable people to hold on to it as they get up or sit on the commode

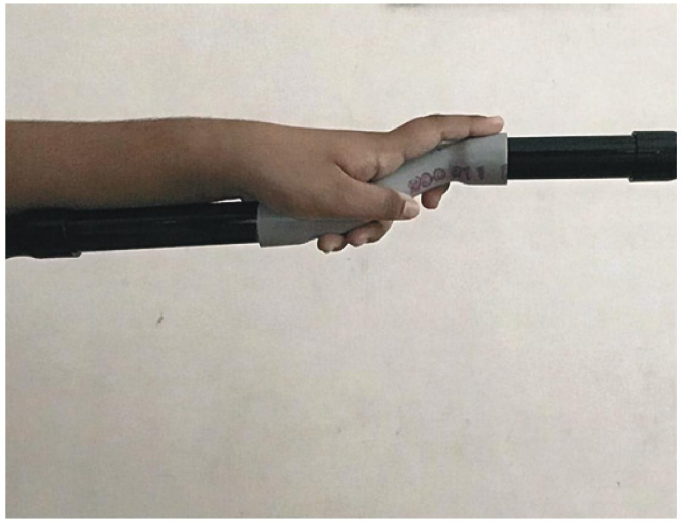
Final Concept - Mockup



A usability mockup of the final concept was made with the geriatric handle to test the flaws and improvements in usabilty. The model dimensions are made for convenience and based on availability of standard parts – not to exact dimensions

Final Concept - Mockup





Pipes were used to create the mockup. A wooden board was cut into shape and a grass top finish was given to the tiles

Final Concept - Mockup

Final Concept - Mockup

The mockup was placed in a toilet and was tested for usability.

Conclusion & Future Scope

The mockup that was made (though not to dimensions) showed us that there were several flaws to the design.

The geriatric handle was not well researched upon and had not been implemented well. The footrest was too large when compared to the size of a real-time toilet which could prove to be intrusive when used in small toilets. Hence, the size of the product needs to be redefined.

Improvements can also be made as far as the aesthetic appeal of the product is concerned.

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