Team: Anulal VS (136130012)
Gautham Varma (136130005)
Manu Revi (136130009)

Affordable Housing

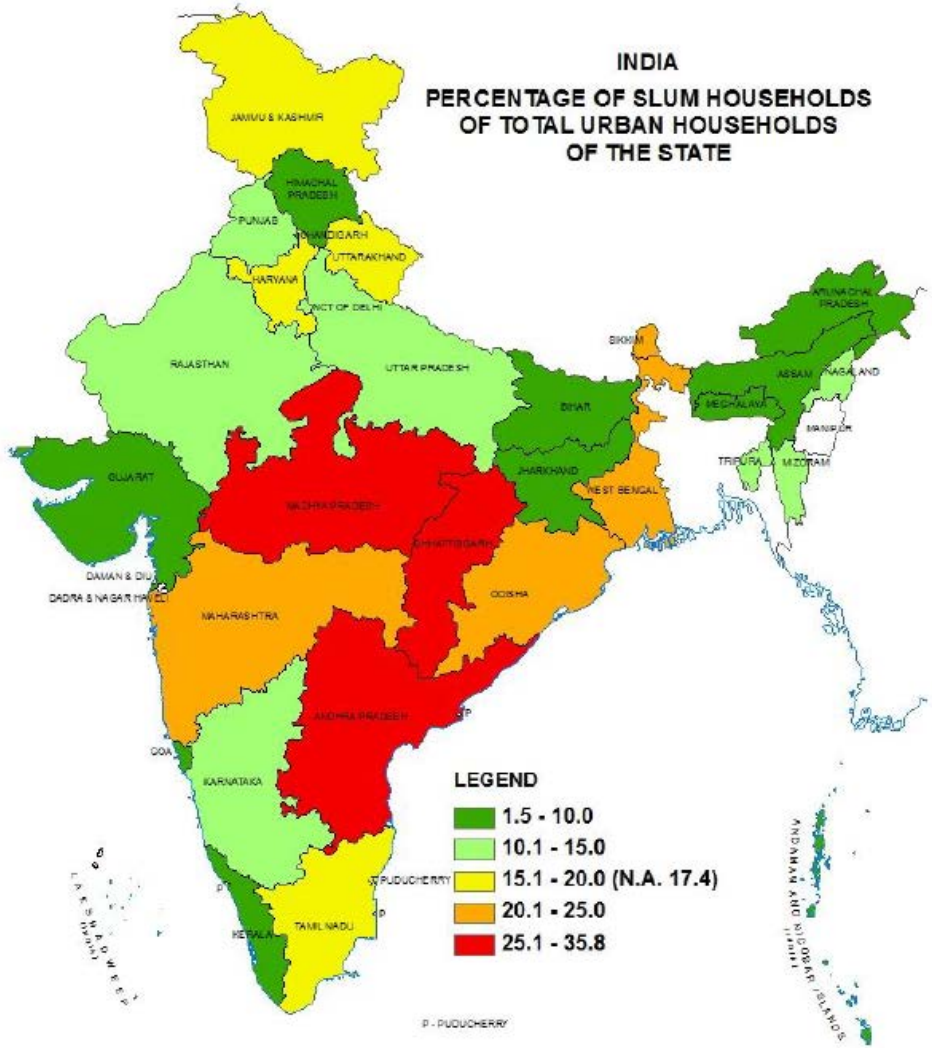
:Fitting more into volume

Guides: Prof. U A Athavankar
Prof. Vijay Bapat
Prof. B Bhaumik

IDC | IIT Bombay

Preface

- Cost of land increasing
- Space constraints
- Slums growing
- Short fall of about 25 million houses in urban india
- Lack of urgent action
- Increasing migrant population



Source: Census 2011

Proportion of slum households

Million Plus Cities	Proportion of Slum HHs to Total Urban HHs (%)
Greater Mumbai (M Corp.)	41.3
Kolkata (M Corp.)	29.6
Chennai (M Corp.)	28.5
Delhi Municipal Corp (U)	14.6
BBMP (M Corp.)	8.5

Source: Census 2011

Project focus

- Super - compact
- Affordable
- DIY
- Incremental
- Temporariness
- Durability
- Effective use of volumetric space
- Cultural context in India
- Shared spaces
- Personalization / Customization

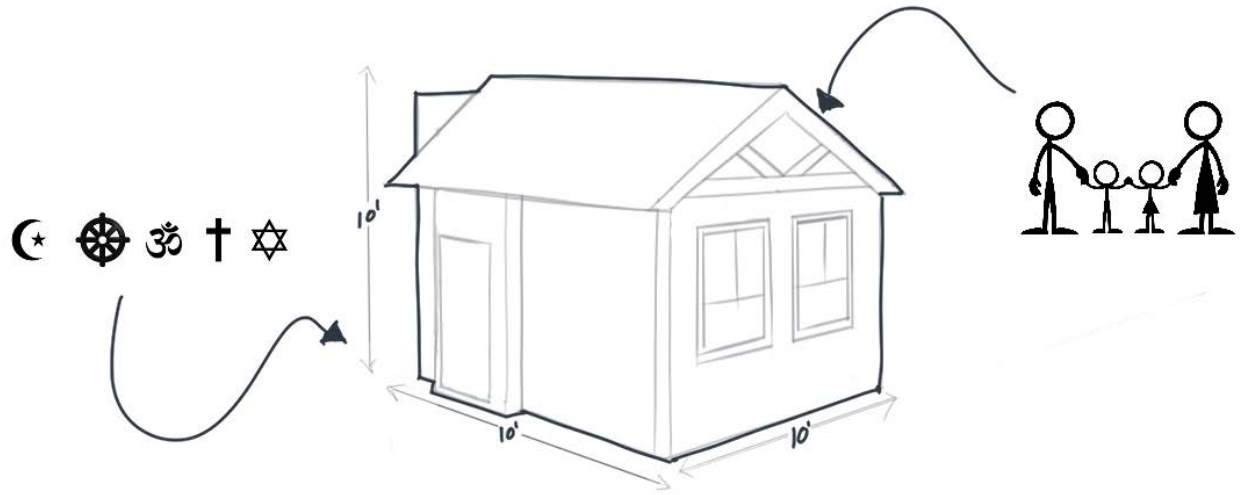
Problems to be addressed

Housing for BOPs

image source: HUDCO project

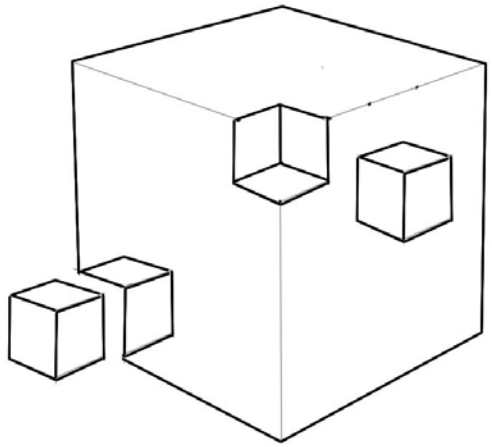
Space constraints

image source: HUDCO project



Problem statement 1

Maximum and efficient usage of space within a volume of 10'x10'x10' which could accommodate a family of 4 members with incremental provision which goes hand-in-hand with cultural context and family growth

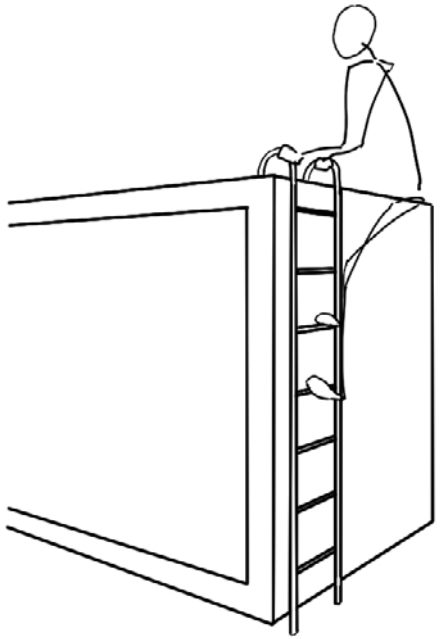


Problem statement 2

Design the interiors which efficiently use each and every unit cubic volume present in the given space

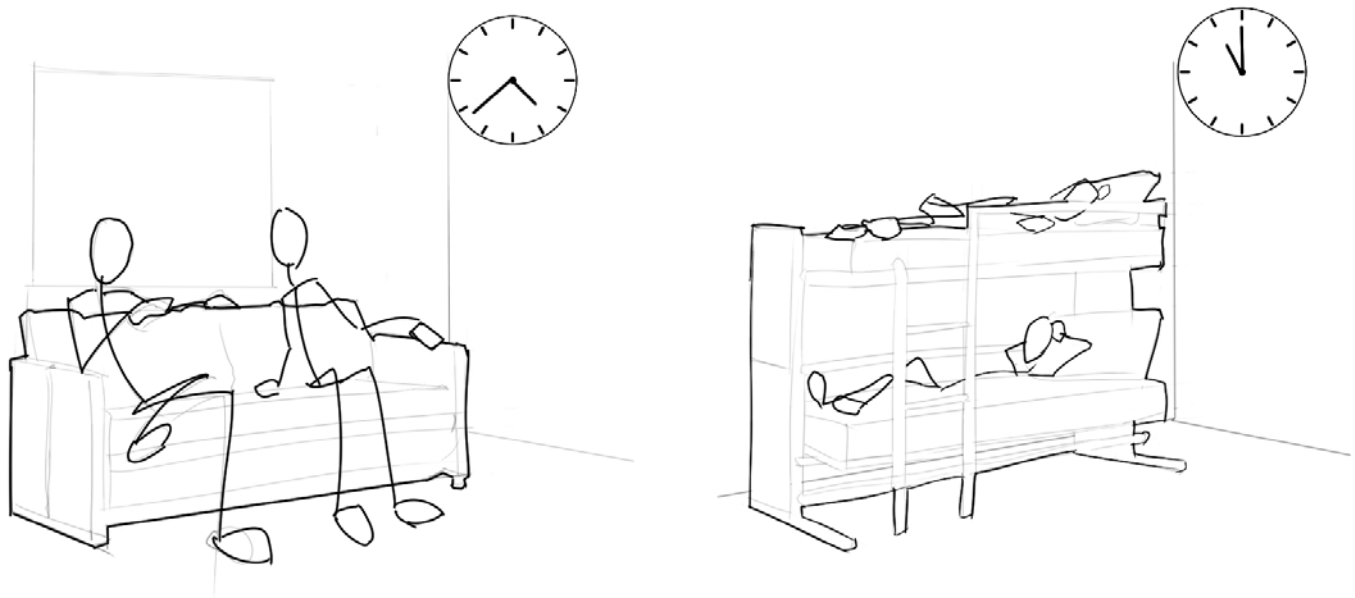
Accessibility to higher levels

image source: HUDCO project



Problem statement 3

An aid to reach higher levels that could be drawn when needed without obstructing the utility of other spaces and also utilize the minimum volume.



Problem statement 4

Design space in such a way that they could be utilized in multiple ways taking usage time-span as a factor

Unhealthy living conditions

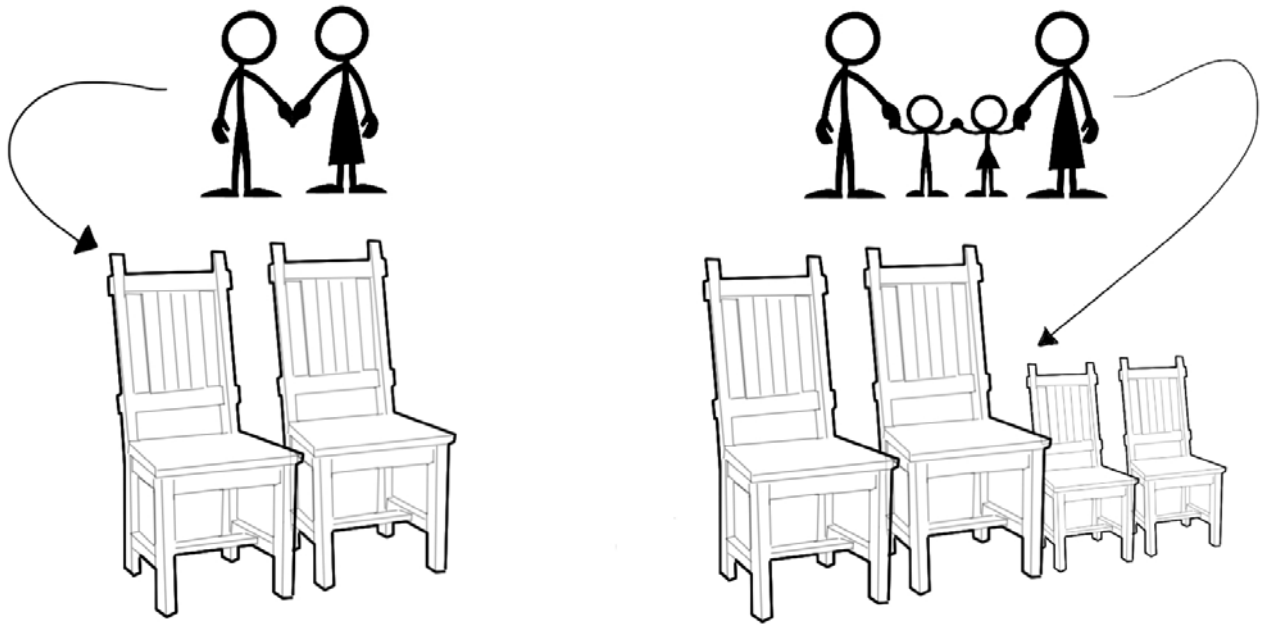
image source: HUDCO project

Rising cost of raw materials

image source: HUDCO project

Temporariness of available space / resources

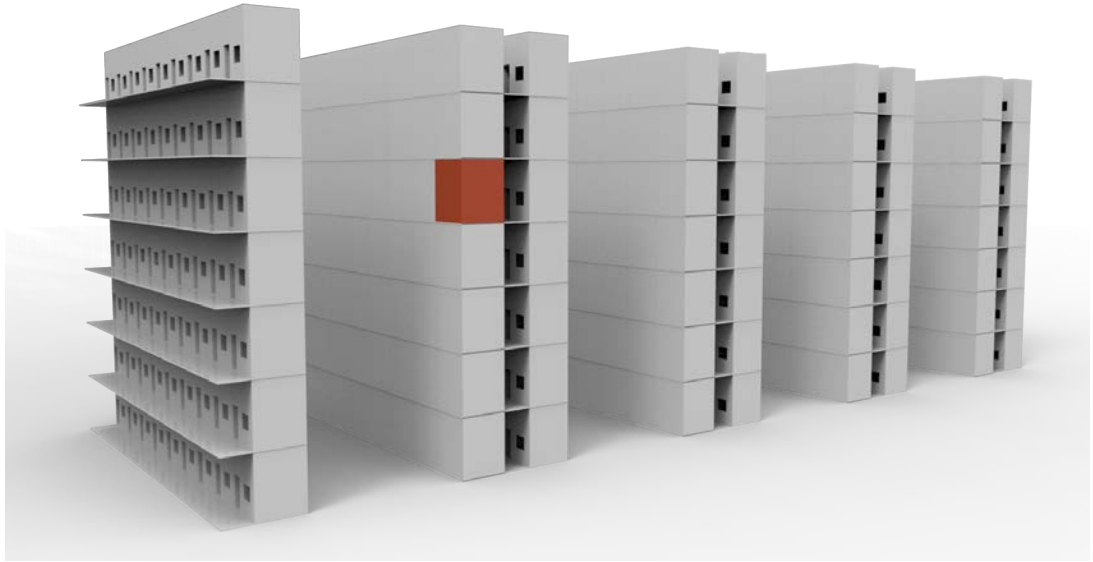
image source: HUDCO project

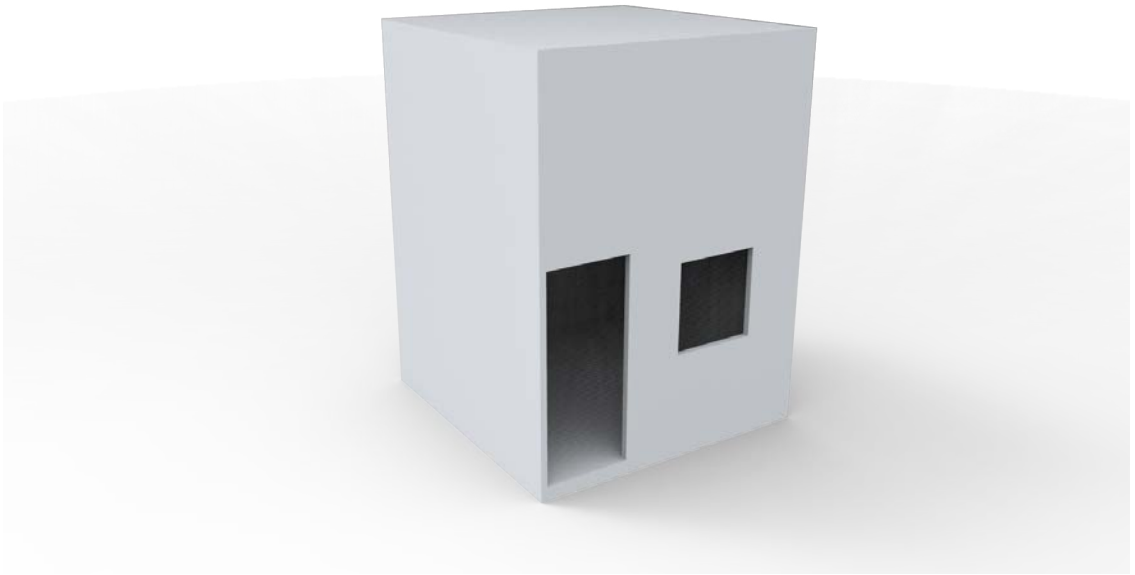


Problem statement 5

Design the interiors and furniture which can accommodate the incremental needs of a user without affecting or obstructing other spaces.

Project assumptions





- Multi-storey building having modules of size 10’x10’x12.5’
- Walls of brick and concrete
- One exterior wall with windows and plumbing connections
- 6 ft corridor between opposite modules
- 100 ft distance between consecutive buildings

Data collection

Available data

- **User data collected over a span of 3 years**
  - *User category*
  - *Occupation*
  - *Annual wages*
  - *Life style*

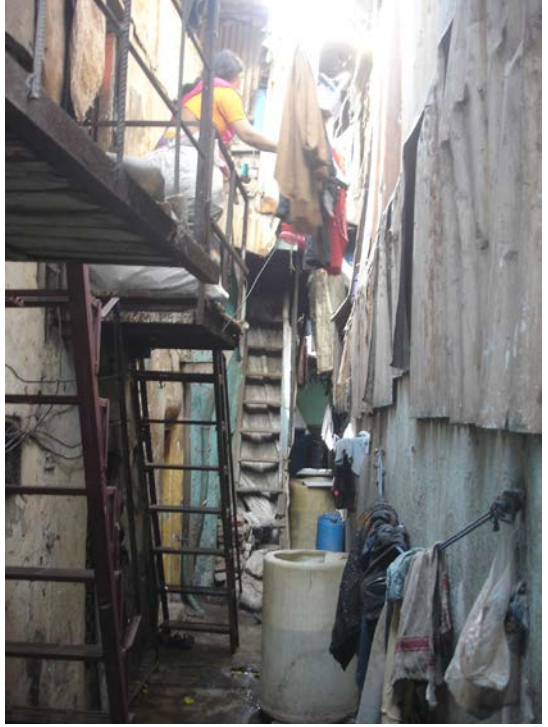
- **Activity analysis**
  - *Understanding time slice of a family of 4 members*

Data ref: HUDCO project

Our research

- A visit to dharavi
- Videos + case study
- People innovatively using space
- IKEA DIY model
- Study of joints
- Current interior scenario

A visit to dharavi



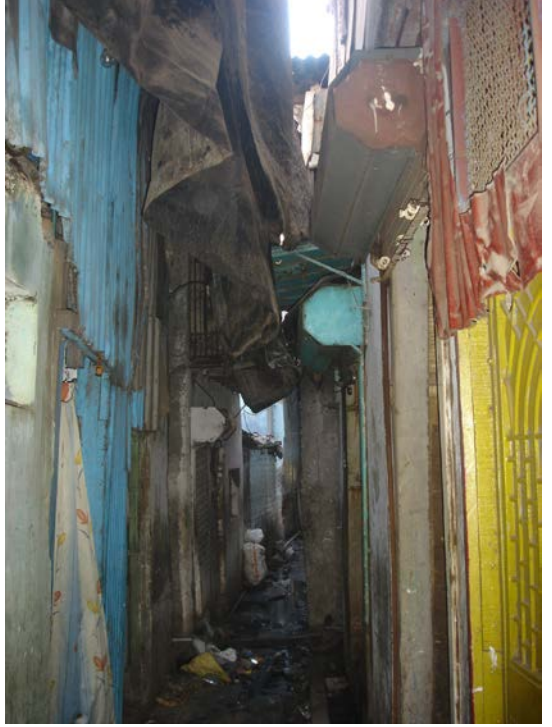


image source: HUDCO proposal

Videos + Case study

- We the tiny house people (documentary)
- Cube and Cube 2 project
- Asian scenario
- Convertible furniture

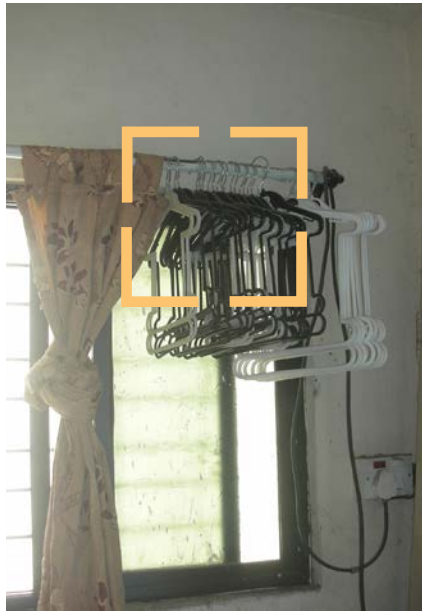
source: http://mreverydaydollar.com/; http://kristabeck809files.wordpress.com- accessed on 2-11-2014

Asian scenario

Caged homes in HongKong

source: http://i.huffpost.com/; http://3.bp.blogspot.com/- accessed on 20-10-2014





People using space

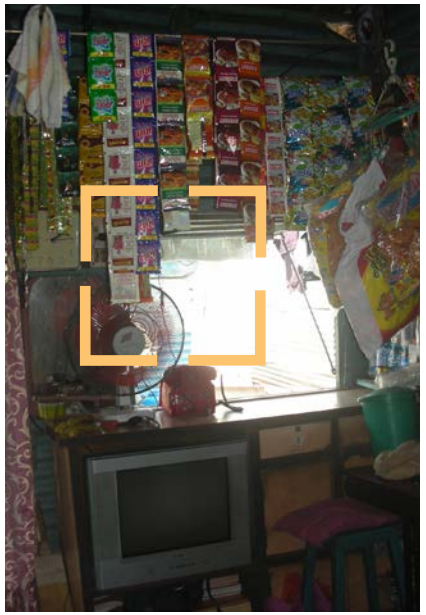
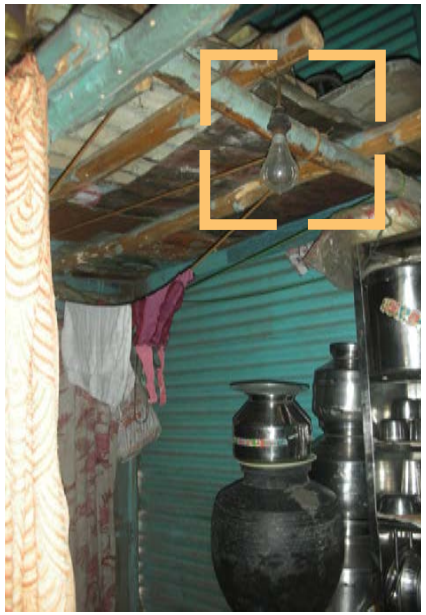
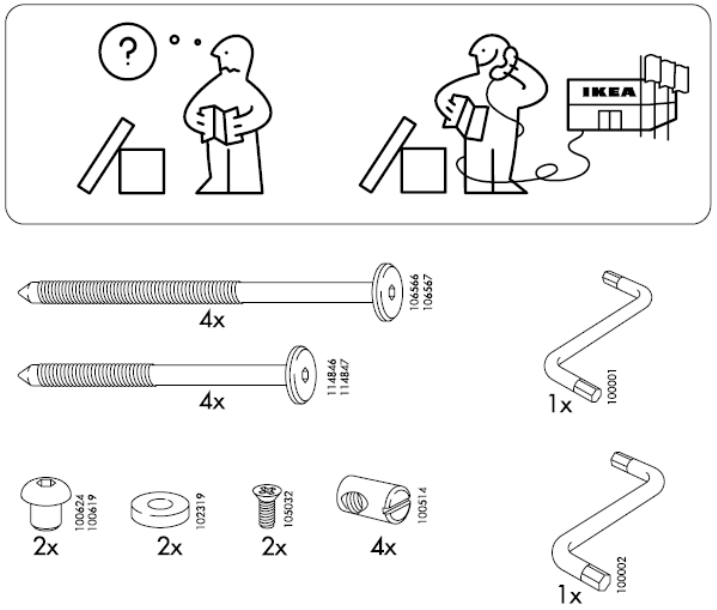
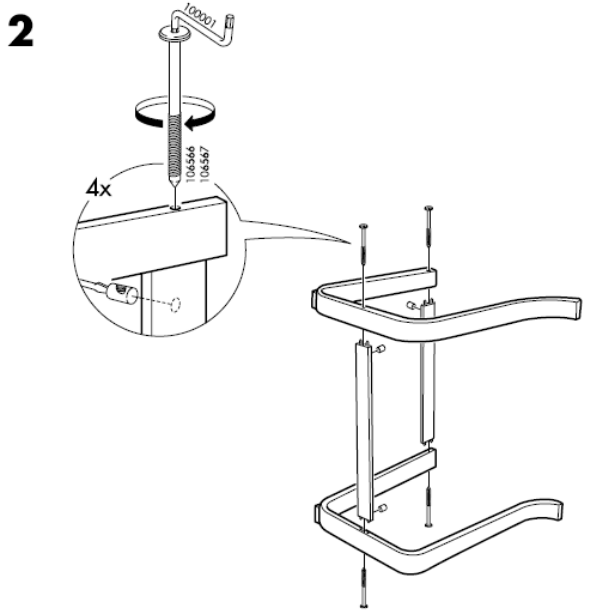
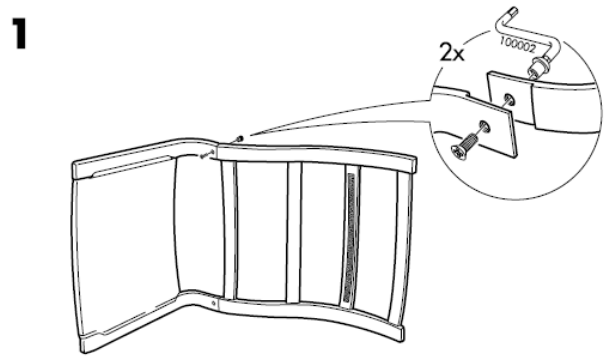
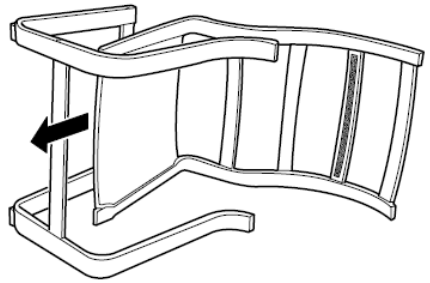



image source: HUDCO project









IKEA DIY model

- Assembly instructions
- IKEA joints

source: Poang instruction manual - IKEA

Study of joints

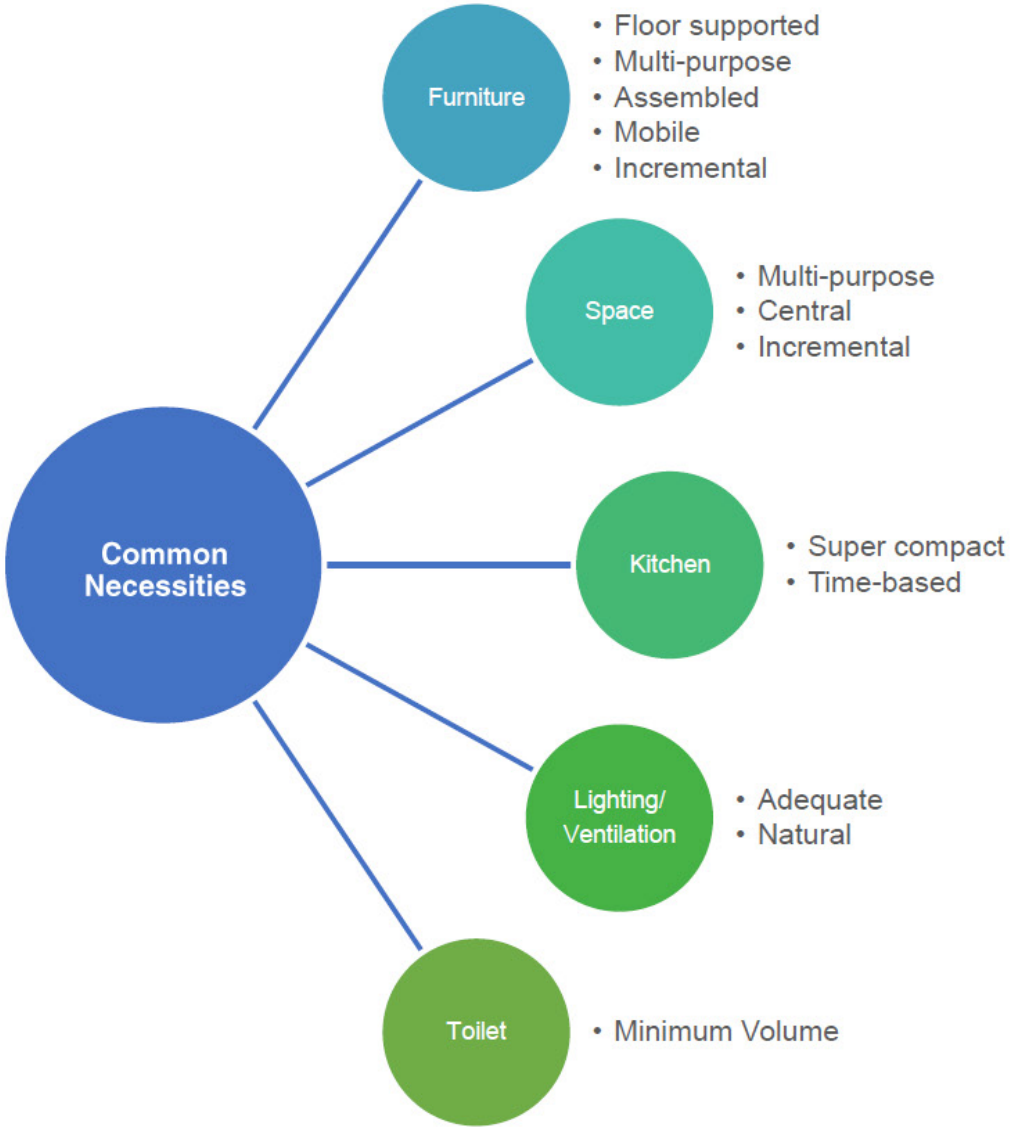
- Bicycle joints
- Exhibition panel joints
- Tripod joints
- Warehouse construction joints
- Scaffolding

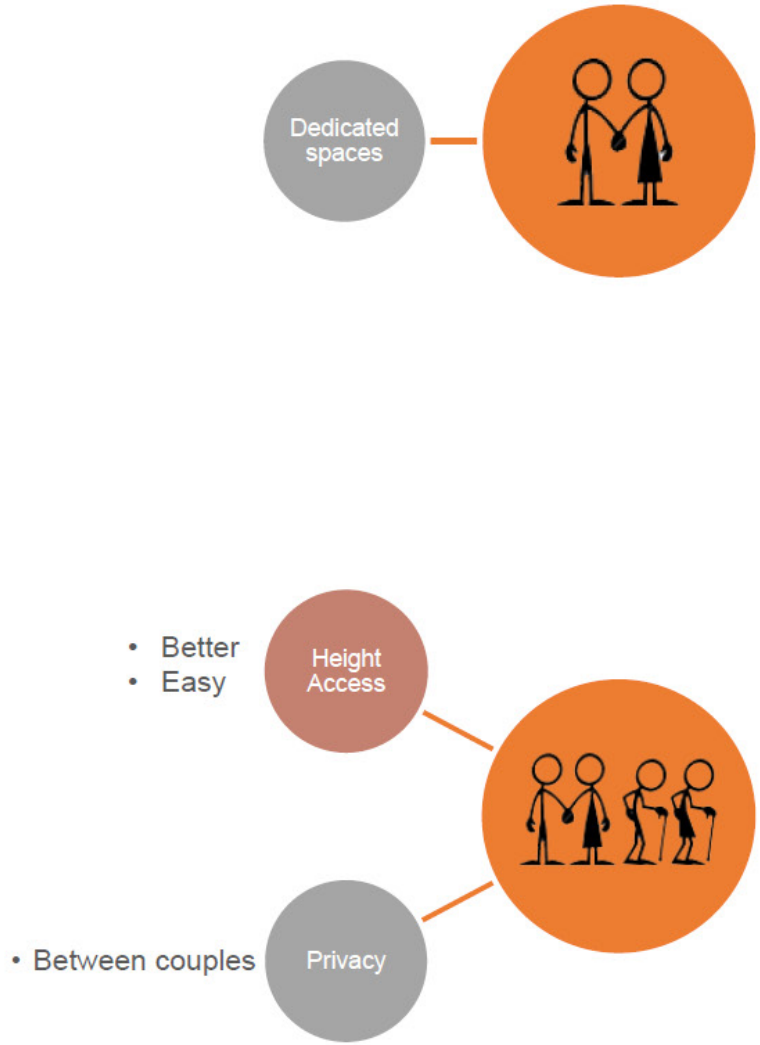
Present interior scenario

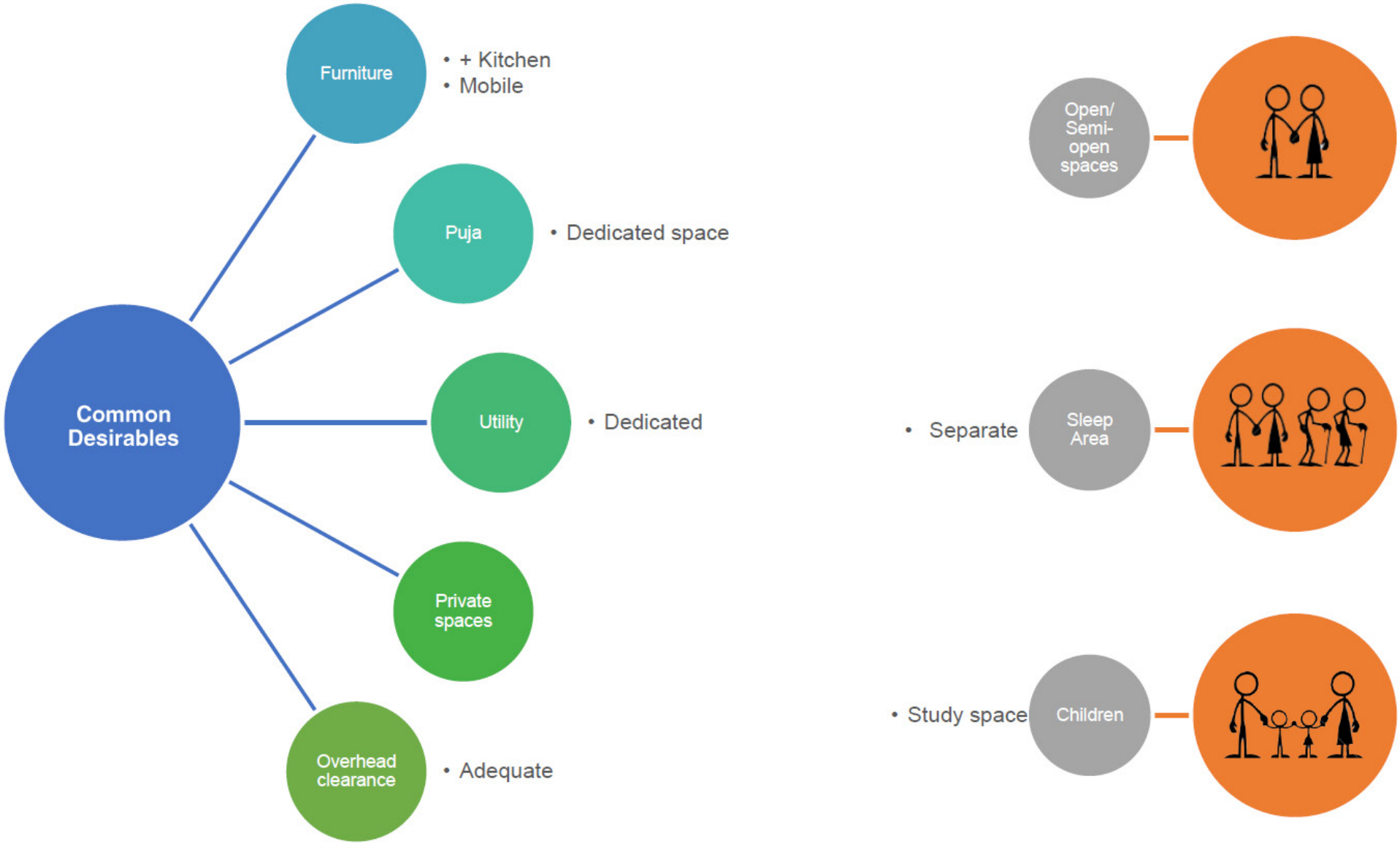
- Weak structure
- Limited privacy
- No 'living' space; they adjust
- Less ventilation and natural light
- Unhygenic toilets / No toilets
- Steel as an accepted material

image source: HUDCO project

Necessities and desirables


Common Necessities
Furniture
• Floor supported
• Multi-purpose
• Assembled
• Mobile
• Incremental
Space
• Multi-purpose
• Central
• Incremental
Kitchen
• Super compact
• Time-based
Lighting/ Ventilation
• Adequate
• Natural
Toilet
• Minimum Volume

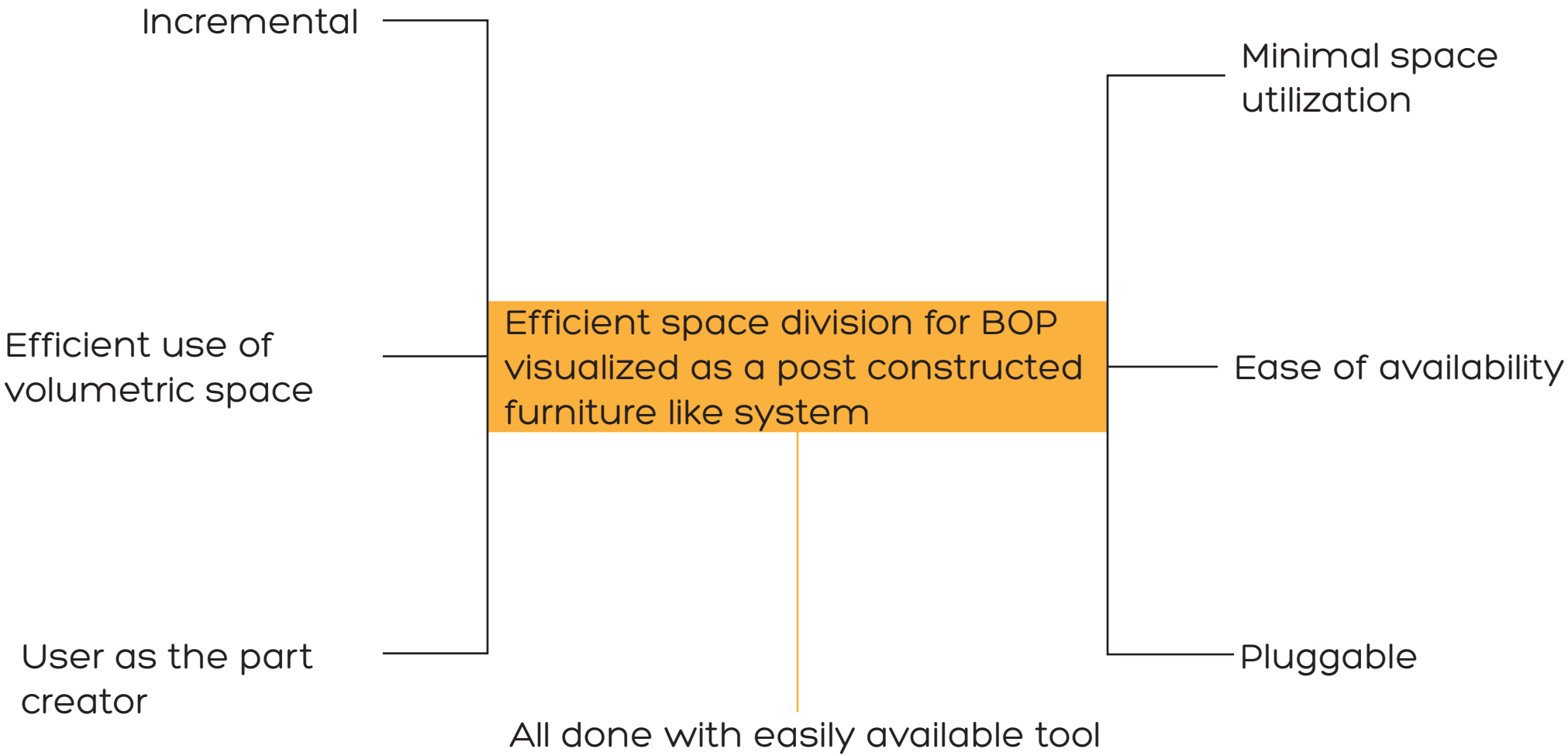

Dedicated spaces
• Better
• Easy
Height Access
• Between couples
Privacy


Common Desirables
Furniture
• + Kitchen
• Mobile
Puja
• Dedicated space
Utility
• Dedicated
Private spaces
Overhead clearance
• Adequate
Open/ Semi-open spaces
Sleep Area
• Separate
Children
• Study space

User profile

- People at the bottom of the pyramid
- Close to 90,000 - 2 lakhs per annum as income
- Living in slums in metro cities
- Tenured residents of the space

Design brief


Incremental
Efficient use of volumetric space
User as the part creator
Efficient space division for BOP visualized as a post constructed furniture like system
All done with easily available tool
Minimal space utilization
Ease of availability
Pluggable

Compromises

In case of

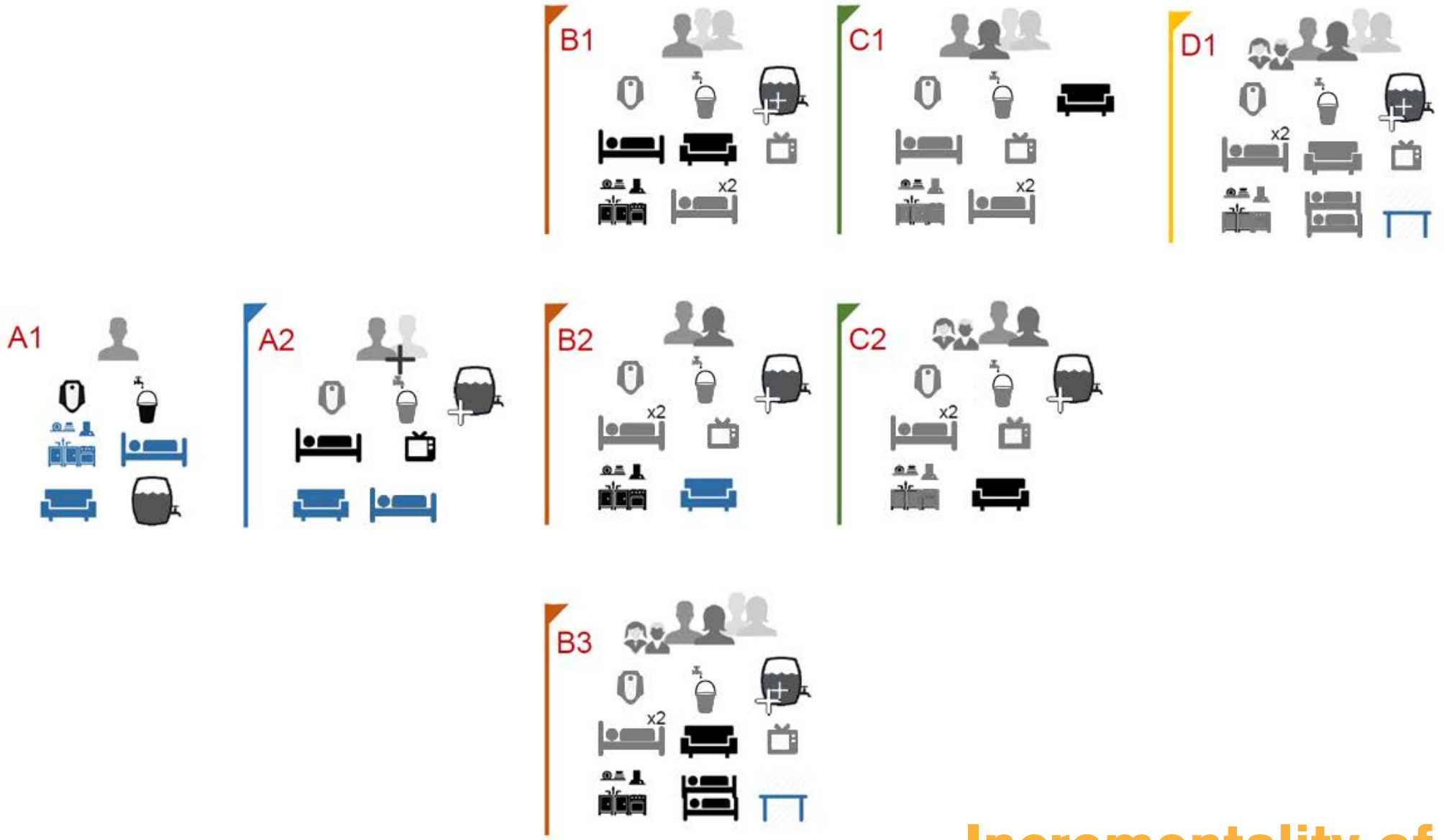
- Space utilization
- Head room
- Higher level access

Keywords

Focus

- Super - compact
- Affordable
- DIY
- Incremental
- Temporariness
- Durability
- Effective use of volumetric space
- Cultural context in India
- Shared spaces
- Personalization / Customization

Study of incrementality



Incrementality of need

Insights

Added-up furniture

- *Bed space*
- *Kitchen space*
- *Storage space*
- *Levels*
- *Living space furniture*

Static furniture

- *Toilet*
- *Staircase*
- *TV space*

Any stage furniture

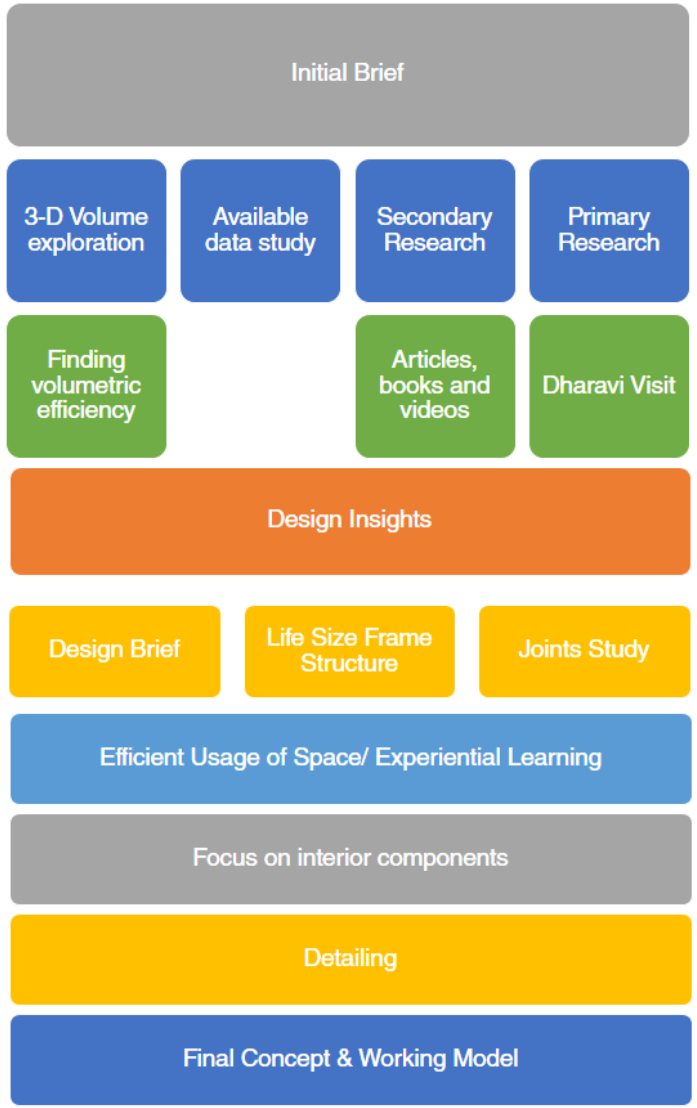
- *Puja*
- *Dining space*
- *Washing space*

Design approach

Design approach

An industrial design approach to housing

Applying agile methodology in product design



Initial exploration

Foam board mockups
- *volumetric space*
- *vanishing space*
- *spaces underneath*

Sketches and ideations

Drawings

Incremental layouts

Life-size model

slotted angle
+
Flute board

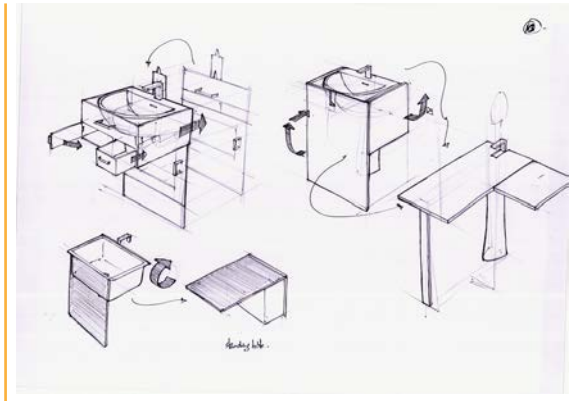
Material Research + Focus areas

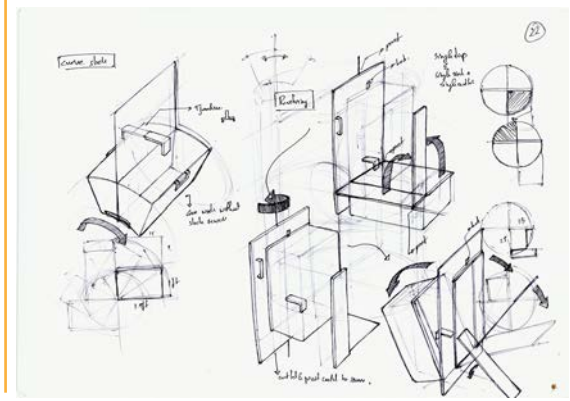
Bathroom + Toilet
Kitchen
Structural members

Fabrication

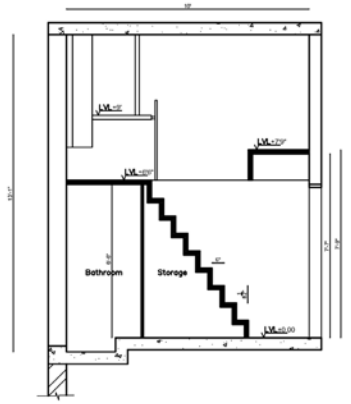
Steel structure
prototype

Initial exploration

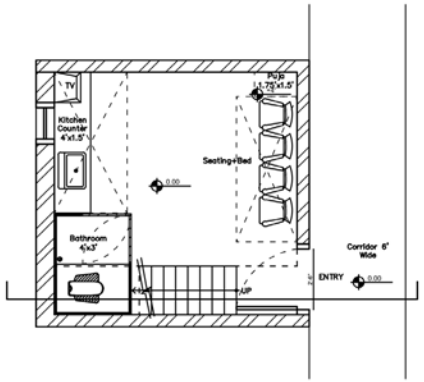




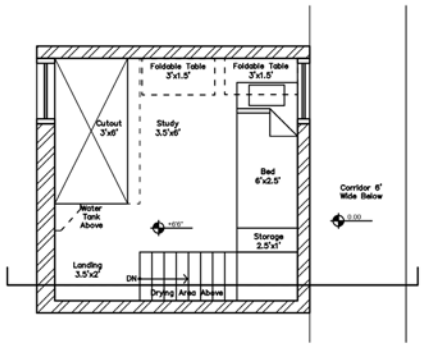
Drawings



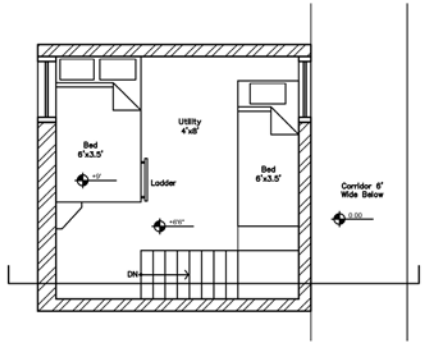
Section



Ground Floor



First Floor



First Floor

Life-size model

Populating space












Simulating living











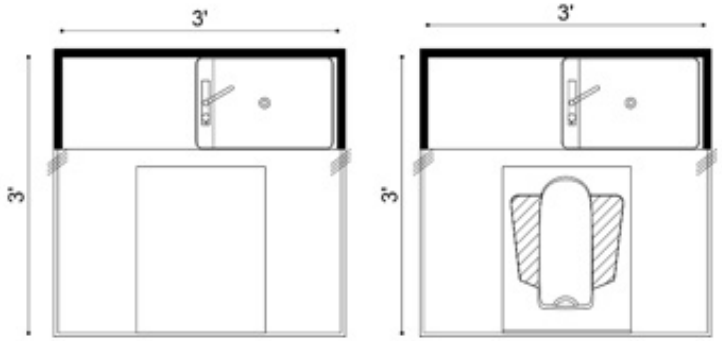

Life-size prototyping

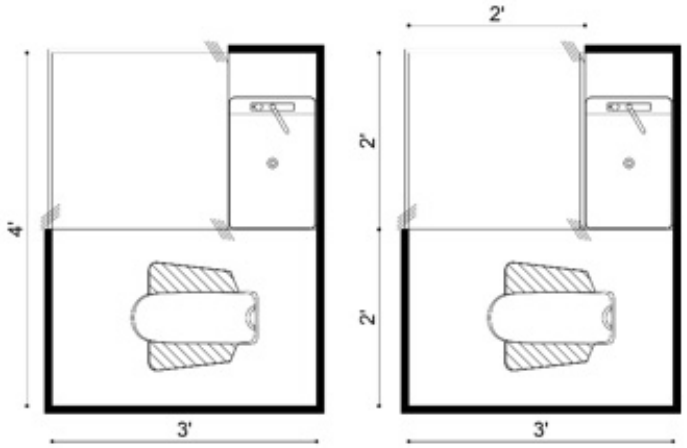
- Bathroom + toilet space
- Kitchen space
- Structural members

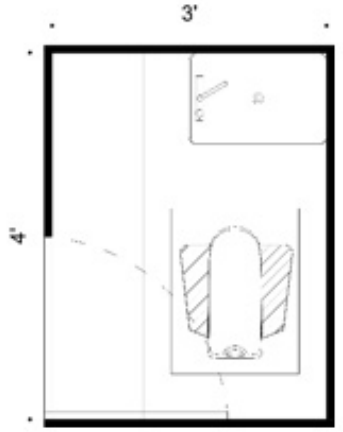
Focusing on to the interior

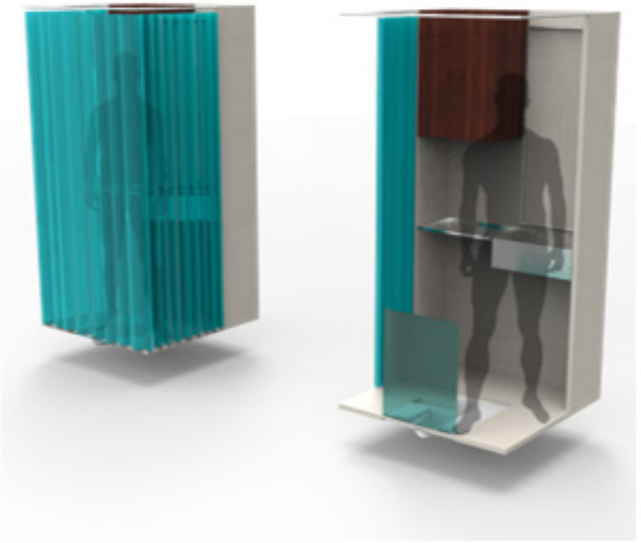
Bathroom + Toilet space

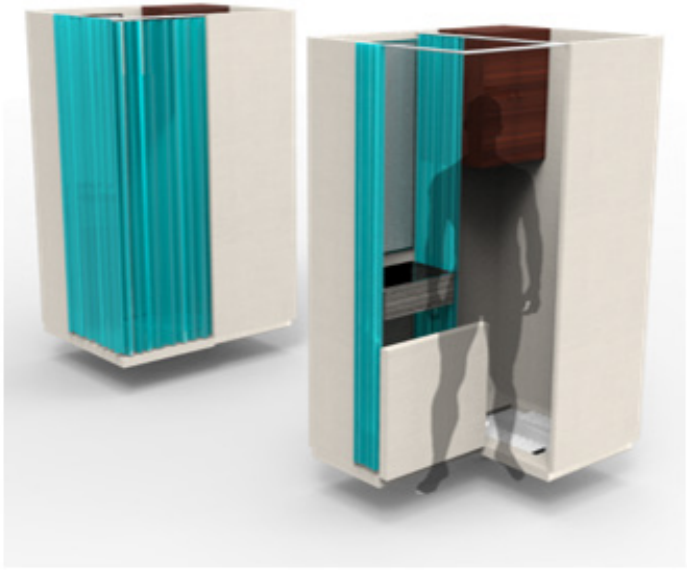
- Efficient usage of volumetric space
- Pluggable
- Minimal assistance in installation
- Easily replaceable partition
- Reducing existing compromises

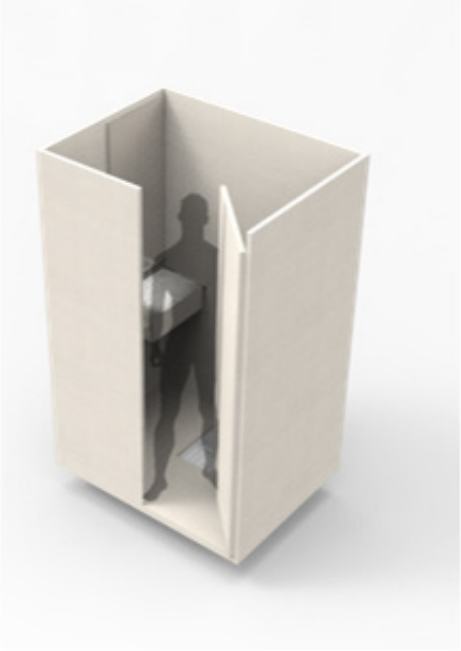












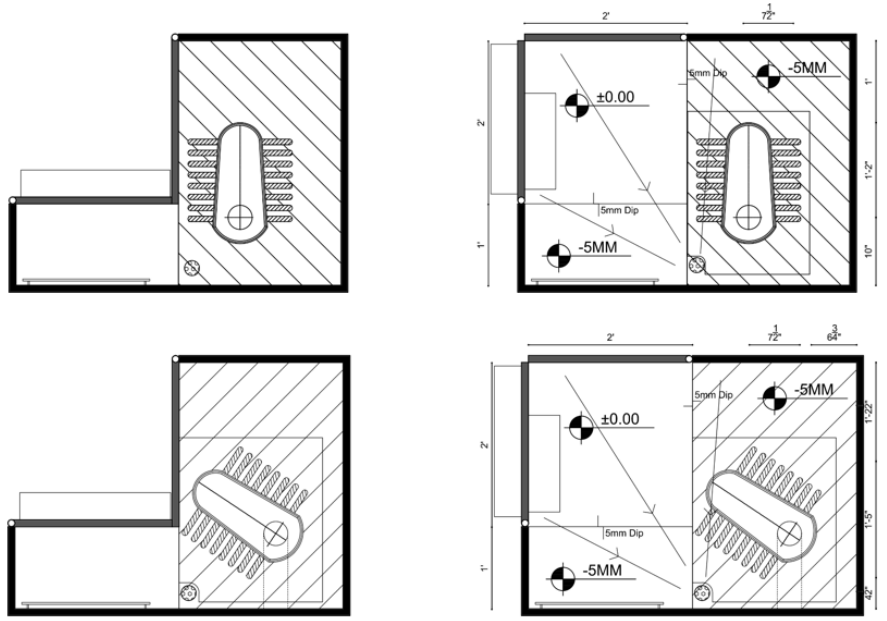
Concept 1

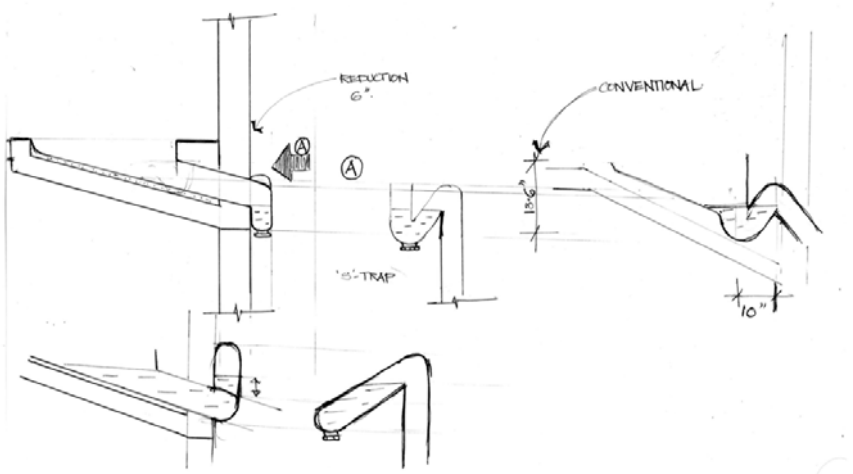
Concept 2

Concept 3

Concept evaluation

- Multiple usage of space
- Time based space utilization
- Low compromise on ergonomic aspects
- Adequate privacy
- Material choices according to cost, availability, manufacturability and above all comfort of the user





Concept 2 detailing

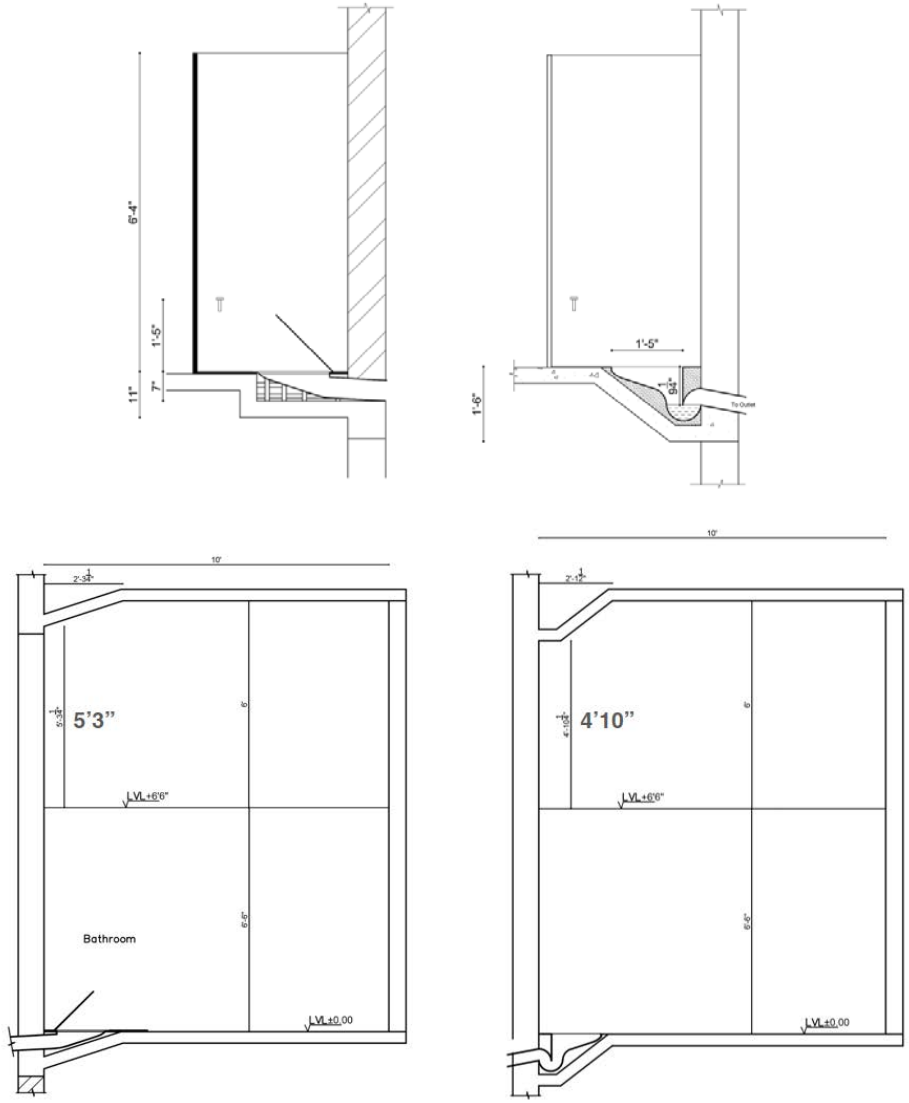
The base

- made of SS 202
- 2 inch skirting
- ridges
- flushed to the floor

The trap

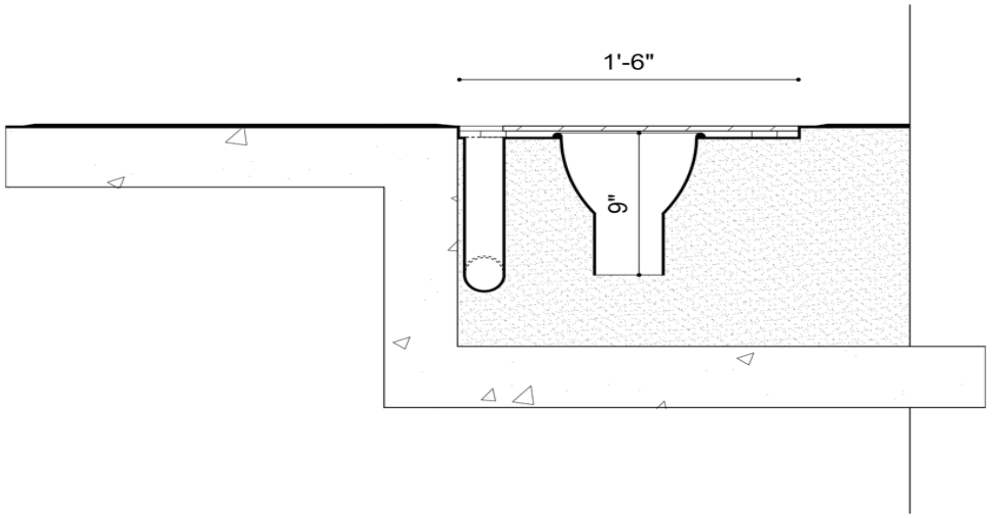
- Positioning trap to consume minimum volume
- comparison of clear heights

Clear height comparison

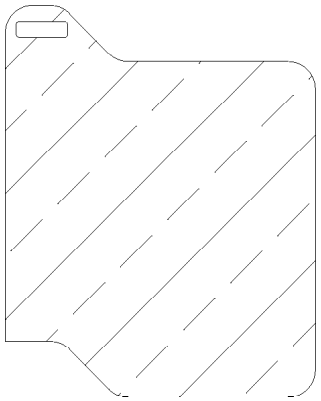


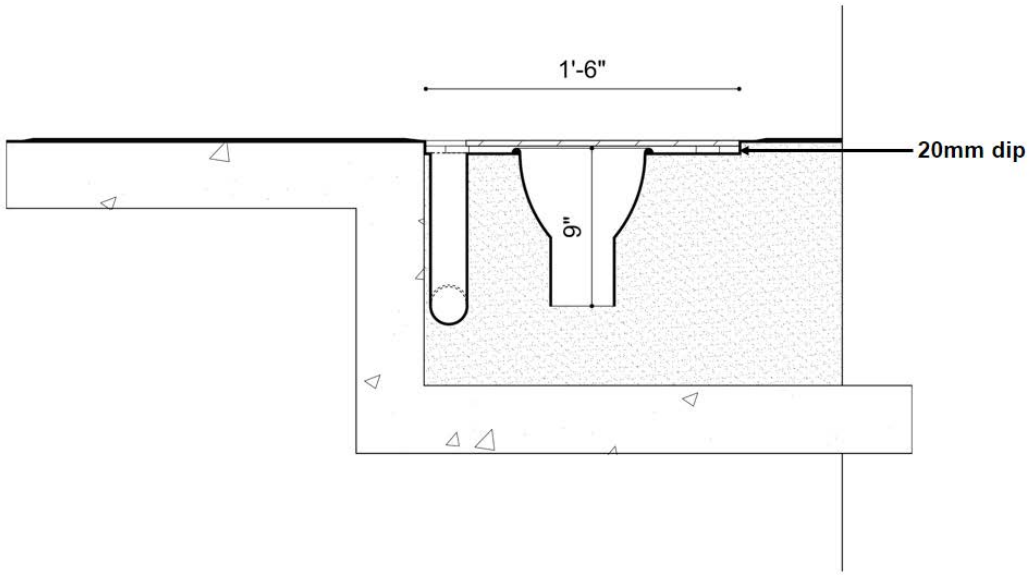
Concept 2 detailing

The base



- **The pan fixing**
  - *- Deep drawing*
  - *- Argon welding*





Concept 2 detailing

The base

- **The lid**

  - converting toilet to bathing area

  - aluminium honeycomb sandwitch

Concept 2 detailing

The partition

- **The panel**

  - Material choices based on pricing, quality and life span

  - Corrugated steel sheet vs PP honeycomb

PP Honeycomb

Pros

1. Planar piece
2. Easy to cut (for window)
3. Easy maintenance
4. Space Efficiency
5. Easy to fix
6. Completely DIY

Cons

1. Material Availability at present
2. Cost- higher than corrugated steel sheet
3. Additional supporting members needed

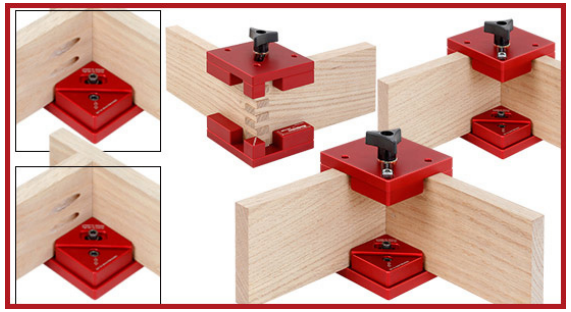
Corrugated steel

Pros

1. Self supporting
2. Easy Availability
3. No additional joints
4. Easy Maintenance

Cons

1. Bending needed- Calls for tooling
2. Cutting not easy (for window)- additional tooling
3. Fixing door not easy



Concept 2 detailing

The partition

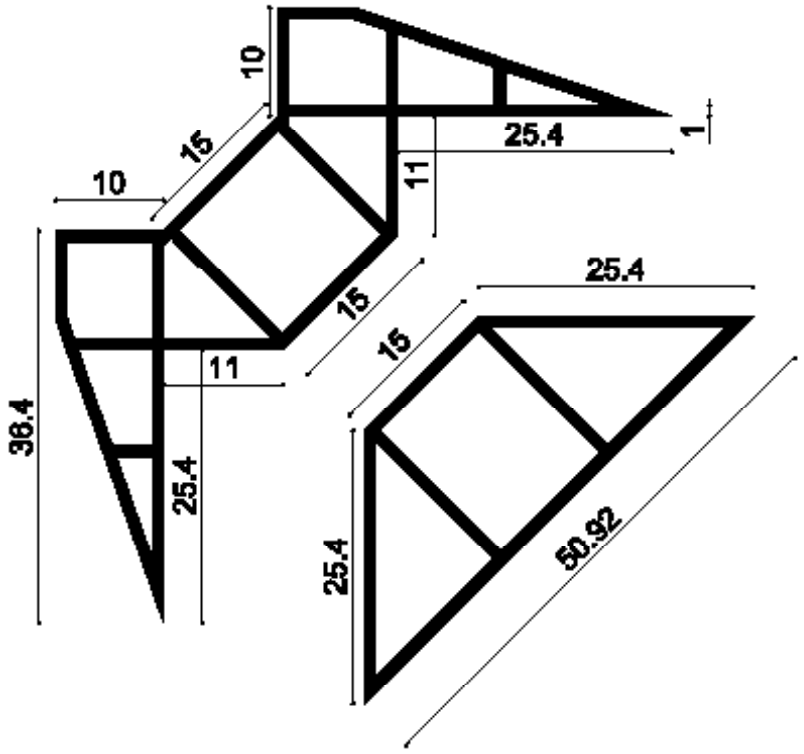
- **The connection**

  - Related product study

source: http://klemlighting.com/; http://woodpeck.com/-; http://wolfcraft.com accessed on 20-10-2014

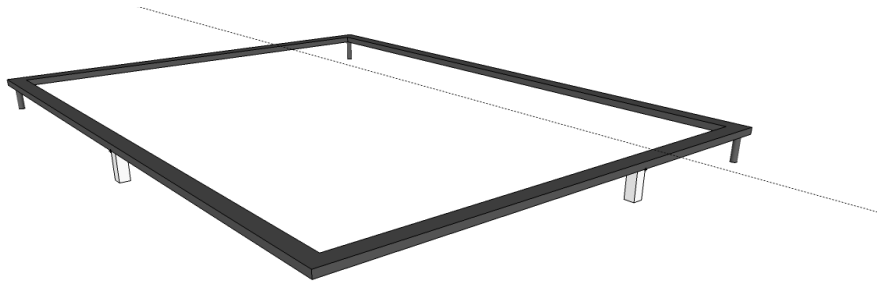
Concept 2 detailing

The partition



- **The connection**

  - PVC extrusion



Concept 2 detailing

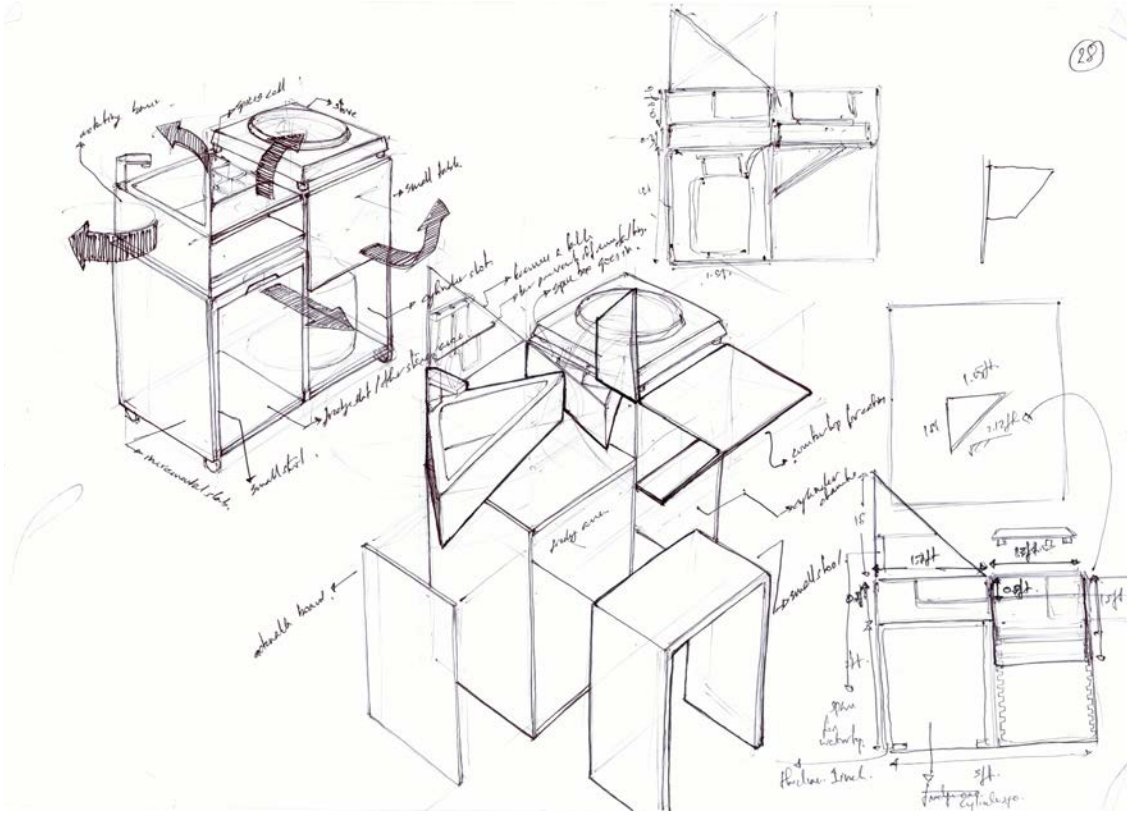
The crown

- to hold the panel members together

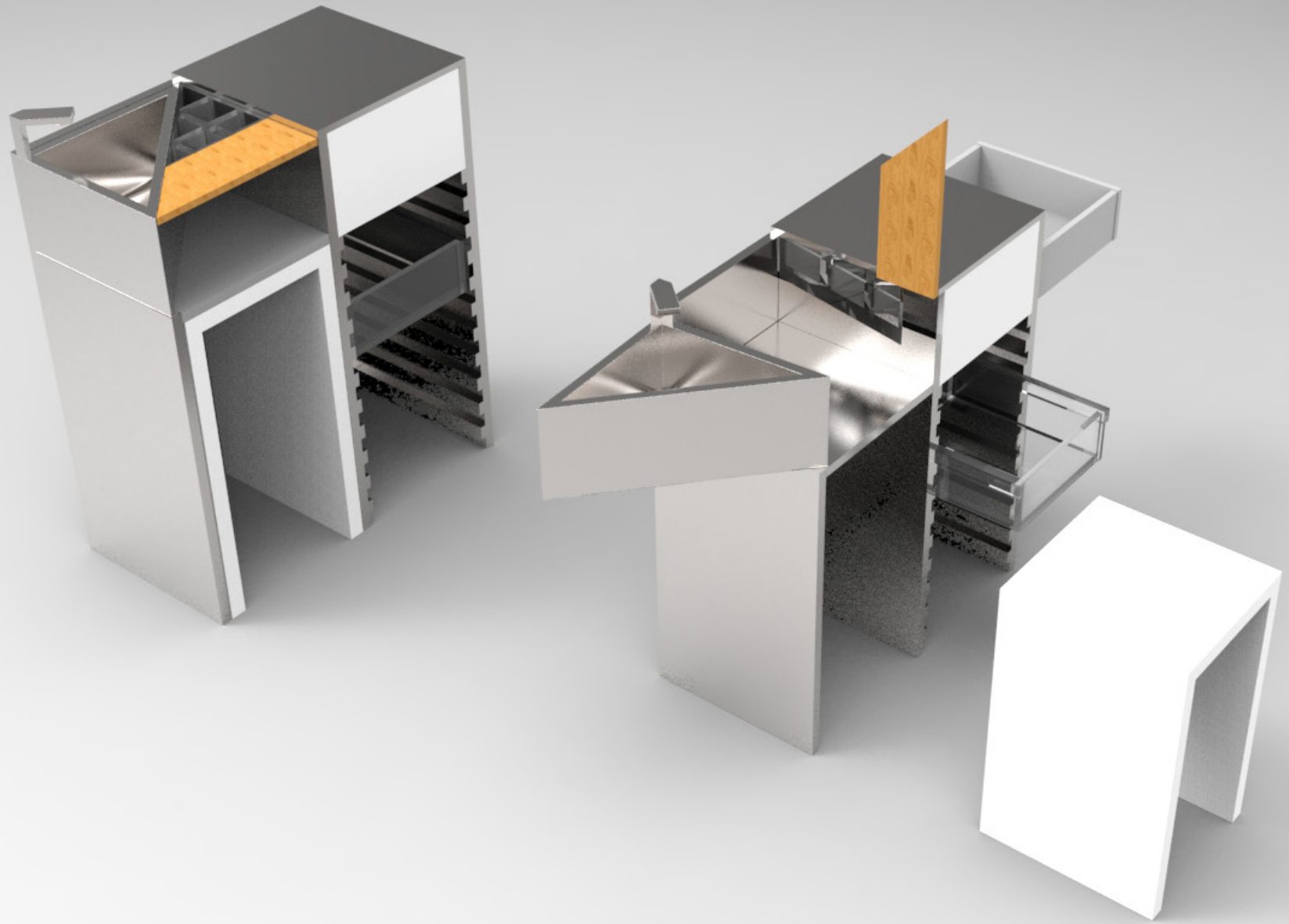
Kitchen space

- Easy to assemble and disassemble
- Efficient usage of volumetric space
- Incrementality
- Provision for user to populate
- Usage of floor space for preparation

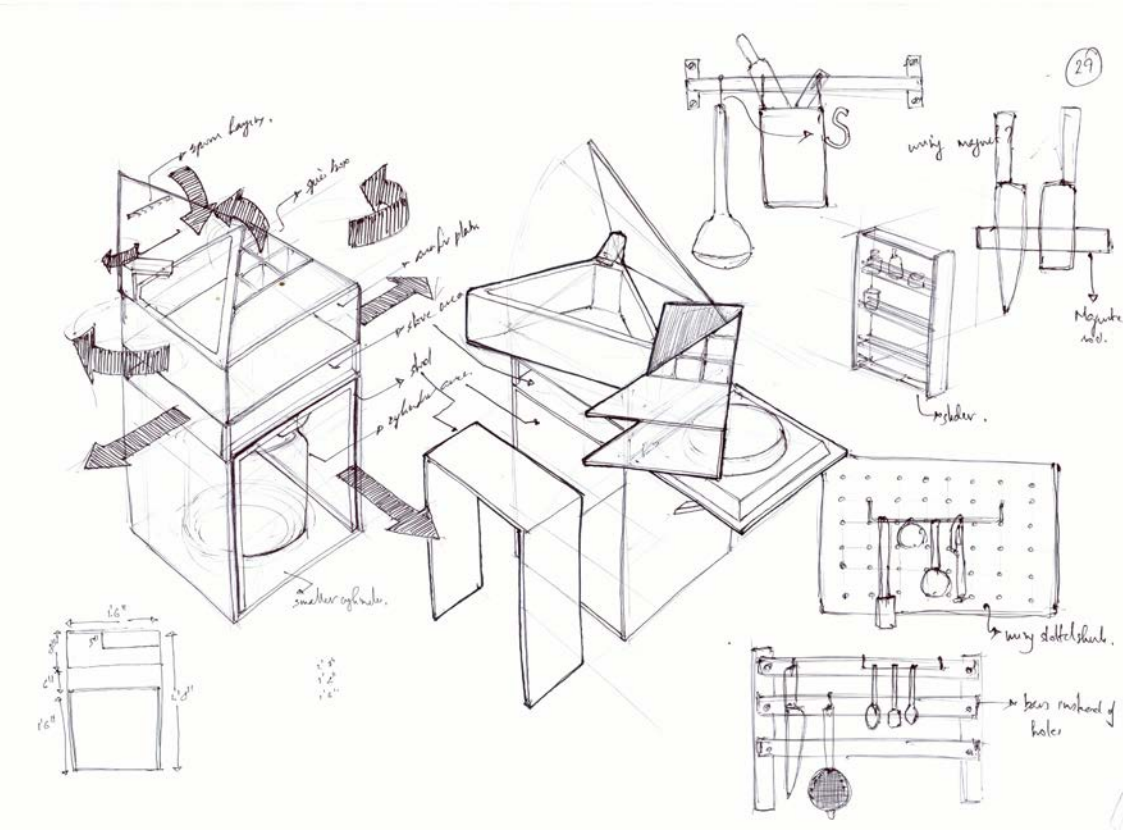
Concept 1



- 1'6" x 3'
- Rotating sink
- Triangular sink for min area
- Countertop for single burner stove
- Pull out stool and countertop extension



Concept 1

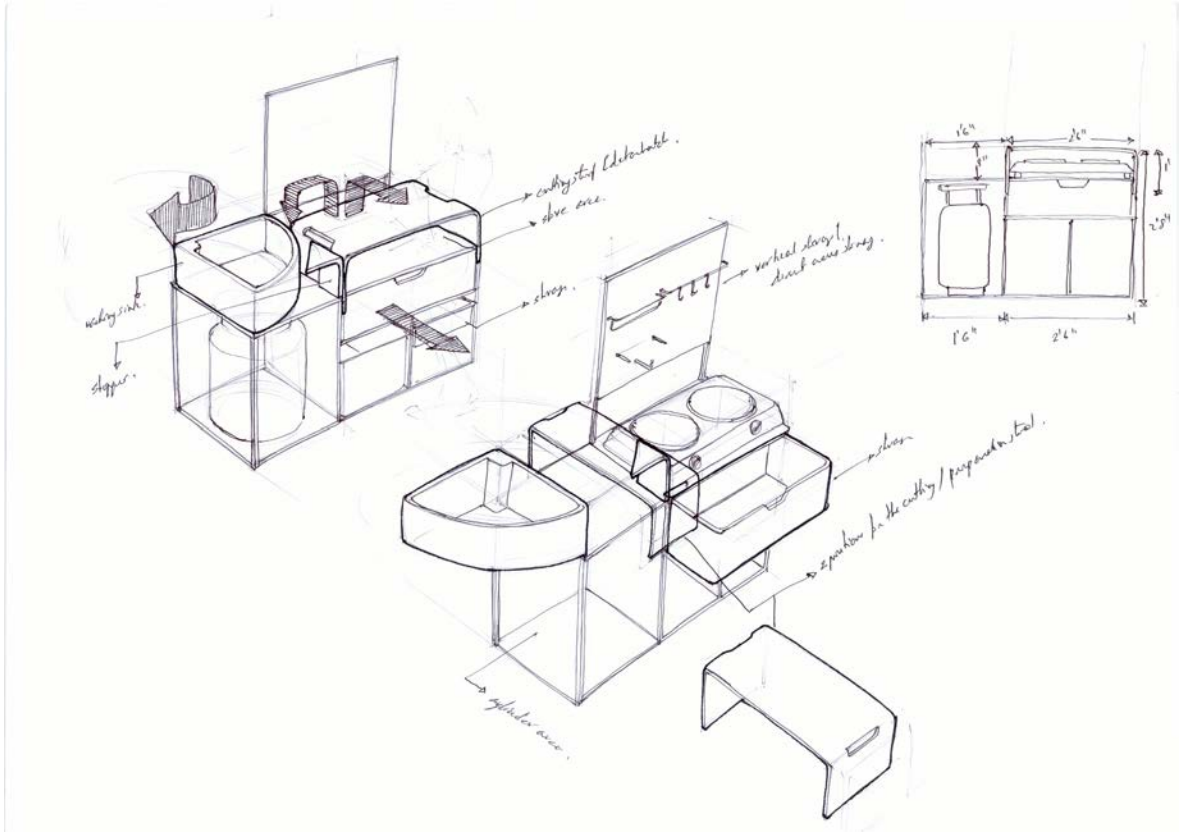


Concept 2

- 1'6" x 1'6"
- Rotating sink
- Triangular sink for min area
- Single burner stove on slide out
- Pull out stool

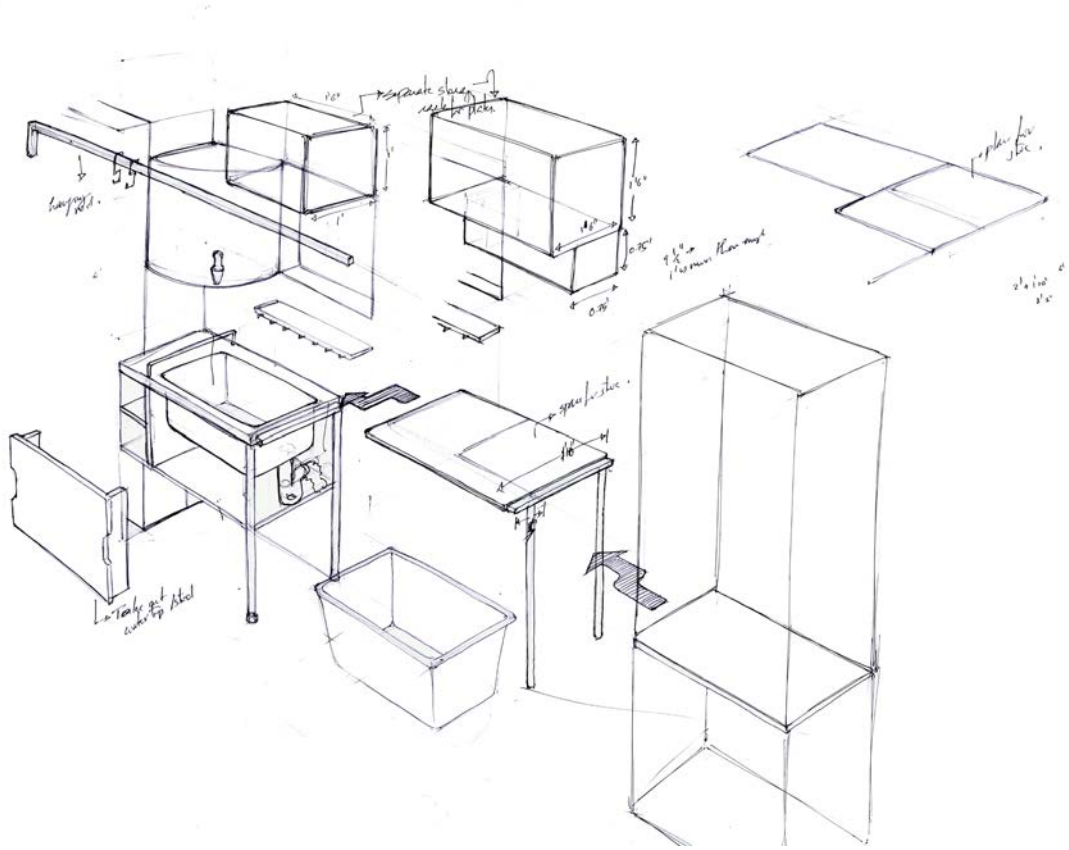
Concept 2

Concept 3



- 1'6" x 4'
- Rotating sink
- Curved countour for sink
- Provision to utilize floor space while preparing
- Dedicated storage space

Concept 3



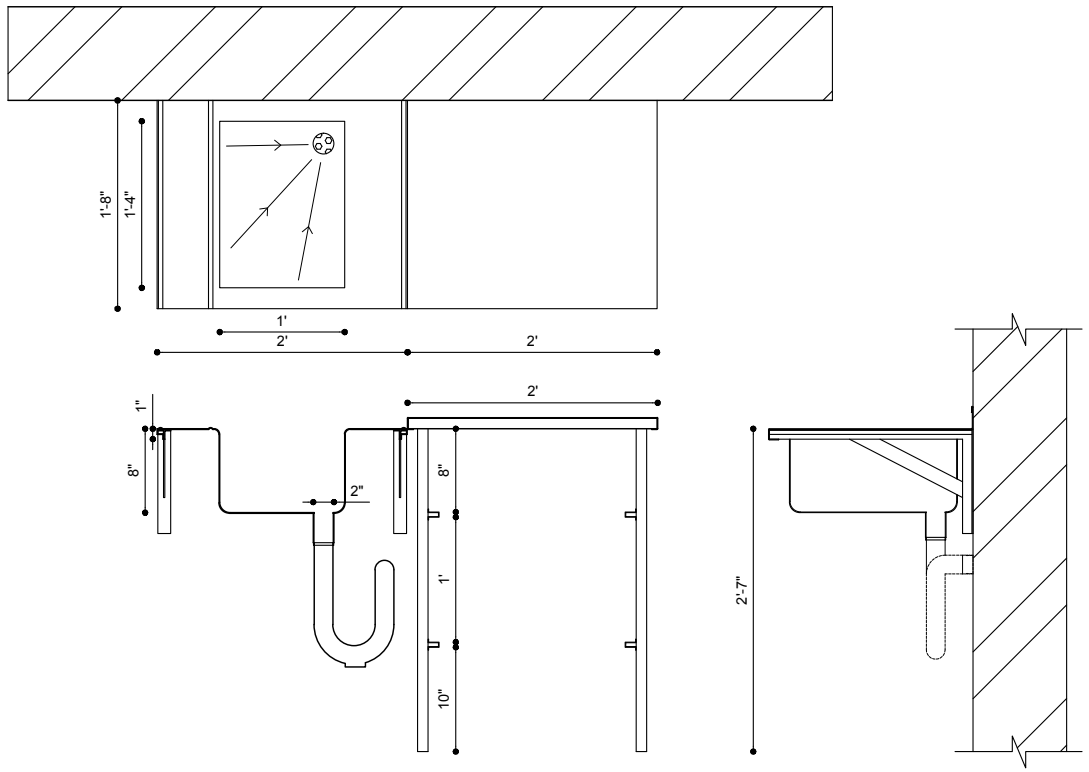
Concept 4

- Sink and countertop separated
- 1'6"x2 for sink ; 2'x2' for countertop
- Sink part made a static entity
- Usage of vertical space
- Negative spaces for storage
- Provision for people to populate

Concept 4

Concept evaluation

- Efficient usage of space (vertical and horizontal)
- Ease of access
- Simple and efficient
- Storage options
- Option for user to populate the space
- Ease of assembly and dis-assembly
- Easy to manufacture



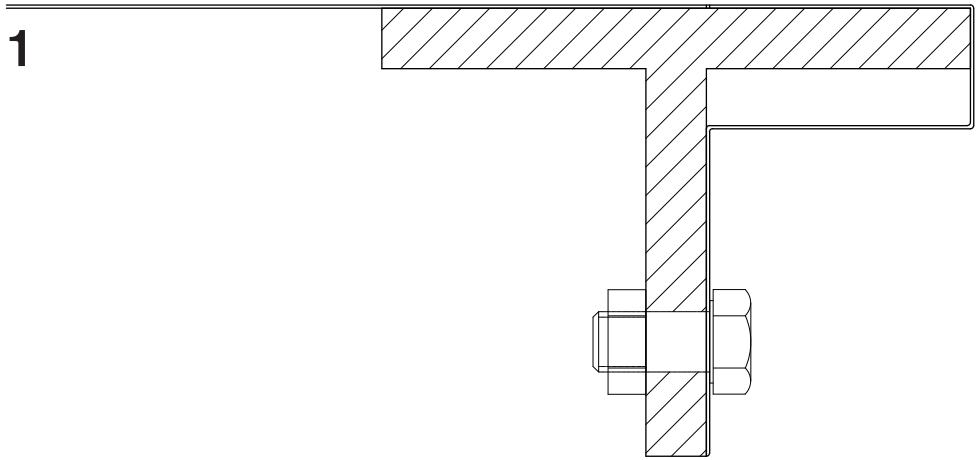
Concept 4 detailing

sink

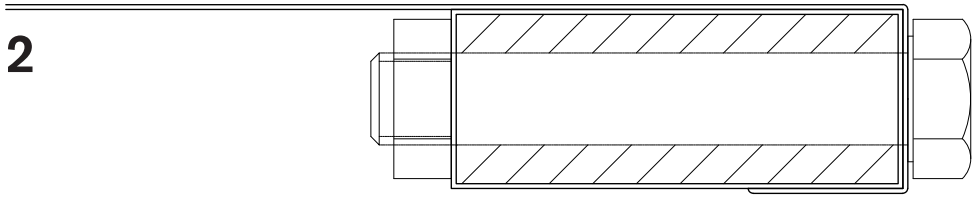
- Size increased to 1'8" x 2'
- 8" deep sink

- **Material**
  - SS 304
- **Strength**
  - Ridges for strength and partition
- **Drain and P-trap**
  - Drain positioned at rear corner
  - Horizontal orientation for trap
- **Support member and connection**
  - Cantilevered T or L section
  - Hiding the bolt

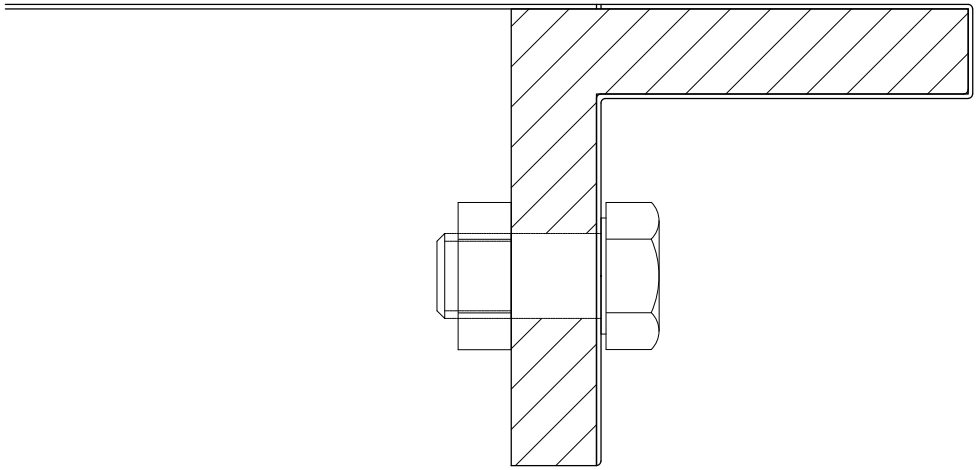
1



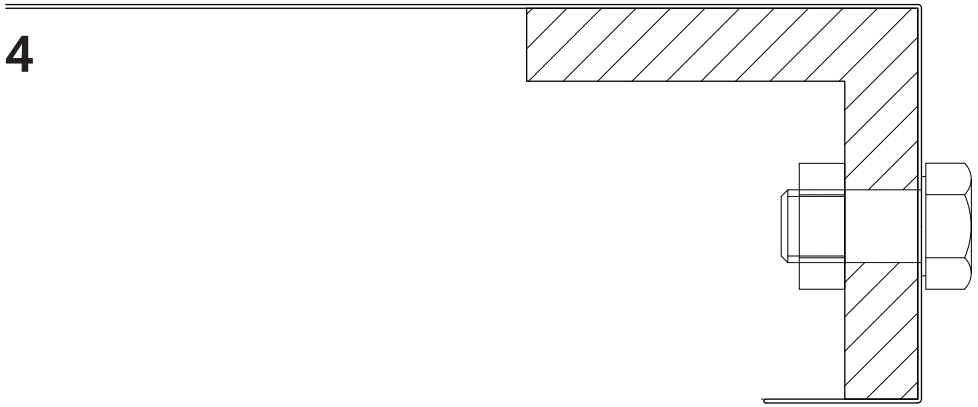
2



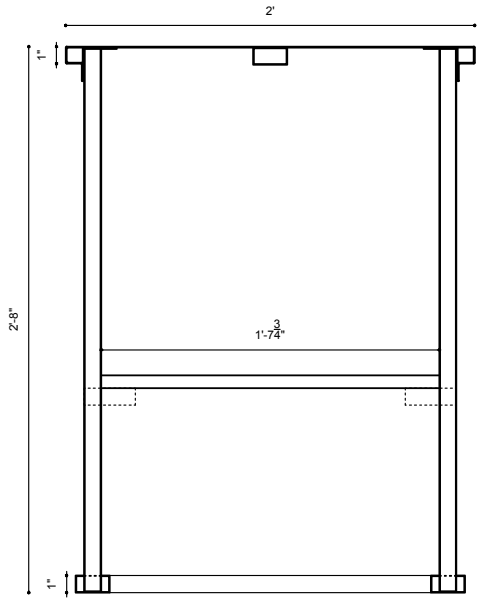
3

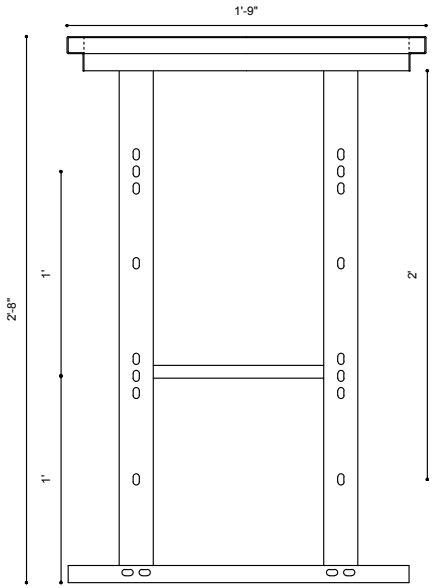


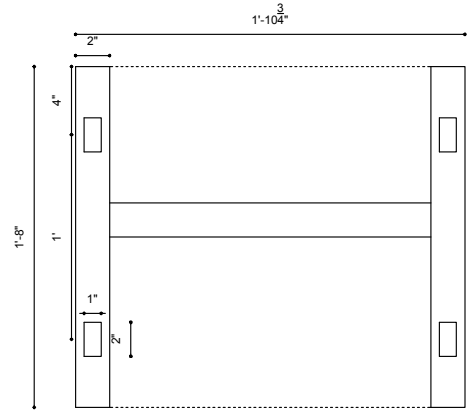
4

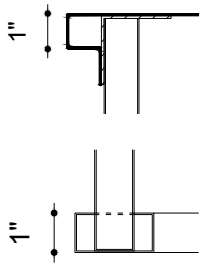


Connection detailing









Concept 4 detailing

Countertop

- Size increased to 1'8" x 2'
- Height maintained at 2'8"
- Can be knocked down to flat parts
- Flexibility of positioning storage racks

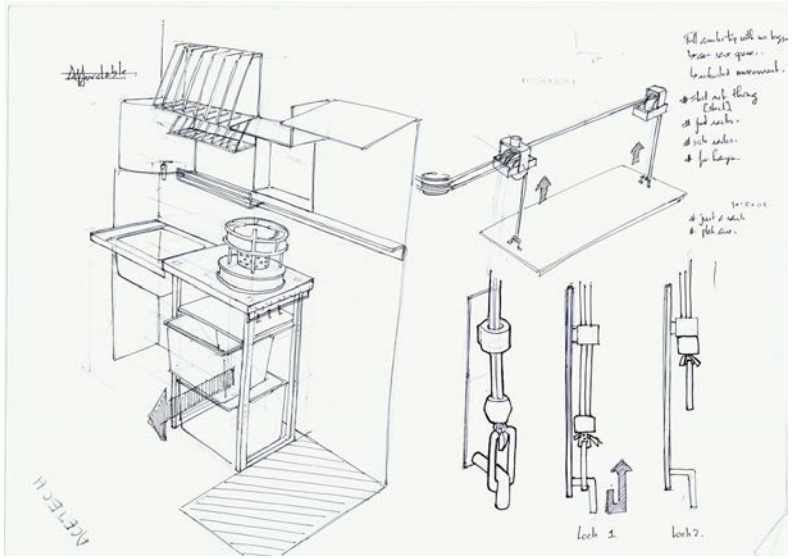
Material

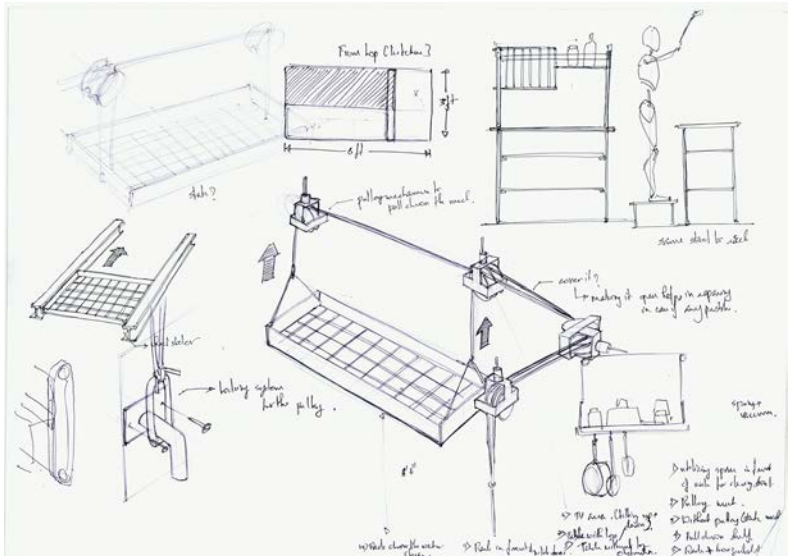
- SS 304 with thickness 1.2mm

Parts

- Countertop
- Legs
- Base


Countertop



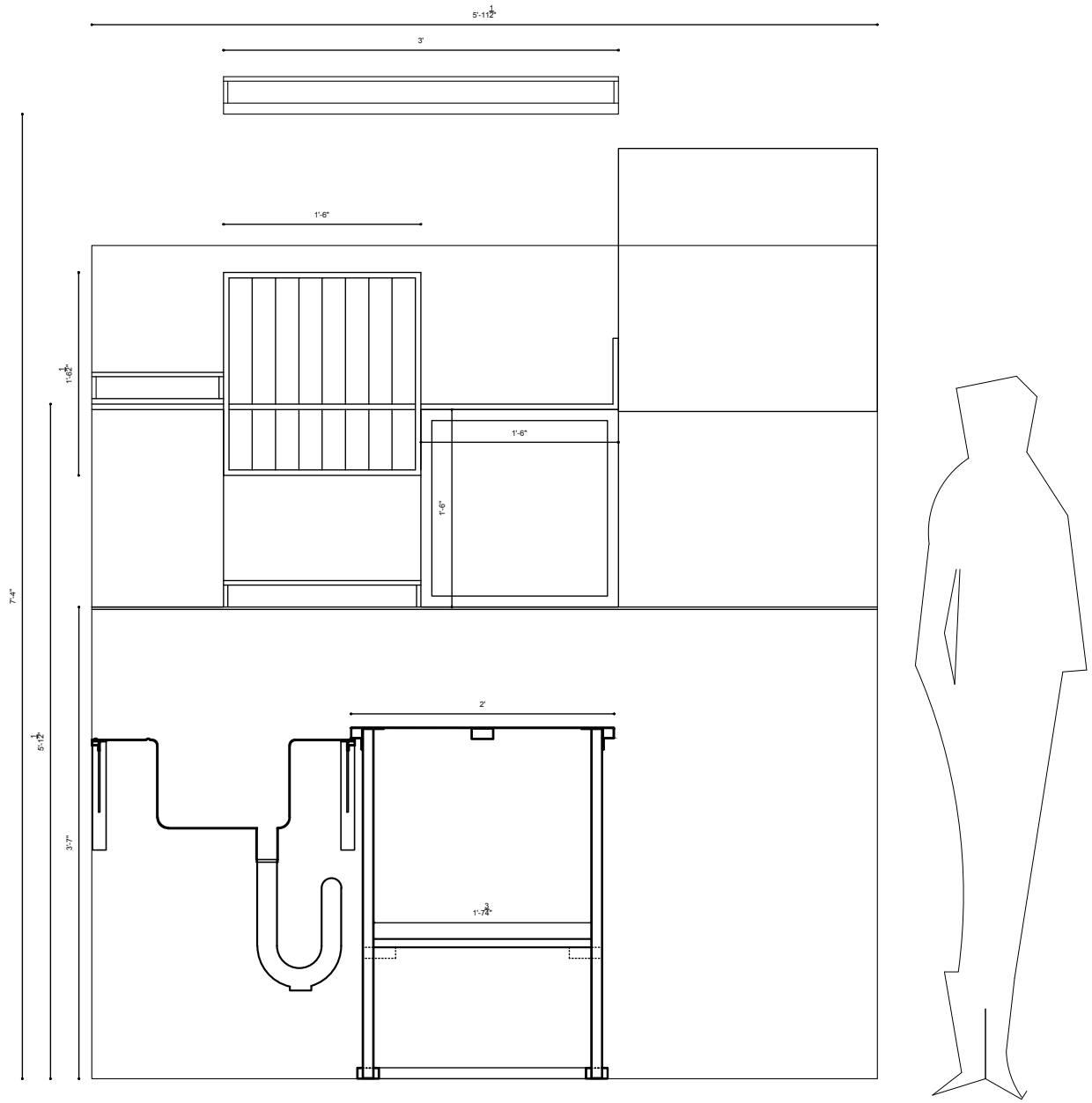


Concept 4 detailing

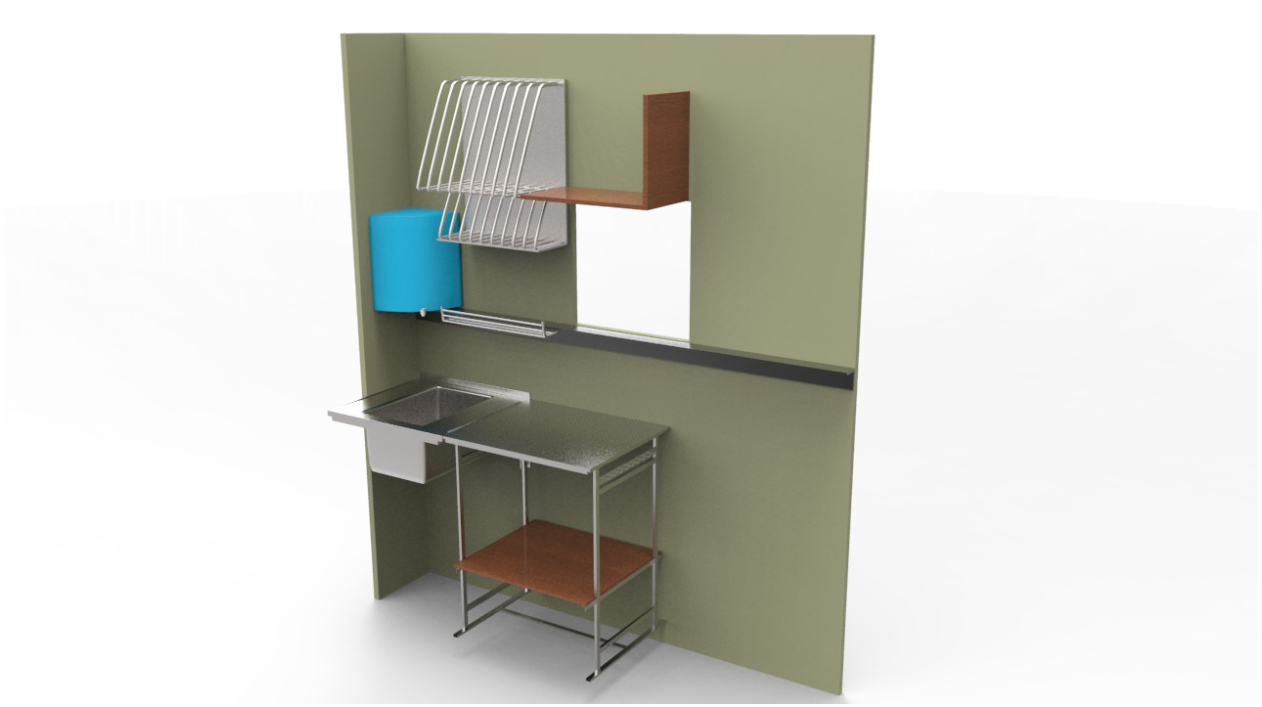
Space

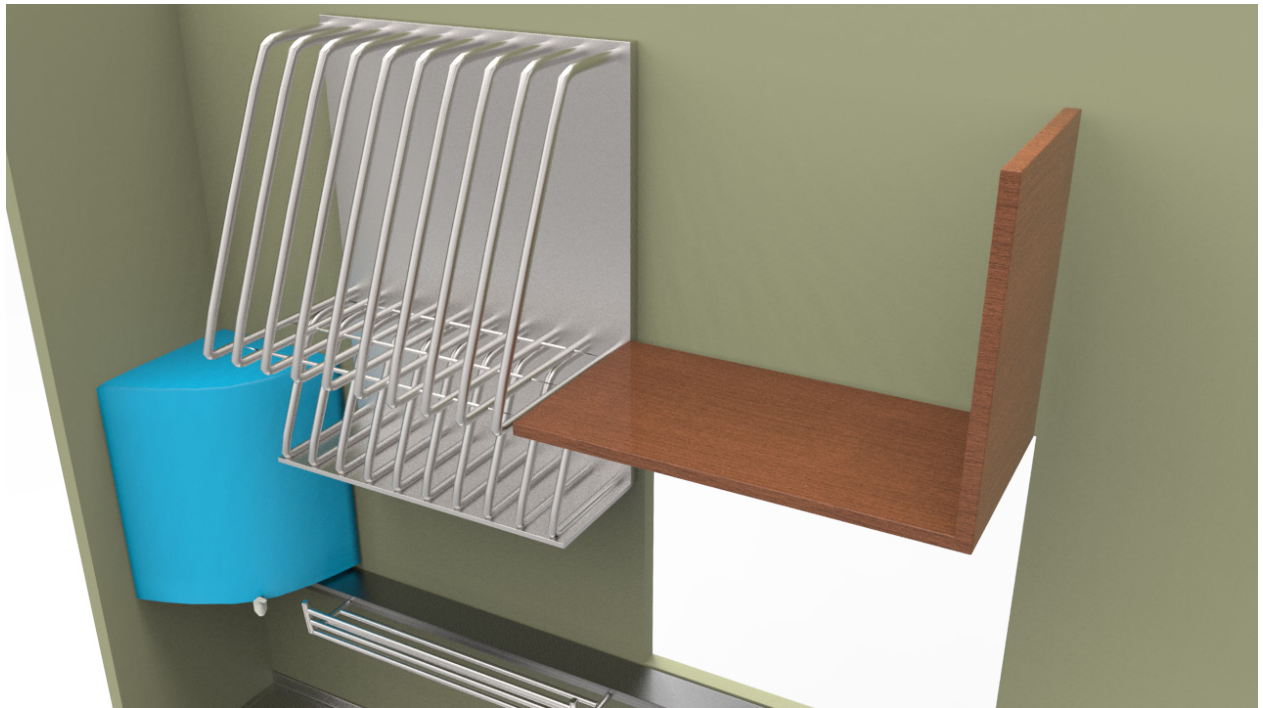
- Add on storages that could be attached to provisions in structural member

- **Vertical storage**
  - *- Mesh functioning as a hanging storage*
  - *- Posibility of incorporating a pulley system*
- **Water can**
  - *- Jerry can support in the corner space*
- **Racks**
  - *- Large and medium plates*
  - *- Hooks for glasses and other hanging utensils*



Kitchen space

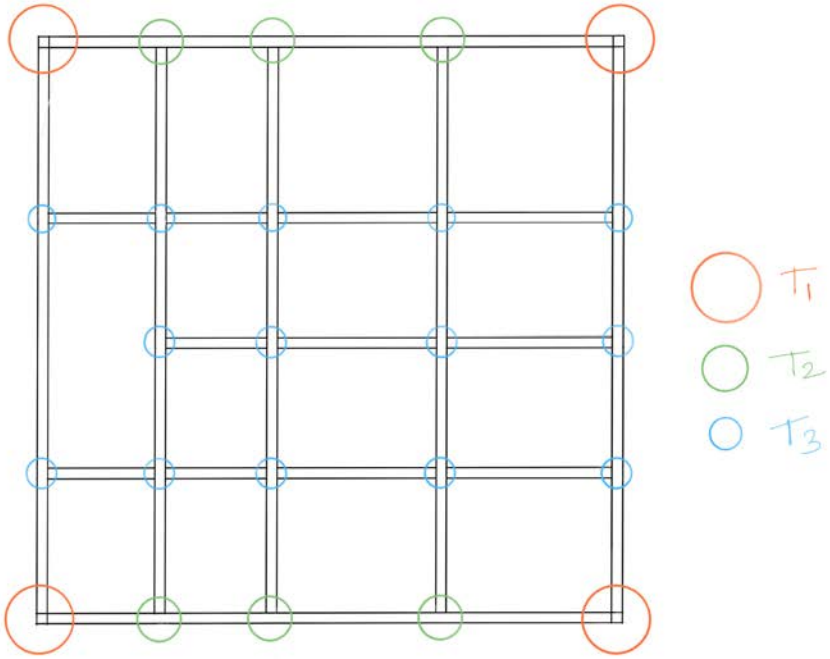





Kitchen space

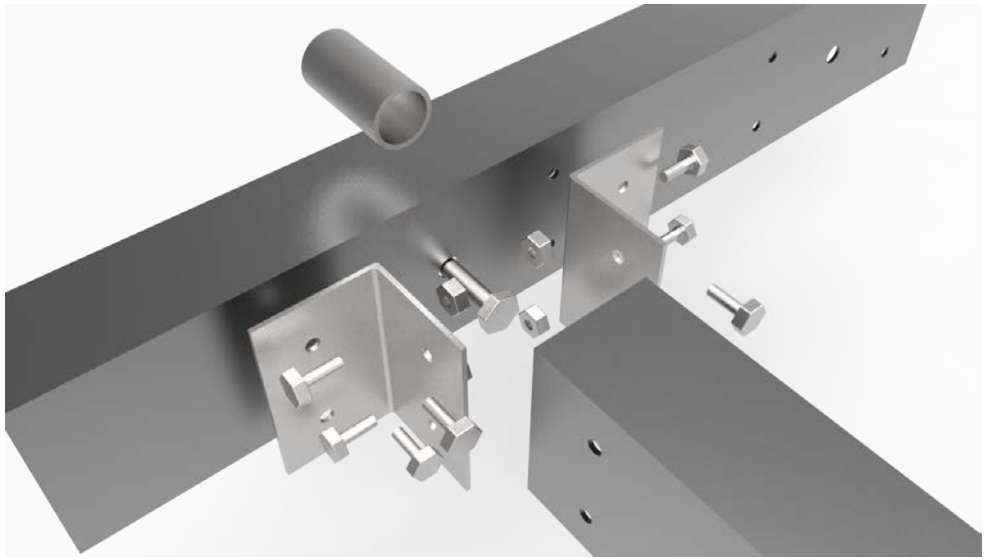
Structural elements

- Easy to assemble and disassemble
- Reduce manufacturing cost
- Locally available tools
- Provision for different layouts
- Flexible for the user to change



Joints classification

- **Depending on the purpose it serves:**
  - ***T1*** *- between main column and main horizontal member*
  - ***T2*** *- between main horizontal beams*
  - ***T3*** *- between main horizontal beams and non structural orthogonal members*



Concept 1

Material

Mild steel

Sections

Main structural member ***: C-section (60mmx90mm)***

Orthogonal support member ***: C-section (50mmx50mm)***

Vertical columns ***: Square section (3mm-4mm thick)***

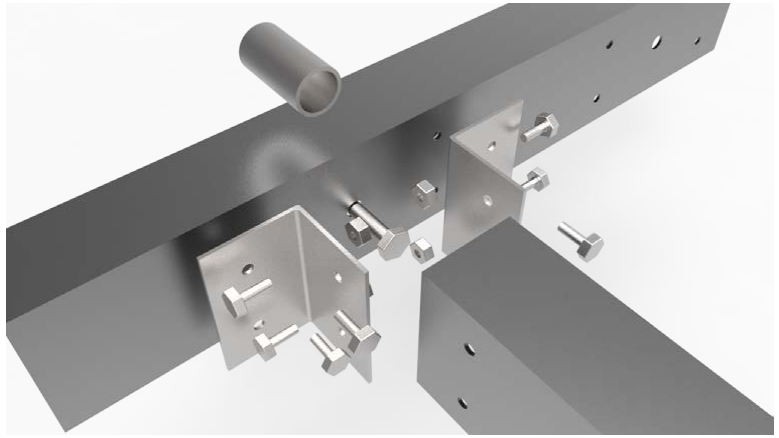
Fitting

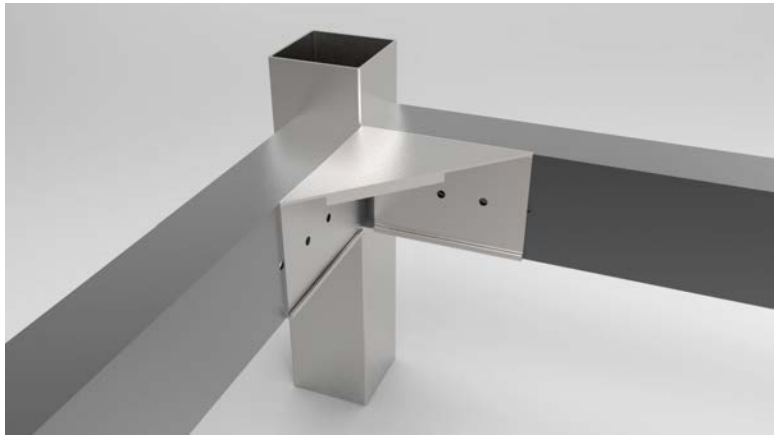
- Floor panels get flushed on to the height difference

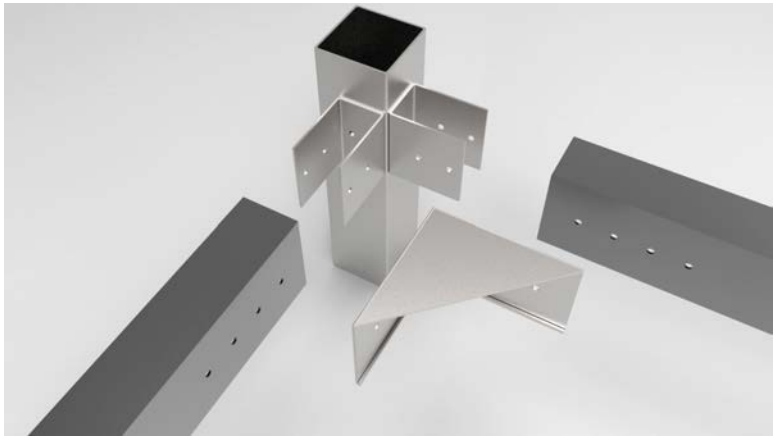
- Welded C-sections on the vertical columns connects the horizontal members

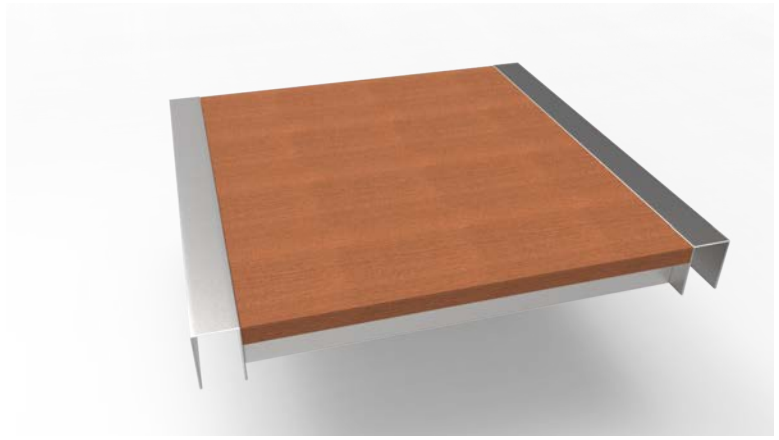
- L sections for connections between inner members

- Spacer tubes to avoid bending

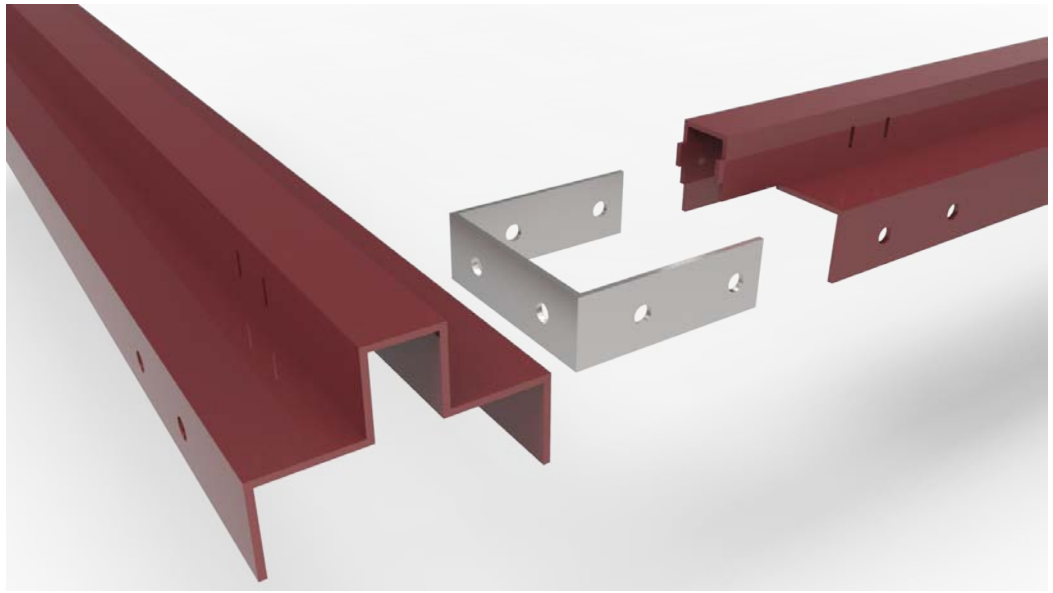








Concept 1 | Visualization



Concept 2

- Emphasis to keeping the floor flushed

- **Material**

  Mild steel

- **Sections**

  Main structural member ***: Open hat***

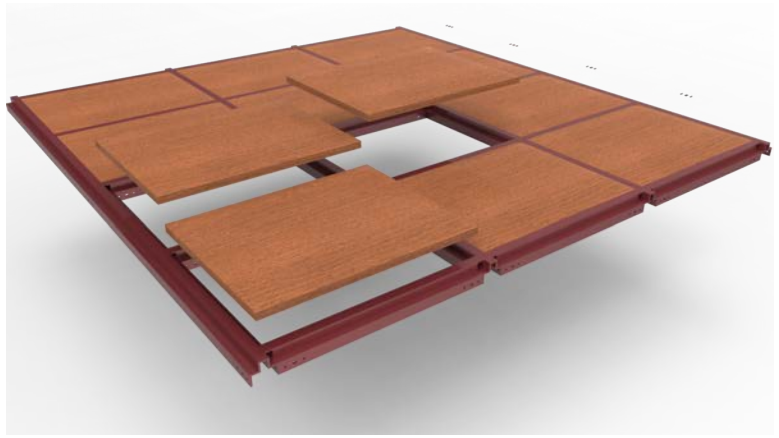
  Orthogonal support member ***: Open hat***

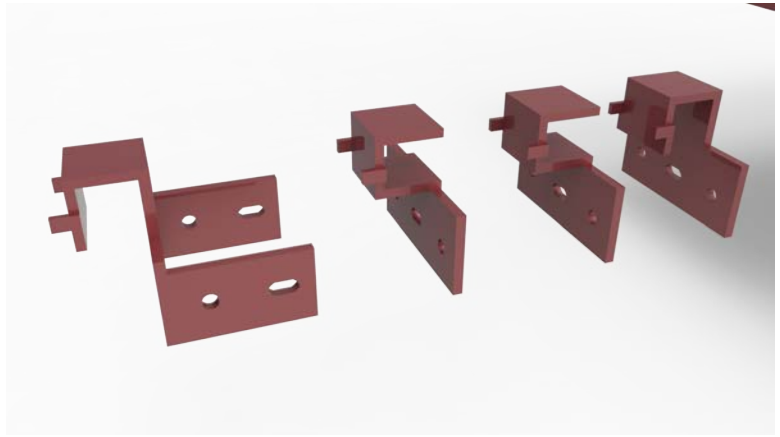
  Vertical columns ***: Square section***

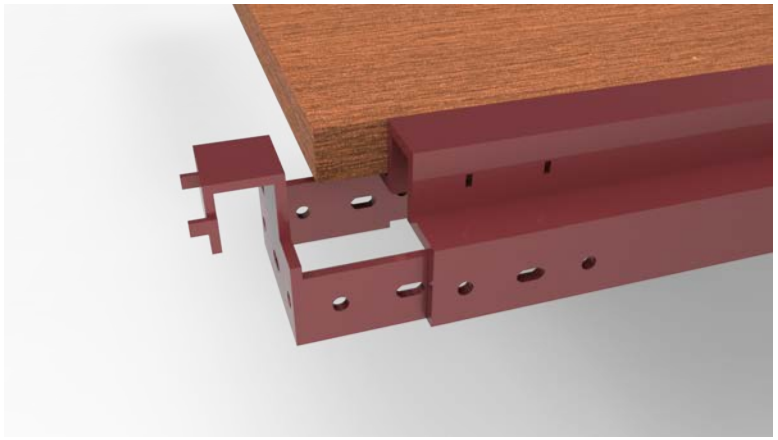
- **Fitting**

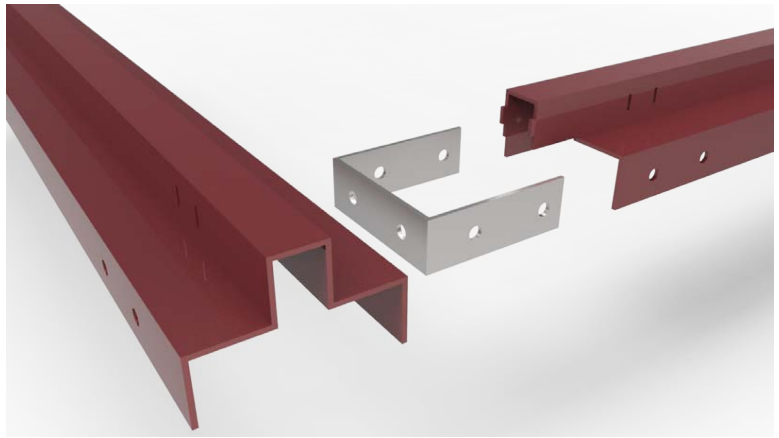
  - Grooves and holes given at joining areas to hold protrusions in the joining plates

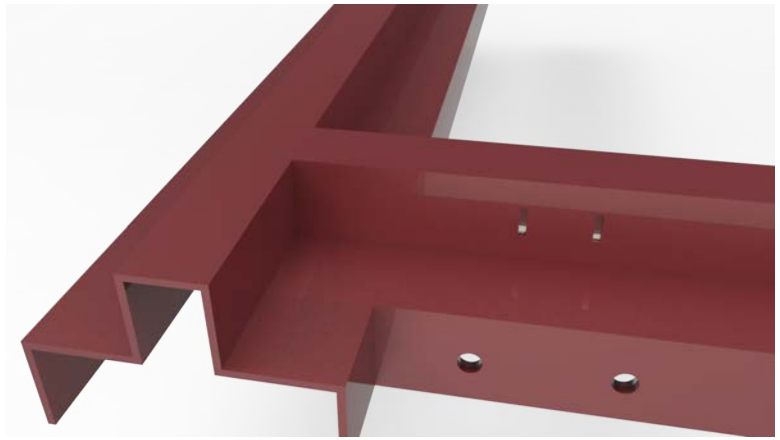
  - Connections through nuts and bolts



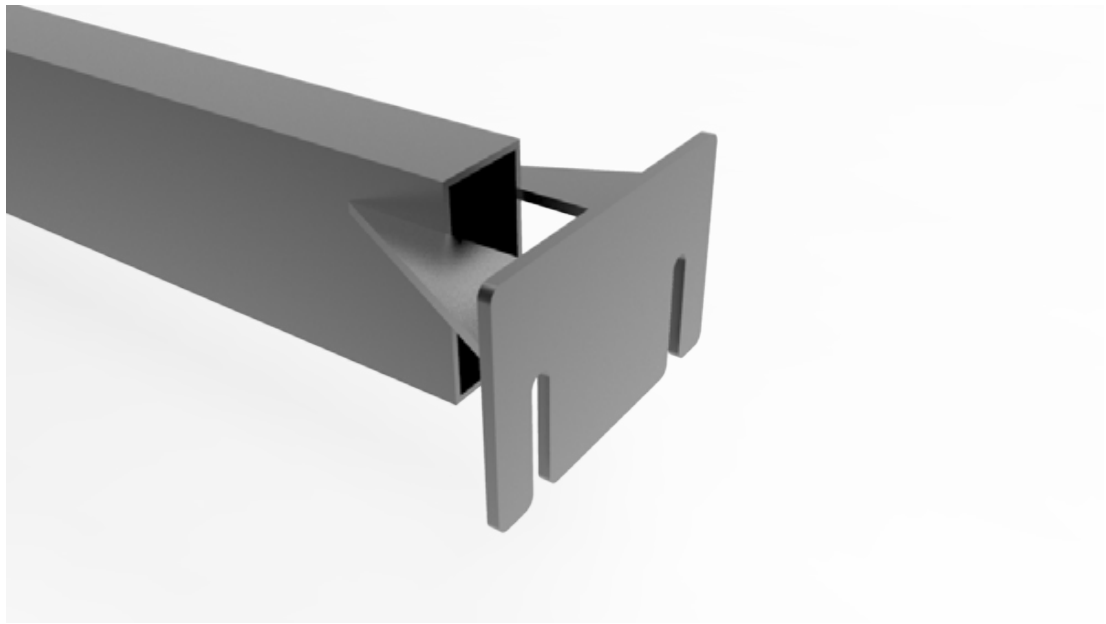








Concept 2 | Visualization



Concept 3

- Emphasis to reduce the number of parts

Material

Mild steel

Sections

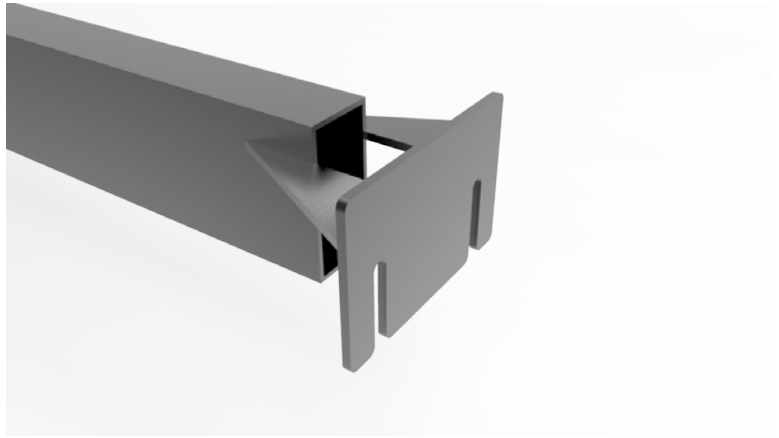
Main structural member ***: square tube (45mmx96mm)***

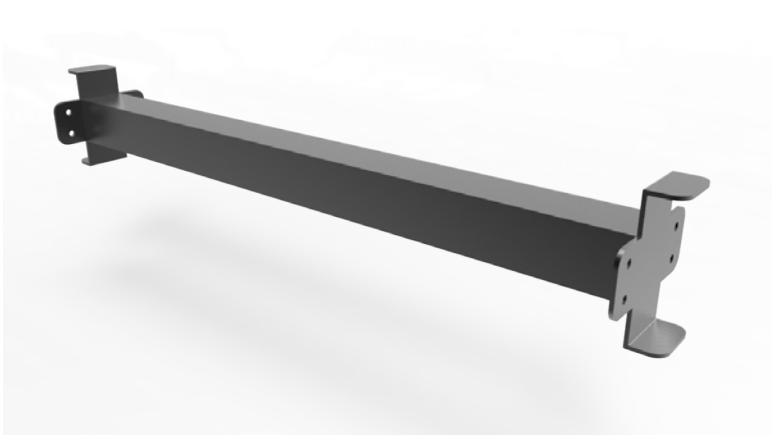
Orthogonal support member ***: square tube (45mmx45mm)***

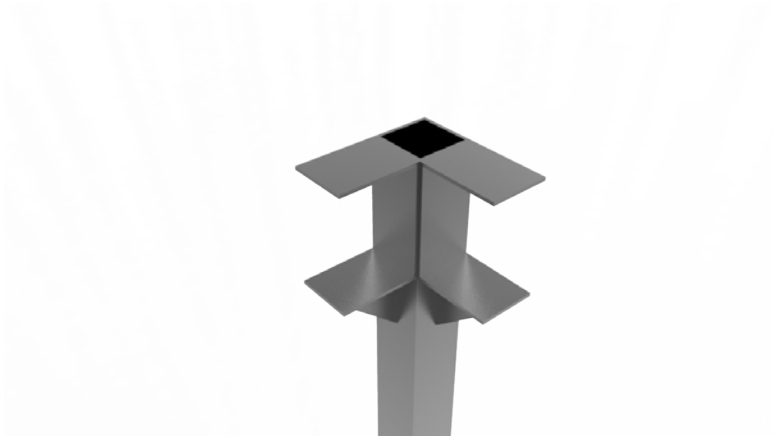
Vertical columns ***: square tube***

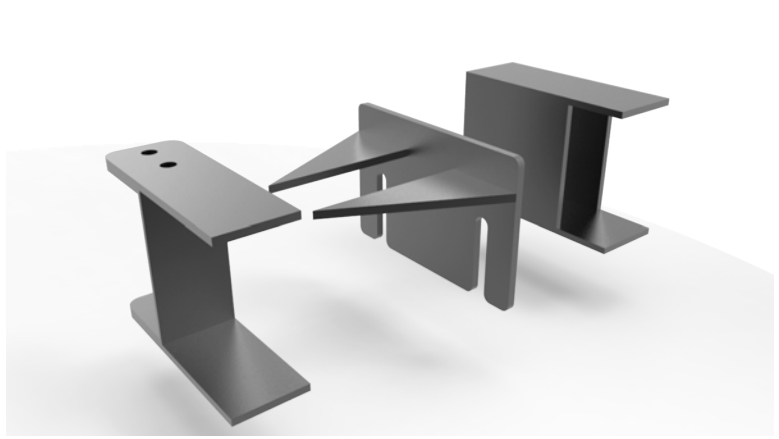
Fitting

- Welding the joining pieces at the end of the members to be connected.







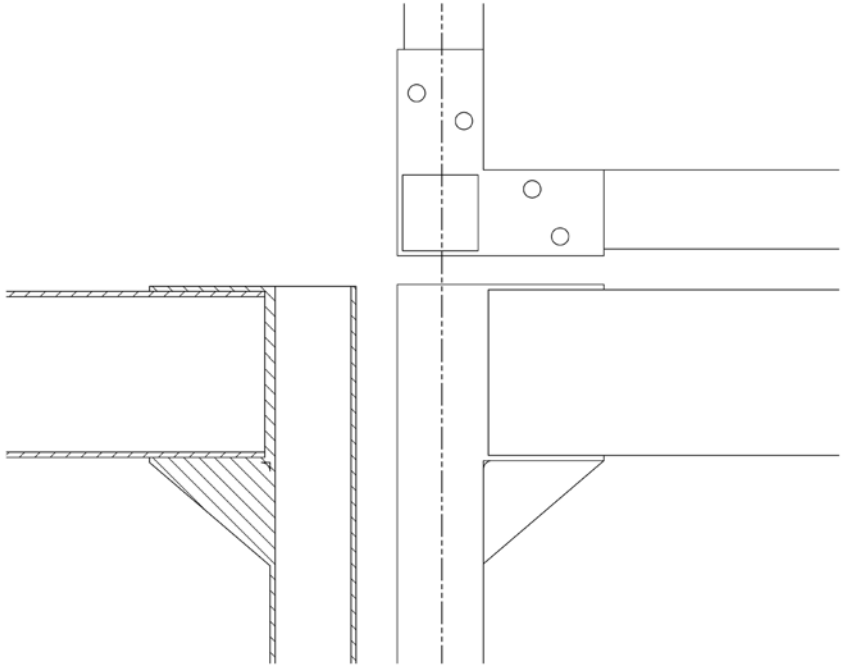


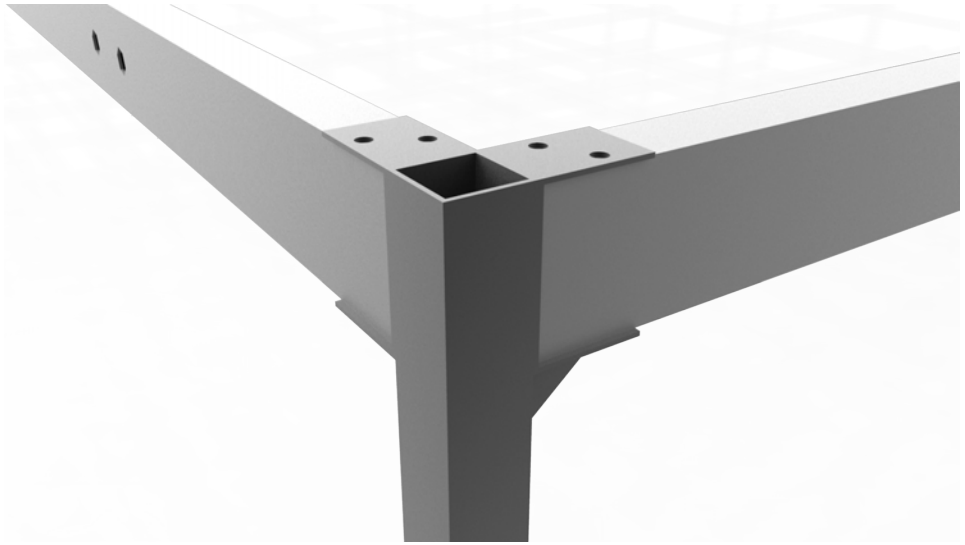
Concept 3 | Visualization

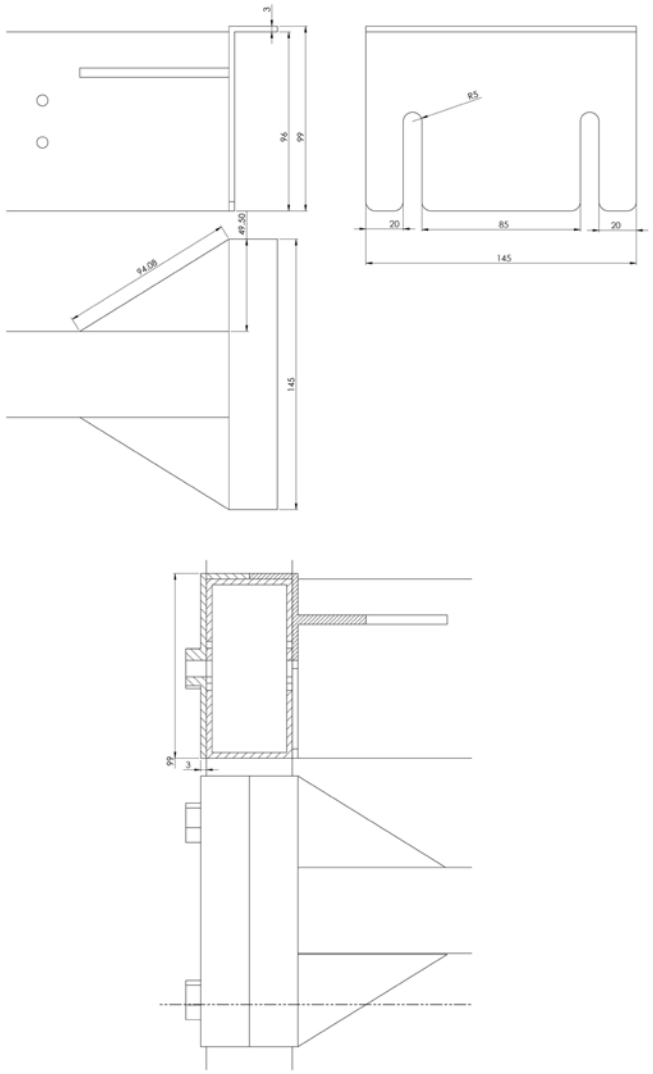
Concept 3

Joints detailing

- T1 joint



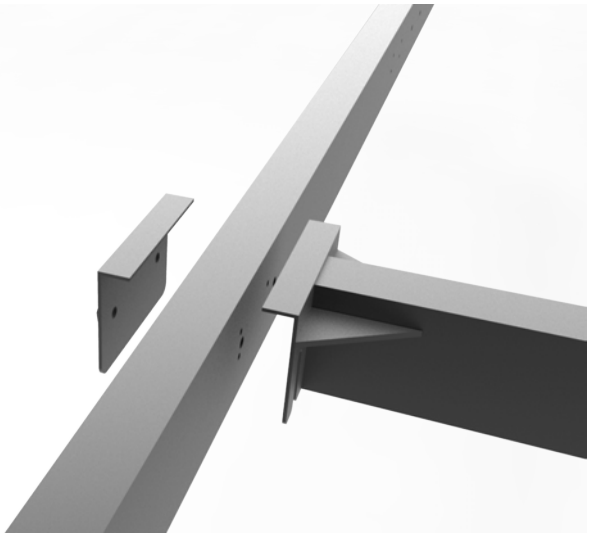


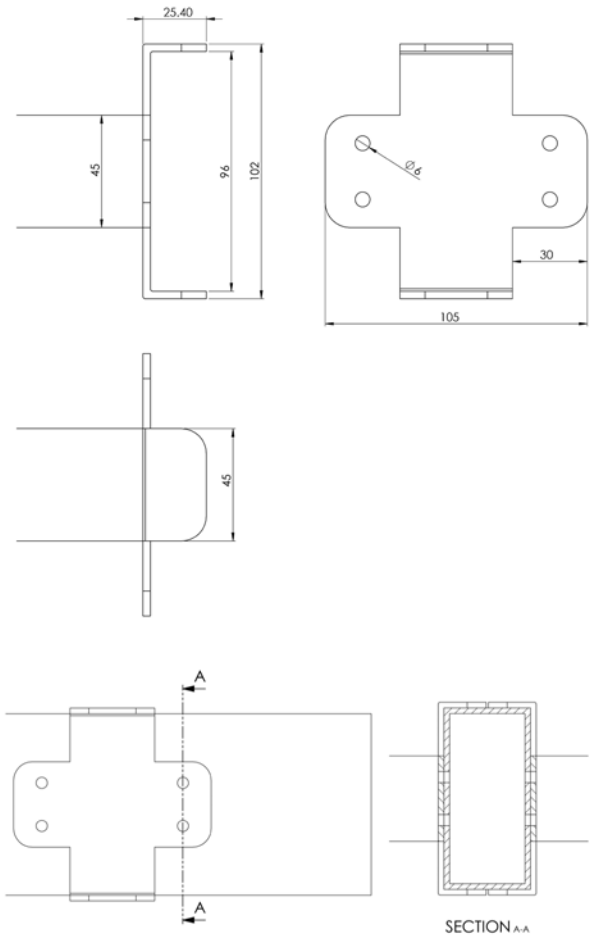


Concept 3

Joints detailing

- T2 joint

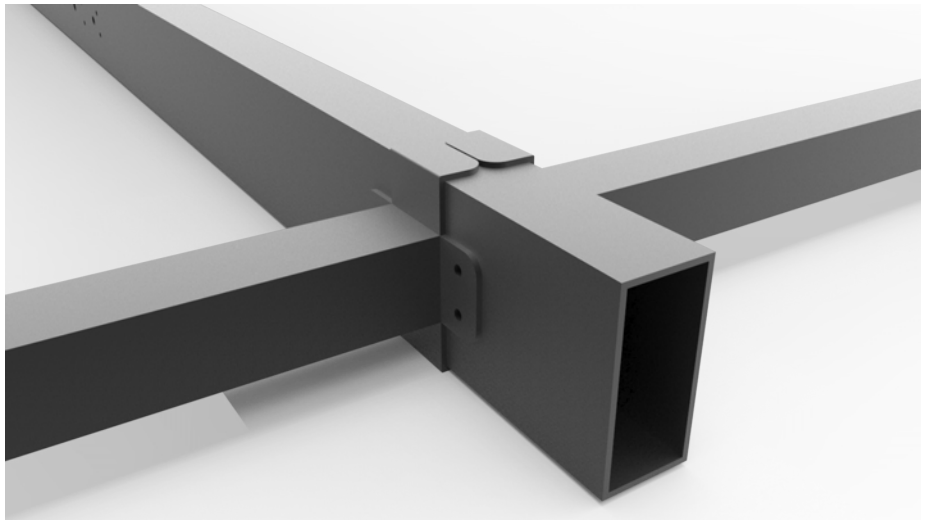


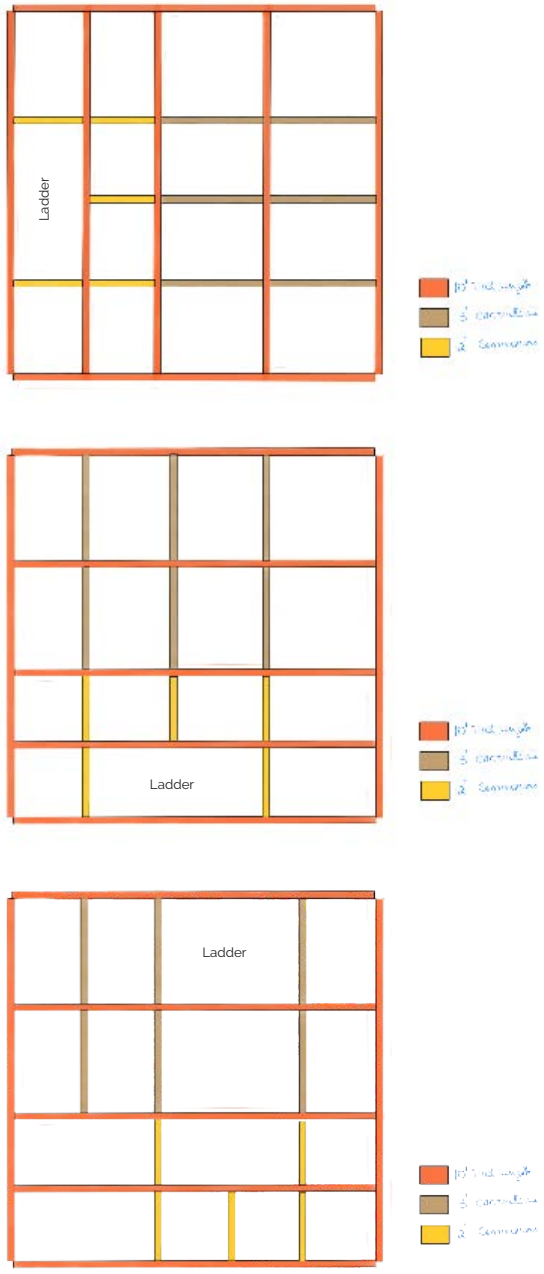


Concept 3

Joints detailing

- T3 joint





Standardizing the components

- Same components to be arranged to create all 3 layouts

- identifying similarities in layouts

- Layouts broken down into grids

Standardized lengths

Orange : 10 ft

Brown : 3 ft

Yellow : 2 ft

Minimum number of members

6'6" x 4 nos (column)

10' x 7 nos (beams)

3' x 6 nos (orthogonal member)

2' x 5 nos (orthogonal member)

Standardized components

Post prototype comparison

User feedback

- Children were happy with their space
- Position of TV was a major issue for both parents and children
- Needs more storage space than comfortable headroom
- Ceiling fan not necessary
- Space above kitchen was appreciated
- Concerned about position of fridge.
- Toilet space was also appreciated.

The way forward

- Fully detailed prototype
- On-site implementation and feedback