

Affordable Housing

:Fitting more into volume

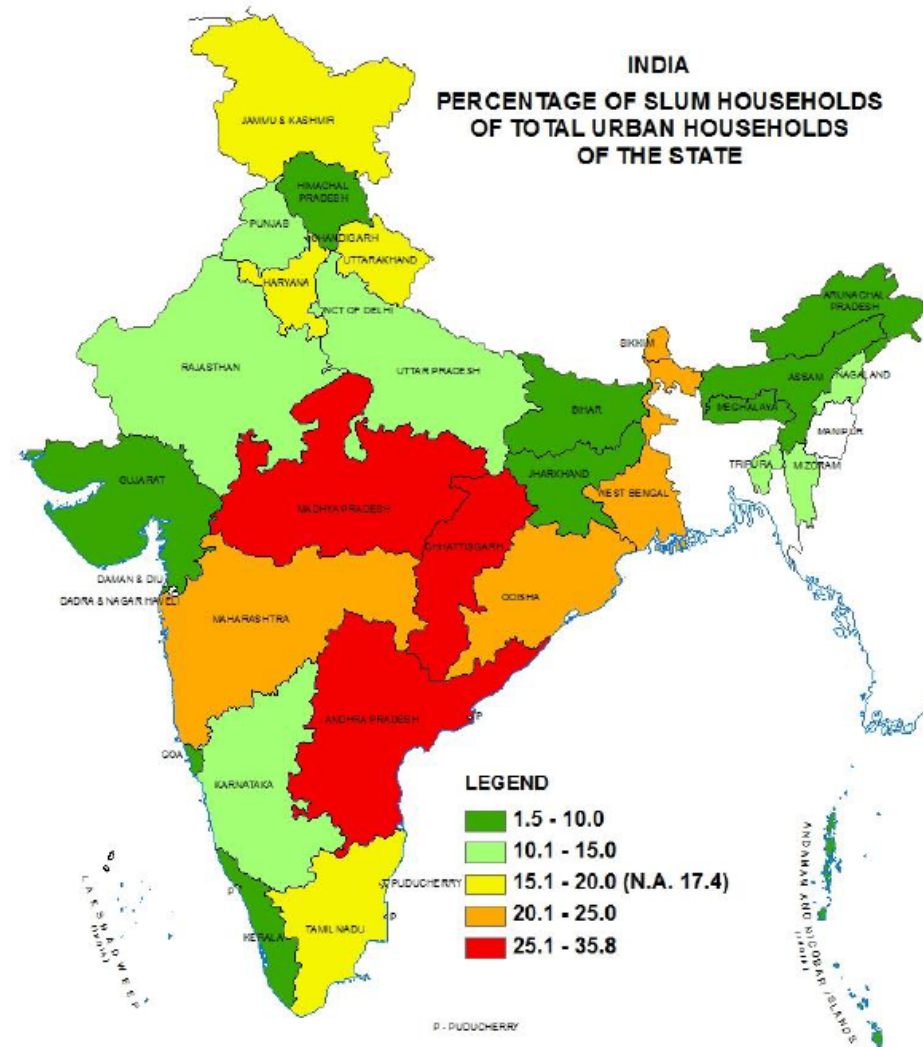
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Preface

- 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**



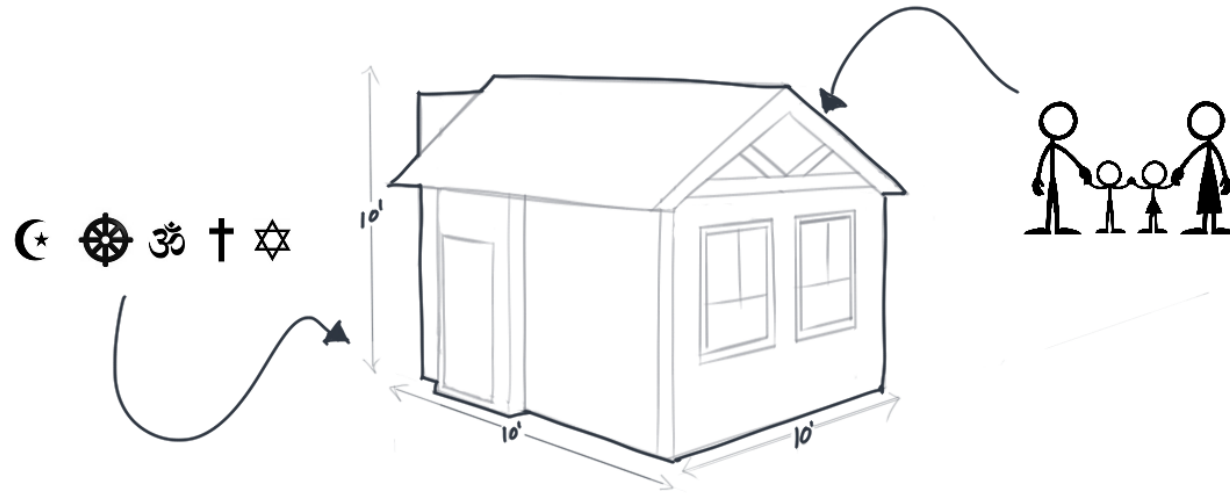
Housing for BOPs

image source: HUDCO project



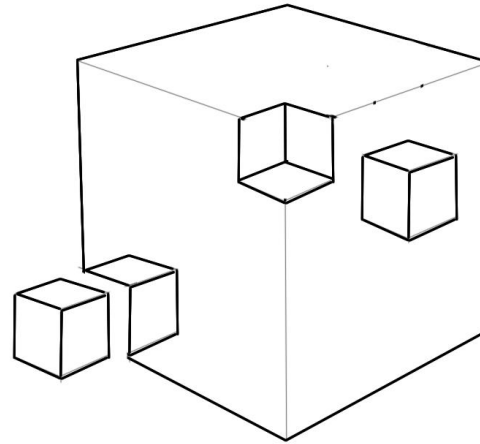
Space constraints

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



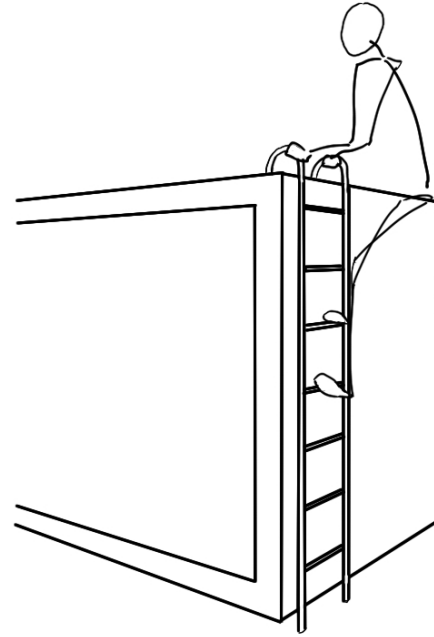
Problem statement 2

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



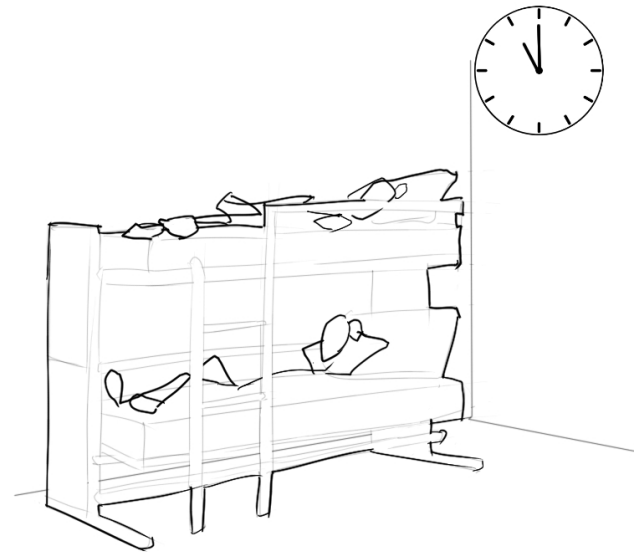
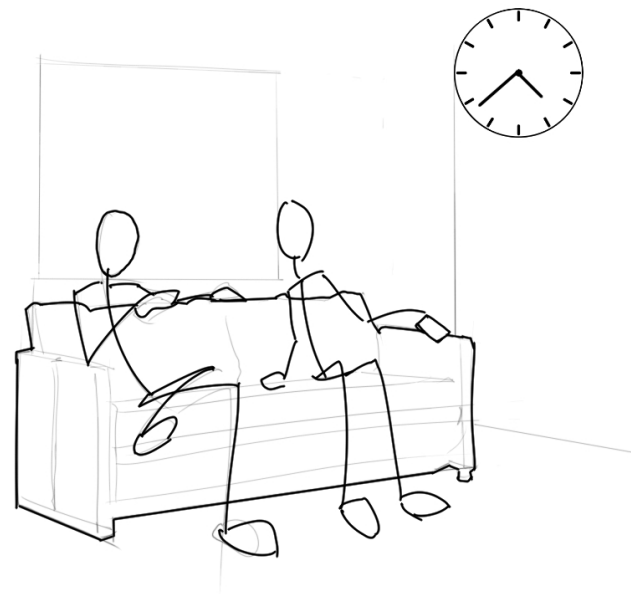
Accessibility to higher levels

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



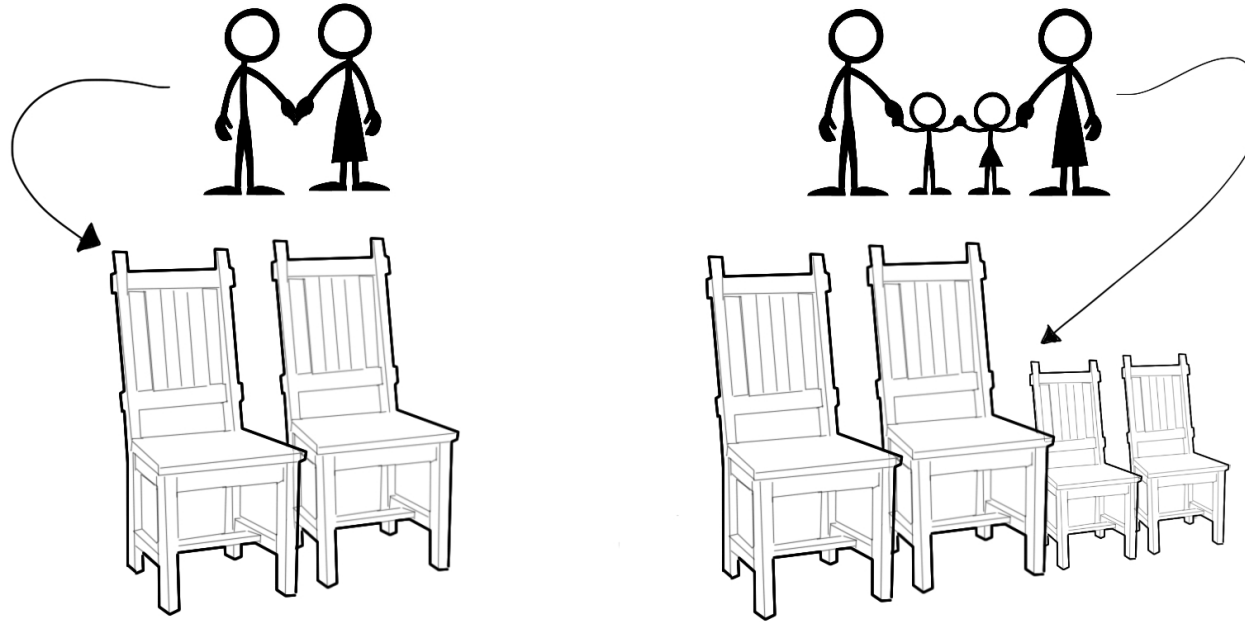
Rising cost of raw materials

image source: HUDCO project



Temporariness of available space / resources

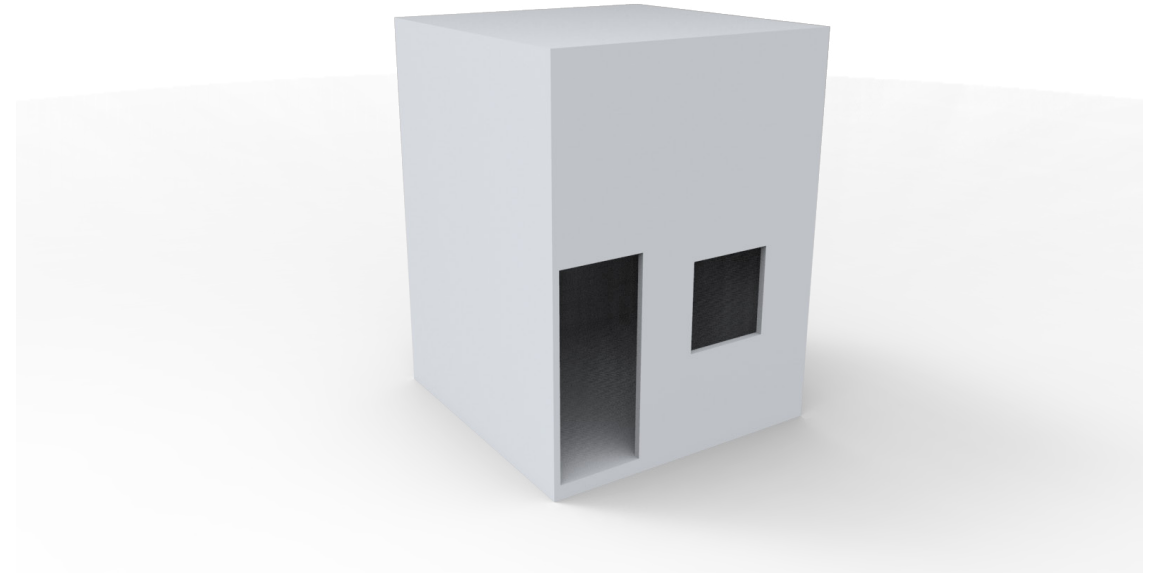
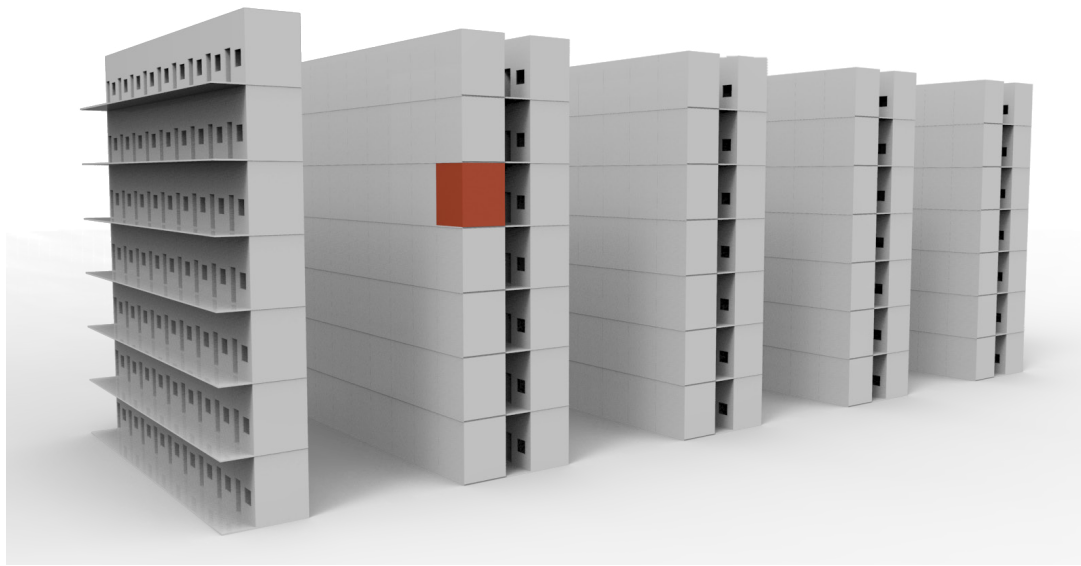
image source: HUDCO project



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*

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 project



Videos + Case study

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



Asian scenario



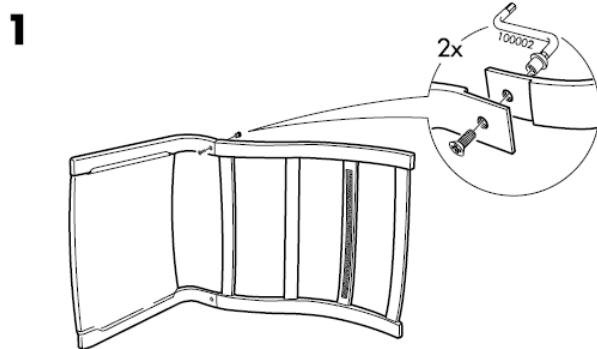
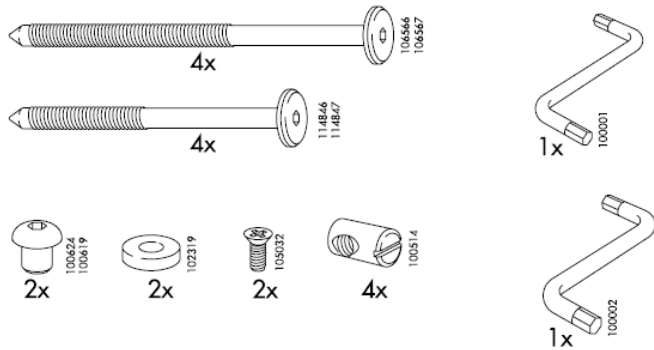
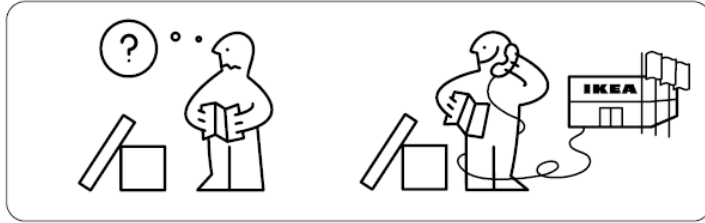
Caged homes in HongKong



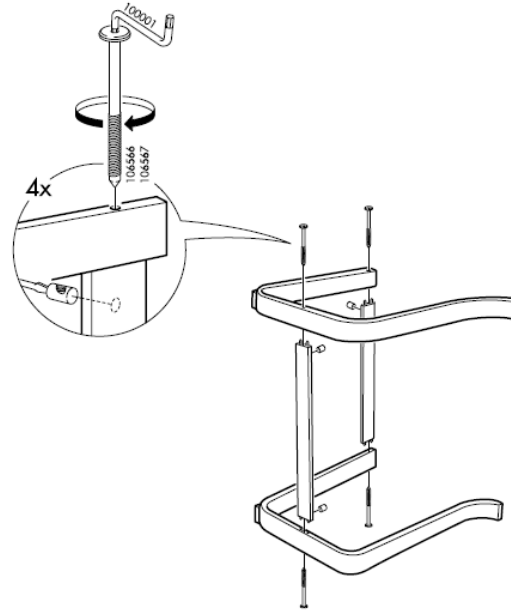
People using space



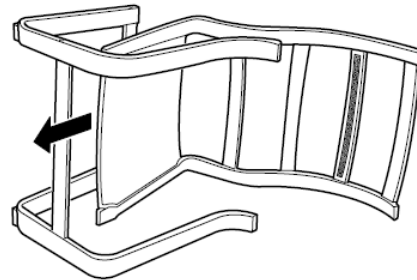
image source: HUDCO project



2



3



IKEA DIY model

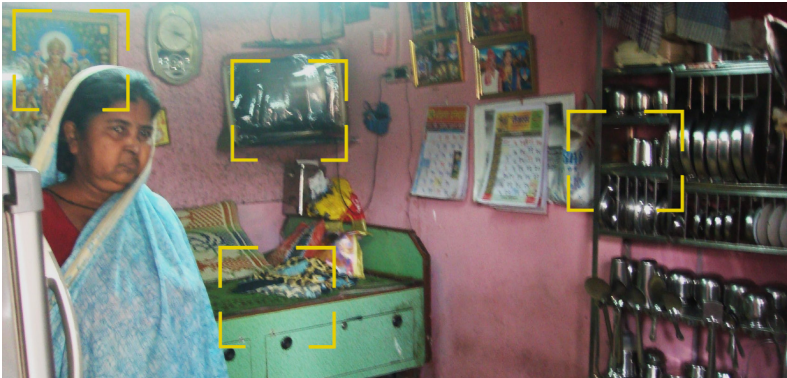
- Assembly instructions
- IKEA joints



Study of joints

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



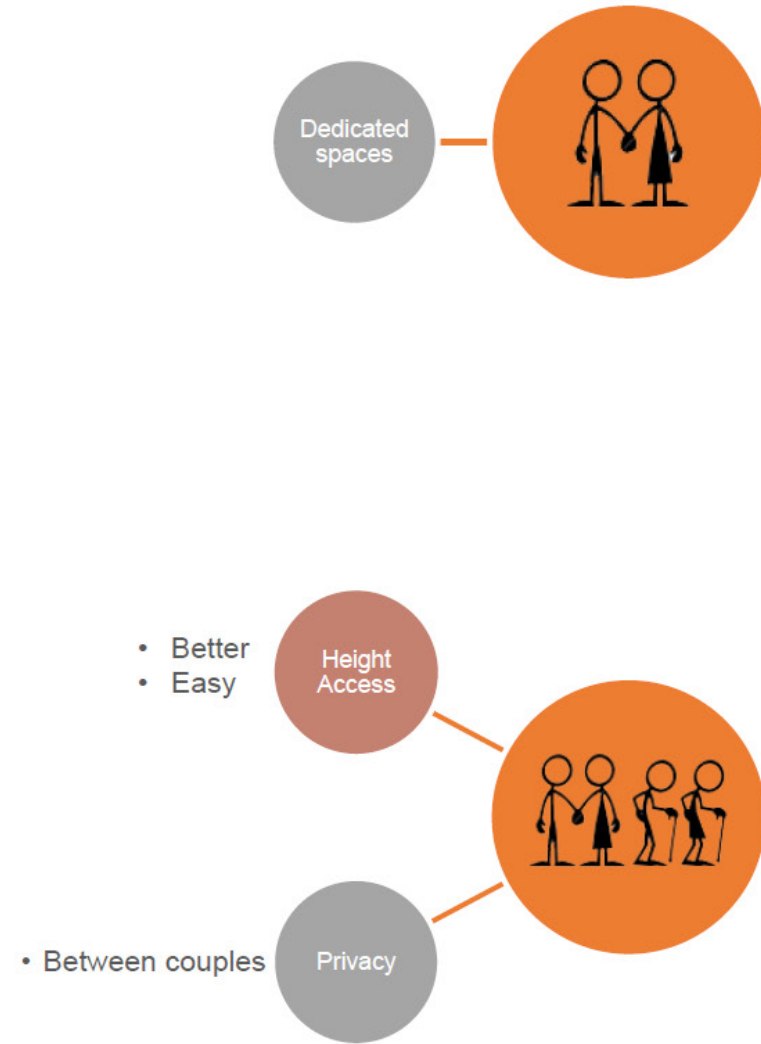
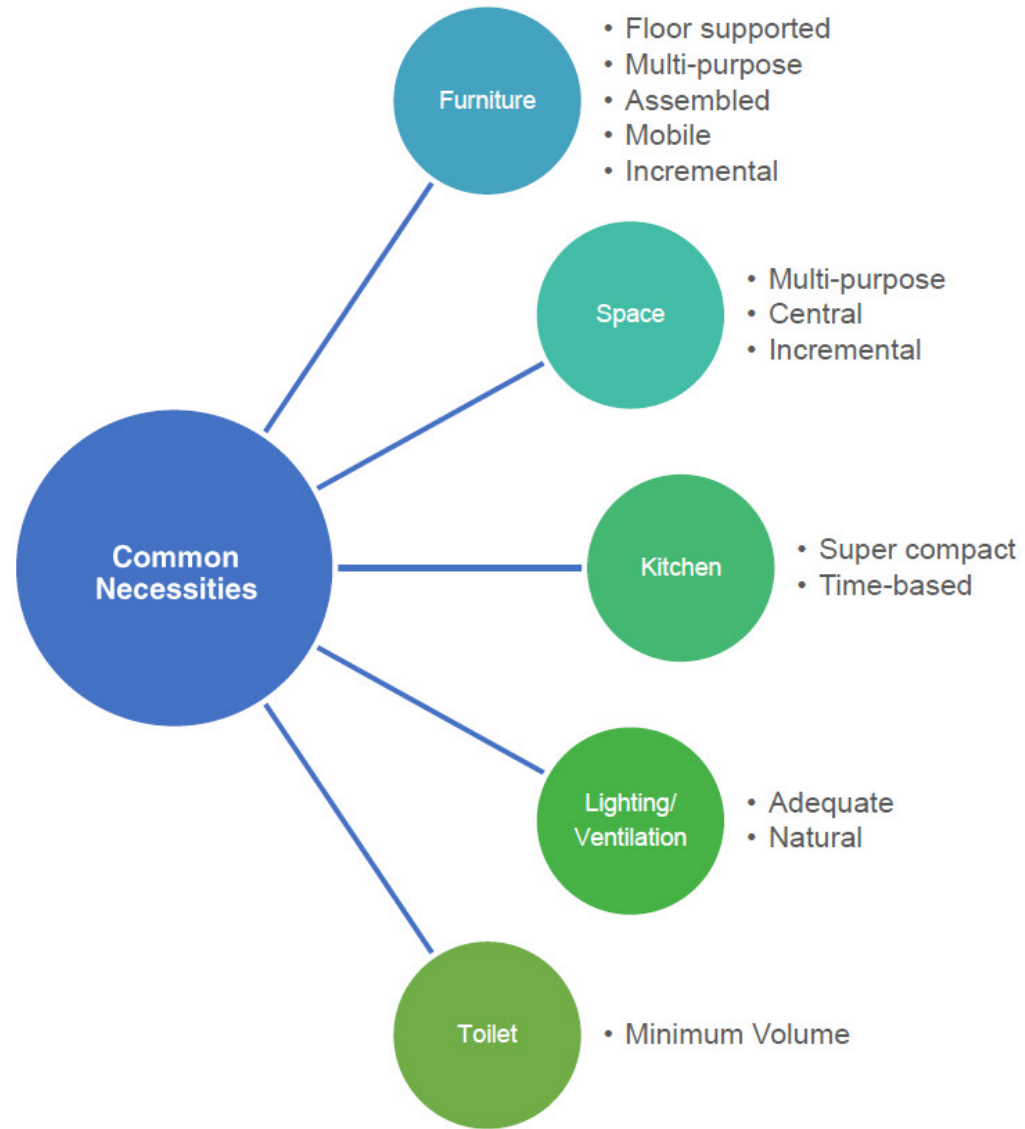


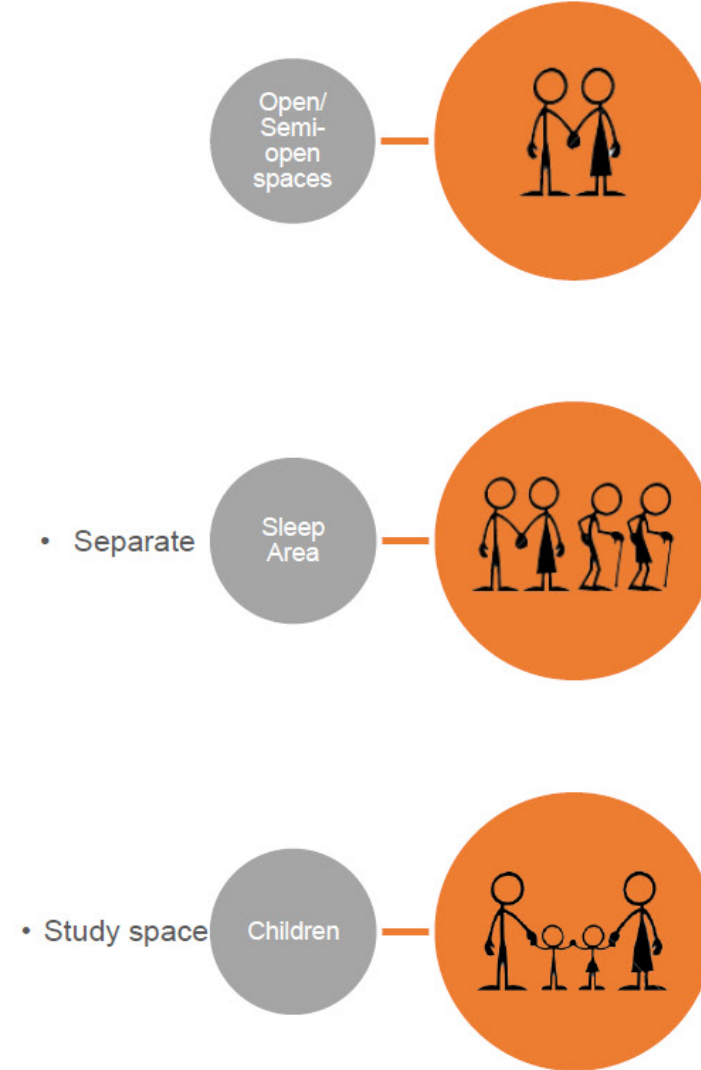
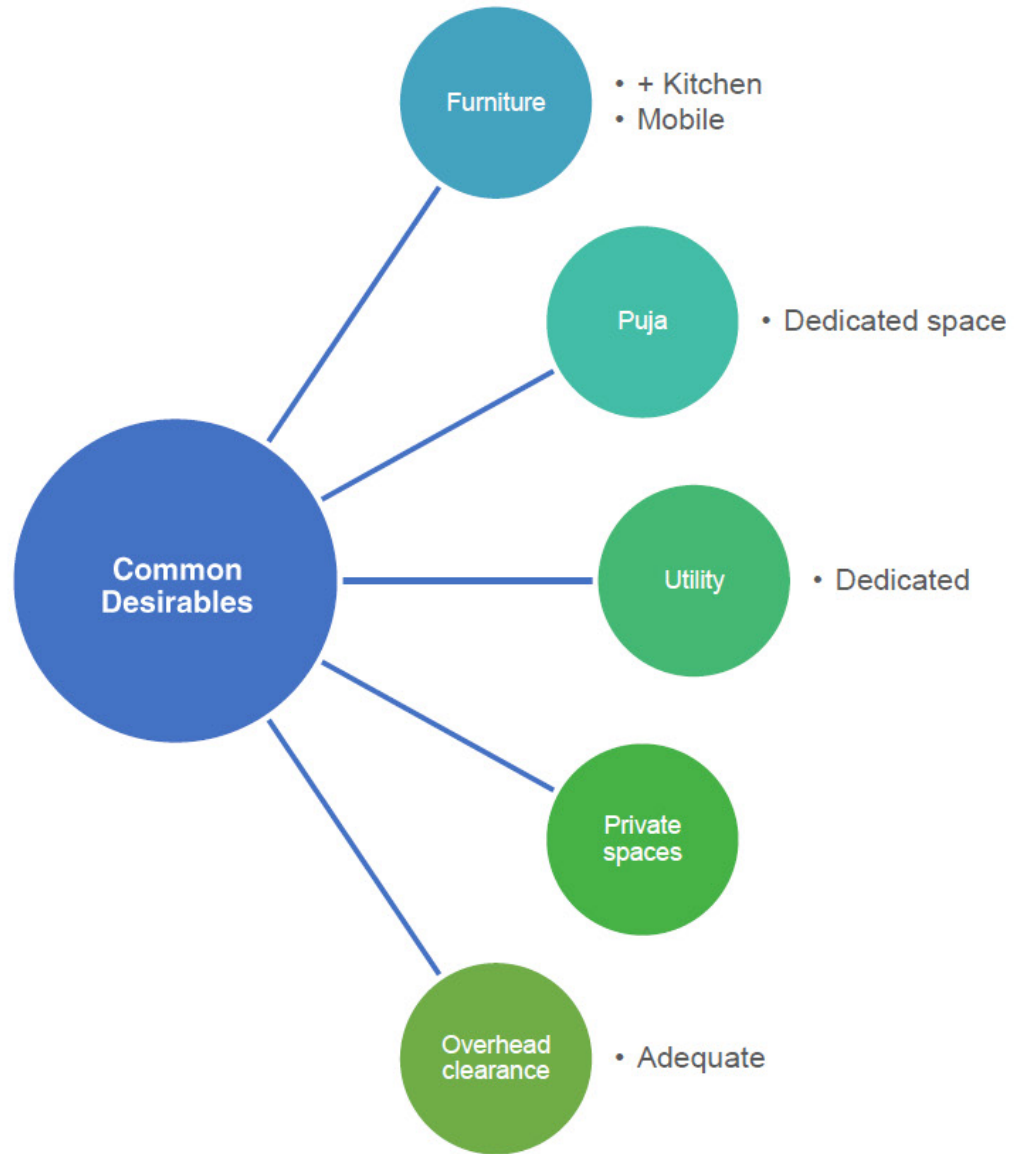
Present interior scenario

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

image source: HUDCO project

Necessities and desirables

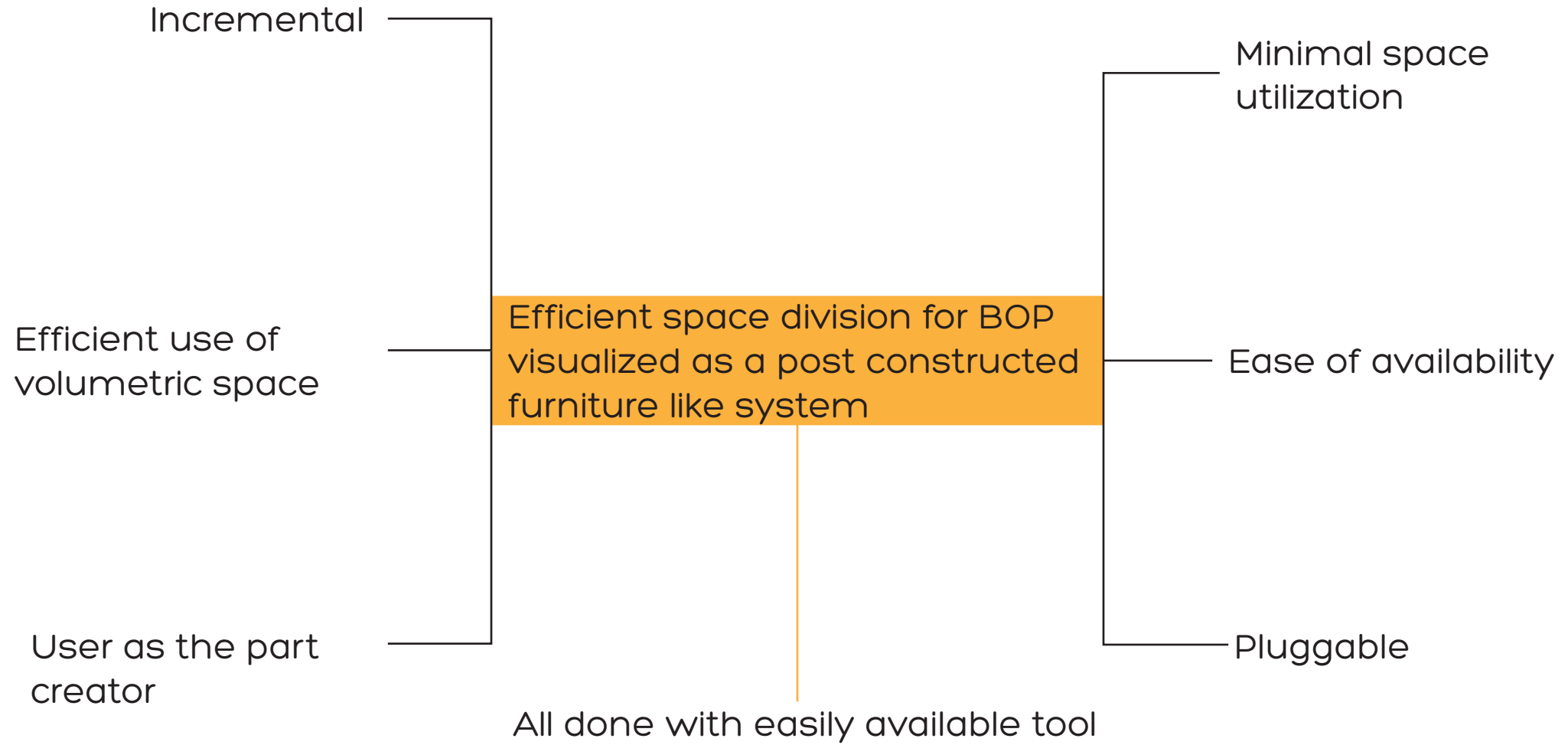




User profile

- 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



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

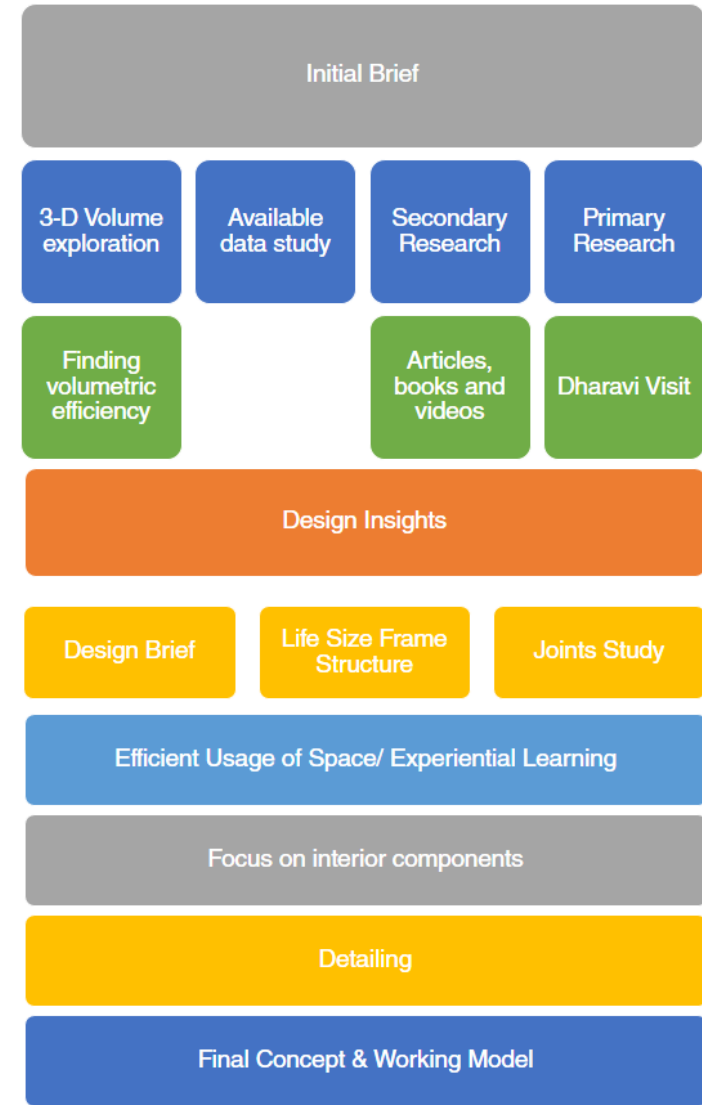
- *Puja*
- *Dining space*
- *Washing space*

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 +

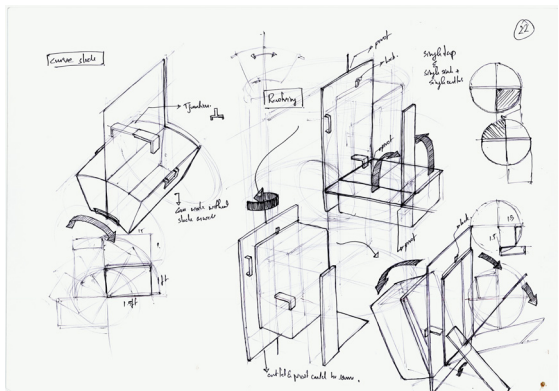
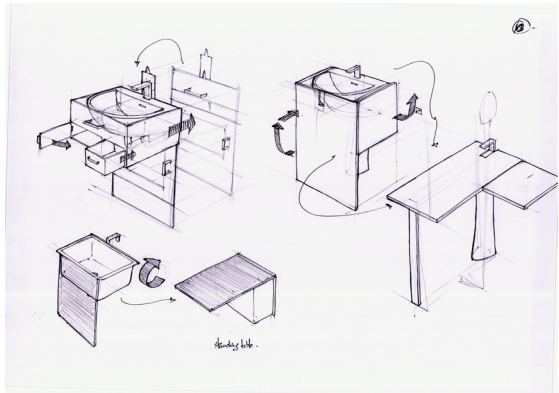
Focus areas

*Bathroom + Toilet
Kitchen
Structural members*

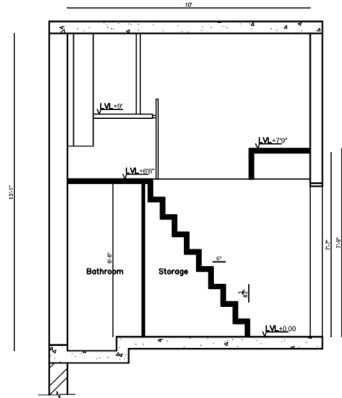
Fabrication

*Steel structure
prototype*

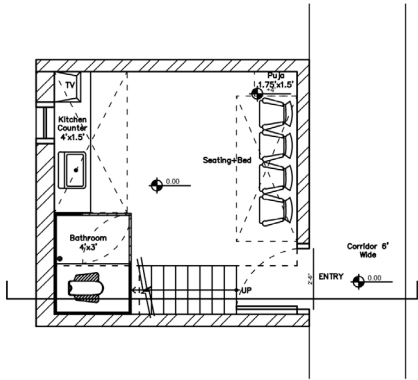
Initial
exploration



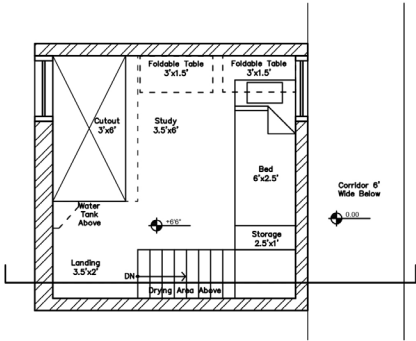
Drawings



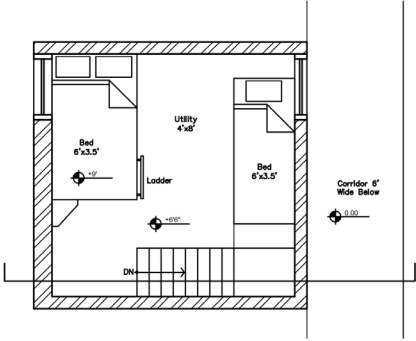
Section



Ground Floor



First Floor



First Floor

**Life-size
model**



Populating space



Simulating living



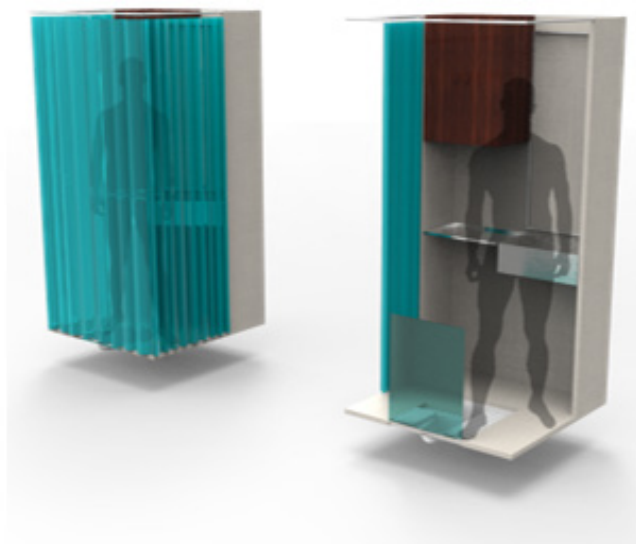
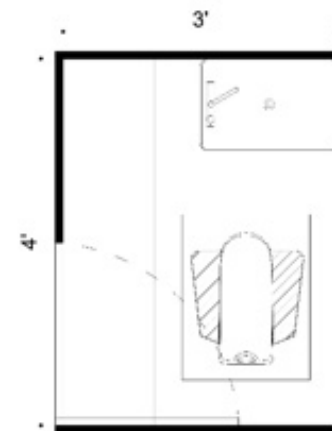
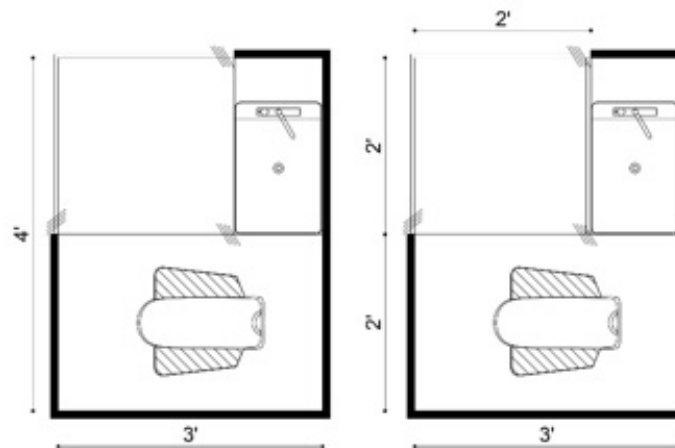
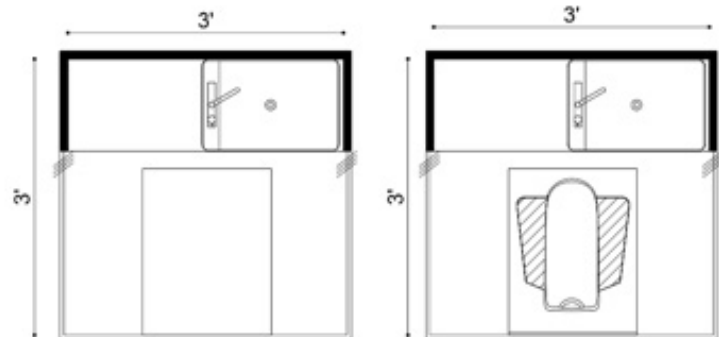
Life-size prototyping

- Bathroom + toilet space
- Kitchen space
- Structural members

**Focusing
on to the interior**

Bathroom + Toilet space

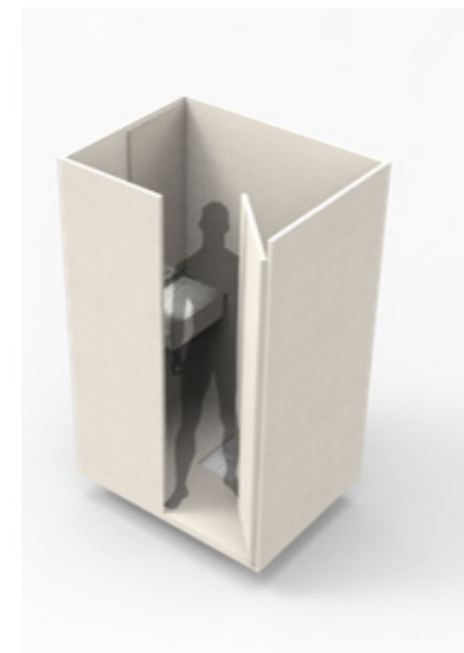
- Efficient usage of volumetric space
- Pluggable
- Minimal assistance in installation
- Easily replaceable partition
- Reducing existing compromises



Concept 1



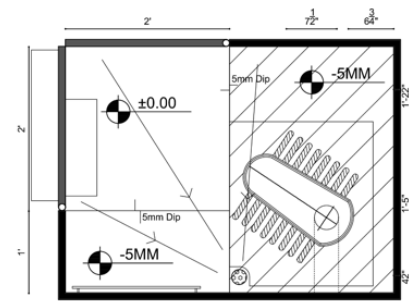
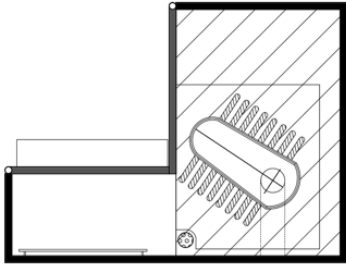
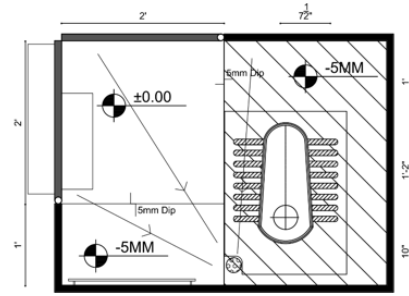
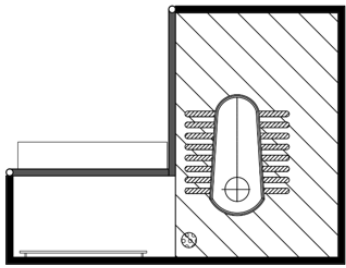
Concept 2



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



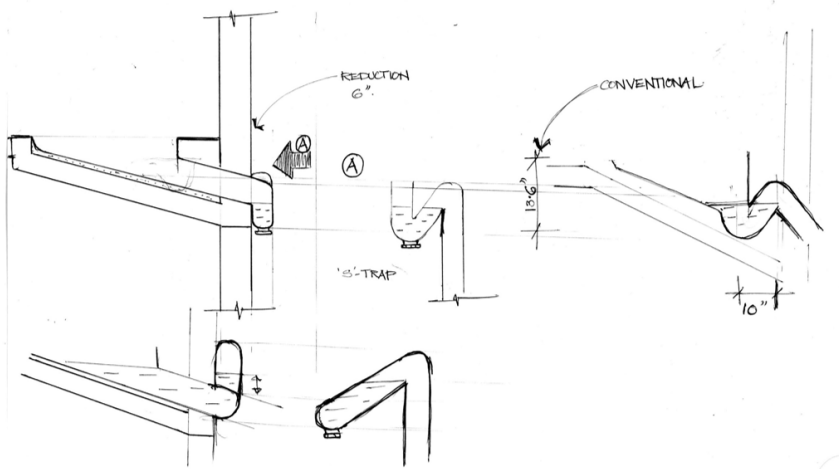
Concept 2 detailing

The base

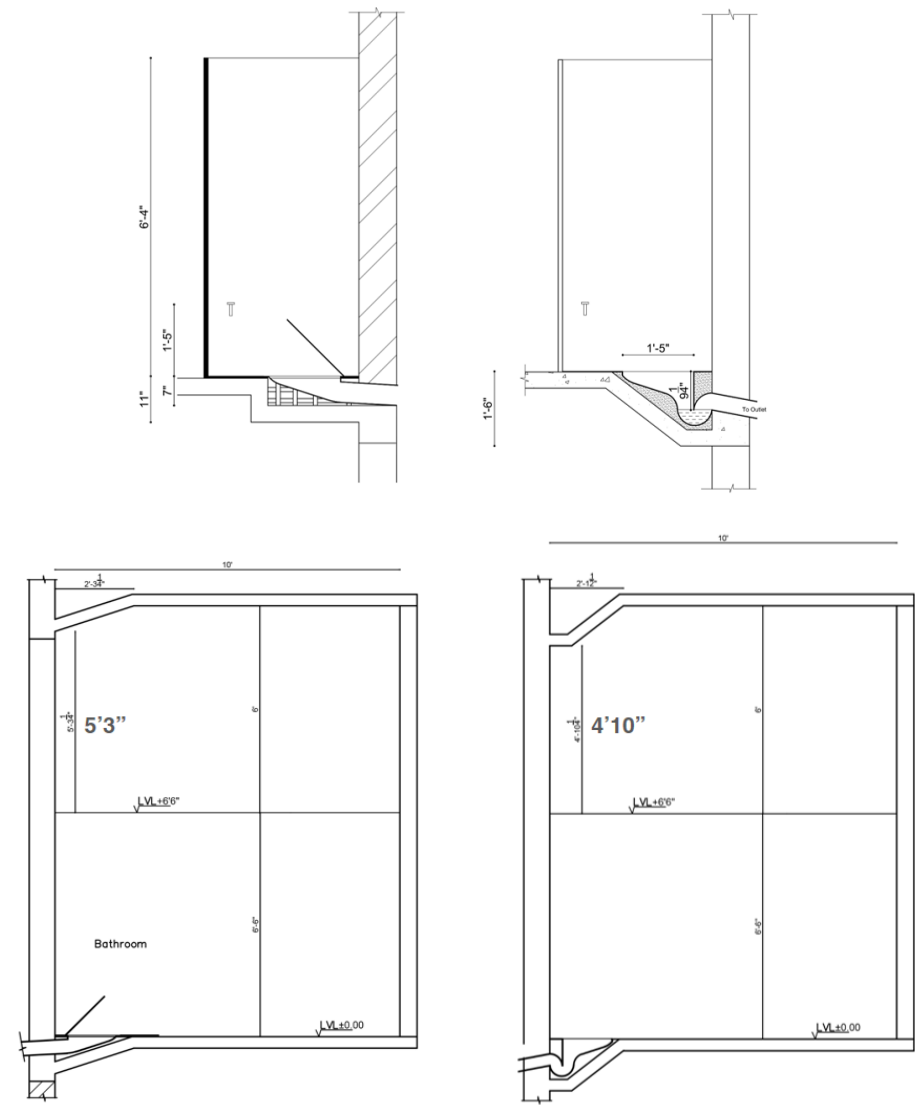
- made of SS 202
- 2 inch skirting
- ridges
- flushed to the floor

■ The trap

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



Clear height comparison

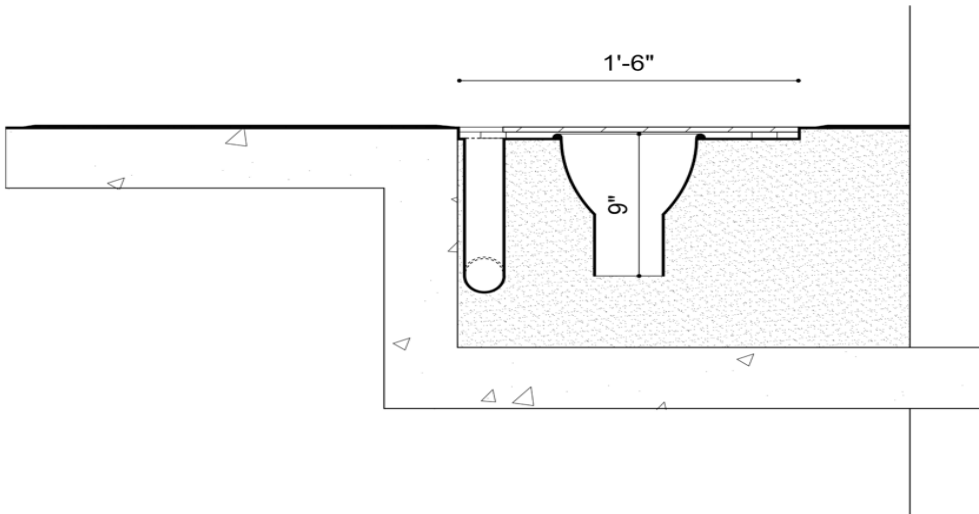


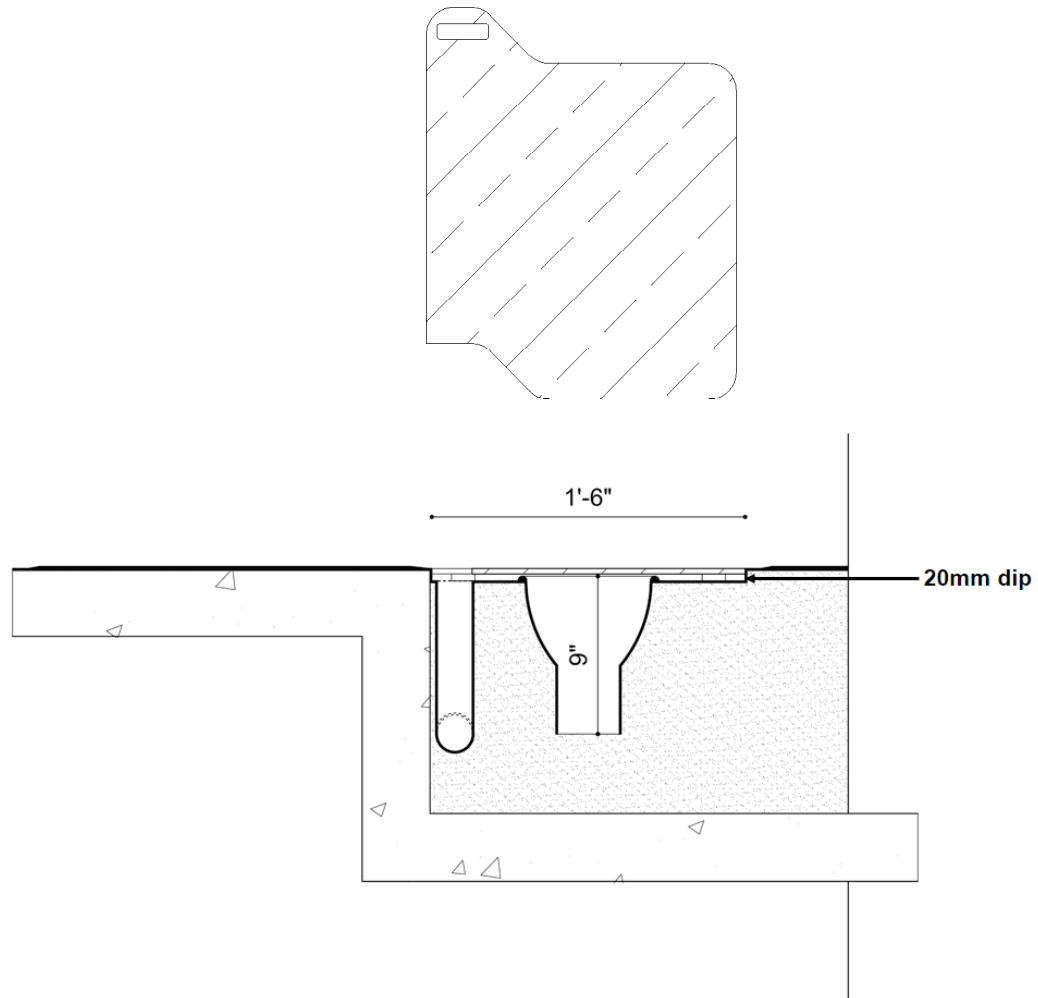
Concept 2 detailing

The base

■ The pan fixing

- *Deep drawing*
- *Argon welding*





Concept 2 detailing

The base

■ The lid

- *converting toilet to bathing area*
- *aluminium honeycomb sandwich*

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

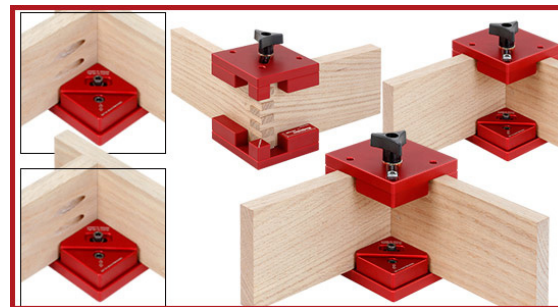


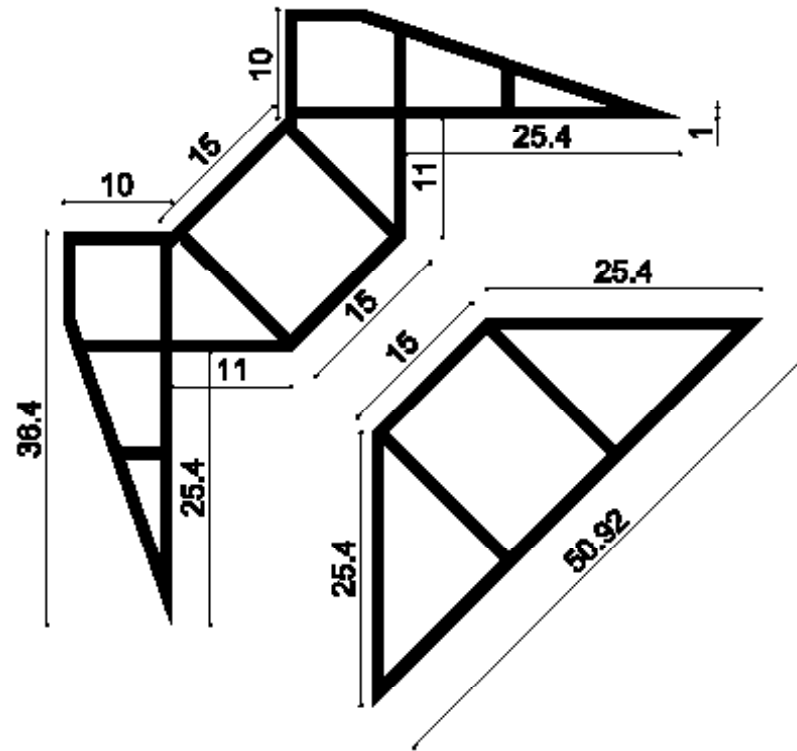
Concept 2 detailing

The partition

■ The connection

- *Related product study*



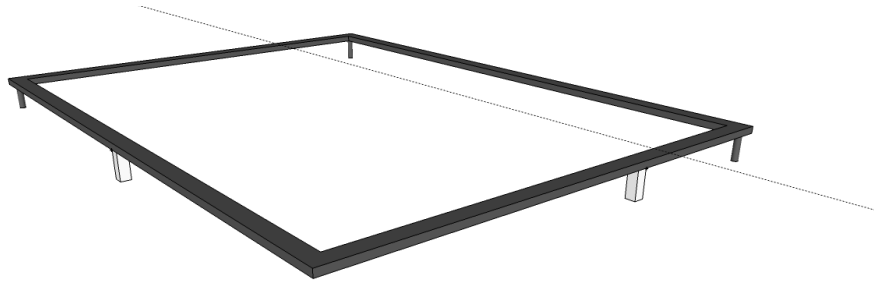


Concept 2 detailing

The partition

- The connection

- *PVC extrusion*



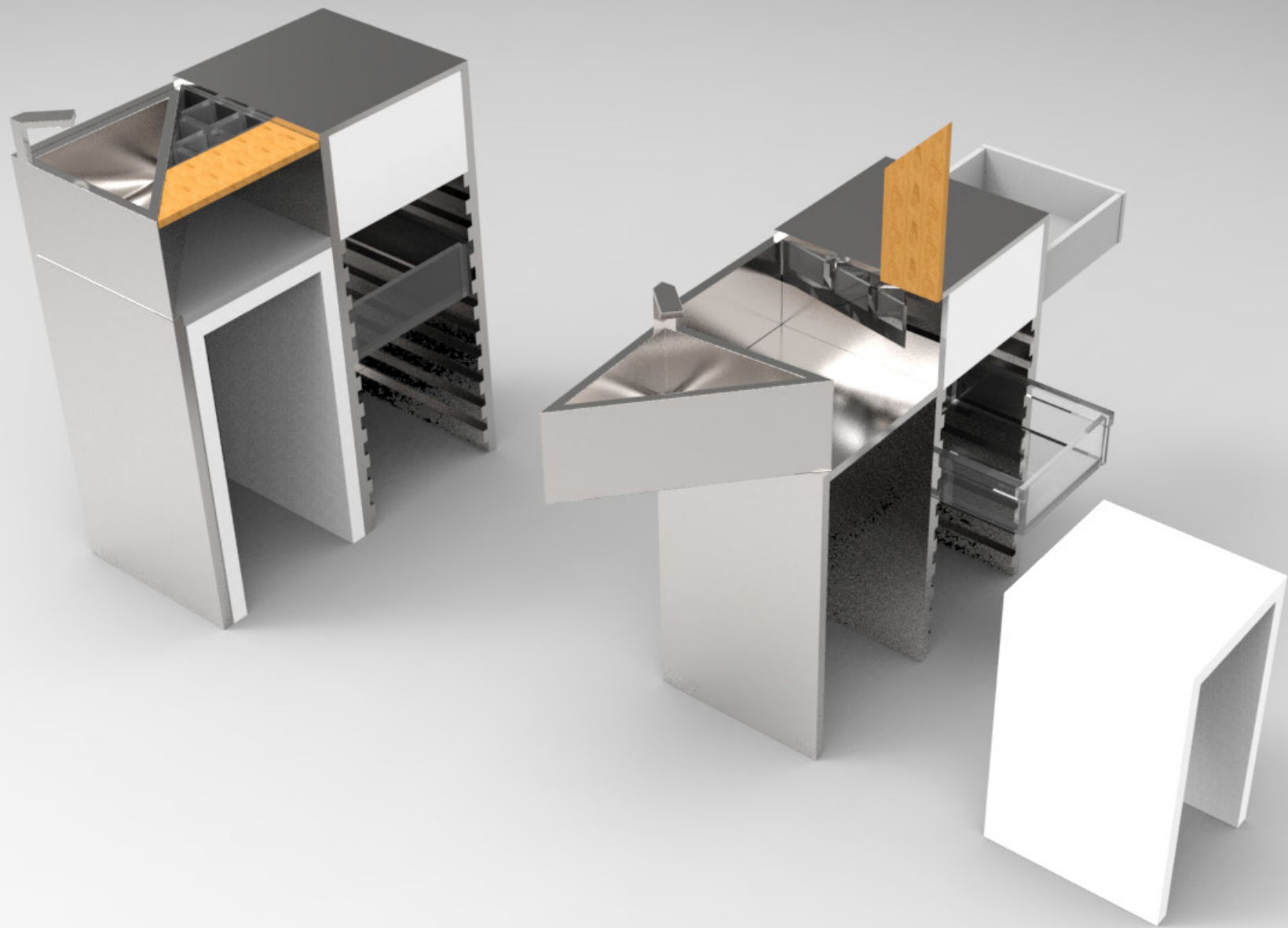
Concept 2 detailing

The crown

- to hold the panel members together

Kitchen space

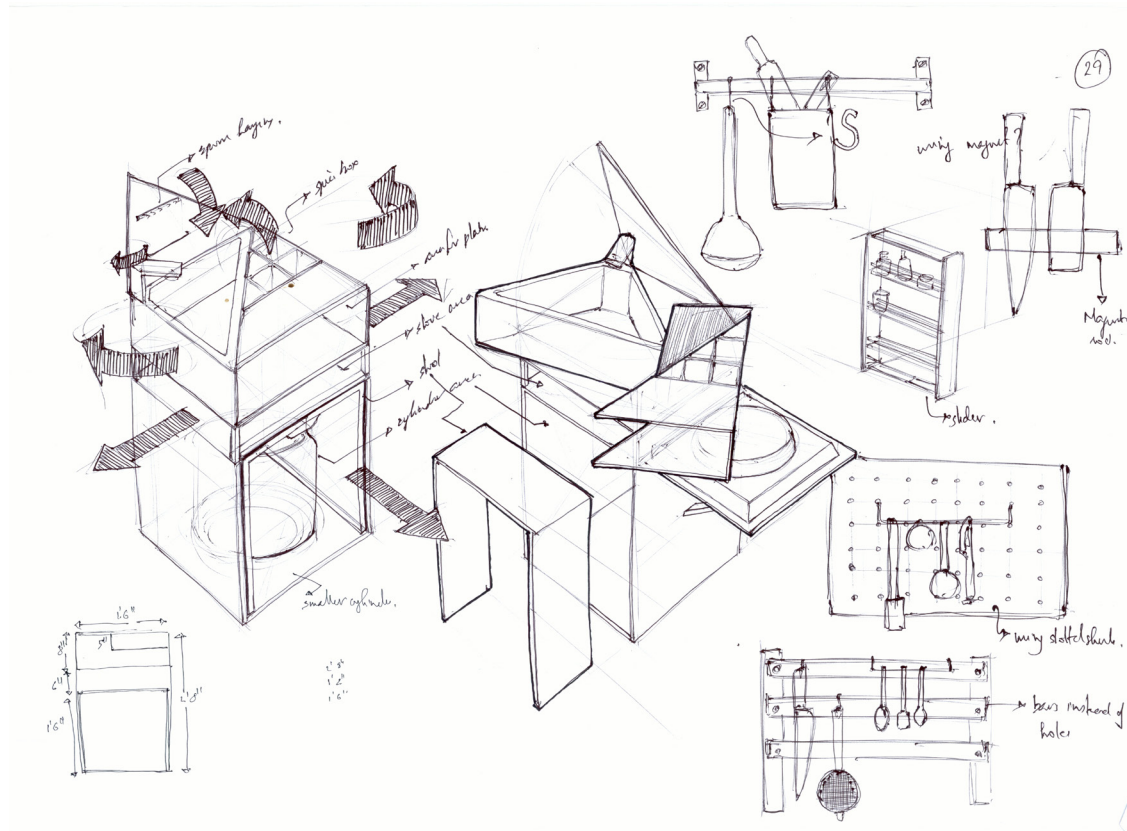
- Easy to assemble and disassemble
- Efficient usage of volumetric space
- Incrementality
- Provision for user to populate
- Usage of floor space for preparation



Concept 1

Concept 2

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



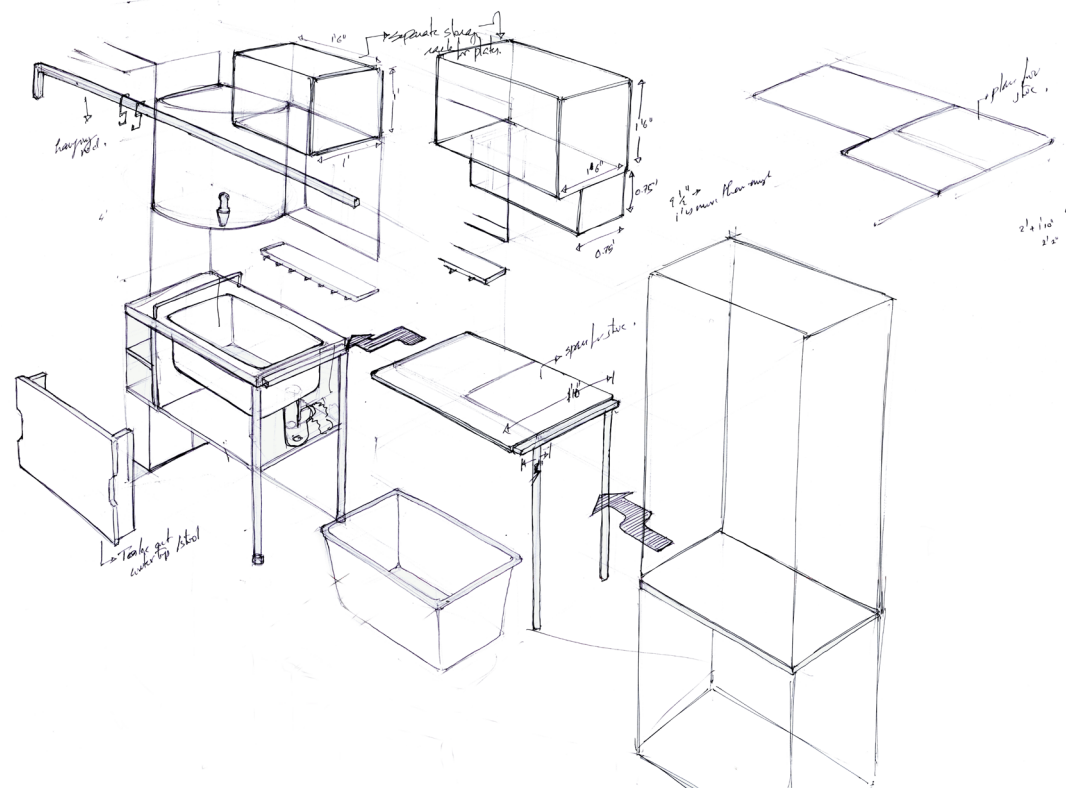


Concept 2



Concept 3

Concept 4



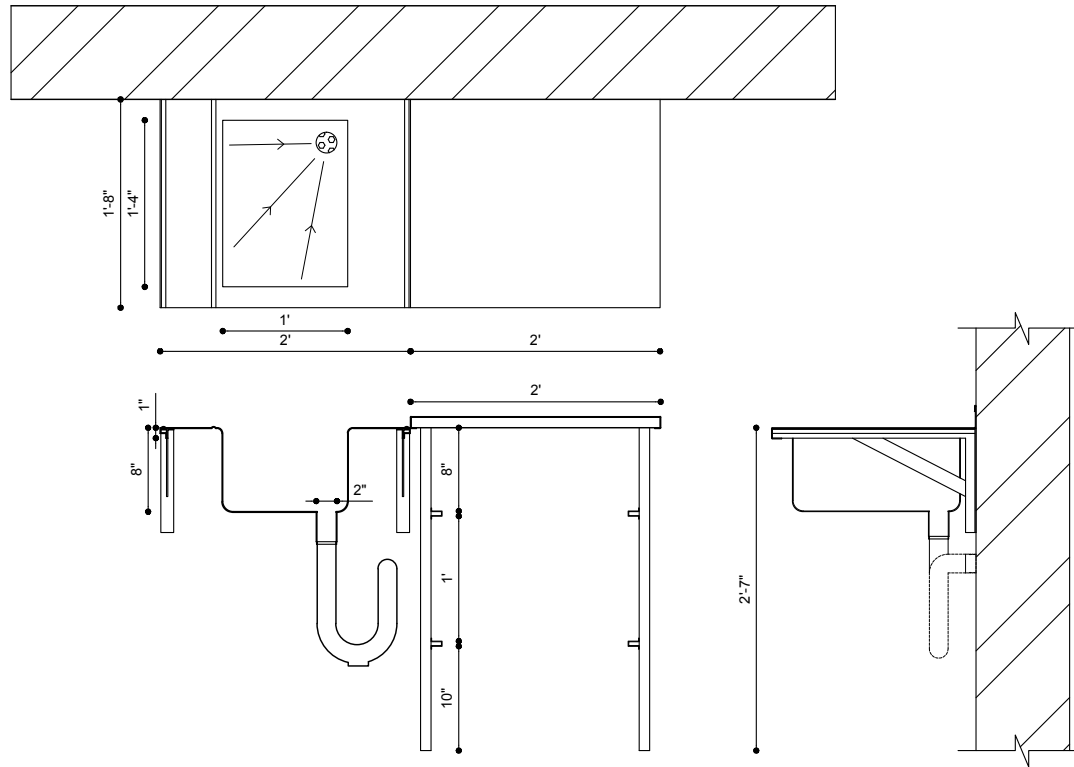


Concept 4

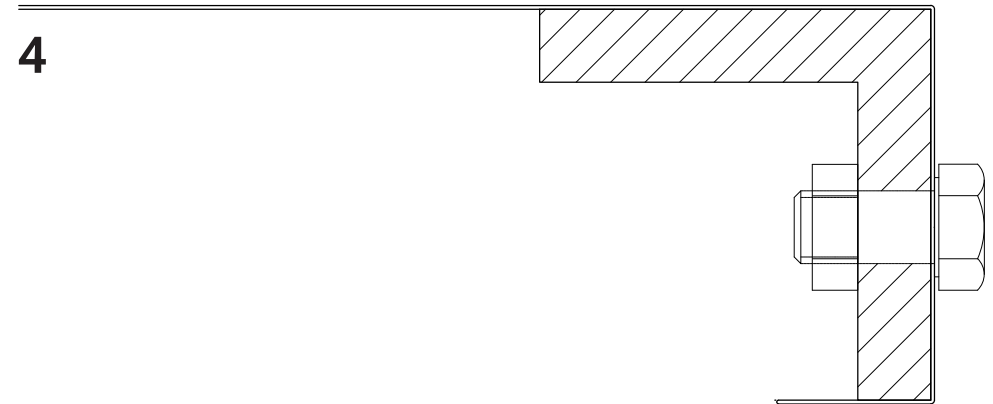
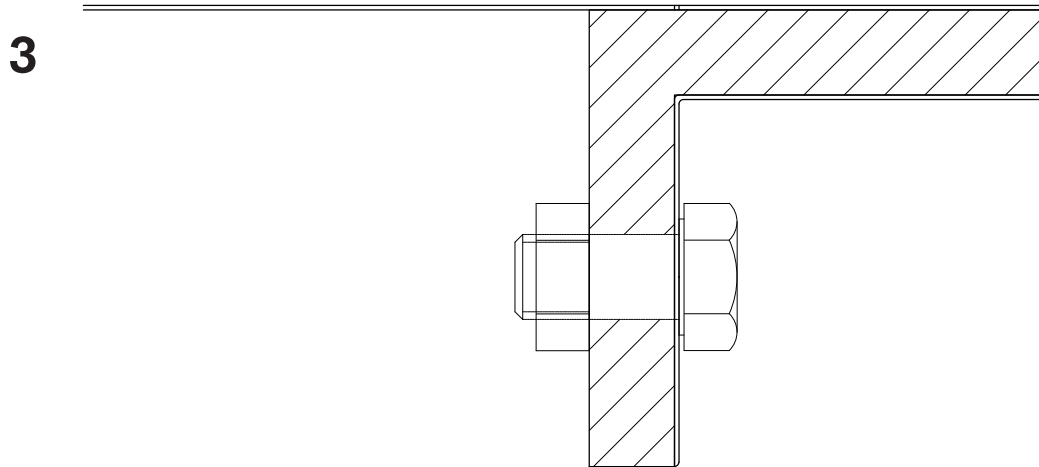
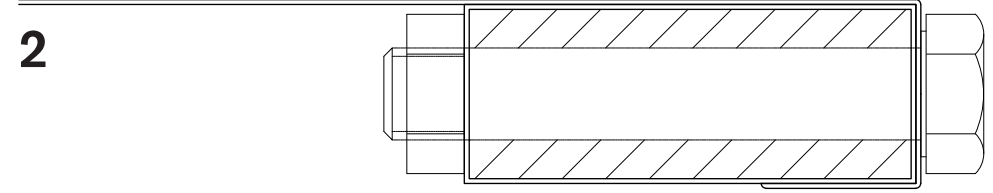
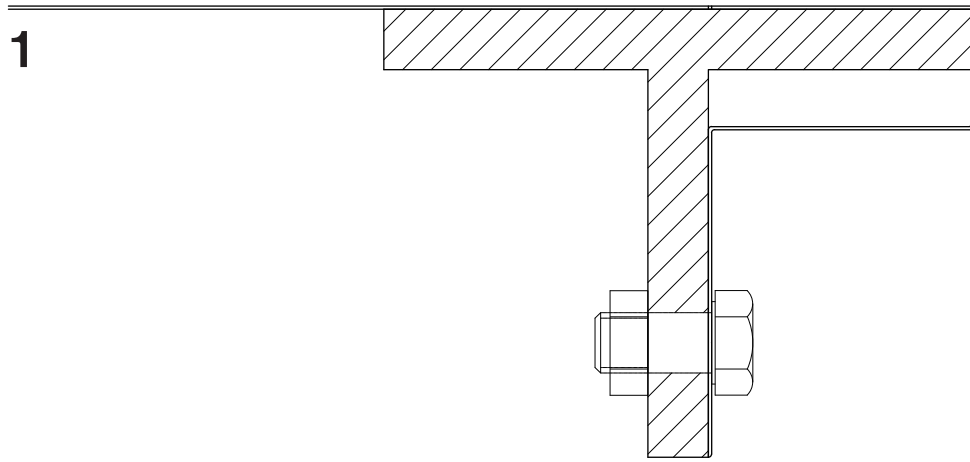
Concept evaluation

- 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

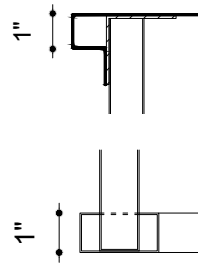
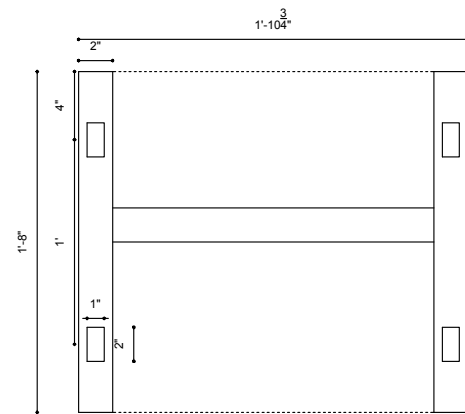
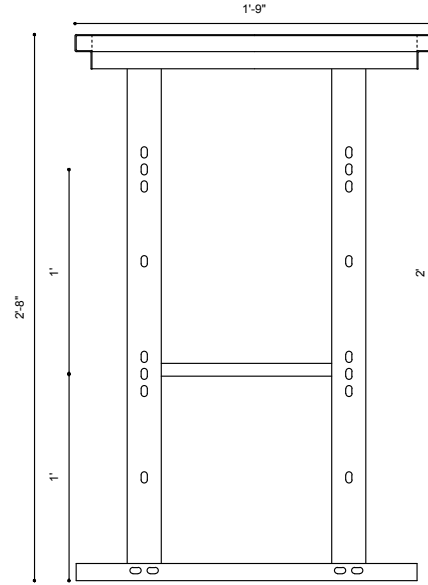
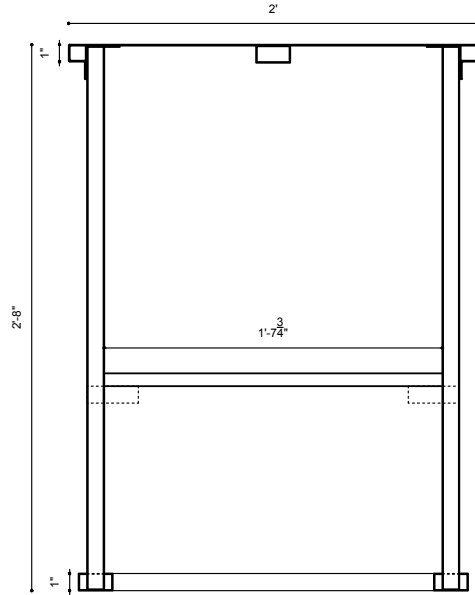
Concept 4 detailing sink



- *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*



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*

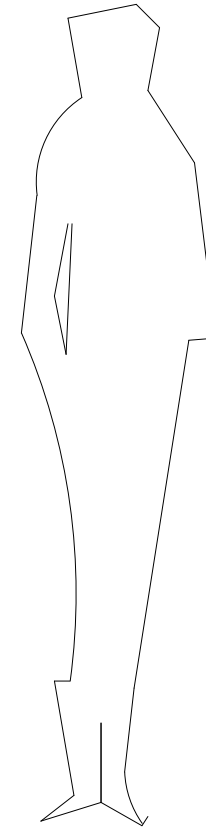
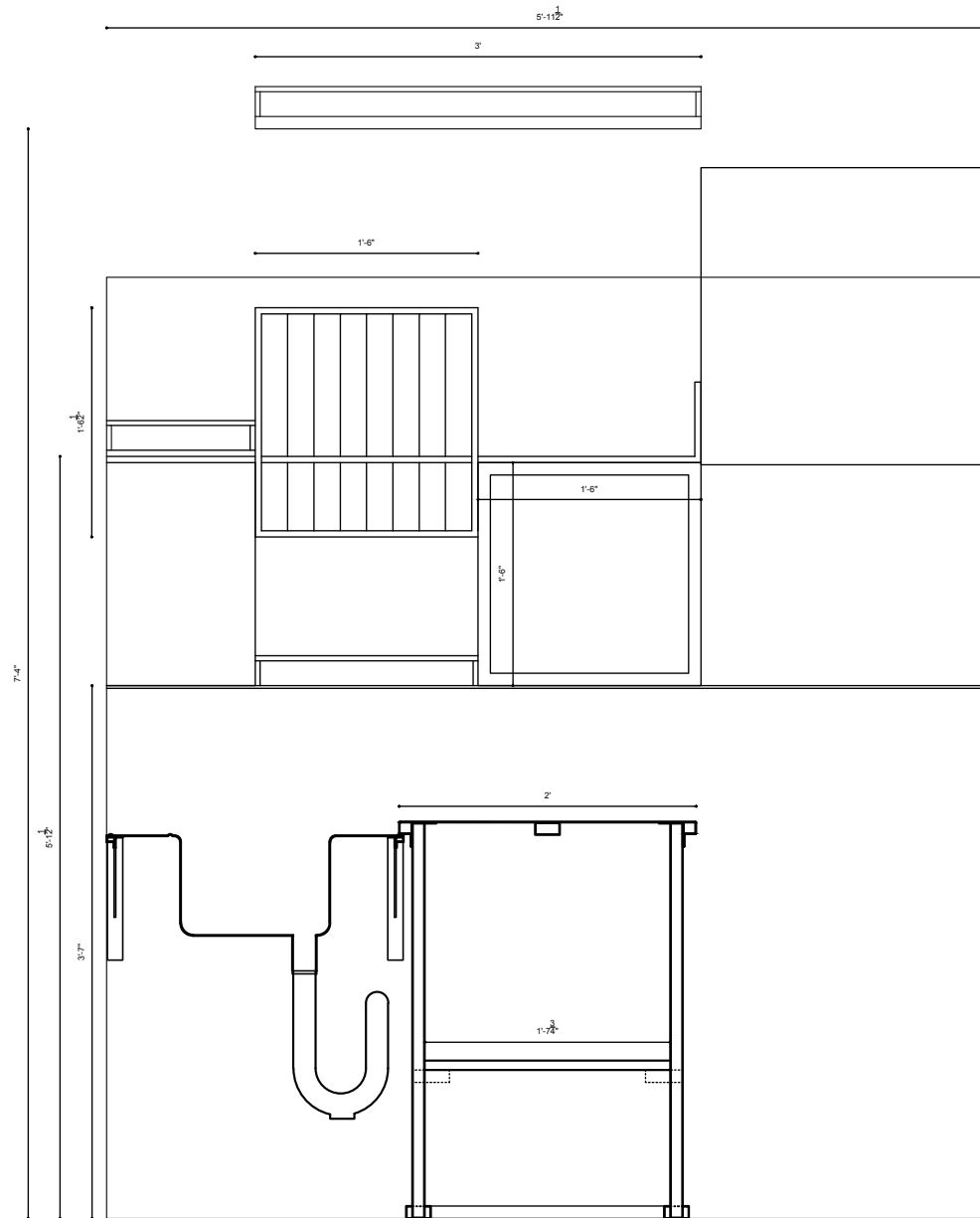
■ Material

- *SS 304 with thickness 1.2mm*

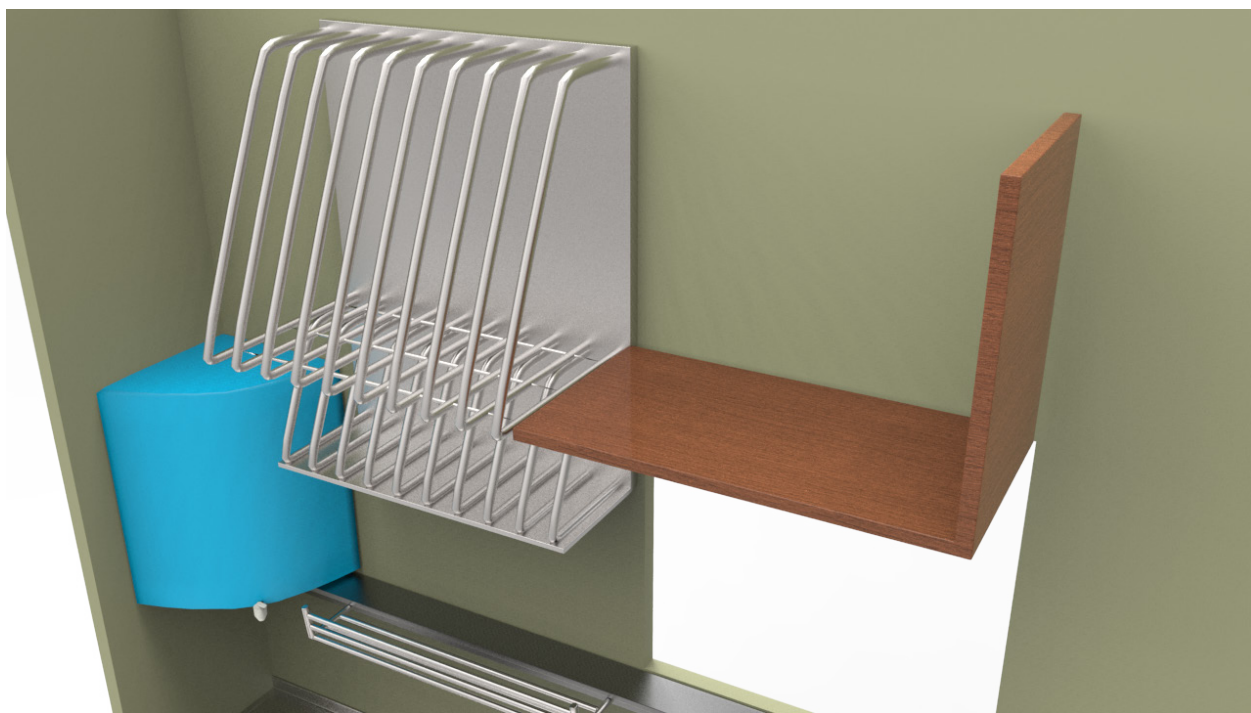
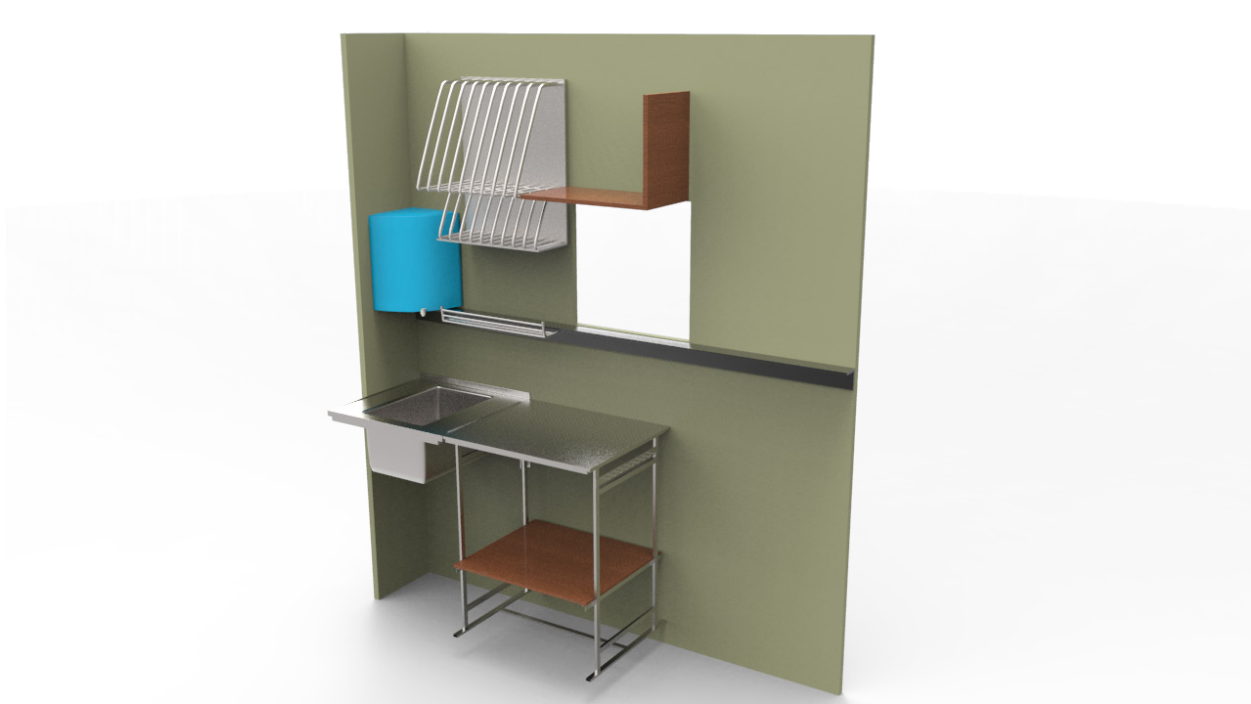
■ Parts

- *Countertop*
- *Legs*
- *Base*





Kitchen space



Kitchen space

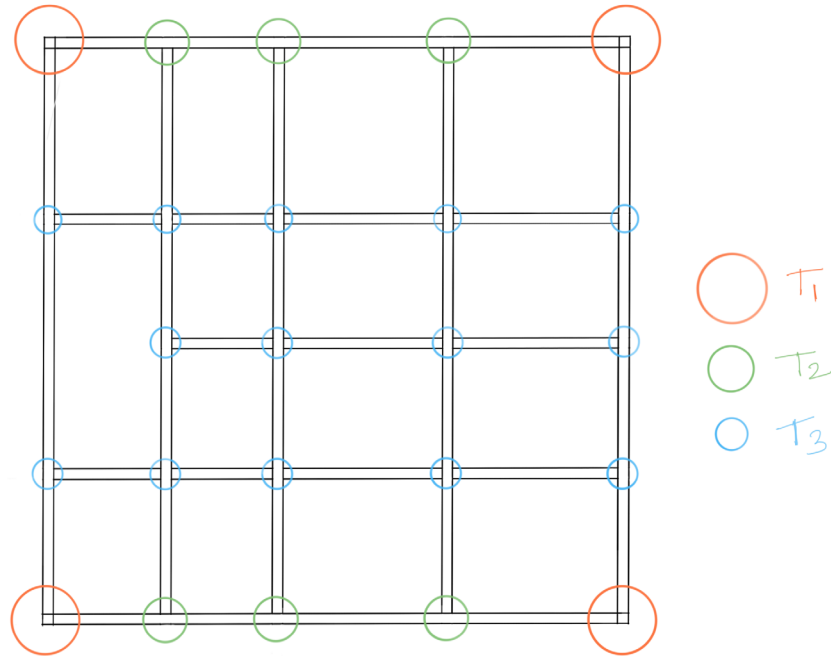
Structural elements

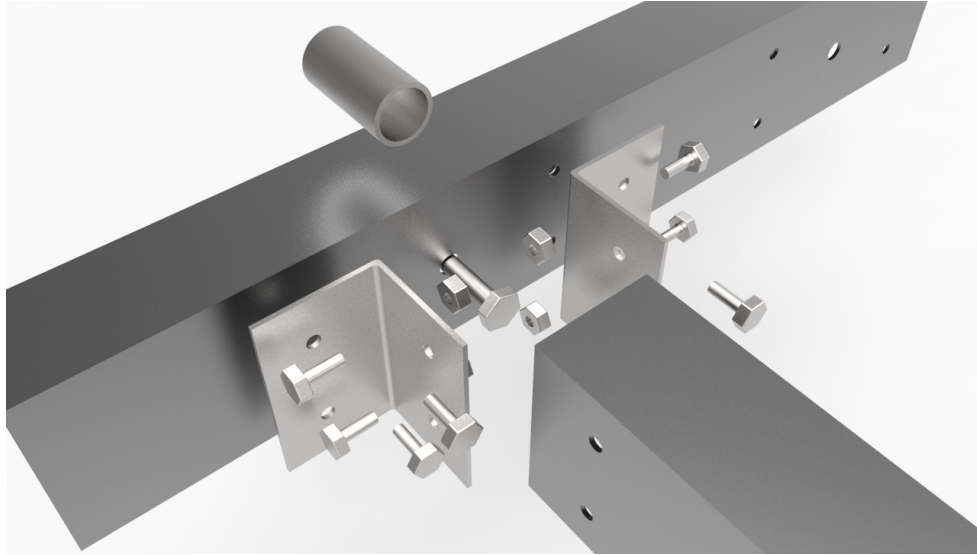
- Easy to assemble and disassemble
- Reduce manufacturing cost
- Locally available tools
- Provision for different layouts
- Flexible for the user to change

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

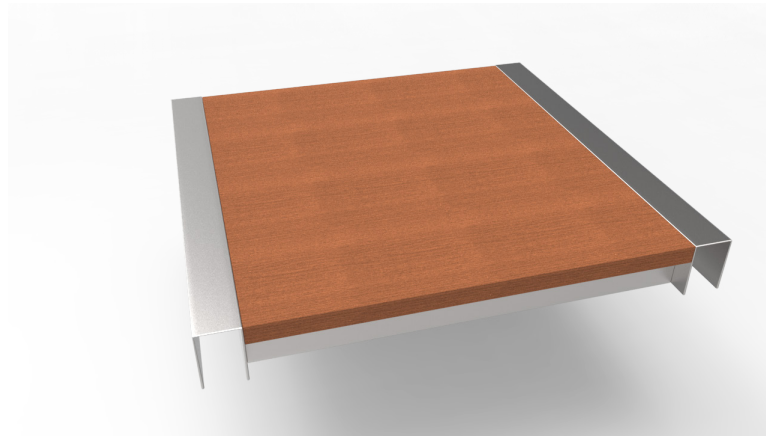
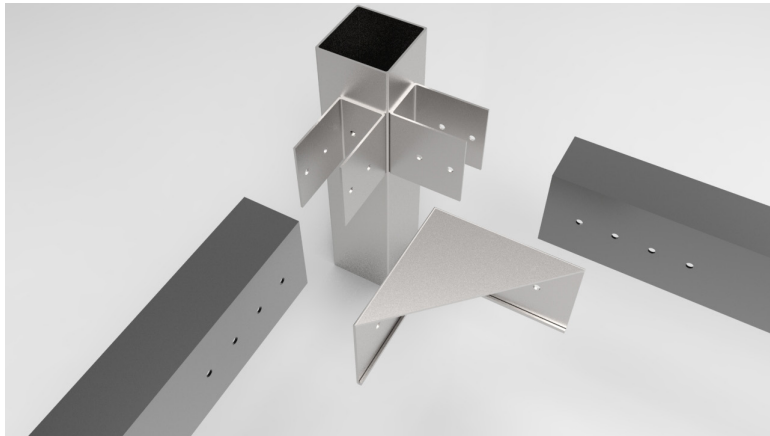
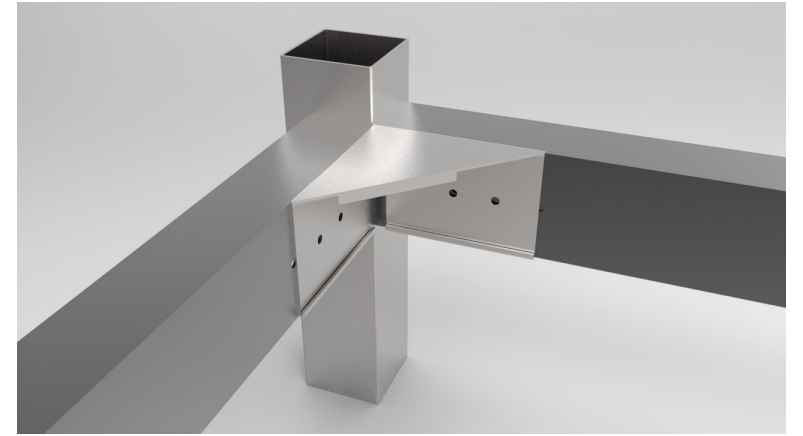
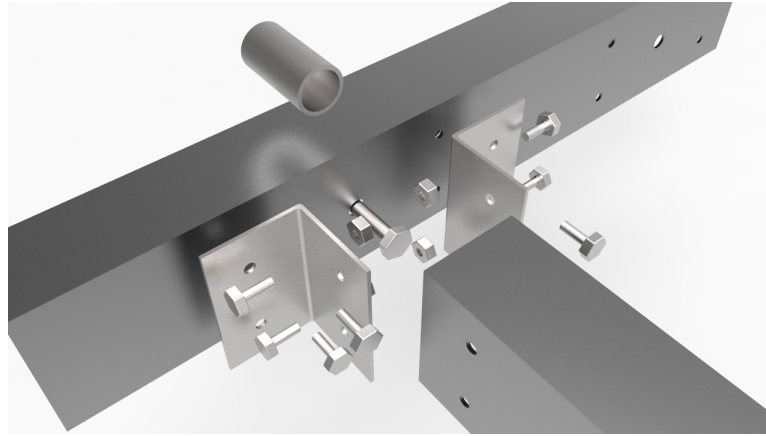
Main structural member : C-section (60mmx90mm)

Orthogonal support member : C-section (50mmx50mm)

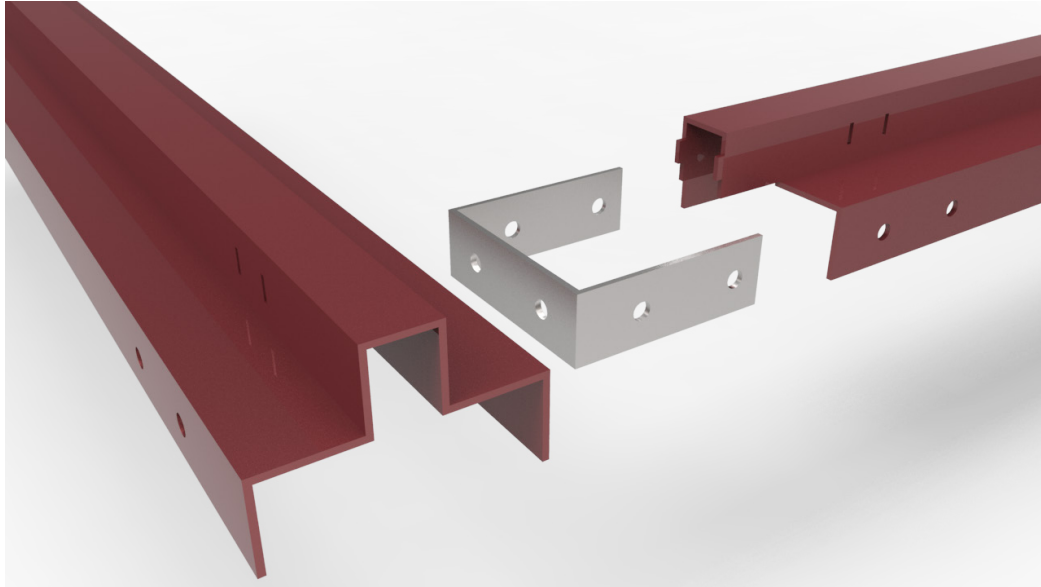
Vertical columns : Square section (3mm-4mm thick)

■ 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

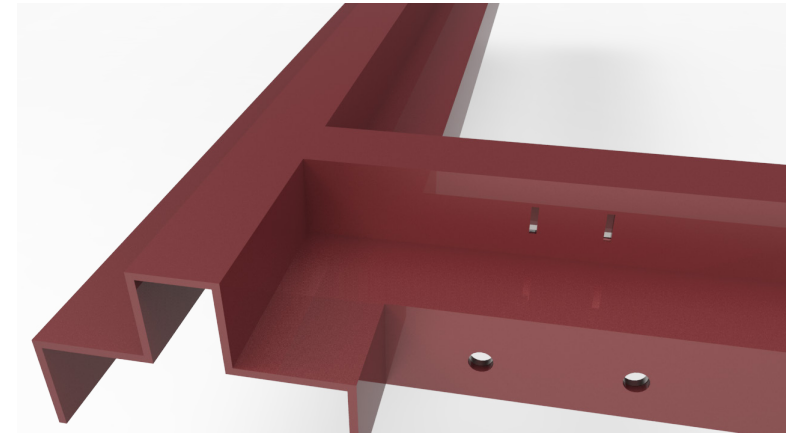
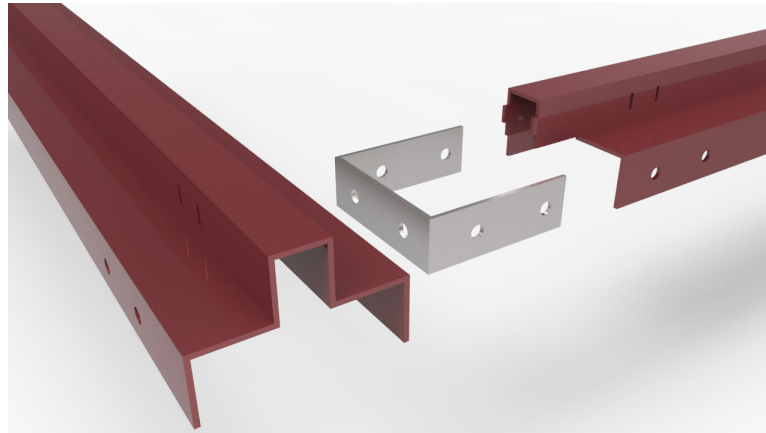
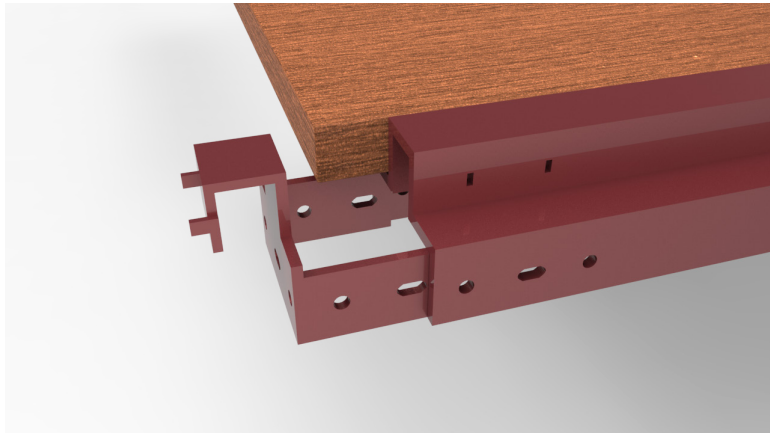
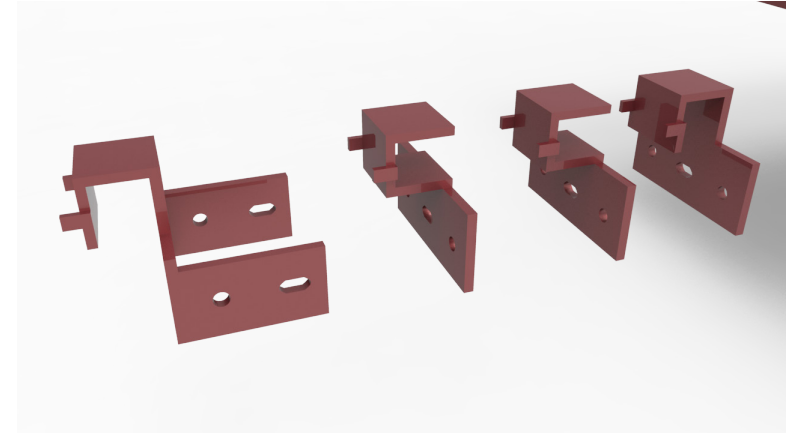
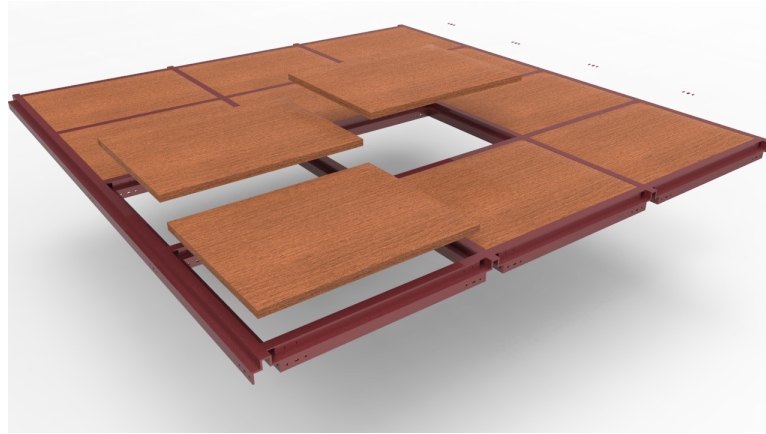
Orthogonal support member : Open hat

Vertical columns : Square section

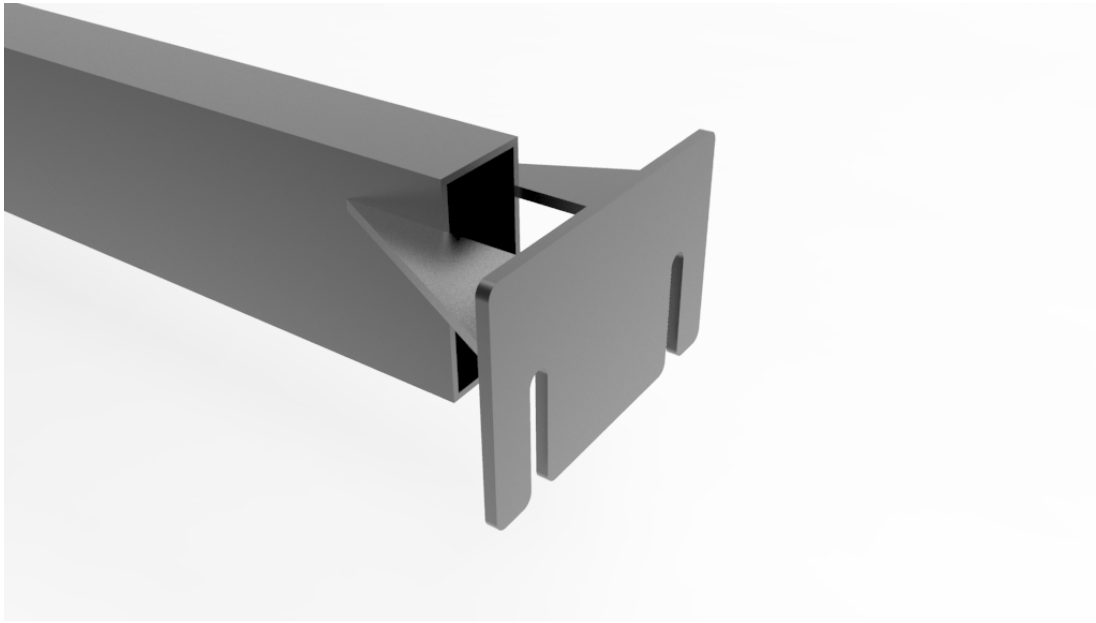
■ Fitting

- *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

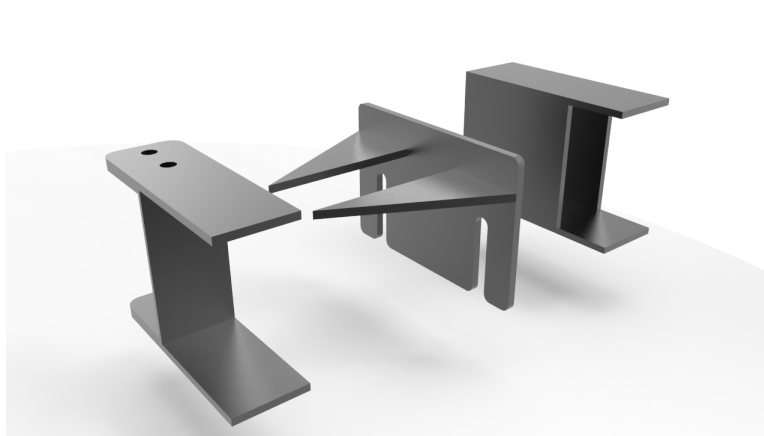
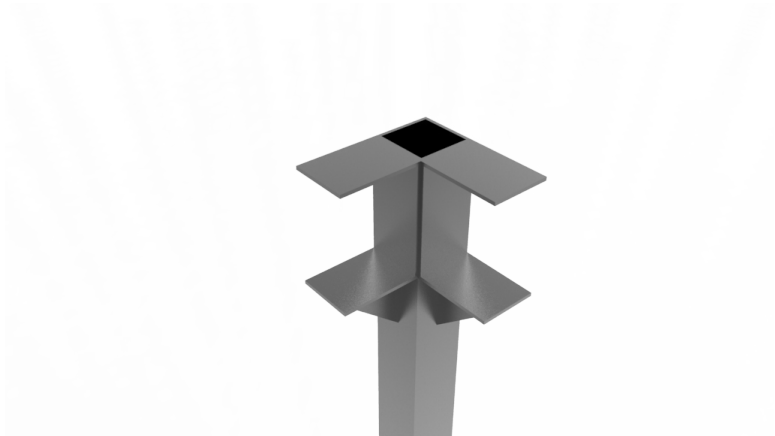
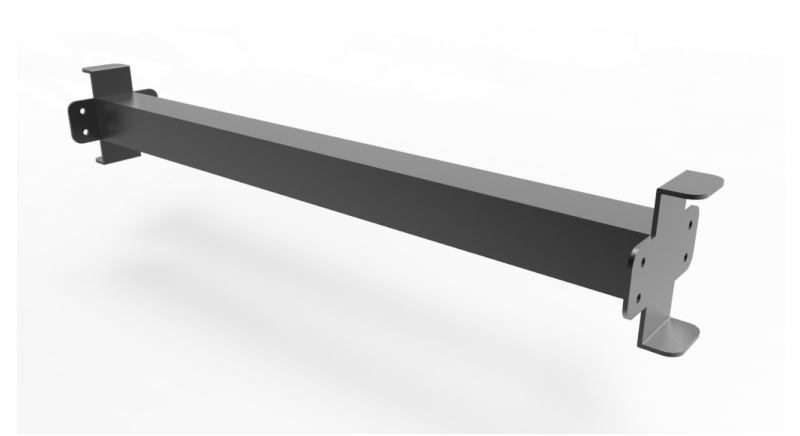
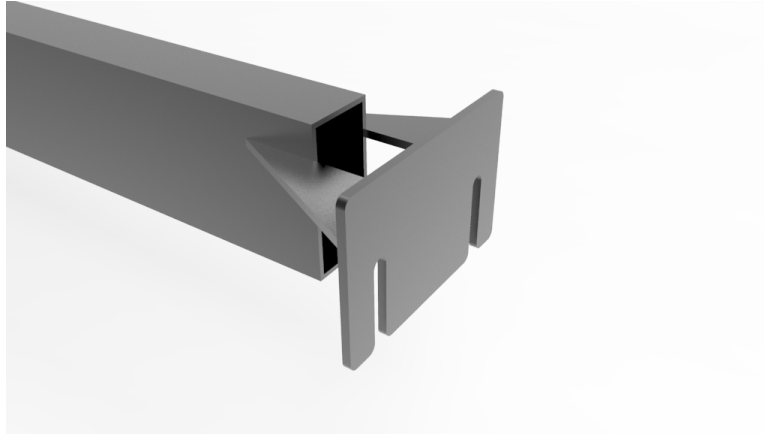
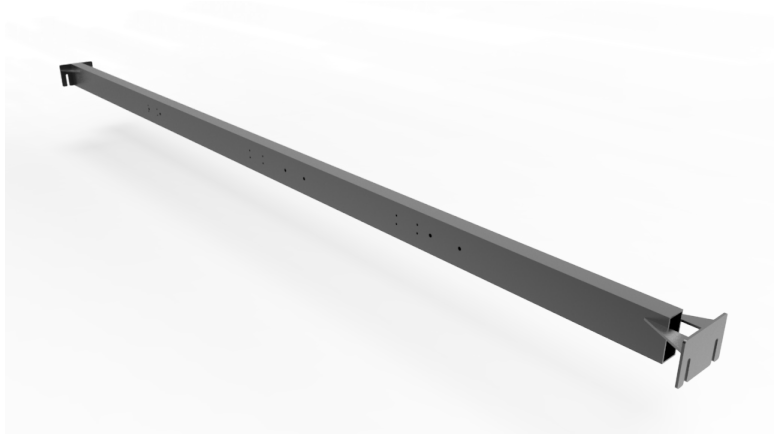
Main structural member : square tube (45mmx96mm)

Orthogonal support member : square tube (45mmx45mm)

Vertical columns : square tube

■ Fitting

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

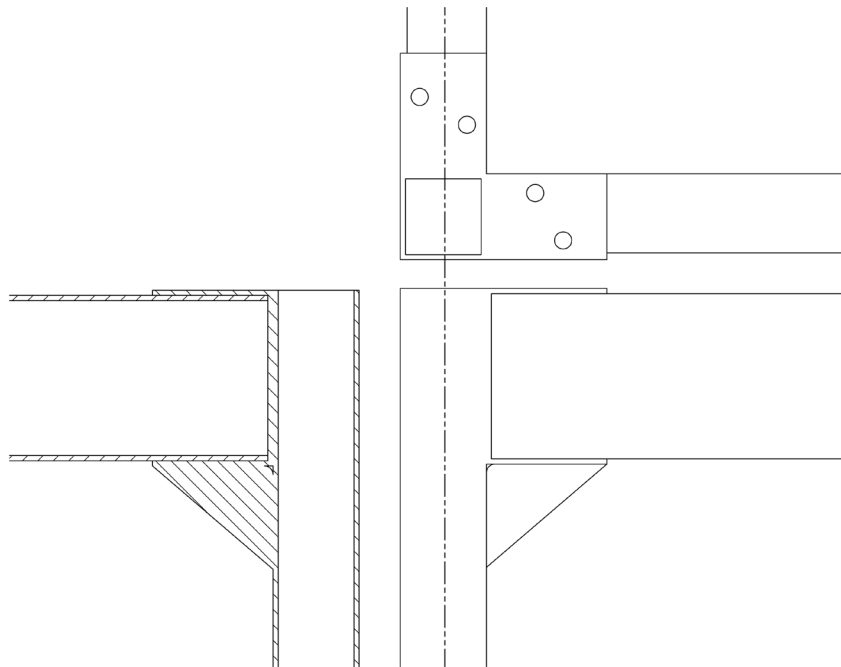


Concept 3 | Visualization

Concept 3

Joints detailing

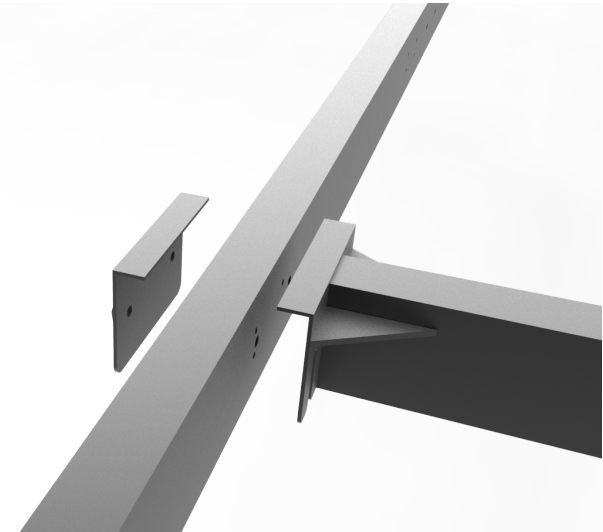
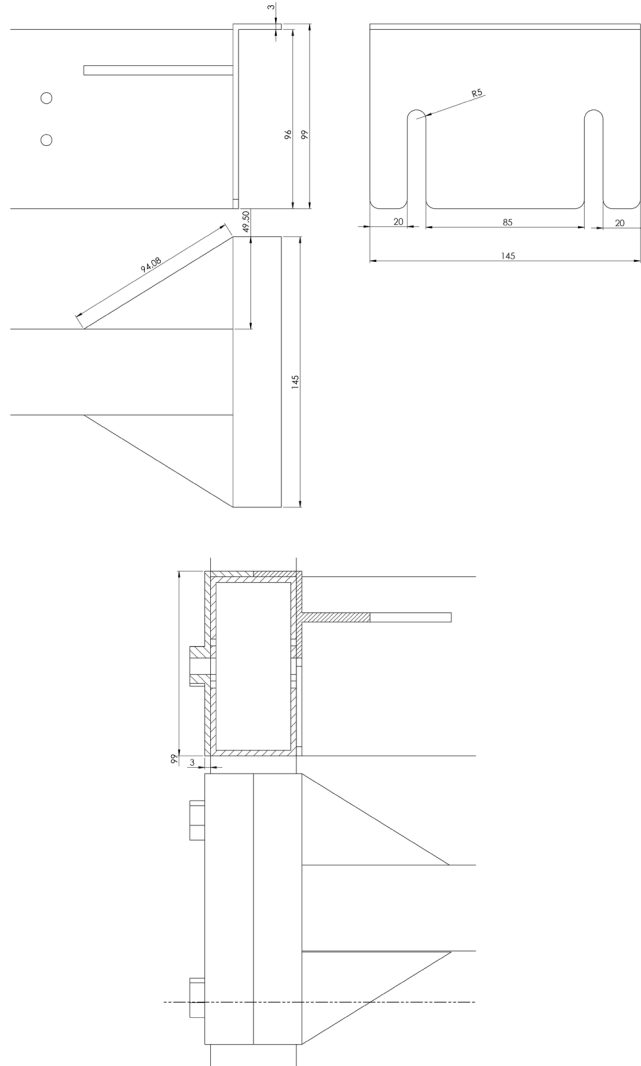
- *T1 joint*

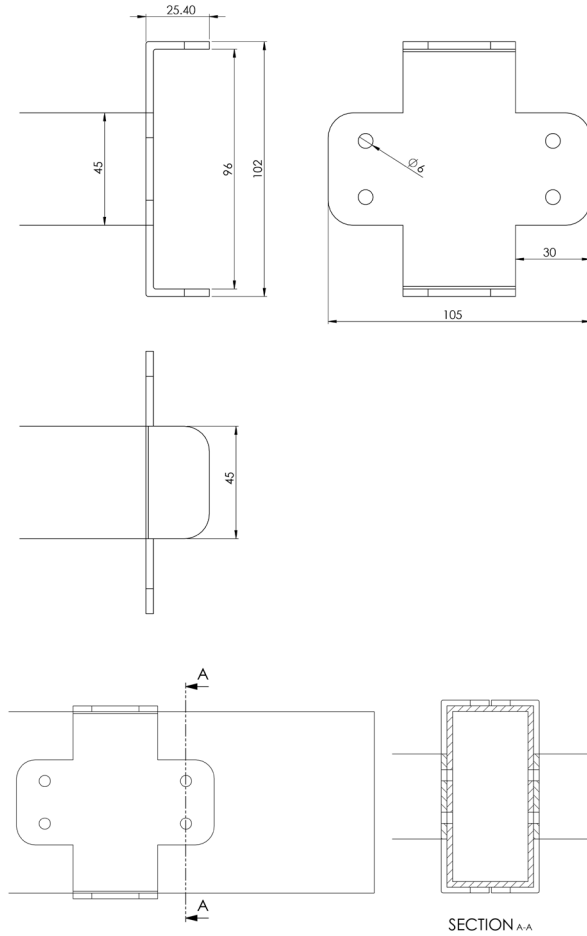


Concept 3

Joints detailing

- T2 joint

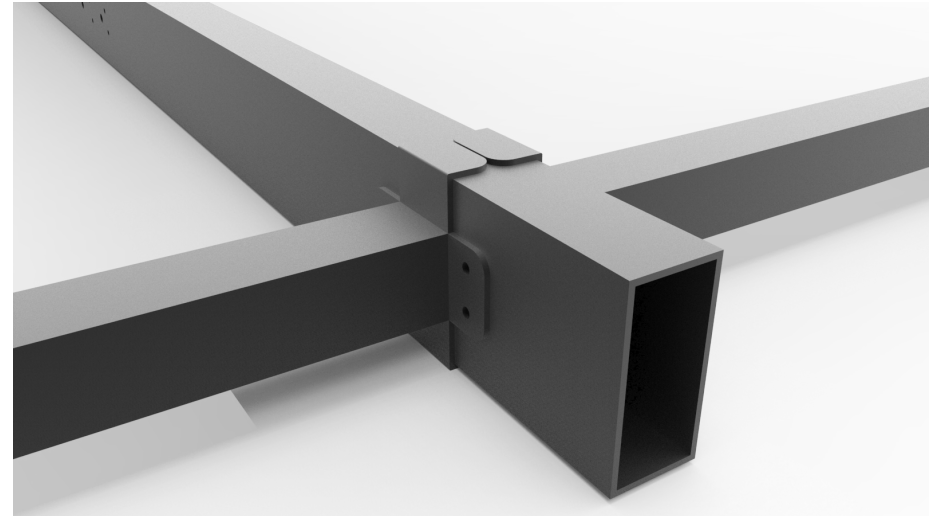




Concept 3

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

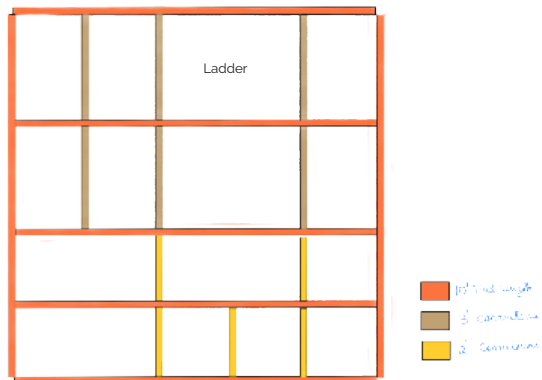
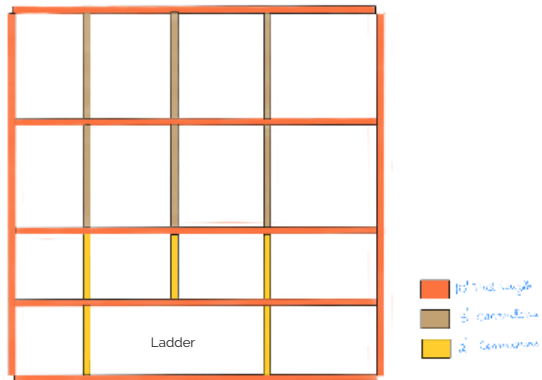
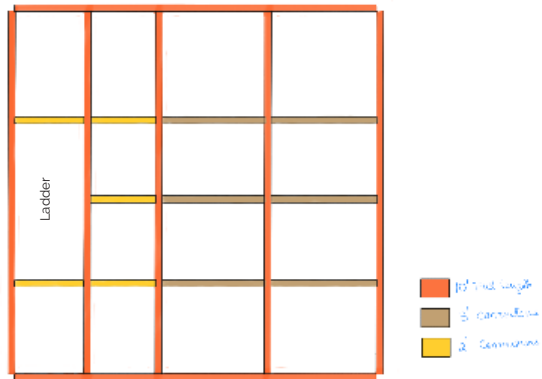
■ Minimum number of members

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**

