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R·I·T

**“Hoilet System”— A Way to Improve Experience in  
High Traffic Female Public Restrooms in the U.S**

Kaining Qiu

A Thesis Submitted in Partial Fulfillment of the Requirements for  
the Degree of Master of Fine Arts in Industrial Design  
School of Design | College of Art and Design

Thesis Committee:

Alex Lobos (Graduate Director)

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Rochester Institute of Technology

Rochester, NY

Jul 29, 2018

## **Abstract**

This paper focuses on improving the experience of women using high traffic public restrooms in the U.S. By looking into the past studies on the insufficient numbers of ladies' rooms provided under building codes and the lack of accommodations for multi-tasking, with further research on public restroom cleanliness and personal privacy, this paper proposes that all four of those contribute to an unpleasant experience. At the same time, little has been done to address these problems nationwide and most of the relevant research is out of date. To further understand the overall experience women go through, a survey was conducted and analyzed. The results highlight concerns on cleanliness and skin contact, the need for accommodation on tasks other than elimination, and the compromise of privacy in a public environment. These unmet need also are related to the delays in use and waiting time. By concluding these findings, this paper argues that it is the lack of research and investigation which impedes the progress of both design and legislation. Therefore, this paper poses that: first, further study is needed on what contributes to these factors in public restrooms and how it could be applied to the redesign of the public restrooms, thus a fundamental research base could be provided for legislators, designers, and architects; second, a clean and convenient public toilet design, "Hoilet System", could be applied in public restrooms to address these problems.

## **Keywords**

**Ladies' Room, Public Toilet Design, High Traffic Public Spaces, Female Experience, System Design**

## **Introduction**

What makes women spend more time in public restrooms? Why is it usually complained about?

It was inferred from former research that the waiting might be due to a longer elimination process and multiple tasks performed inside the restroom. These persist even when there have been changes to building codes where the number of ladies' rooms to men's increased (almost double). The tests conducted for this paper along with former research also point at the factors of privacy and cleanliness, and how they affect women's experience in public restrooms negatively. Designs concerning these issues, like standing urination products, squatty-potty, Japanese public restrooms, etc. are evaluated. Gender-neutral restrooms and family restrooms are investigated for a wider perspective. Progress and setbacks in legislation are also discussed.

By concluding these findings, this paper points out the need for further study in discovering the contributors to the overall unpleasant experience, and how it could be addressed for redesign and replanning of the public restrooms. Based on its survey and testings, the paper presented the development of a new public restroom system, 'Hoilet', to offer a possible solution on minimizing the unpleasantness for ladies using crowded restrooms.

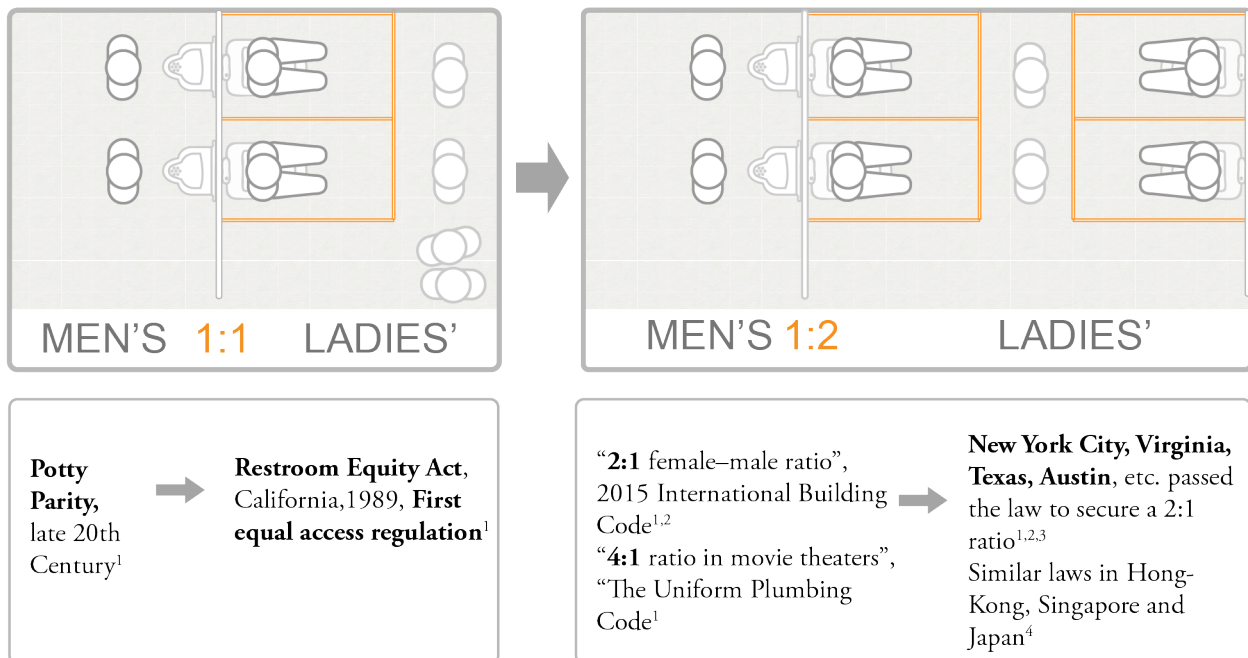
## Why is public restroom experience always unpleasant to ladies?

In public places like shopping malls, schools and airports, females are often seen lining up in front of the restrooms while men usually don't. Reasons behind this situation are complicated in modern society and are being neglected in toilet design and urban planning. They are discussed as follows.

### (1) Insufficiency

By improving the building code on restroom provision from a 1:1 female-male ratio to a 2:1 (or even higher ratios), advancements have been made in providing proper number of public restrooms for ladies in the past decades, especially in urban areas (Figure 1)<sup>1,2,3</sup>.

Figure 1. Advancements in Restroom Building Code



Despite such improvements, researchers suggest that the intention of increasing the ratio, as investigations indicated, is to accommodate the gender differences in time spent and frequency of urination or defecation (Figure 2)

<sup>1,4,5,6,7,8,9,10,11,12,13</sup>, which in their words, is the “elimination”<sup>8,13,14</sup> process. However, most of these research is conducted decades ago and focused solely on the elimination, with some asserting it to be fully responsible for the long lines<sup>4</sup>.



Women on average take **twice or even trice** the amount of time men do for the elimination<sup>7,8,9,10,11,12</sup>

&

Female's physiological characteristics related to excretion would make them **pay more toilet visits**<sup>13</sup>

Figure 2. Gender Differences in "Elimination" Time and Frequency

In addition, for most buildings, toilets being a non-profit setting, are often built in minimal numbers for economical and spatial considerations, hence the minimal-designed building code has become a common standard<sup>4</sup>. High traffic places such as schools and offices were reported to lack in ladies' rooms<sup>15,16</sup>, while others like stadia "stipulated more toilets for men, on the assumption that most sports fans were male"<sup>17</sup>. Such situations sometimes force women in urgent need to use men's restrooms and face embarrassment<sup>4</sup>. Some argue the inequality of accessing restroom is "a form of sex discrimination"<sup>18</sup>. And the newly signed North Carolina Restroom Law, which bans people for using restrooms not in their "birth gender", increased such concern for not only women but other sex minorities as well<sup>19</sup>.

In conclusion, increase in the female-male restroom provision ratio is making progress in some places, but adapting it statewide or even worldwide might face obstacles due to cultural, social, economic and political differences. The need of federal regulations to ensure equitable access is pointed out under "the constitutional equal protection"<sup>18</sup>, while women's lack of resources and government support is also indicated<sup>20</sup>. That being said, a noticeable gap exists between the current improved code and supporting research.

## (2) Multi-Tasking

The design of women's restrooms is problematic in function as it allots one stall for different tasks<sup>13,14, 21,23</sup>.

Motherhood as well as menstruation not only add multiple tasks to this set, but also increases the frequency of use (Figure 3)<sup>13,21,22</sup>.



Figure 3. Ladies' Multi-tasks in Public Restrooms

However, public restrooms are not planned or designed to fully meet those considerations. Changing station is the only regulated installation for mothers by some building codes (2009 ICC A117.1 Accessible and Usable Buildings and Facilities, International Building Code® (IBC), but are not generally a requirement<sup>23</sup>. Recent progress on equity was made by California's legislature which passed a bill requiring diaper changing tables in men's room<sup>24</sup>. With California being the first, others might follow.

Ignorance of women's needs in multi-tasking is argued to be a discrimination<sup>12,25</sup>, and a growing number of legislators, designers, architects are calling for a change and revolution<sup>26</sup>. Rising attention also focuses on family restroom, nursing room and gender-neutral restroom to satisfy the needs for ladies and other gender groups. Along with that, the trend to provide amenities beyond basic need is thriving, as places with high traffic like restaurants, shops and parks are hoping to attract customers with a more satisfactory experience<sup>26</sup>.

## (3) Cleanliness

Cleanliness might be the most important consideration during the use of public restrooms. Dirty floors, foul odors, half-flushed toilets, etc. are not just the signs of lack of maintenance but are potentially a health hazard<sup>27,28</sup>.

However, the default perception of the public toilet being dirty is leading people into even bigger problems. For example, most of the dangerous residing bacteria in public restroom "perish quickly on barren bathroom surfaces"<sup>27,28,29</sup>, and "a functioning immune system" with a cool dry smooth toilet seat altogether act as the excellent

barrier<sup>27,28</sup>. On the other hand, toilet paper and toilet seat cover are more likely to catch bacteria by providing warm and moist environments and could potentially cause bacterial infection than the seat itself would<sup>27,30,31</sup>. However, those two are being used most often to cover the seat, as surveys from Initial Washroom Solutions (IWS)<sup>32</sup> and NY Daily News (NYDN) showed<sup>33</sup>. Some even hover over the seat to avoid direct contact<sup>32,33</sup>, and this position may be unhealthy for bowel movements<sup>27,28</sup>.

These surveys also provide a glance at how people manage to make an extra effort in coping with cleanliness inside public stalls (Figure 4)<sup>32,33</sup>. The seat has been found to get the most attention with cleaning and avoidance in contact.

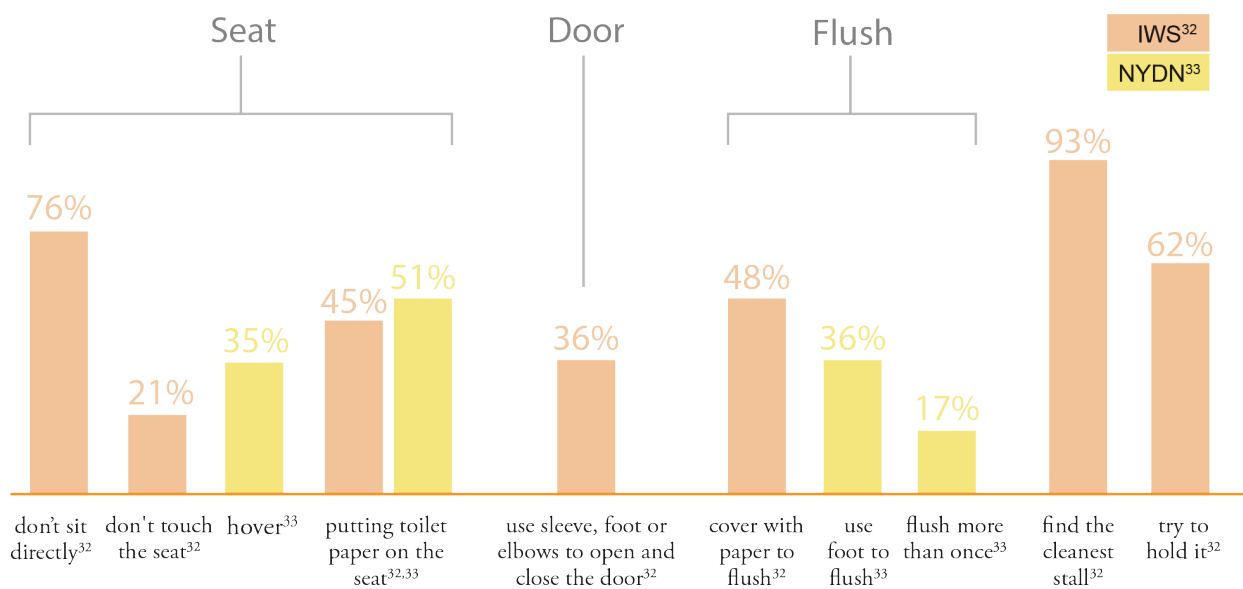


Figure 4. Survey Results on Restroom Tasks by IWS<sup>32</sup> and NYDN<sup>33</sup>

The challenge, thus, relies on how to present a clean restroom both visually and psychologically, by taking ladies' in-stall self-protective behaviors into consideration.

#### (4) Privacy

Another issue that is considered taboo and seldom gets talked about is the privacy. The word “public” already implies that there might be little room for privacy in public stalls beside using doors and walls to avoid being fully seen.



It is noticeable that concerns on privacy were discussed a lot in the online community like Quora, Reddit and BuzzFeed, where people sometimes made fun of huge gaps in restroom doors and editor Edds concluded it to be “a real and terrifying danger for mid-poo eye contact”<sup>34</sup>.

Research has not gone far enough to investigate privacy factors such as sensory feelings in using public restrooms and it might take further understanding to fully explore the experience and to make a change.

## Study: Survey

To gain more insight on the tasks ladies undertake and what they feel and when using a public restroom, a survey was conducted. A questionnaire, first, broke down a bathroom trip into thirteen tasks (Figure 5). Participants were asked to record each tasks with their way of doing it, their feelings towards it and the time taken to do it.

**Questionnaire on Tasks Ladies Perform in A Single Public Restroom Trip**

1. What do you do in a single restroom trip and how long do they take?

Tasks	1	2	3	4
	Walk In	Close the Door	Lock the Door	Store Belonging
Time(s)				
What you do				
How you feel				
Tasks	5	6	7	8
	Wipe the seat	Cover the seat	Undress	Sit down
Time(s)				
What you do				
How you feel				
Tasks	9			
	Elimination #1 Urinate	Elimination #2 Defecate	Hygiene Product Changing	Others
Time(s)				
What you do				
How you feel				
Tasks	10	11	12	13
	Wipe	Dress	Flush	Leave
Time(s)				
What you do				
How you feel				

Feelings you might have: uncomfortable, unpleasant, meh it's fine, happy, relief, awkward, surprised, angry, unsafe, ANYTHING!

2. If there are other tasks you do besides those in the chart, name them and record the time as well.

3. Of all the tasks you perform, what are the 3 most time-consuming tasks and why?

Figure 5. Questionnaire on Tasks Ladies Perform in A Single Public Restroom Trip

From a dozen subjects, ten responses were collected to better understand user behavior pertaining to public toilets, though this is a small sample set - this lays ground for the design to be developed from.

The result is visualized in Figure 6, which shows: the top three most time-consuming tasks; the ones that might take longer if certain needs are not met, and/or negatively affect the rest of the process. Further analysis and interviews were conducted on these specific tasks with results concluded in Figure 6-A and Figure 6-B.

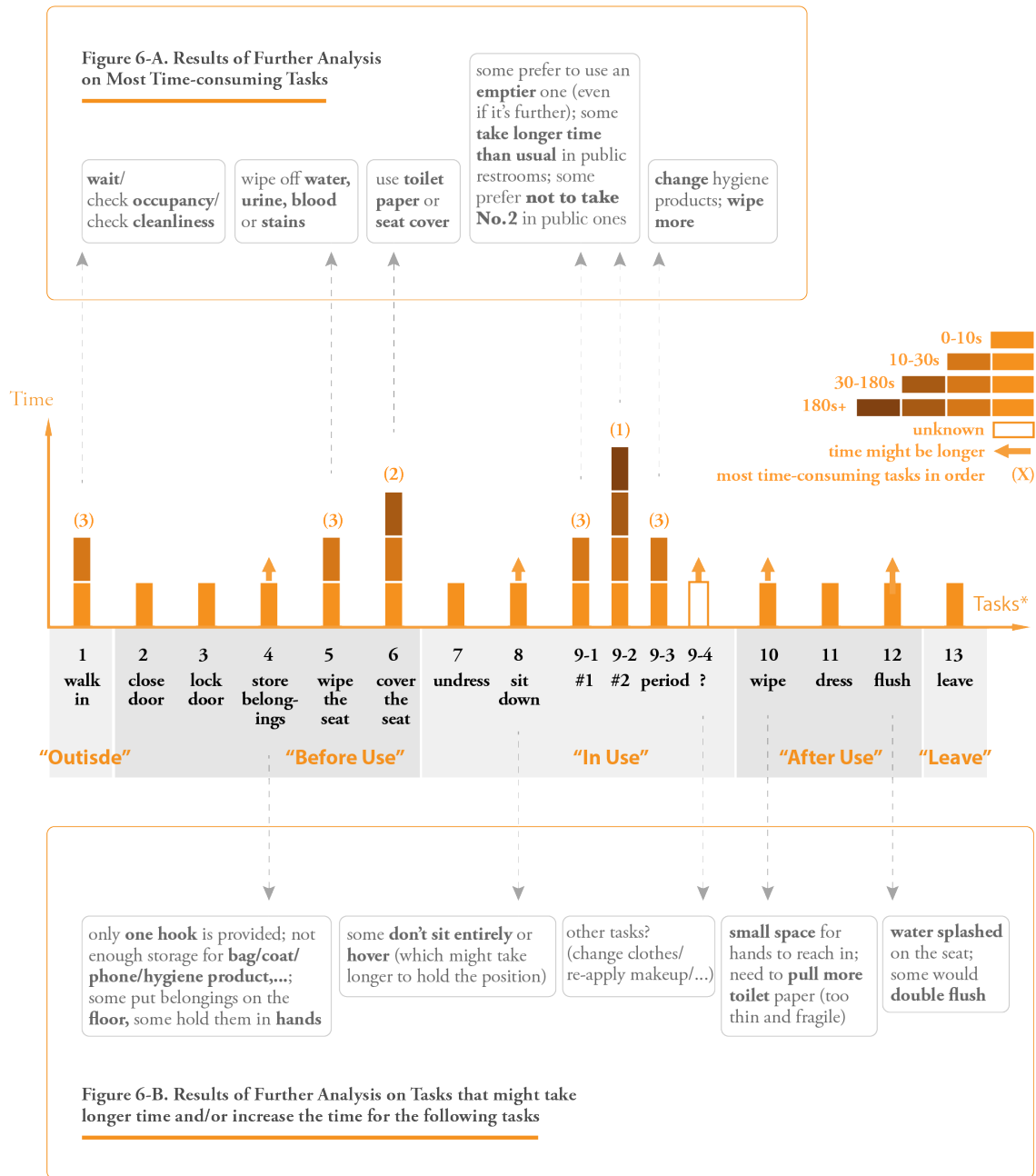


Figure 6. Results of the Questionnaire on Tasks Ladies Perform in A Single Public Restroom Trip (By Author)

Figure 6-A indicates that respondents, in general, spent most of the extra time in cleaning and also finding the “right” spot for “Elimination”. Menstruation, a task which includes cleaning and changing adds a considerable

amount of time as related needs are not met in the stall. Figure 6-B shows how other tasks besides the core purpose, such as storing (#4) and sitting down (#8) could add up to the unpleasant experience.

In terms of users' feelings, further interviews revealed that participants, in general, avoided unnecessary contact and were cautious of being heard or noticed so as not to be embarrassed. This factor of embarrassment also relates to the behavior of opting for less crowded restrooms.

The analysis of the questionnaire results is shown in a restroom trip map below (Figure 7), with the most time consuming and effort taking tasks pointed out.

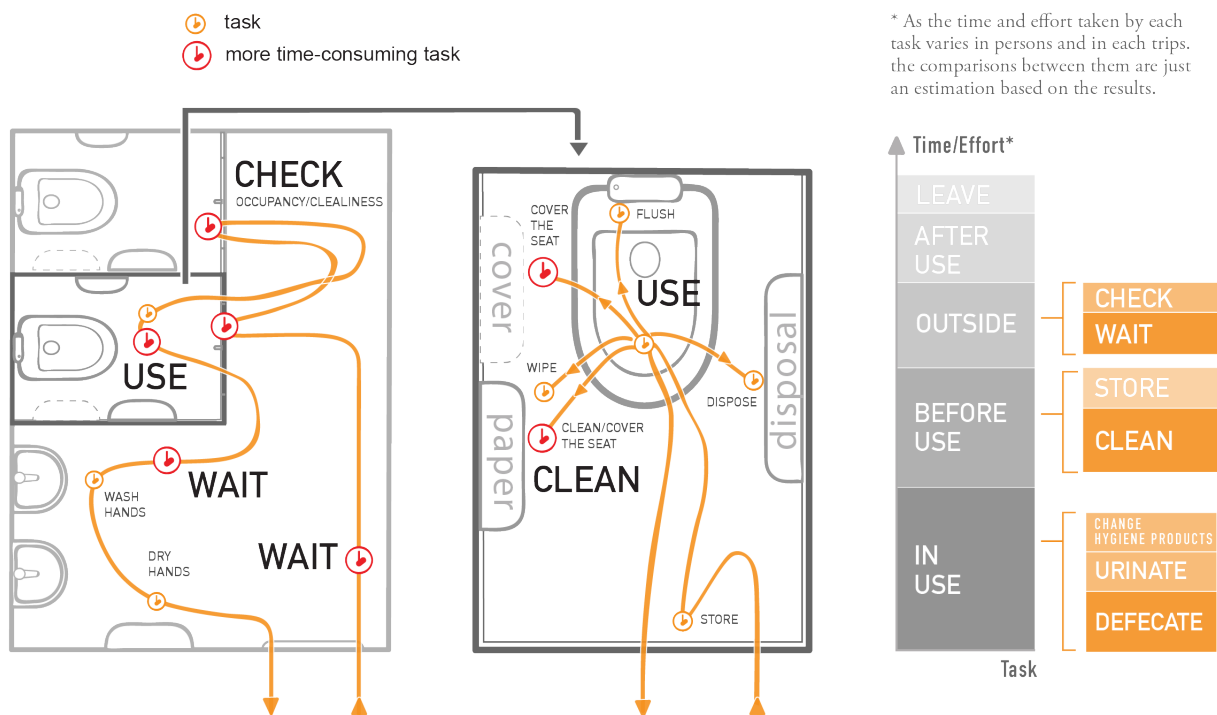


Figure 7. Results of the Questionnaire Analysis Shown in A Restroom Trip Map

It is obvious that a single trip consists of multiple tasks that intertwine with and affect each other. Therefore, to improve the overall experience and decrease the time in each use, focusing on the most problematic areas of the restroom space and addressing the most concerned issues in use would be more efficient while having a generally positive effect on the rest of the trip. Based on Figure 6 and Figure 7, these factors could be concluded in Figure 8. The main areas could be visualized in three states: In Use, Before Use, and Outside. And the main issues\* could be generally concluded as Cleanliness and Conveniency. Possible solutions lie among those areas while those main concerns are addressed, providing directions for future design.

MAIN AREAS		MAIN ISSUES	CLEANLINESS	CONVENIENCY
IN USE		ELIMINATION	<b>POSSIBLE SOLUTIONS!</b>	
		PERIOD		
BEFORE USE		STORE		
		CLEAN		
OUTSIDE		CHECK		
		WAIT		

Figure 8. Main Areas and Main Issues to Address in A Single Restroom Trip

*\* Even though privacy is also a crucial concern indicated in the questionnaire, the author did not include it as the main issue compared to the significance of the other two.*

## **Current Solutions**

Apart from the progress in legislation to provide more ladies' rooms or regulation on certain installations, other solutions that satisfy more needs and help improve the experience are also presented.

### **(1) Standing Urination**

Gershenson in his study mentions an “1898 London public Lavatory Planning with female urinettes” which required standing and attributes products to work with such stalls like P-mate, FEMMETM pissoire, and FEMME P-system Pants<sup>35</sup>. He points out women's unwillingness to use them might be “out of fear, distaste”, and calls for the “rethinking of the female toilet” that can challenge the fixed assumptions about “proper female behavior” and pushes against “collective expectation”, which further affects “new objects or conventions of behaviors”.<sup>35</sup>

Although being controversial and hard to implement, supports are shown towards such solutions through high rating standing urination products sold on Amazon like Shewee and GoGirl.

Author Anthony suggested that with standing position initially aiming to make up for the insufficiency, it “has not become widespread enough to affect policy formation”<sup>12</sup>. But such approaches have been gradually adopted in outdoor environments and also in avoiding direct contacts with dirty public toilets. The emergence of these products indicates a growing willingness among ladies to break out of the convention, thus hinting at future trends.

### **(2) Re-planning Space**

Re-planning the space has been proposed by designs like Gentolet (2014 Red Dot Award Winner), a “unisex public toilet module”, which serves both sexes with privacy and security and “increases the rate of cubicle use”<sup>36</sup> by putting an innovative challenge on the current building codes.

### **(3) Restroom for other sexes/needs**

The call for gender-neutral restrooms has been put forward for long and a revolutionary move towards it can already be seen through the increased provision of nursing rooms, family restrooms and unisex restrooms in airports, shopping malls, restaurants and colleges<sup>12,37</sup>.

A recent case drawing serious attention is the new Target restroom access rule that lets people opt for the bathroom of their choice, with a boycott followed claiming this as a reckless move<sup>38</sup>. The policy takes a jump from providing

unisex restroom to granting access to people to use binary restrooms freely. Its massive boycott indicates that decision-makers need to find a balance between inclusion and safety.

#### **(4) Occupancy Monitor**

Numerous guidance systems outside the stalls have been suggested, one being, a provision of better instruction from the employees working at an institution<sup>39</sup>. Other high-tech methods already in use include the realtime occupancy monitor on the Taiwan MRT Metro<sup>40</sup> and the occupancy light doors in Japanese highway public restrooms<sup>41</sup>.

Compared to slowly evolving building codes, these solutions are quicker to implement.

#### **(5) Privacy**

Products like Stall Stopper®<sup>42</sup> secure broken doors while “privacy strips”, attachable long plastic narrow strips, provide “cover” by sealing the gaps between doors. Others go beyond function and approach the problem differently via sensory stimuli. A successful marketing example is Poo-Pourri (Figure 9), a portable fragrance spray which traps unwanted odors. Another such design gaining prevalence in Japan, named “Sound Princess”<sup>44</sup> (Figure 10), produces flushing water sounds to provide aural cover, and is now used with bidets in nearly every modern public toilets in Japan<sup>45</sup>.

#### **(6) Cleanliness**

To save on time and cost, many modern toilets employ innovative methods to reduce maintenance. Chicago O'Hare Airport's toilets with automatic-changing plastic seat covers have served for 17 years (Figure 11). Other similar approaches include a Japanese street toilet with a self-cleaning seat<sup>46</sup> and a futuristic Two-In-One Turn-Around Loo<sup>47</sup> with UV and heat disinfection system.

Although initially with a high cost, such implementations indicate a more advanced and automated system in public service and infrastructure.

#### **(7) Domestic Toilets**

Domestic toilet design such as washlets/bidets from TOTO (Japan) and Duravit (Germany) are also worth looking into as they value aesthetics, comfort, cleanliness and privacy thus providing better user experience beyond basic functions.

## (8) Asian Style Toilet

Although being cleaner and enabling better bowel movement, Asian style/Eastern style squat toilets never gained traction in the west because of the apparent ‘difficulty’ in use which challenges the traditional sitting position. A move towards this is the Squatty Potty which provides a stepping stool to use with sitting toilets.

By comparing eastern and western cultural conventions around toilet use, interesting avenues could be explored using the best of both worlds.



Figure 9. Poo-Pourri

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[https://c1.staticflickr.com/8/7494/15564494714\\_09016c5ed6\\_o.jpg](https://c1.staticflickr.com/8/7494/15564494714_09016c5ed6_o.jpg)

Figure 10. Japan - Japanese Toilets (9982742145)

By Maya-Anaïs Yataghène from Paris, France (Japan - Japanese Toilets) [CC BY 2.0 (<http://creativecommons.org/licenses/by/2.0/>)], via Wikimedia Commons

[https://upload.wikimedia.org/wikipedia/commons/a/a2/Japan\\_-\\_Japanese\\_Toilets\\_%289982742145%29.jpg](https://upload.wikimedia.org/wikipedia/commons/a/a2/Japan_-_Japanese_Toilets_%289982742145%29.jpg)

Figure 11. High-tech toilet with automated plastic toilet seat cover in Chicago O'Hare International Airport

By Nskrill (Own work) [Public domain], via Wikimedia Commons

High-tech toilet with automated plastic toilet seat cover in Chicago O'Hare International Airport



## Conclusion on Findings

In conclusion (figure 12), an insufficient number of ladies’ rooms, lack of functional support for multiple tasks, cleanliness and privacy are four of the most critical issues contributing to the unpleasant experience. First two are greatly bound by legislation and regulations, which would take further study, effort and time to make changes, while the latter two seldom get studied or researched. Therefore, the author surveyed women about their experiences and activities in a single bathroom trip. Results show that possible solutions lie in the states of In Use, Before Use, and Outside if cleanliness and convenience are addressed.

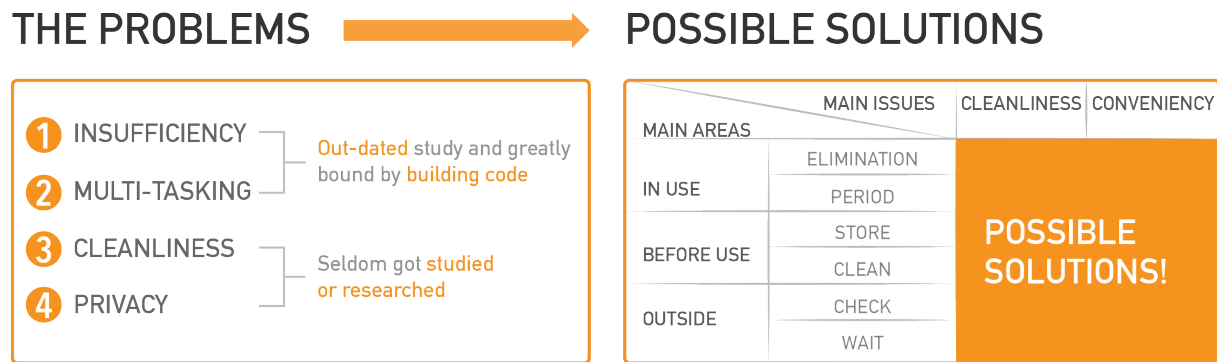


Figure 12. Conclusion on Previous Findings

By looking into the current solutions, innovative and user-friendly approaches are discovered, indicating a call for providing better services beyond the basic needs, setting a trend to challenge convention, while providing inspiration and insights for creating pleasant experience for ladies (Figure 13).

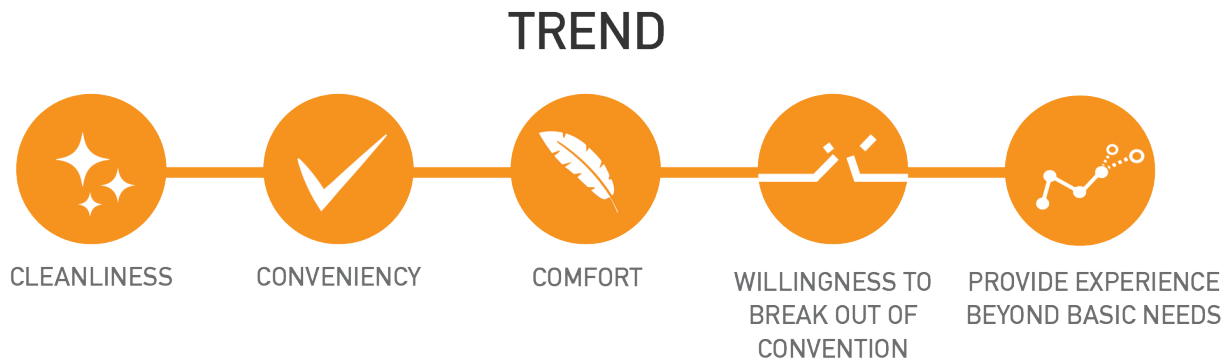


Figure 13. Trends in Restroom/Toilet Design

## Methodology

To develop possible solutions based on the findings, methods in Table 1 were considered.

Table 1. Methodology

	Methods	Goal
Interview	Interior designers	Acquire helpful information on public restroom planning.
	Psychologists	Get directions on further research.
	RIT ID faculty	Get help on mock-up building, user testing, final prototyping, etc.
	Individual woman/group of women	Thought discovery on public restroom trips and get advice and different opinions on future designs.
	Librarian	Get help on further research.
Further Research	Ergonomic factors	Guide the design process with critical human body dimensions.
	Psychology	Learn more about people's perception of 'clean' and 'convenient' and take advantage of them in future design.
	Restroom environment	Discover other factors that have not been considered yet, such as lighting, sounds, temperature, colors, materials, textures, etc. and the impact they have.
Design	Brainstorming & Ideation	To develop design solutions.
	Mock-up Building	With constant refinement, physical mock-ups will be built and tested to validate future designs in usability (such as dimensions, ergonomics, practicality, user friendliness, manufacture ability, etc.) and decide how well they fit in restroom interior and what experience they will create.
	User Testings	

## Brainstorming & Ideation

### (1) Brainstorming

Based on the previous research and Figure 8, heat maps of movement within the restroom stall were created (Figure 14). Results indicate that the center part is being used the most, while space in the front, sides and back is not as much, which should be taken into consideration.

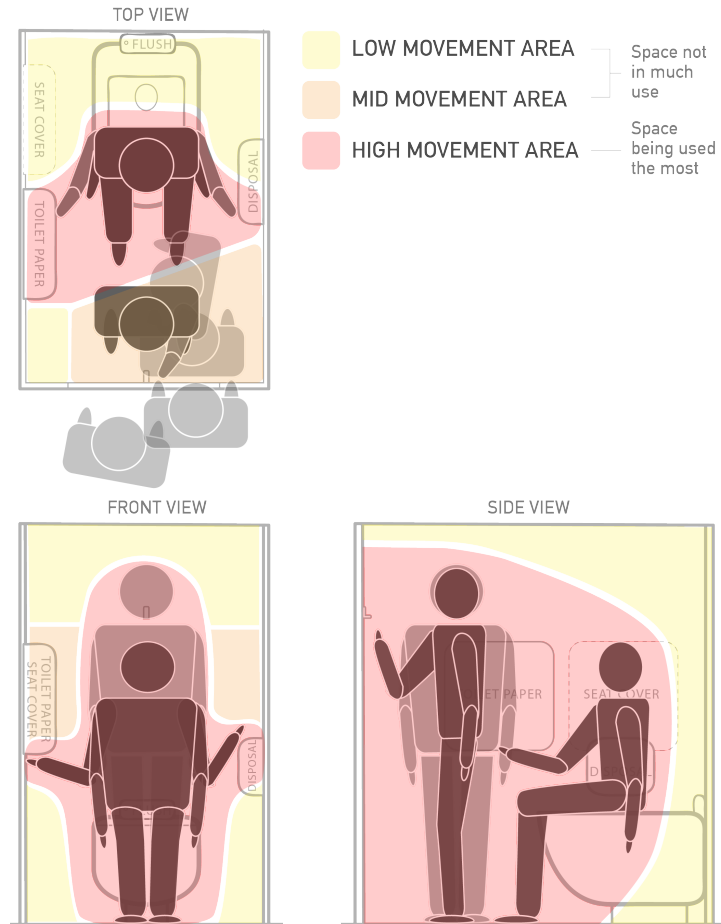


Figure 14. "Heat Map" Inside A Stall

Based on Figure 8 and Figure 14, a brainstorm of ideas was conducted as Figure 15 shows.

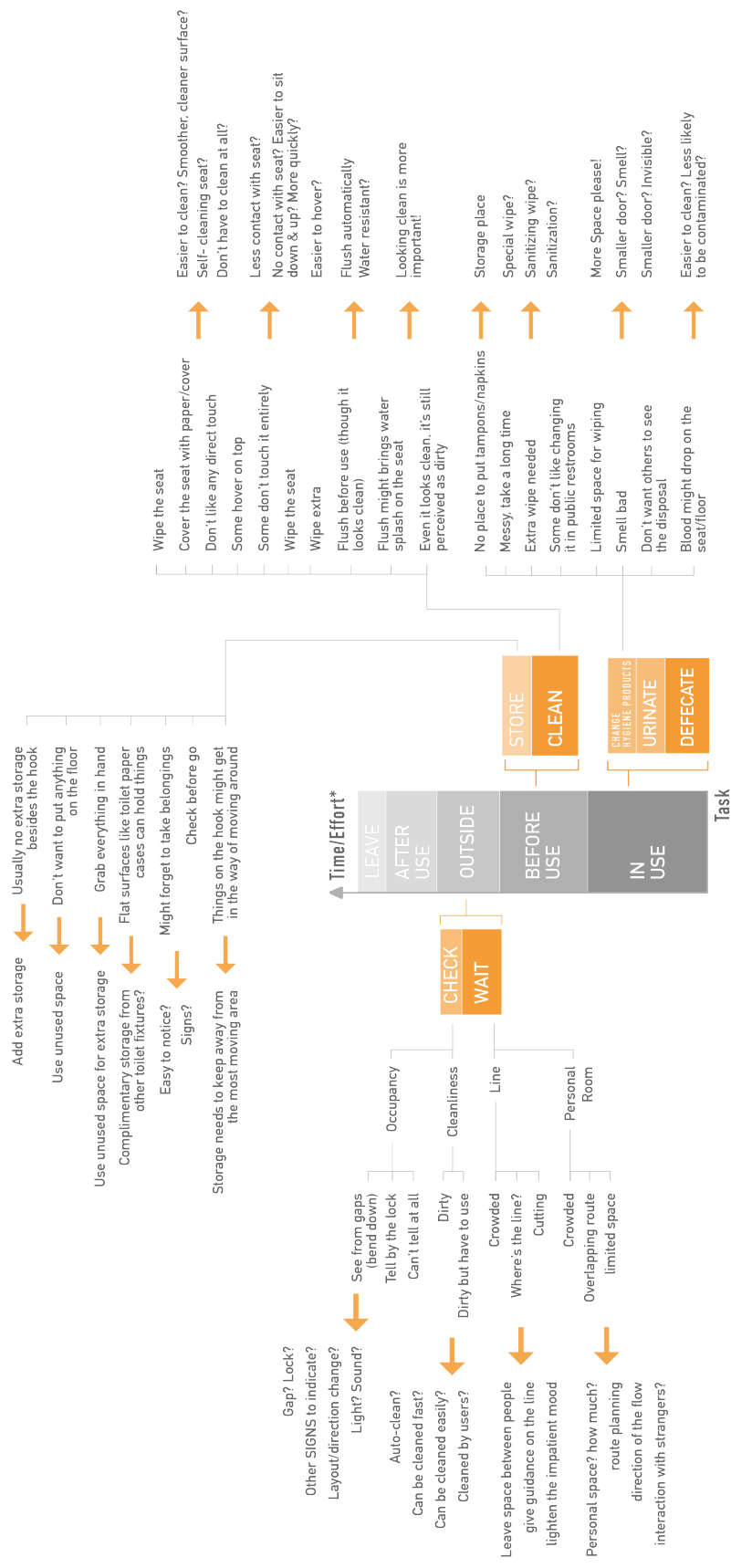


Figure 15. Brainstorming

## (2) Ideation

Based on the above brainstorming, a broad design ideation (Figure 16) was carried out to tackle the problem areas.



Figure 16. Ideation

### (3) Evaluation

Evaluation of the ideations was conducted using Figure 8 as criteria as Figure 17 shows. Ideation #2, #4, #6, and #7 show better potential in moving forward as they address more needs while having a greater impact on others. To further develop, #2 should be taken into the whole toilet stall interior/environment for consideration, while #4 could be combined with #6 & #7 to refine the hover concept.

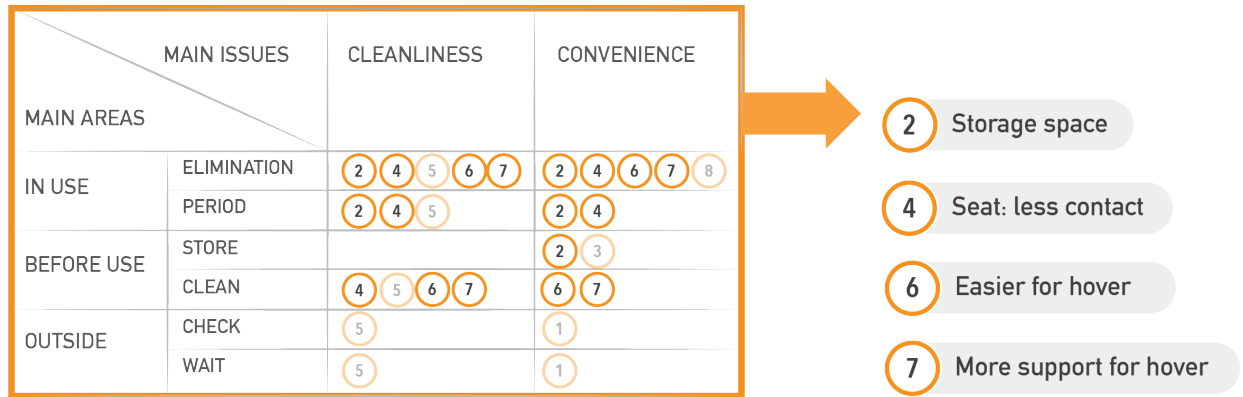


Figure 17. Evaluation of Ideation

## Concept Development

### (1) Early Concept

Based on Ideation #2 (Storage space), combination of #4 (Seat with less contact) and #6 (Easier for hover toilet), and combination of #4 (Seat with less contact) and #7 (More support for hover), further ideation on A(Figure 18), B (Figure 19) and C(Figure 20) were conducted respectively. Each was later tested with full-scale mockups(Testing A in Figure 21, Testing B & C in Figure 22) to determine the function, dimension, and shape. Selected ideas were further developed as Early Concept A(Figure 23), B(Figure 24) and C(Figure 25) to move on to the next step.

‘Further Ideation A’, with extra storage on the door, aims to free users from holding things in hand and provide a surface for changing sanitary products. To finalize its location, size and functions, a full-scale toilet stall based on 2010 ADA Standard was built with several boxes representing the install features. Testing result indicates that in Figure 21, (2) works the best\* with the ability to accommodate different types of belongings with a storing table and a hook placed in a proper distance (\*Storage on the side combined with the disposal container shows potential in being within reach, but also carries higher risk of bacterial contaminations while allowing for fewer things to be stored). Based on that, Early Concept A was developed.

‘Further Ideation B’, by shaping the toilet to match the hovering position, allows easier hover without leaving a mess on the seat or the floor, which might ultimately speed up the whole process. Further Ideation C explores extra supports for hands, knees or legs to support the hovering. Seating option with reduced contact shall be added for both to serve the general public, as hovering requires certain movability and strength, also not being ideal for elimination. Testings were performed to determine the toilet height, the angles of hovering, ease of access, better visual language of “hover” and proper support, with 95th percentile female as the reference (<The Measure of Man and Woman: Human Factors in Design Revised Edition> by Alvin R. Tilley, Henry Dreyfuss Associates). With catchment of urine, less splashing and less sound as the criteria, testing results imply that mockup (3) and (5) in Figure 22 work the best with an 18 to 20 inch height allowing an approximately 20° to 40° leg-thigh angle, while support at the knee or leg might work the best. Based on that, Early Concept B & C were developed.

## A Further Ideation: Storage Space

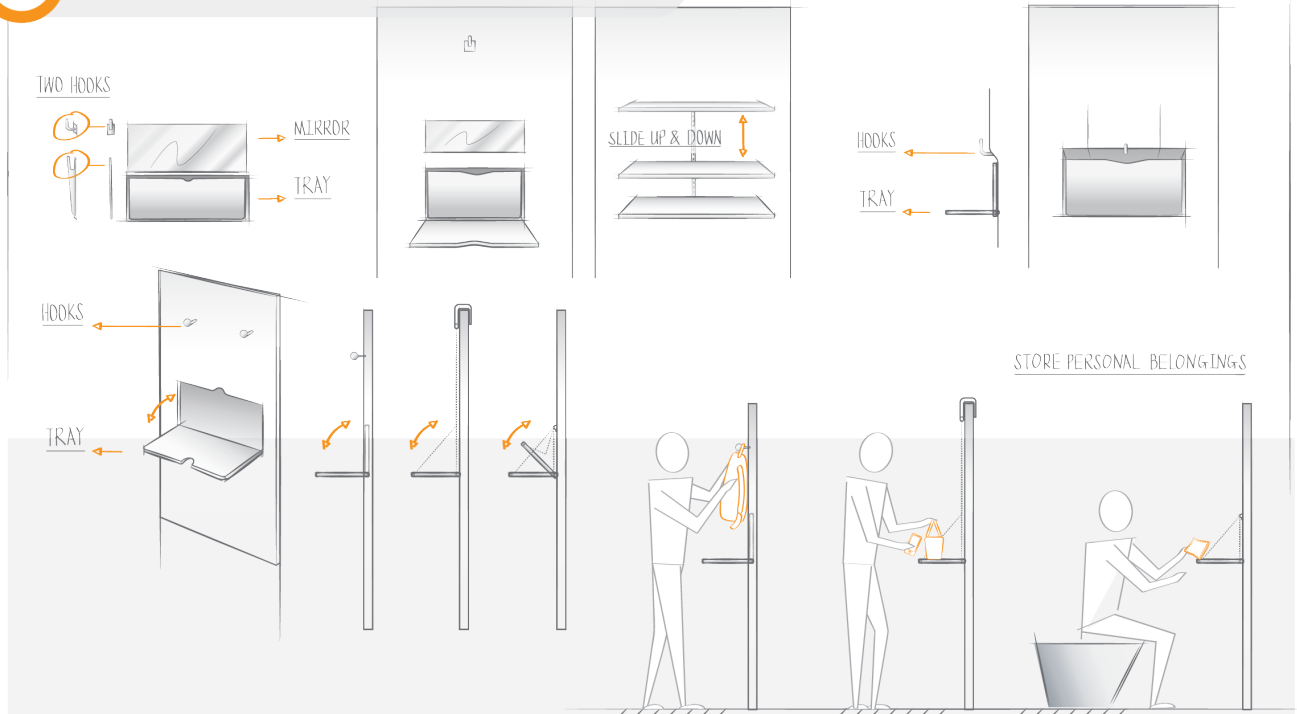


Figure 18. Further Ideation A

## B Further Ideation: Easier for Hover (with a Less-Contact Seat)

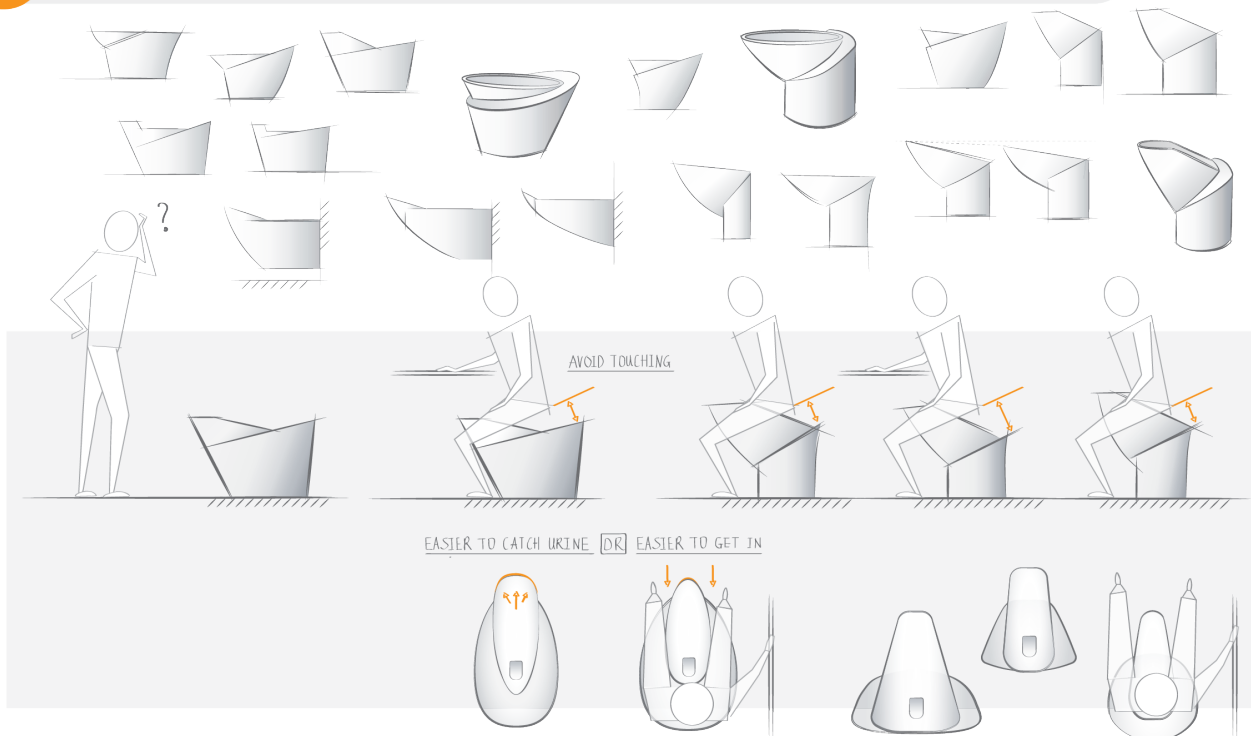


Figure 19. Further Ideation B



**C Further Ideation: More Support for Hover (with a Less-Contact Seat)**

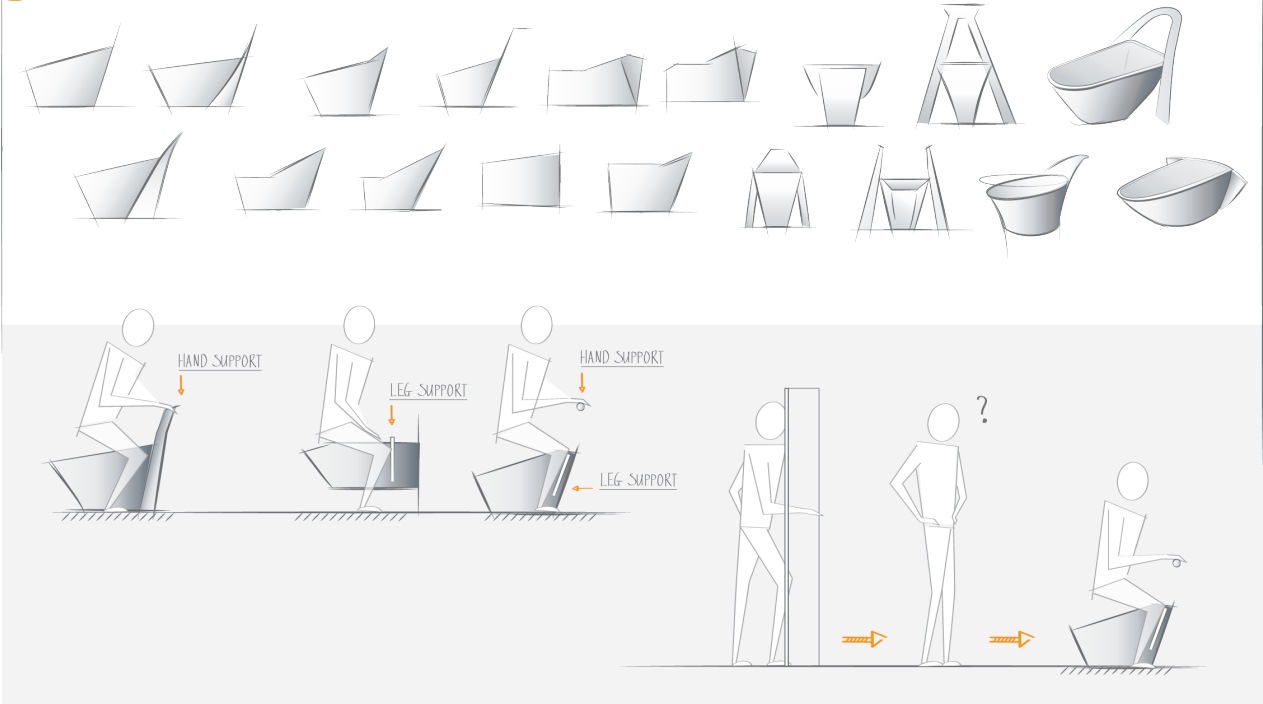
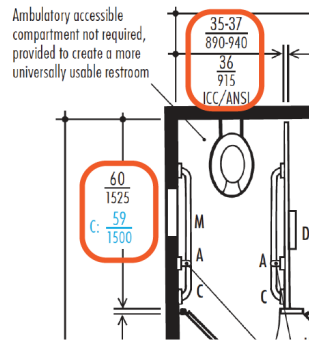


Figure 20. Further Ideation C

# TESTING: FURTHER IDEATION A

## STALL BUILDING



2010 ADA and 2009 ICC/ANSI Standard



## TESTING



Figure 21. Mock-up Building and Testing on Further Ideation A

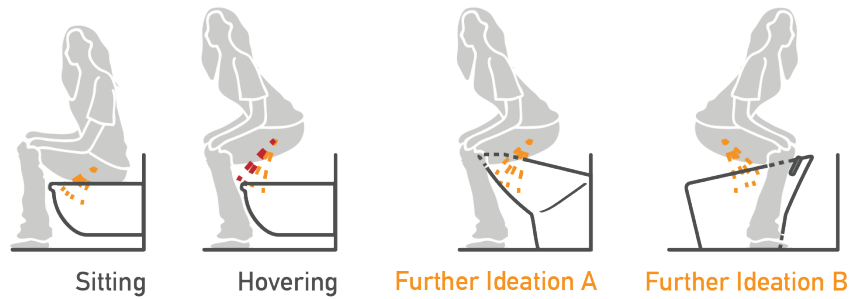
# TESTING: FURTHER IDEATION B & C

## CRITERIA

Catch Urine

Less Splashing

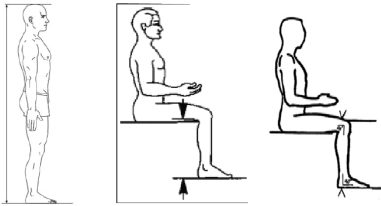
Less Sound



## ERGONOMICS

Female, 95th percentile, age 18-79

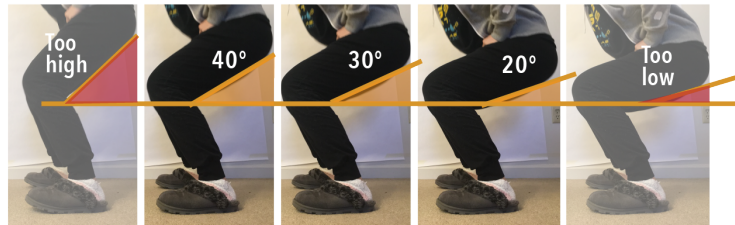
Tester Stature: 170cm



Stature:  
170.4 cm

Knee Height:  
21.5 inches

Popliteal  
Height:  
17.5 inches

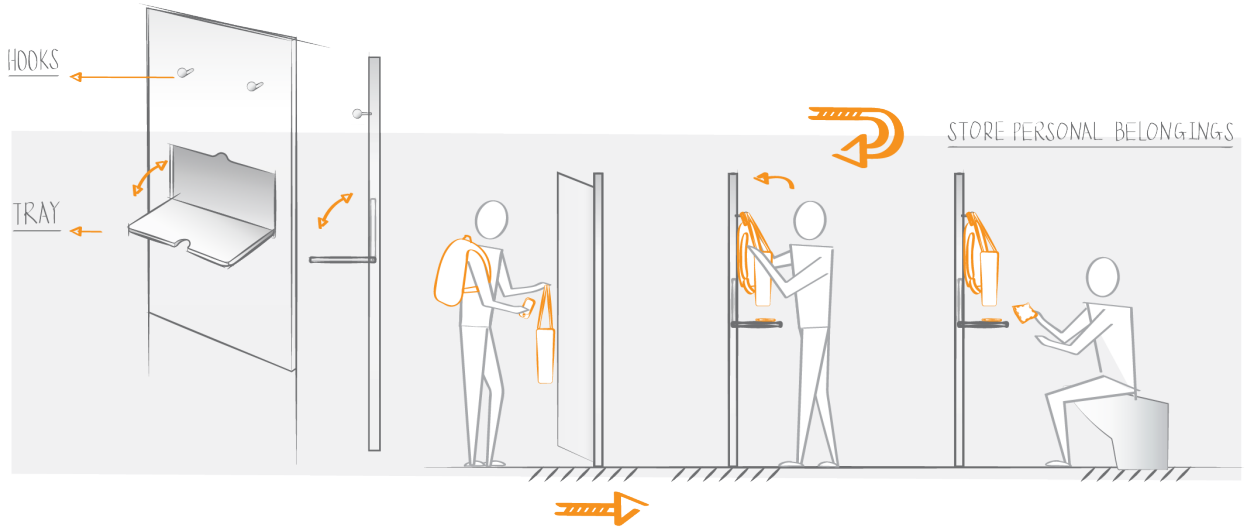


Leg angle when hovering to urinate: 20-40°

## TESTING

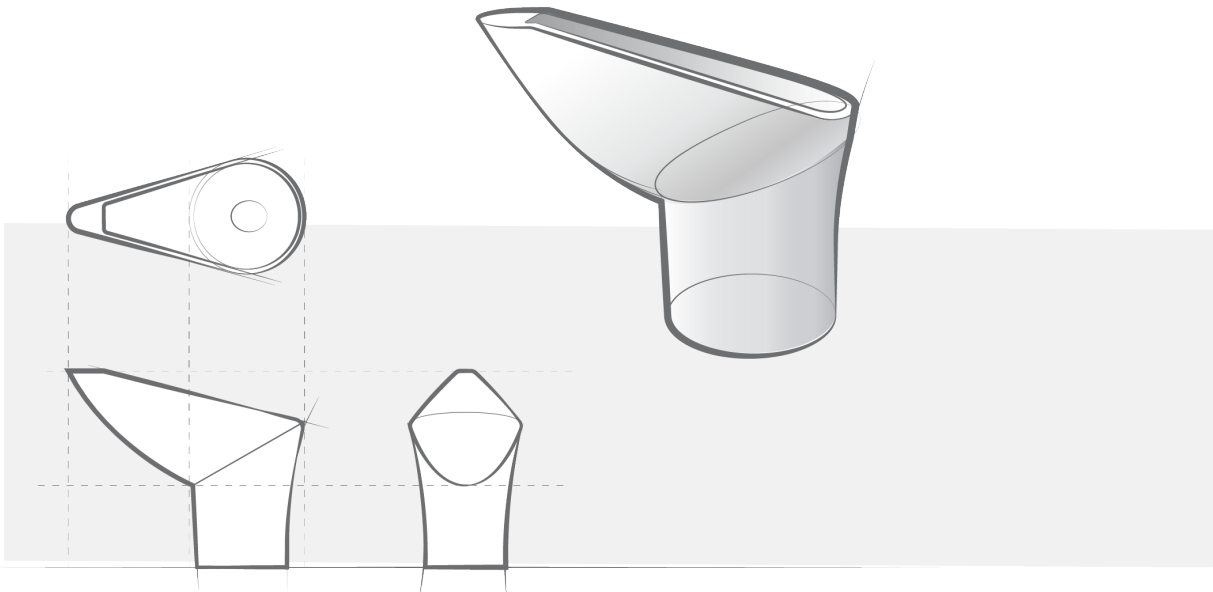


Figure 22. Mock-up Building and Testing on Further Ideation B & C



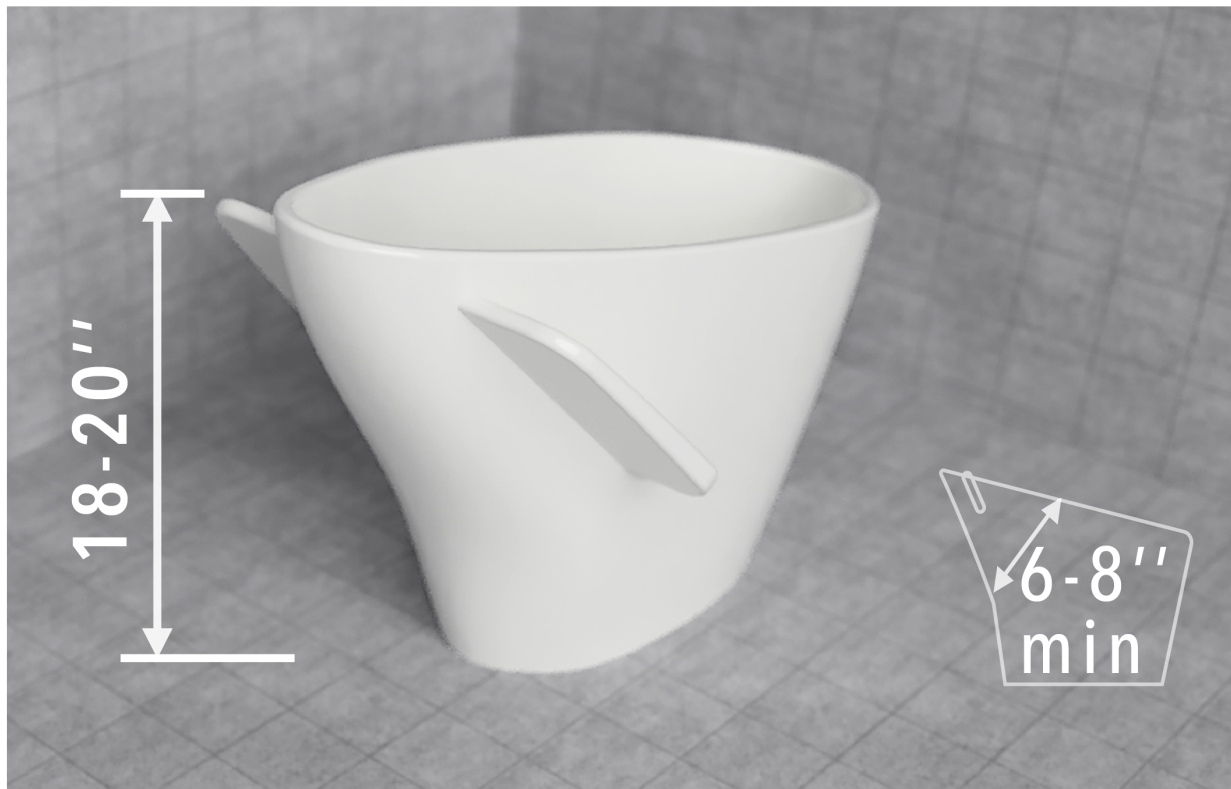
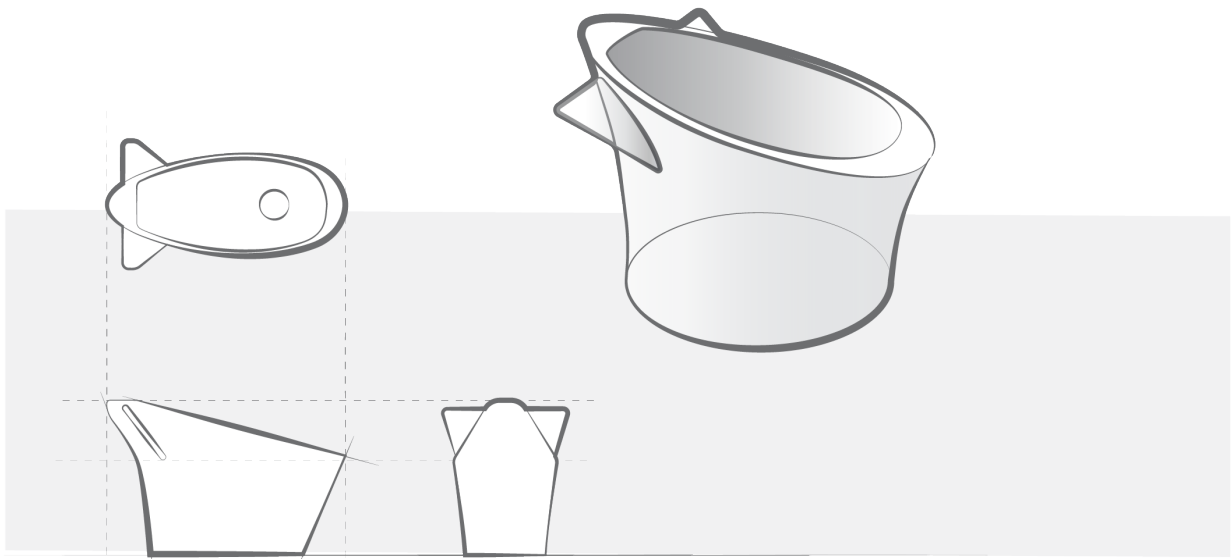
## EARLY CONCEPT A: STORAGE ON THE DOOR

Figure 23. Early Concept A



**EARLY CONCEPT B: HOVER TOILET (WITH EASE)**

Figure 24. Early Concept B



## EARLY CONCEPT C: HOVER TOILET (WITH SUPPORT)

Figure 25. Early Concept C

## (2) Refined Concept

CNC-cut foam mockups of Early Ideation B and C were built in order to finalize the ergonomics, dimensions, shapes and material, along with other critical factors. Two mockups were placed in a mocked restroom space and tested by a group of six subjects (with varying heights and body type, aged 22-28) with given instructions and questions. (Figure 26).

Analysis of the result (Figure 27) illustrates that tester, in general, favored Early Concept B more for its “continuous shape”, “ease in cleaning” and “proper height”, with a 30° to 45° leg-thigh angle. However, a better point of entry to indicate the body location over the toilet should be offered. Urinating target should be bigger as some claimed it to be pointy and small, which made them move closer to the toilet and led to undesired contact. Lastly, leg support restricted the movement of the users with pants; hand support might be included as an add-on feature to ensure safety but isn’t necessary when the seat option is provided.

Based on the testing, a refined concept of the hover toilet (Figure 28) was established.

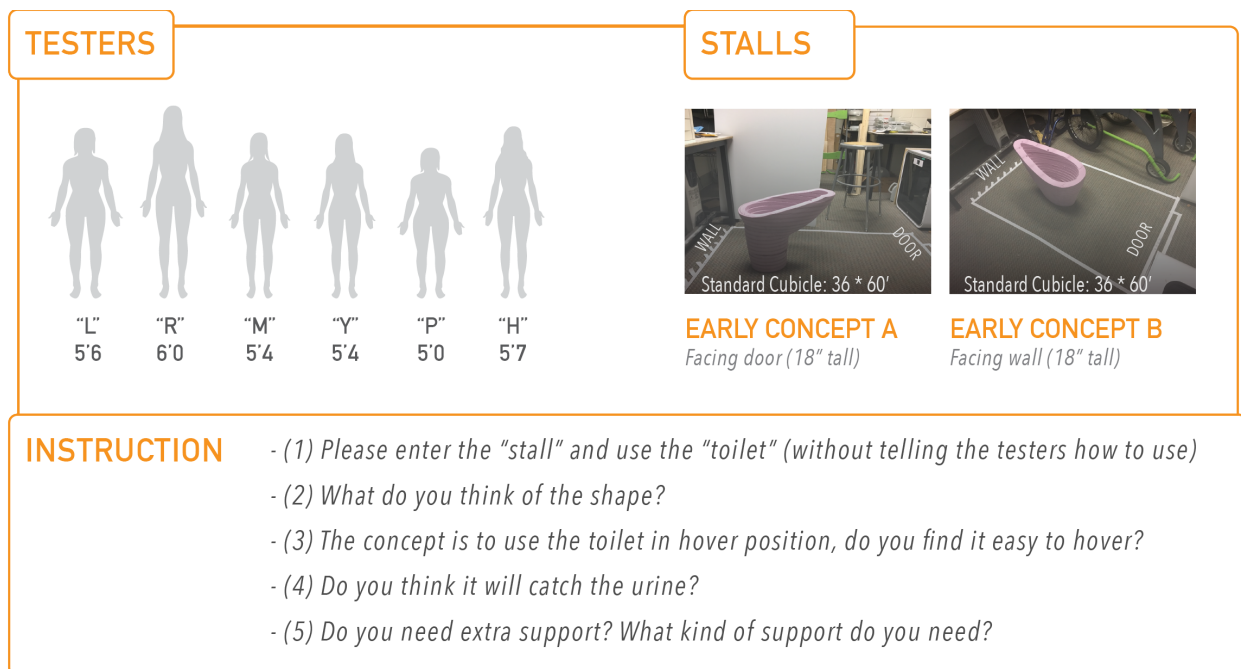


Figure 26. Testing Process of Early Concept B & C



Figure 27. Testing Results and Analysis of Early Concept B & C



Figure 28. Refined Concept of the Hover Toilet



### (3) Final Concept

Two mock-ups based on the Refined Concept were built and placed in the same space for testing (Figure 29).

Results imply that Mock-up 1's target is big enough while addressing all problems in the previous testing. A mock-up of the seat was also made and tested with the consideration of minimizing skin contact and being less likely to get water flushed back on. The seat needs refinement with a smooth surface to ensure easy cleaning and liquid repellent.

Subsequently, final concept of the hover toilet with a seat (Figure 30) was formed, which needs further finalization with the storage space concept A.

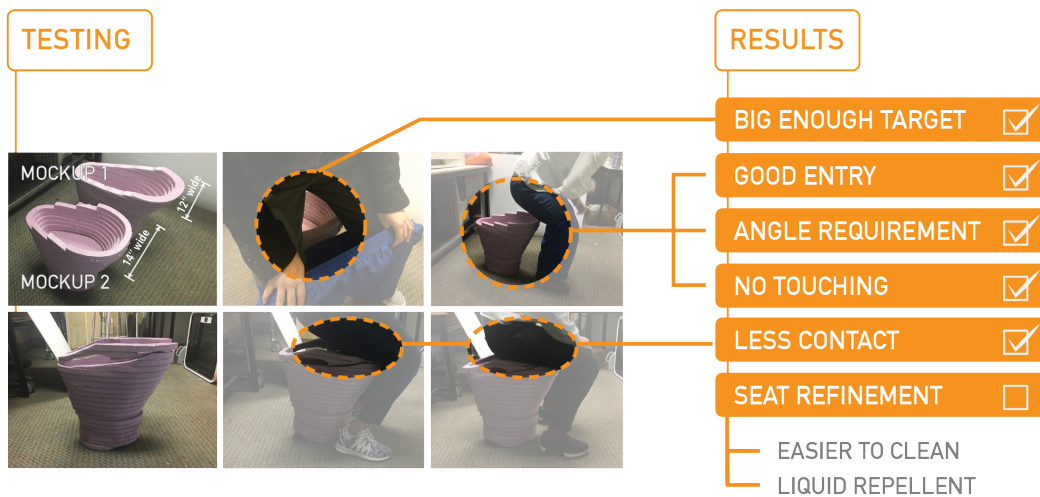


Figure 29. Testing Results on the Refined Concept

## FINAL CONCEPT



Figure 30. Final Concept: Hover Toilet with Seat

## Final Design: Hoilet

The final model is CNC-cut, laminated, sanded and finished (Figure 31).

Based on the final concept, the final design — Hoilet was established with a simple and organic shape to enable easy hovering, while a wing-like seat is also provided with less contacting surface and ability to prevent liquid residue.

Users could choose to either hover or sit. Specific features are showcased in Figure 32, 33, 34.



Figure 31. Final Design Prototyping

- A** Users could hover with ease to use.
- B** Users could also press the seat down to use.
- C** Gap between the seat and toilet help reduce water splash on the seat
- D** The curved shape helps any liquid on the seat drip down.
- E** The seat will spring back after each use, providing hover as the first option and sitting the second
- F** Skin contact with the seat is minimized.
- G** Storage on the door accommodates personal belongings, providing a changing place for hygiene products and could ultimately speed up the process of each restroom trip per user.
- H** Instruction could be found on the door once users close the stall.
- I** The concept could be applied in floor-mounted toilets, wall-mounted toilets and bidets as well.

\* Material Choice: Traditional Porcelain is the ideal material for making toilets as they are sturdy and easy to mold, with its smooth dry surface being water-proof, clean, and sanitary.



Credit: Elizabeth Torgerson-Lamark

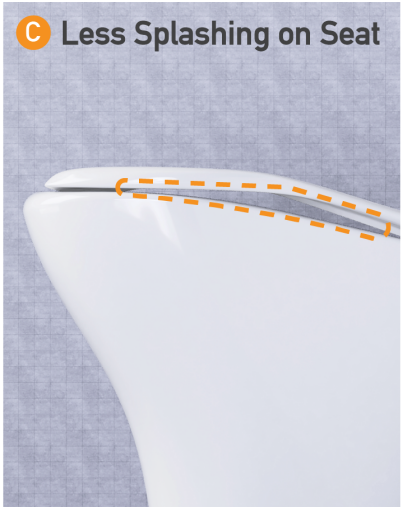


**A** Hover to Use



**B** Press Seat Down to Use

Figure 32. Final Design & Design Features



**H** Instruction

**HOILET**  
Clean & Convenient!

Hover to use      Press the sit down

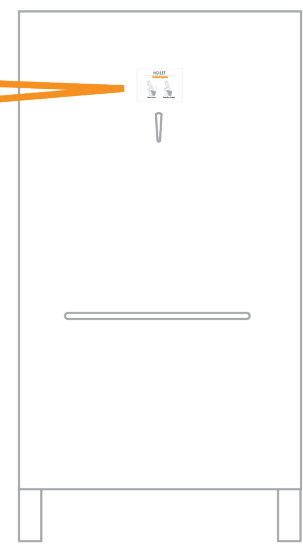


Figure 33. Final Design Features

## 1 Further Application

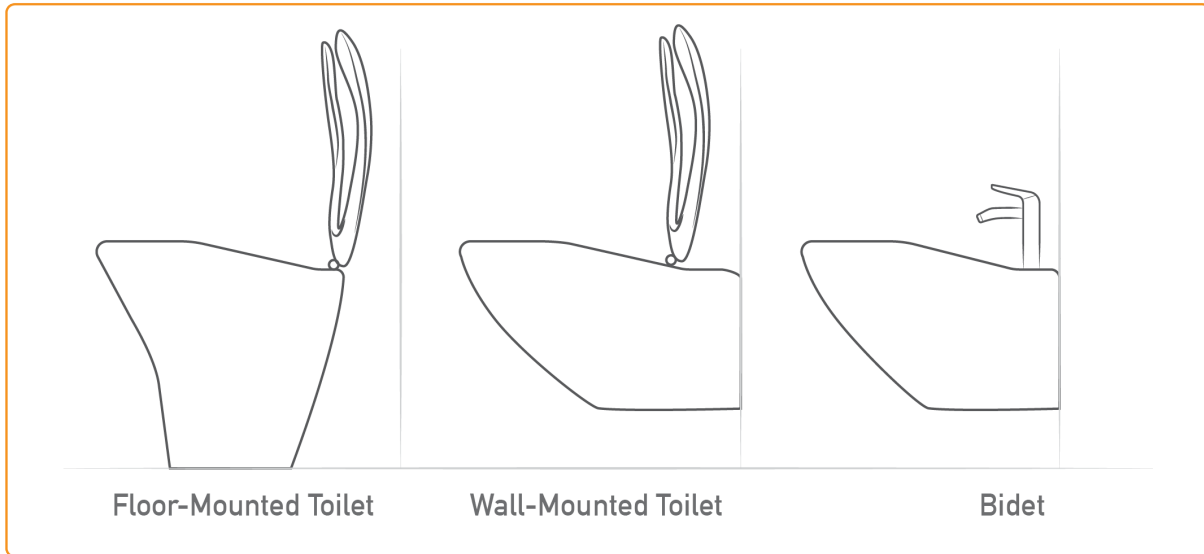


Figure 34. Final Design Features

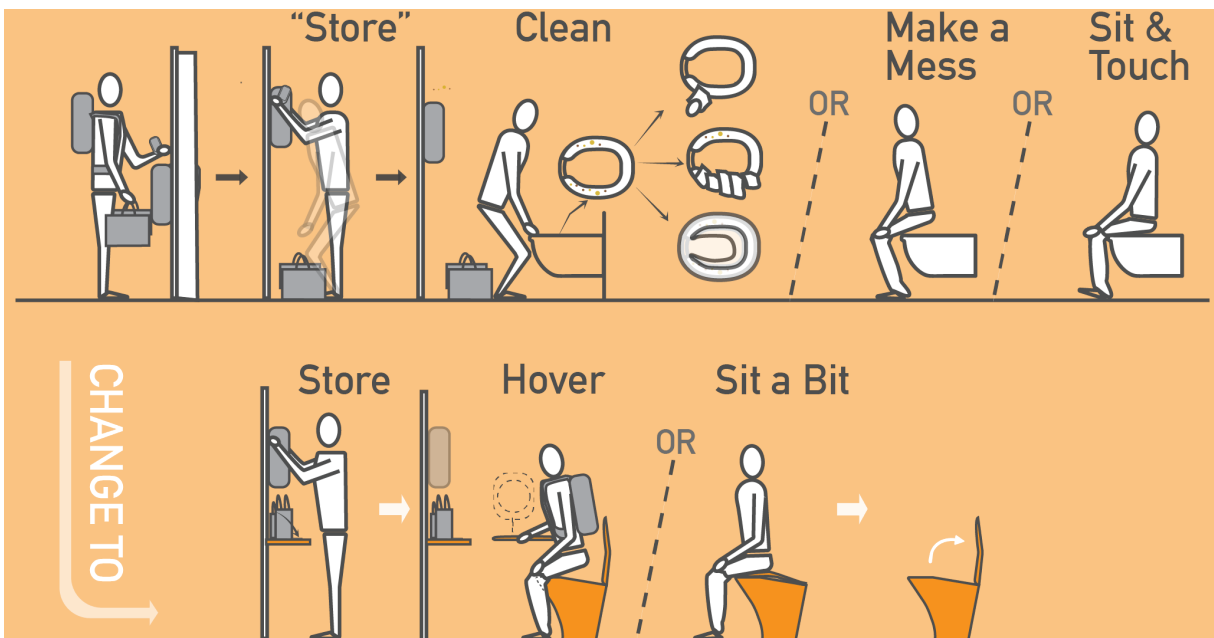
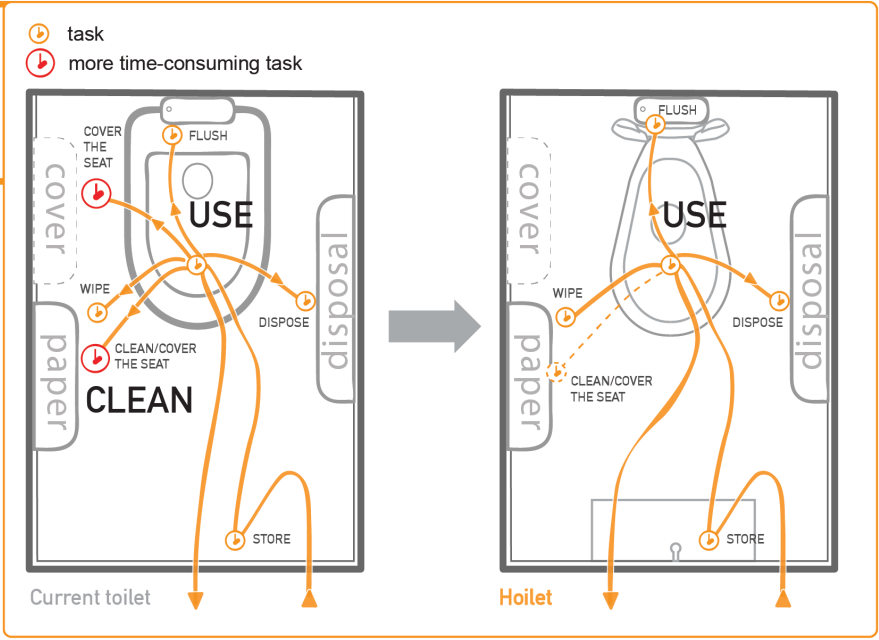
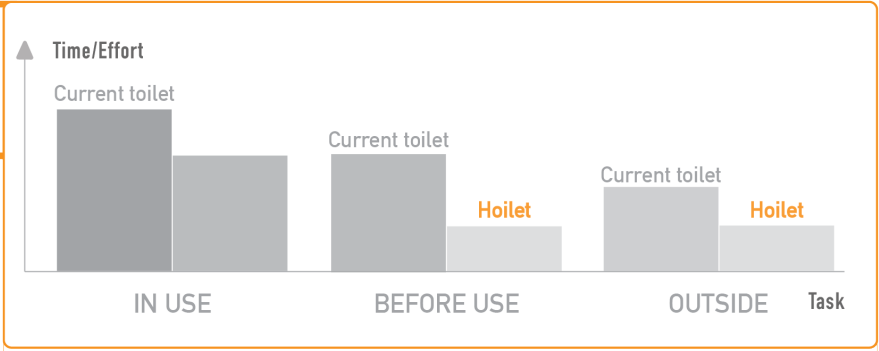


Figure 35 . Hoilet System

**FEWER STEPS  
LESS CONTACT  
LESS MESSY**



**FASTER  
MORE CONVENIENT**



**CLEANER**

HOW MUCH YOU (MIGHT) TOUCH INSIDE A STALL	DOOR	SEAT	PAPER CASE	DISPOSAL CASE	COVER CASE	TOILET PAPER	FLUSH	HOOK	STORAGE	FLOOR
Current toilet	👉👉	👉👉👉👉	👉👉	👉👉	👉	👉👉👉	👉	👉		👉
Hoilet	👉👉👉	👉	👉	👉		👉	👉	👉	👉	
DIRTYNESS	●○○○○	●●●○○	●○○○○	●●○○○	●●○○○	●●●○○	●○○○○	●○○○○	●○○○○	●●●○○

\* All comparisons are estimations based on previous research and analysis.

Hoilet System (Figure 35), compared to current ladies' room planning, manage to speed up the public restroom trip not just for users inside the stall, but also for others waiting outside as well. Undesired contact with shared spaces and things are reduced, while allowing sufficient clean storage to accommodate different needs. Figure 56 shows the direct relation of minimizing steps, contact and messiness to creating a faster, cleaner and more convenient ladies' room and how improvements are made with the implementation of the Hoilet System.

#### **(4) Future Scope**

Given the scope of the project and resources available, certain issues could not be studied, but could augment the design. These are related to the factors of:

- Storage space: the ability to store different types of belongings; appropriate location, size and material; add-on feature; ease of maintenance; etc.
- Body types
- Age Group
- Accessibility
- Support options
- Ergonomics
- Manufacturing requirements
- Product line exploration into floor-mounted toilets, wall-mounted toilets, bidets, washlets, etc.
- Privacy concern
- Adaptability for other sexes

## Conclusion

With the lack of toilet provisions influencing over 2 billion people, the effects of it, though more severe, go unnoticed/undiscussed in the case of women<sup>48,49</sup>. The lack of provisions for function division, unhygienic environment and little privacy in public restrooms also make matters worse. Though research conducted was mostly out-of-date with limited focus, current products and designs are offering inspirations and indicating a trend to provide a better experience beyond basic needs. At the same time, women are showing more acceptance of change in conventions and customs concerning restrooms.

Besides the proposition of more research needed for designers, regulators and architects, the author also conducted a research on specific tasks women take in each restroom trip and how those contribute to an overall unpleasant experience. Results imply that the need for cleanliness and convenience are of highest concern. A system like Hoilet addresses these issues, the effects of which have been demonstrated through tests. The Hoilet system consists of a minimal contact design that allows for hovering during use, it also offers a storage space on the door. By applying the Hoilet system in the current public restrooms, strides could be made to minimize the time and efforts to clean dirty toilet seats and performing tasks with things in hands. Ultimately, the design aims to improve for women the experience of using public restrooms by tackling the core problems.

With the Hoilet System, the intention is not to solve one complicated problem with a single solution, but to present the overlooked aspects and needs, as the design and planning of ladies' rooms haven't changed much in decades. If pushed further, it could potentially be adapted for other scenarios that span culture and genders.



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