

P1 Report

Visit to MIT, Boston and New York

Sheet metal Furniture fundamentals at
Godrej Interio

Vishal Bhushan Jha
Industrial Design Center
IIT Bombay

Preface

The following is the report of visit to MIT in US as Tata Fellow and works done and experiences learnt during short internship at Godrej interio.

The Duration of USA visit was 2nd May to 15th may and Duration of Godrej Interio Internship was 22nd May to 12th June in the year 2015.

Declaration

The content provided in this report represents my ideas in my own words and where other ideas or words have been included, adequate citations and references of the original source have been made.

Vishal Bhushan Jha

146130008

1st Year M. Des | Product Design

IDC IIT Bombay

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USA Visit

Abstract (MIT visit)

The main agenda of visit to Massachusetts Institute of Technology as a Tata fellow is to interact with the tata fellows at MIT to learn about their projects, research methodologies and approach. Also exposure to international design and art field is important hence all possibilities of exploring art and design scene to be done.

Introduction

Tata Centre for technology and Design is an organization initiated by Tata trust to promote design for bottom of pyramid in Developing countries. The centre has chapters at MIT Boston and IIT Bombay and the fellows and research scholars at each college work in various fields related to bottom of pyramid some of them being Housing, healthcare, Education, Power and Energy etc. The trip of Tata fellows to MIT was organized to facilitate mutual learning, wider exposure to international research methodologies and contact building. Tata fellows spent 1 week at MIT getting exposed to various projects done at MIT and India. Also I took this opportunity to visit all the famous buildings of Boston and also Museum of fine arts Boston which has America's largest artwork collection.

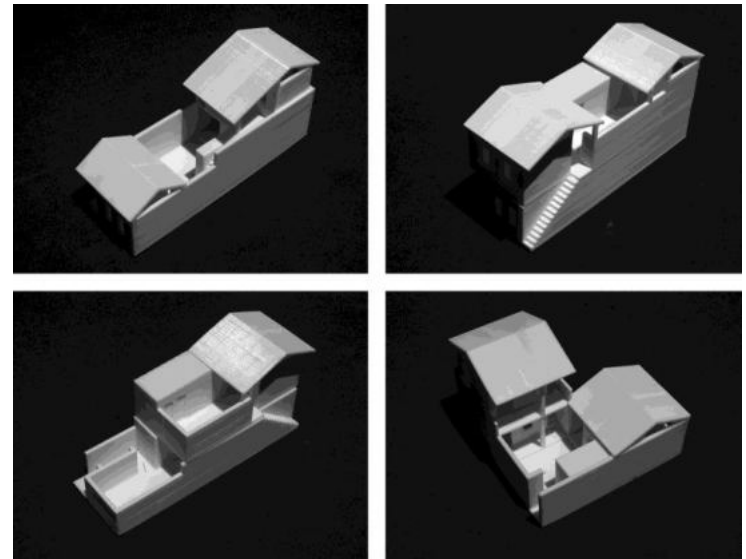
After MIT I extended my trip by further 4 days to explore architecture, art and design scene of New York. In New York I visited MOMA, American Museum of Modern Arts, American museum of natural History and street artist at Times square.



MIT Presentations by Tata fellows

I gave a short presentation on the project “Fitting more in Volume” done by Manu Revi, Gautham Verma and Anulal of 2013-15 batch. After that Aditya Barve discussed that there are many cities in India which are growing fast at alarming rate and are not planned properly. They are carrying out projects on the field of Housing which were discussed in detail. In health section one major project was design of high performance low cost prosthetic foot getting inspired from jaipur foot. Another project carried out by same department was designing of prosthetic knee using biomechanics understanding. The knee had to be low cost but to perform all the activities of a natural knee. . Another presentation was about electricity. One of the major concerns in the world today which is considered the basic need of people is providing electricity to each person in the planet. Reja Amarya discusses this issue and how to solve this by research on similar fields. The three solutions she proposed were:

1. Micro grid
2. Planning tool based on computer modelling
3. Energy system optimization



<http://tatacenter.mit.edu/housing-infrastructure/> as seen on 1st june 2015





MIT Presentations by Tata fellows

3rd may was the first day of series of presentations. One of the major concerns in the world today which is considered the basic need of people is providing electricity to each person in the planet. Reja Amarya discusses this issue and how to solve this by research on similar fields. The three solutions she proposed were:

1. Micro grid
2. Planning tool based on computer modelling
3. Energy system optimization

She proposed that one household which can afford to buy a solar power generator starts producing electricity by doing a capital investment. They sell the electricity to people in need in the village at minimal profit. It also empowers the generator by providing them a means of income. Successful demonstrations of this project is done at Jamshedpur. Then we had short Library session which was very informative. in afternoon session, the various water related projects were presented.



<http://mimobaby.com/> as seen on 1st june 2015

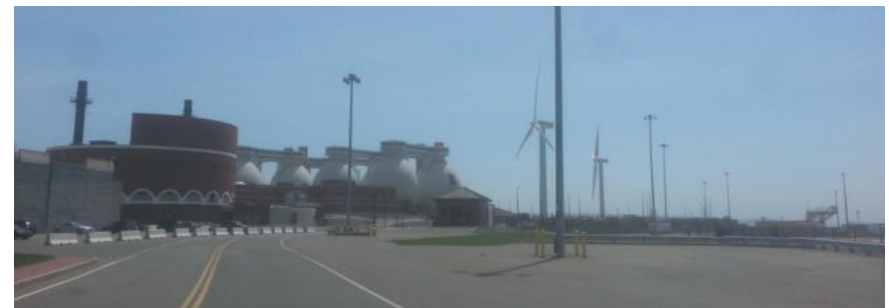
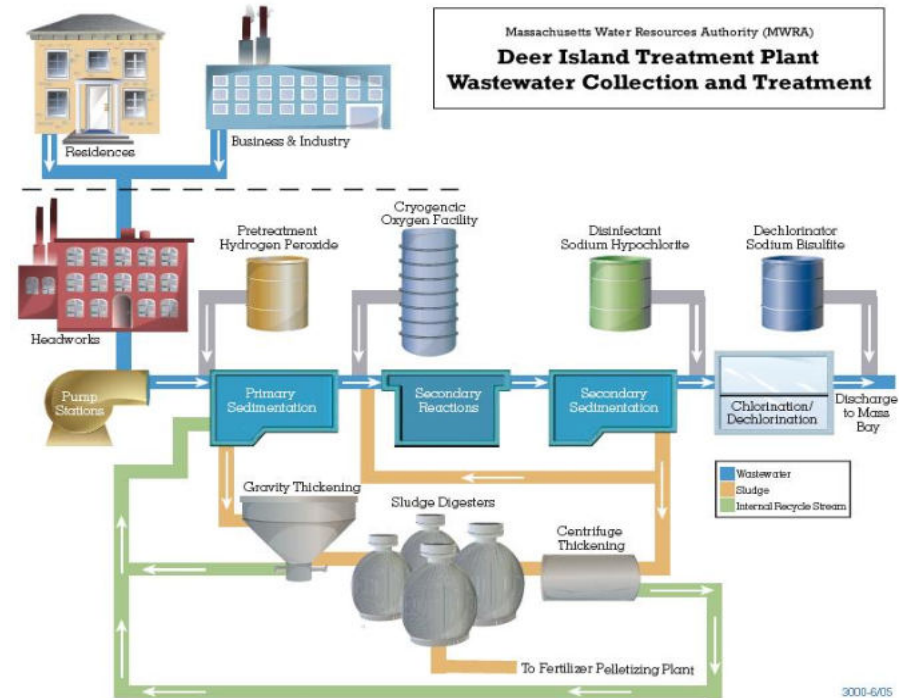
MIT Presentations by Tata fellows

Third day consisted of discussions about health and diagnostics and social sciences research. We got to attend pro seminar with the tata fellows of MIT which was great experience. We noticed the way their classes are conducted and it felt similar as well as different in some sense.

Fourth day, we had discussions about building material shortage. Prof. John Ochendorf and Tata fellows are working on a project to use industrial waste of paper factories to make bricks. The project highlighting all its advantages were discussed. next, the discussion with Thomas Limpoa about him developing infant monitoring device Mimo Kimono in 3 months and bringing it to market was inspirational and informative.

Deer Island Visit

Final Day of the conference was Deer island wastewater treatment plant visit. The island demonstrates great limits to which one can go to treat the water before leaving it to nature. The deer island treats water of whole Boston metropolis and releases it to sea. There are 3 collection points from where water comes to deer island. The island has specific areas designated as primary sedimentation tank, secondary treatment tank, secondary sedimentation tank, digester, chlorination tanks etc. The visit was truly fascinating as we got to see a restricted area in US and the facilities were great.





BOSTON CITY HALL

Two men standing in the foreground, one wearing a blue shirt and the other a brown shirt, engaged in conversation.

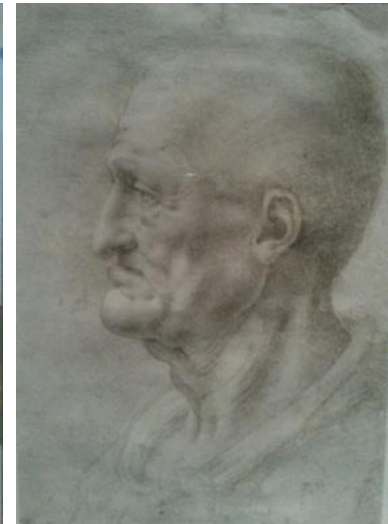
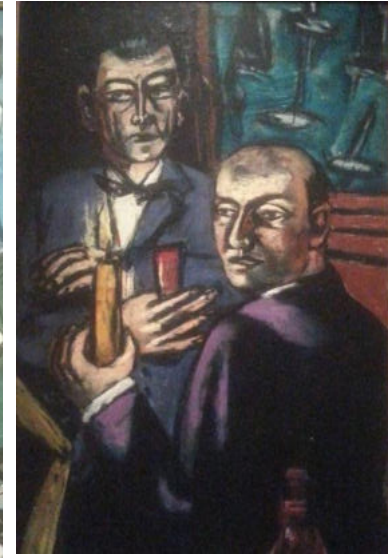
Boston

Boston is a beautiful city with lots of health conscious intelligent people doing all kinds of physical activities all day. Charles river marks the boundary between Boston and Cambridge. The city skyline is dominated with brown colored old buildings with lots of cherry blossoms in spring. The river is always full of ducks, seagulls and rowing boats.



Museum of Fine Arts

America's largest museum (collection of artworks) has almost all famous artists and movements artworks. Other than that there are art, sculptures and craft collections from many old civilization. When I visited, Leonardo Da Vinci's original study sketches and Hokusai's entire screen printing collection were on special display.



To make a reproduction, the blockcarver starts with a good, clear photograph of an original print. (The first editions of Hokusai's prints were made from his own drawings, which were destroyed in the process because they were used as patterns for the smooth bamboo leaves.) Each color is printed in a separate step, using the edge of the blocks to place the paper correctly in the color tray. A line demonstrates the printing process.





New York

As soon as one enters New York one sees the jungle of glass, steels and concrete. New York is full of awesome buildings designed by great architects all soaring high in sky all trying to be different from each other yet similar at the end.

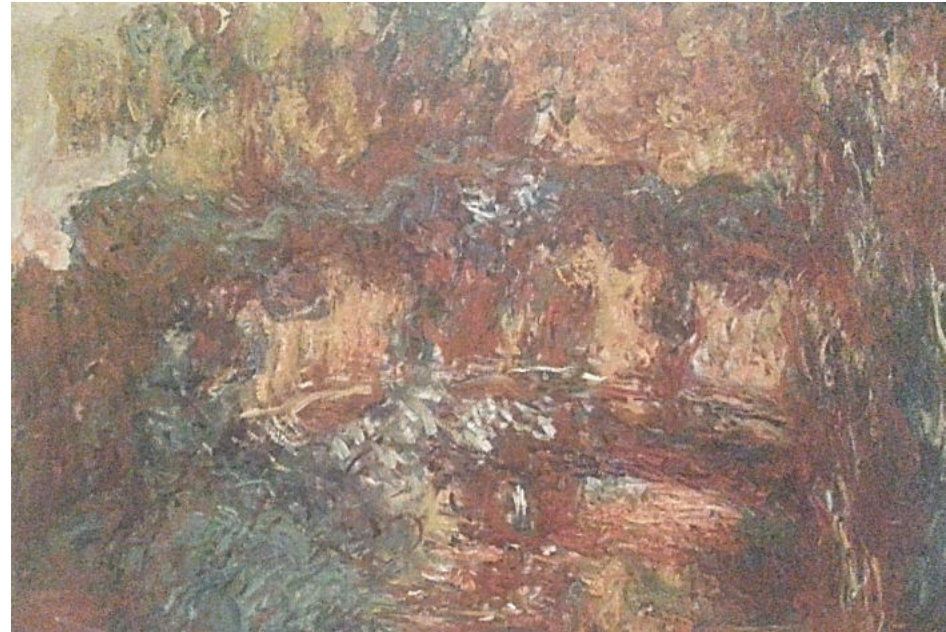
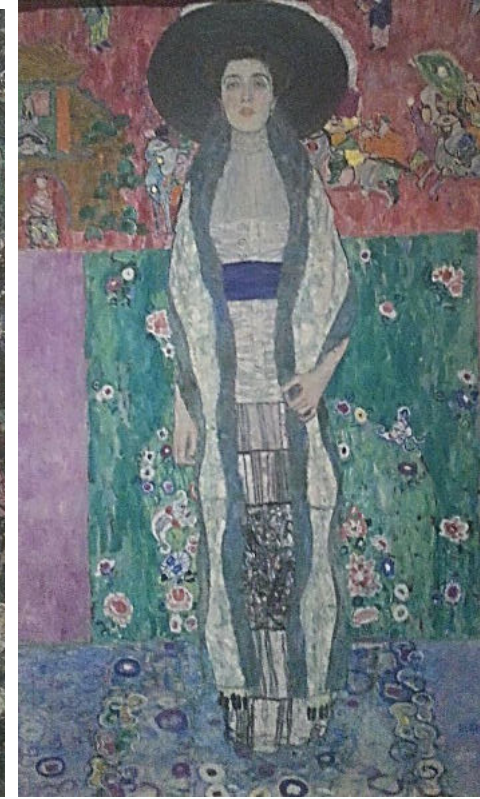




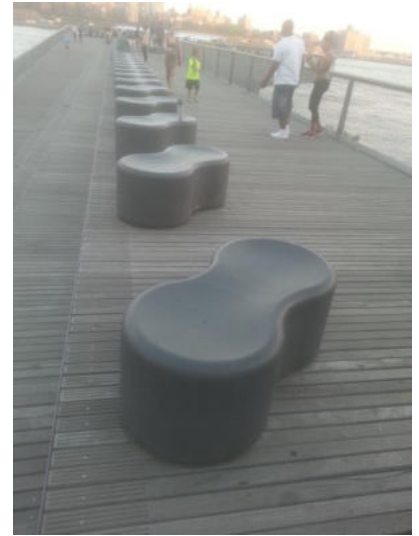
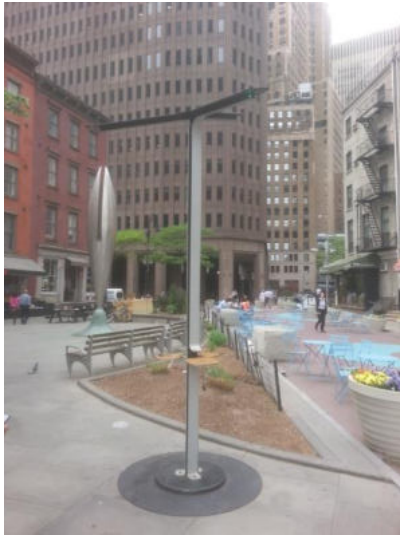


MOMA

Museum of modern arts is identified as the most influential museum of modern arts in the world and has been influential in the developing and collecting modern and contemporary arts. I decided to take selfie with all the works I liked even before visiting this place and documenting this place.



Public seating





Conclusions

The short visit to MIT, Boston and Newyork was one of the major milestone in my life as it was the first time I visited abroad. The presentations at MIT helped in understanding the processes and procedures followed by students in their research. Boston city travel gave a walk through history of america. The tour to Deer island water treatment plant was very informative and impressive to know to what extent a developed nation can go to treat waste before releasing it to environment. New york felt like creativity paradise with over whelming energy and creativity. Overall this trip satisfied the traveller in me and gave me confidence that I can plan tour in a city anywhere in the world on my own.

Godrej Interio

Abstract (Godrej Interio Internship)

Metal furnitures are getting really common in market recently as they provide wide variety and designs, are durable than plastic and cheaper than wooden furnitures. My internship at Godrej is to learn about designing of metal furnitures, working with sheet metal, getting knowledge about various processes associated with steel sheet and designing some simple product if possible to get better understanding of the concepts learnt.

Introduction

Godrej Interio is India's largest furniture brand. They started manufacturing simple strowel cupboard in 1930's. The design office develops all the products manufactured by godrej interio. Sometimes reverse engineering, Benchmarking foreign products and collaboration with outside designers are also done. They mainly provide solutions for home, office and marine fields.

The design office has many sections being:

OPOS- Open office partition system

Seating and desking

Healthcare

Home solutions

Lab solutions

Marine

I worked in Home solutions department with Ms. Vaishali shah as my guide. I worked mainly with team working on Metal furniture.

Godrej Interio Showroom Visit

Godrej Interio Showroom Vikhroli

Observations:

- Arrangement of furnitures on display matters a lot and gives customer a feel of how the furniture would look in their home.
- There is a permanent interior designer at the showroom for designing the displays immediately when required



https://www.godrejinterio.com/Godrejinterio/CategoryImages/LargeImages/KarbonBed_Concept.jpg as seen on 24th may

Godrej Interio Showroom Visit

Metal Furniture:

Wardrobes, Lockers, beds, Cabinets
and Shoe racks.

Observations:

Thickness of the sheet for products varied as per use.
Within products, Sheet thickness varied based on its
location.

Bending in the sides of sheet metal panels for extra
stability

Stiffeners used in long span

Knockdown facility in many products if possible for easy
transport

Main considerations in Packaging : efficient Space usage
and Product safety.

Cut on the corner while bending on all 4 sides

Spot welding used often

Powder coated steel finish for flat colors, Percolated steel
with PVC film for textures and patterns.

Godrej Interio Showroom Visit



Godrej Interio Showroom Visit



www.tradeindia.com

as seen on 24th may



www.cbsdesignz.com

as seen on 24th may



www.godrejinterio.com

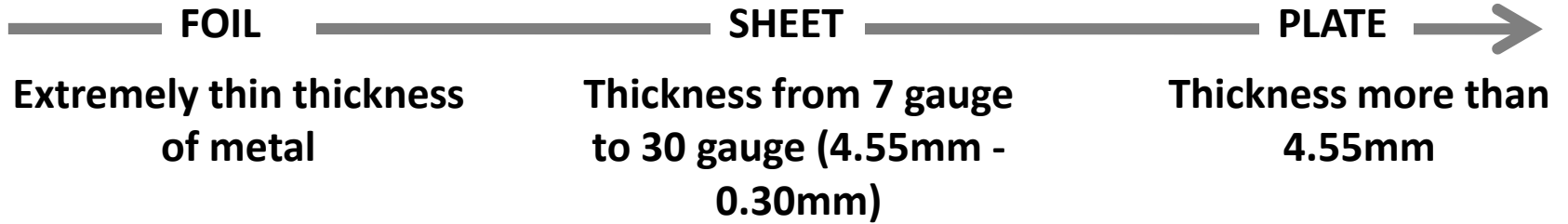
as seen on 24th may

3 Dominating Metal Wardrobe series in the showroom are:

1. Centurion 2. Slimline and 3. Kreation

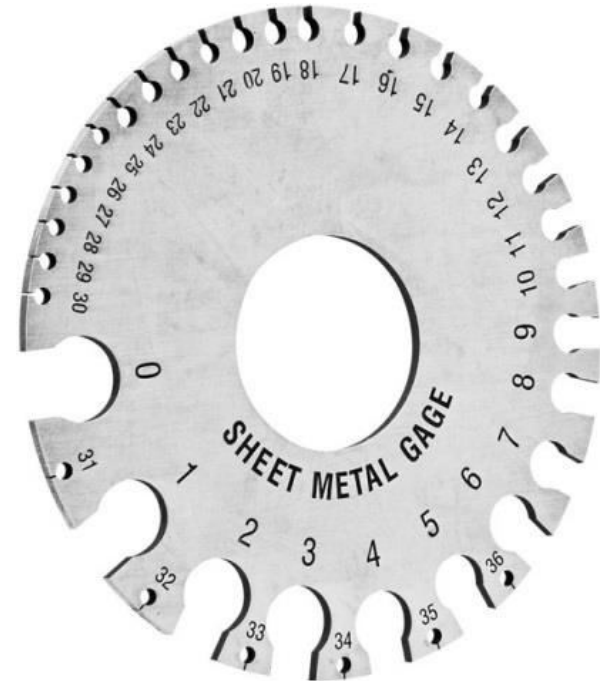
The thickness of sheet in centurion is maximum and its welded product so gives maximum security. Slimline and Kreation are newer product with thinner sheet metal and knockdown assembly.

Flat steel



Plates are not very often used in bent steel furniture though can be used in welded products

Gauge is the non-linear thickness representation method of steel. Steel sheet thickness reduces as the Gauge increases. Hence sheet metal of 30 gauge will be thinner than sheet metal of 20 gauge.



www.eastwood.com as seen on 25th may

Gauge in decimals of an inch

Use the chart provided below to convert standard gauge numbers in decimals of an inch for sheet steel, strip and tubing, aluminum and stainless steel.

Gauge #	Sheet Steel	Strip & Tubing	Aluminum	Stainless Steel
5/0	----	.500	.5165	.4375
4/0	----	.454	.4600	.4062
3/0	----	.425	.4096	.3750
2/0	----	.380	.3648	.3437
0	----	.340	.3249	.3125
1	----	.300	.2893	.2812
2	----	.284	.2576	.2656
3	.2391	.259	.2294	.2500
4	.2242	.238	.2043	.2344
5	.2092	.220	.1819	.2187
6	.1943	.203	.1620	.2031
7	.1793	.180	.1443	.1875
8	.1644	.165	.1285	.1719
9	.1495	.148	.1144	.1562
10	.1345	.134	.1019	.1406
11	.1196	.120	.0907	.1250
12	.1046	.109	.0808	.1094
13	.0897	.095	.0720	.0937
14	.0747	.083	.0641	.0781
15	.0673	.072	.0571	.0703
16	.0598	.065	.0508	.0625
17	.0538	.058	.0453	.0562
18	.0478	.049	.0403	.0500
19	.0418	.042	.0359	.0437
20	.0359	.035	.0320	.0375
21	.0329	.032	.0285	.0344
22	.0299	.028	.0253	.0312
23	.0269	.025	.0226	.0281
24	.0239	.022	.0201	.0250
25	.0209	.020	.0179	.0219
26	.0179	.018	.0159	.0187
27	.0164	.016	.0142	.0172
28	.0149	.014	.0126	.0156
29	.0135	.013	.0113	.0141

Gauge Chart (www.freetechnicalcharts.com as seen on 28th may)

Sheet metal

Type of sheet metal:

Cold Rolled steel

Hot rolled steel

Stainless steel

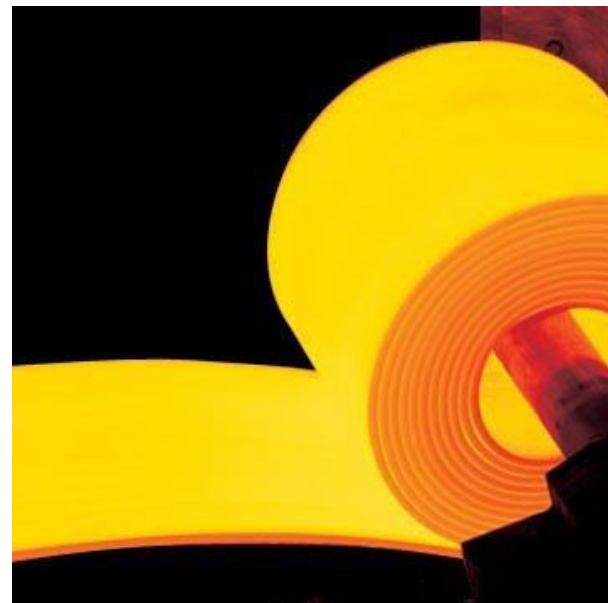
Hot rolling of steel happens above the crystallization temperature of steel thus the strength of steel gets affected.

Cold rolling occurs with the metal below its recrystallization temperature (usually at room temperature), which increases the strength via strain hardening up to 20%.

Usually most complex products and products requiring thin sections are done with cold rolled steel.



cndmetals.en.alibaba.com as seen on 27th may



cndmetals.en.alibaba.com as seen on 27th may

Pre coated steel with PVC foil

Pre-coated steel with PVC foil is already finished sheet with patterns or graphics coated on them with PVC. Usage of PVC coated steel in market is very widespread and can be seen everywhere from furnitures to appliances.

The pre coated steel sheets are already finished hence one has to be very careful while working with them. No spot welding or Co2 welding could be done on them. These pieces are fixed by pasting, rivets and screws.



<https://m2.behance.net/rendition/pm/22189015/disp/01c1d245338495a79be9f2624f652aa3.jpg> Seen on 29th May



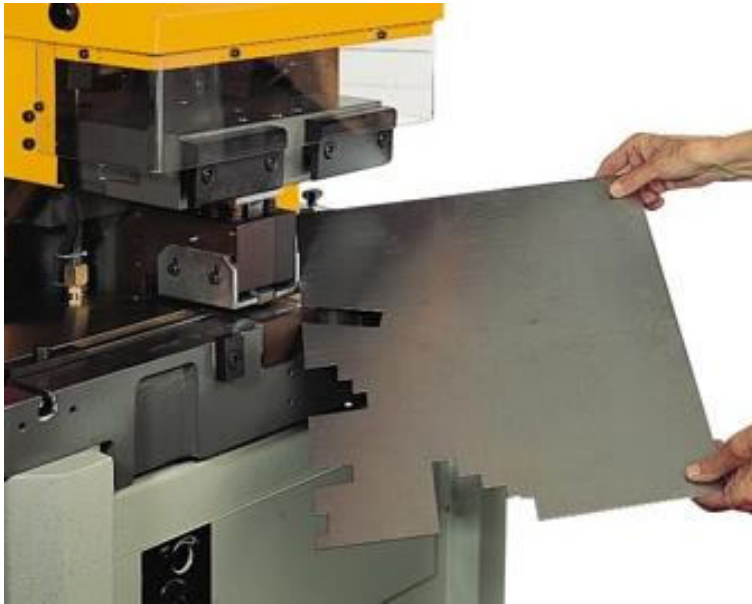
www.lampre.com/en/productsservices/precoated/ seen on 29th may

Sheet Metal cutting and Bending

Cutting

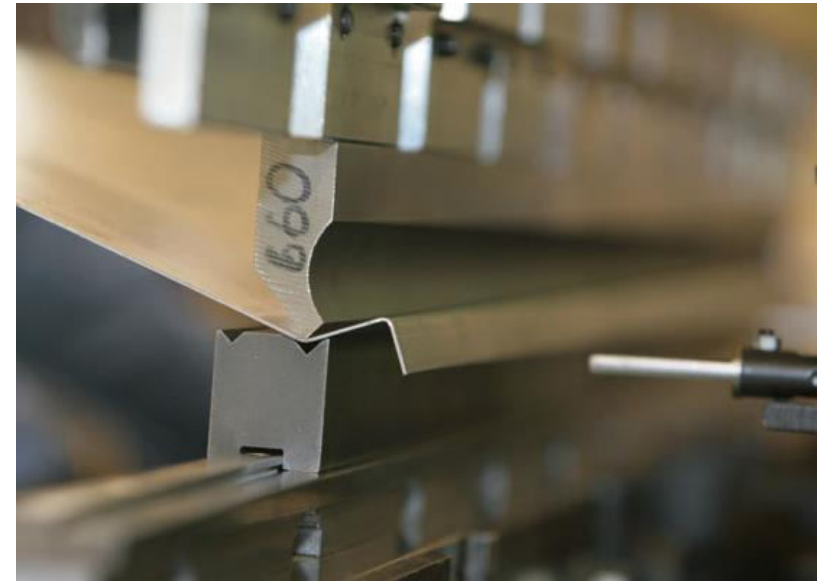
- Shearing
- Notching
- Laser cutting
- Stamping

BLM Group - Tube works videos
Possibility of fast work through laser
cutting



Bending

- Die and Punch
- Edge bending and wiping die
- Rotary die
- Air bending
- Channel bending
- Flanging
- Roller Bending
- Roll forming



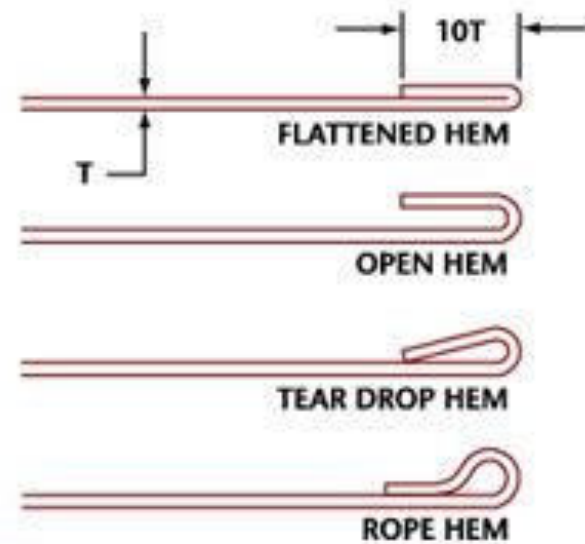
http://www.thelibraryofmanufacturing.com/sheetmetal_bending.html seen on 30th may

Increasing strength of sheet metal

Hems are created when you fold over the metal back onto itself. It saves time (less de-burring), gives a more finished look to your edges, and, most importantly, it adds tremendous amounts of strength to a face!

Beads are embossed lines that run across the surface of the sheet. These are made using a bead roller. These indentations add strength perpendicular to the bead. This is the idea behind corrugated tin roofing.

Grooved Seams are a great way to join two pieces of sheet metal, but they also create tremendous strength perpendicular to the joint. A properly grooved hem has 2 broken edges, and 4 layers of sheet metal in one spot.

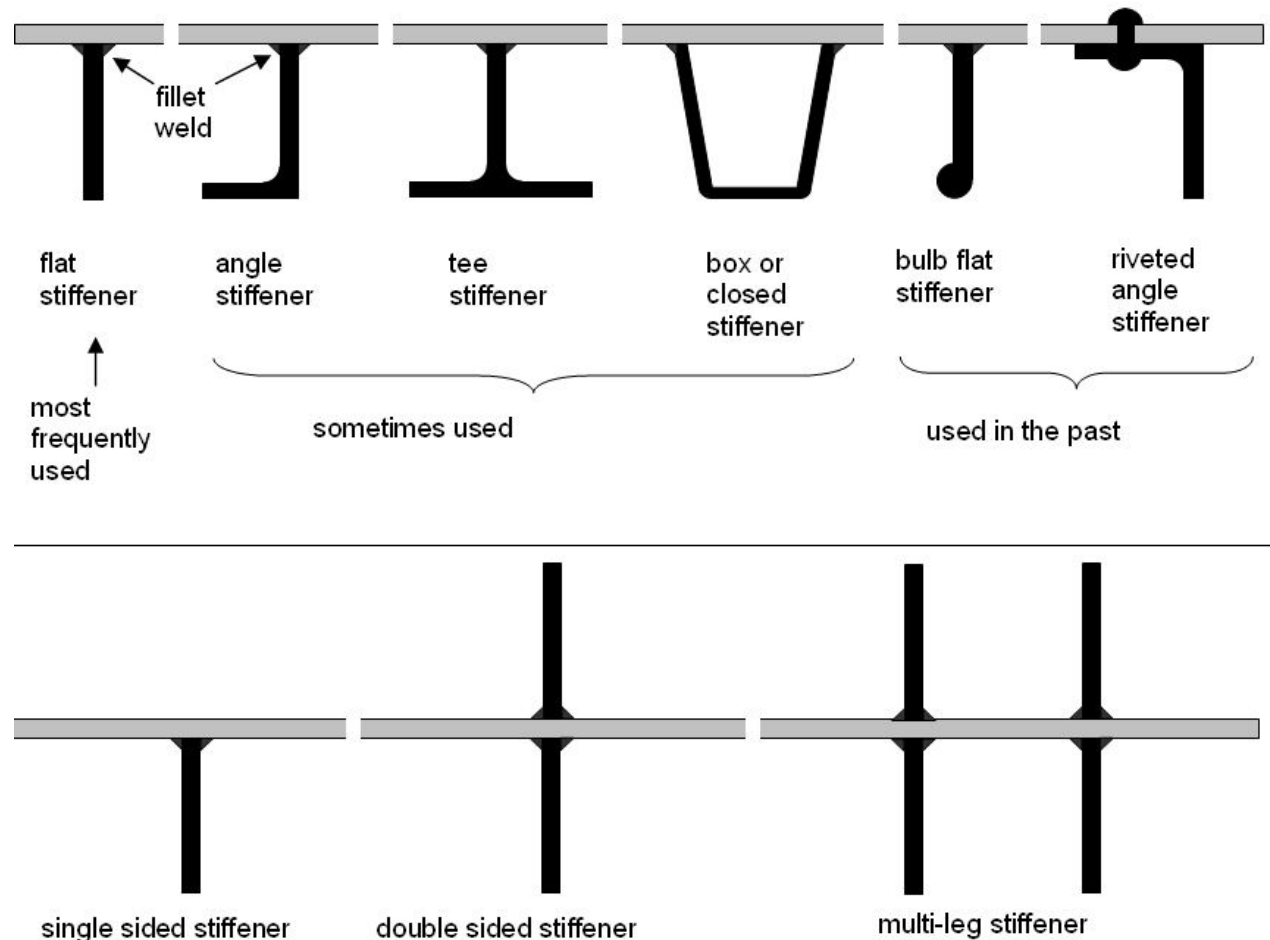


All images www.instructables.com
as seen in 4th may

Increasing strength of sheet metal

Stiffeners are secondary plates or sections which are attached to steel sheet pieces to stiffen them against out of plane deformations.

Stiffeners are used in controlling local buckeling
Adding additional strength to the sheet metal section
Provide shannels for concealed wiring or accessories fixing



<http://www.steelconstruction.info/Stiffeners> as seen on 6th june

Slimline Drawings Study:

Types of steel sheet and other Material, BOQ study

Each and every part drawing in various stages: Plain sheared sheet, Notching details, Bending details

Packaging drawings: Detailing out packaging of product in sequence

Assembly Guidelines: Detailing out all sequence and process of assembly, Removing packaging and on site riveting

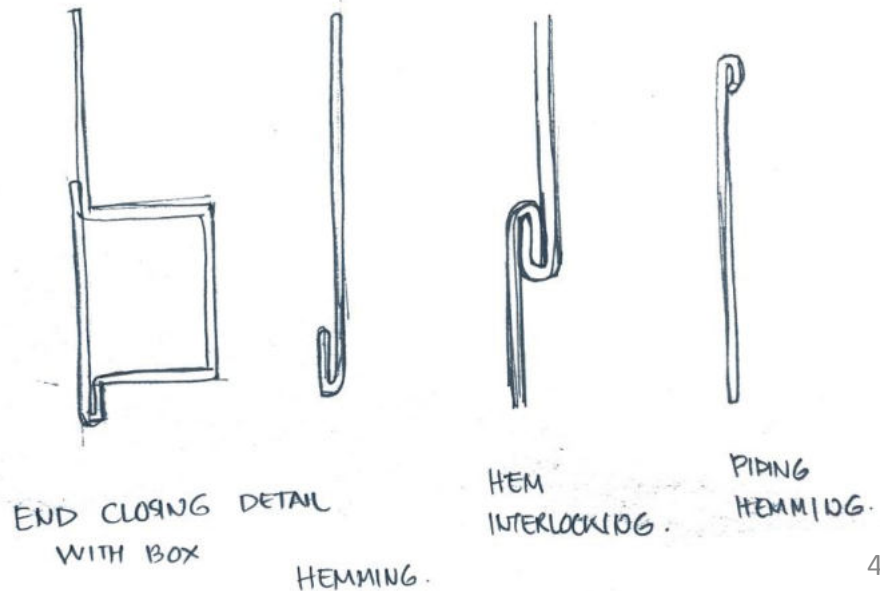
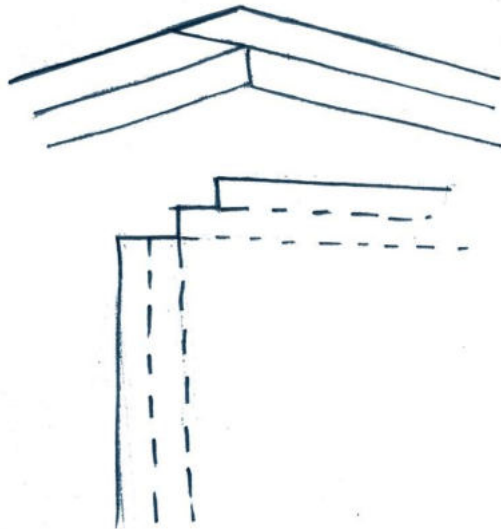
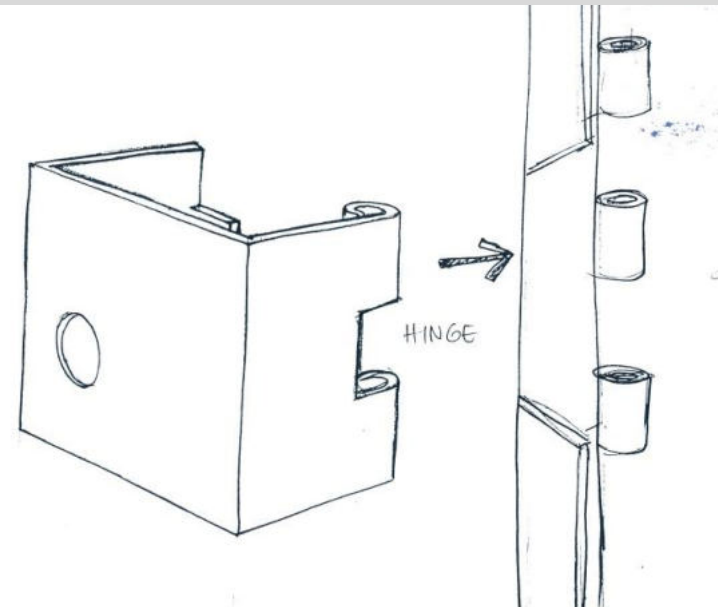


www.godrejinterio.com as seen on
29th may

Slimline Drawings Study:

Important points to note:

- Seaming joints
- Fixtures
- Hooks
- Hems, Side bend and stiffener for stability
- Sliding and sequence of storage
- Decision to use spot welding and co2 welding
- Decision to go for knock-down product or welded product



Slimline Drawings Study:

Types of Assembly fixtures:

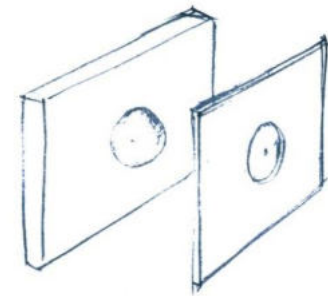
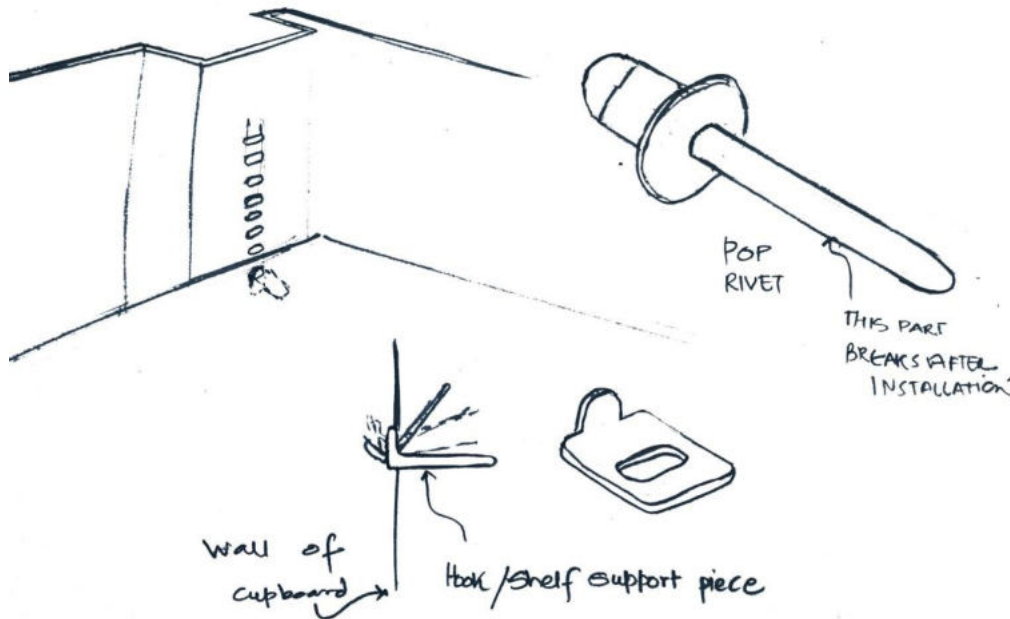
Various types of assembly joints are:

Interlocking in bent sheet

Protrusion and cut fixing

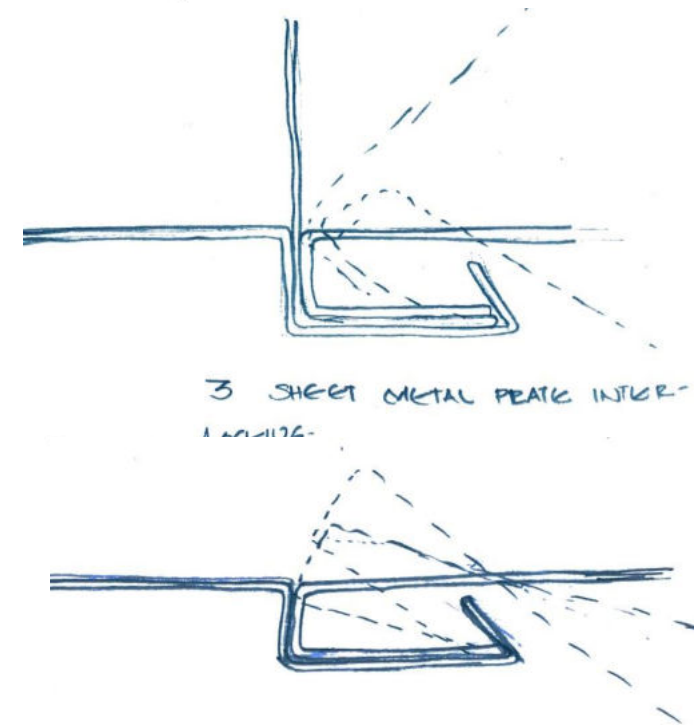
Pop rivets and screws

Hooks/ support pieces for shelf



PIMPLE AND DIMPLE
FIXTURE

PROTRUSION AND CUT INTER-
LOCKING



3 SHEET METAL PLATE INTER-
LOCKING

Sheet Metal Interlocking Joint

Factory Visit (Plant 13 and 14)

Steel Sheets Procured in form of rolls/coils
Thickness of sheet varies as per requirement

Mainly the activity at shop floor can be divided into 5 activities:

Cutting, Bending, welding/joining, Painting/Finishing and Packaging

Cutting of steel sheet:

Shearing – Cutting of sheet metal by pressing it along blades

Notching – Cutting Scraps or parts out of sheet metal.
There is manual notching as well as electronically programmed notching.

Bending and Folding of steel sheet:

Mechanical Press

Electronic press

Side hem, perpendicular bending and angular bending, all depends on the punch and die shape.



www.h-hmetals.com seen on 27th may



www.hacoatlantic.com seen on 27th children

Factory Visit (Plant 13 and 14)

welding/joining of steel parts

Spot welding – where flat parts getting attached

CO2 welding – where 2 separate planes join forming edge

Rivets and Screws- where required, specially in pre-coated steel sheet

Interlocking

Painting/Finishing

Buffing

Finishing of weld joints

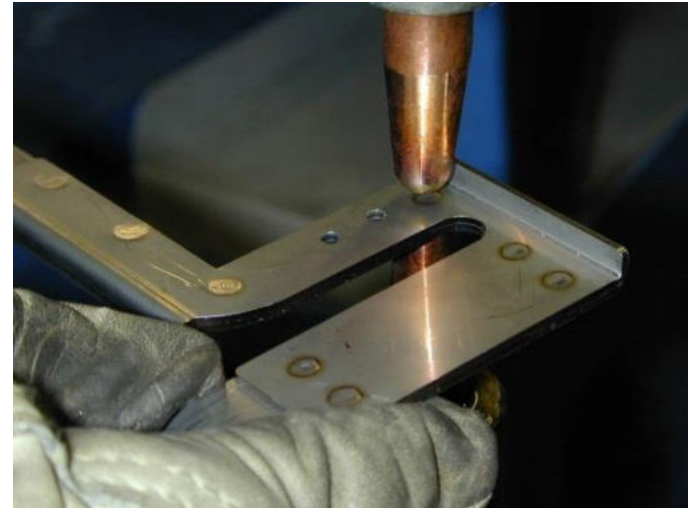
Degreasing

Powder coating

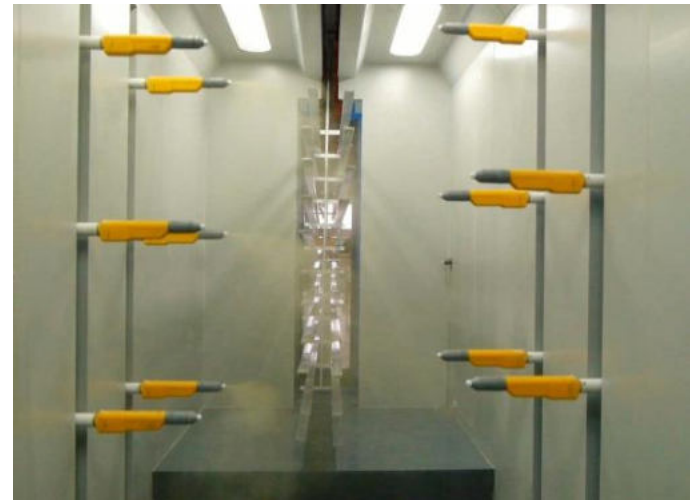
Packaging

Parts are packaged in box as per instruction.

Knockdown products go as kit of individual pieces, welded products are packed in box as it is.



www.deltec-inc.com as seen on 29th may



www.directindustry.com as seen on 29th may

Design Assignment

Design a bed side Table using Steel tube and steel sheet metal.

Important Points to be considered:

Utilities/ different uses of bed side table

Safety features (Sharp side/edges)

Structural Integrity

Decision on Knockdown Vs. Welded

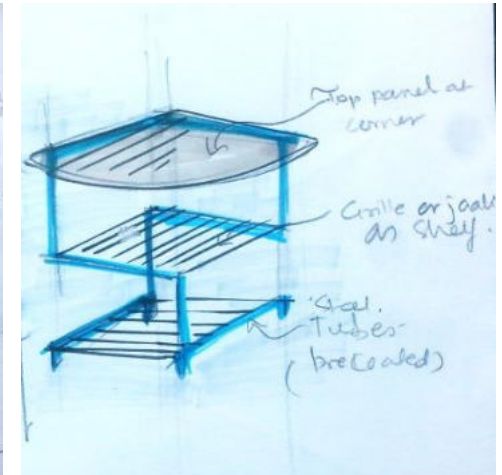
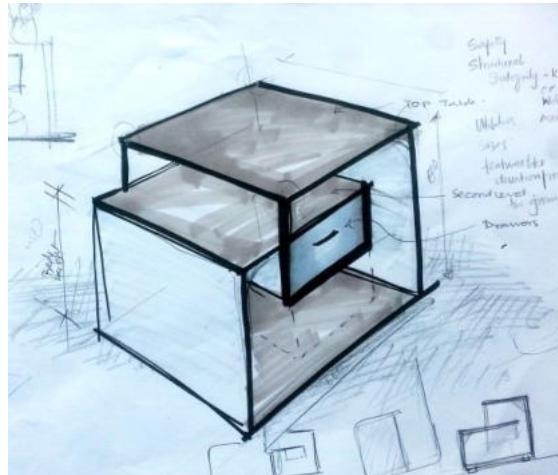
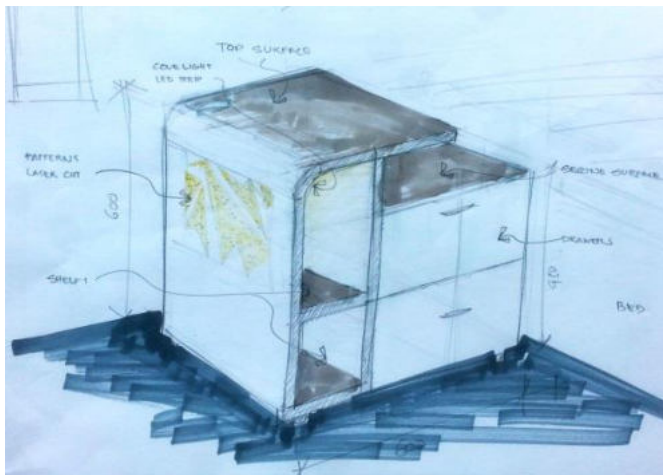
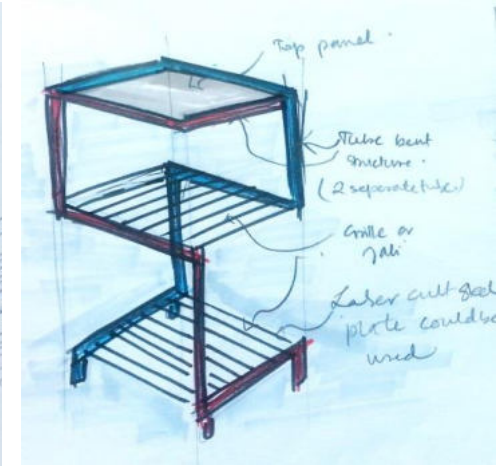
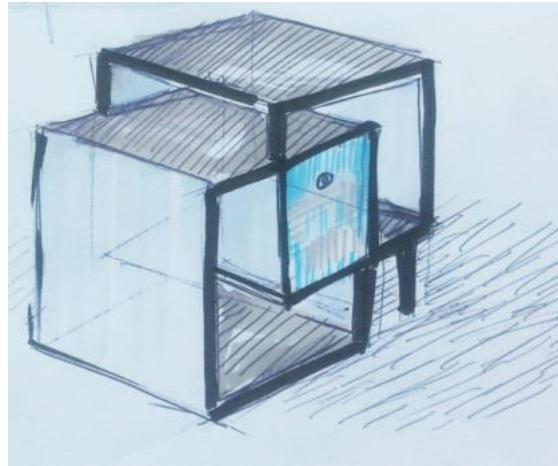
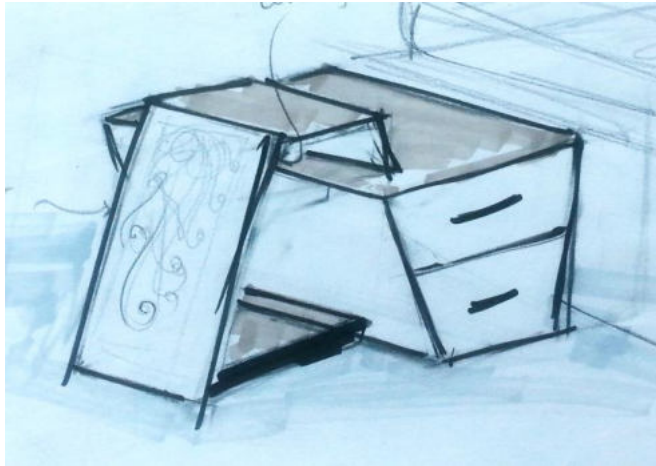
Size/Packaging

Elevation from Ground – Details

Structural details (introduction of features eg. Flanges, stiffeners, corrugation, bends, pimples, perforation for extra stability)

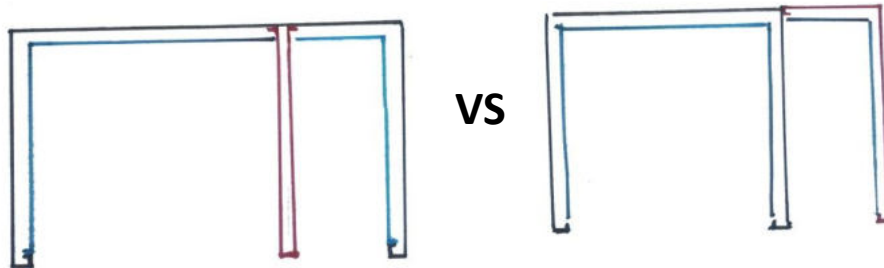
Aesthetic features

Design Assignment (Ideations and discussions)

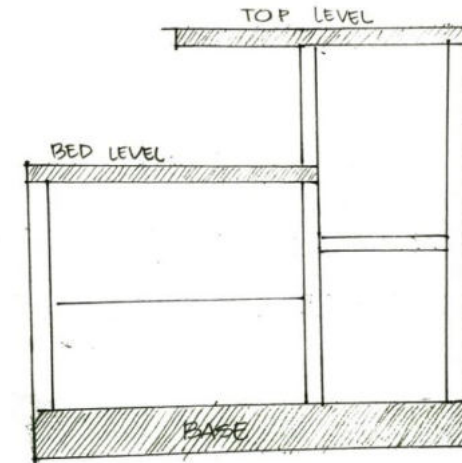


Design Assignment (Decisions taken)

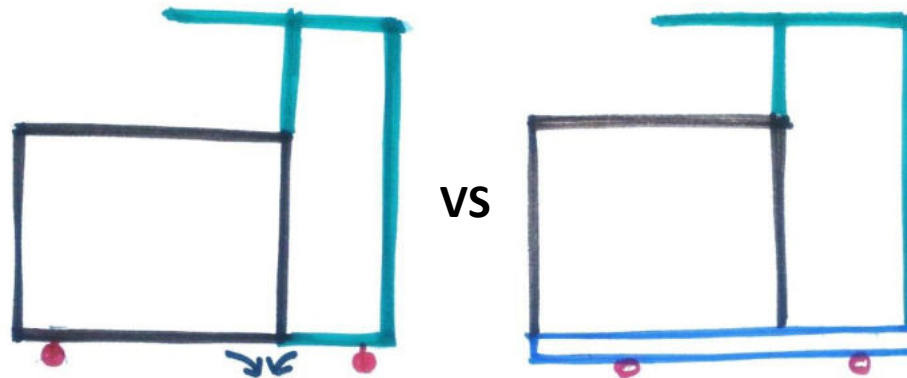
Decision on Panel division



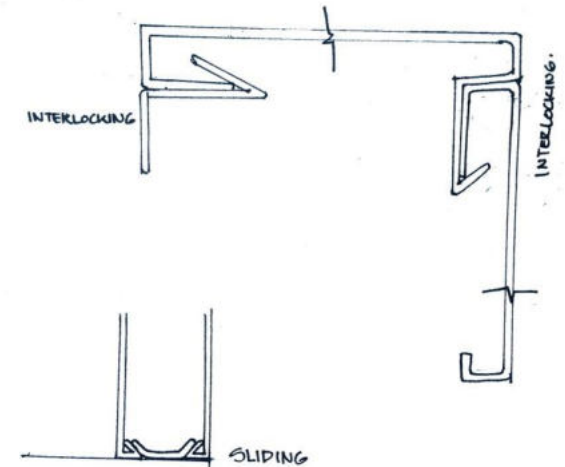
One outer skin and all welded product vs. Knockdown product.



Horizontal members of design Highlighted

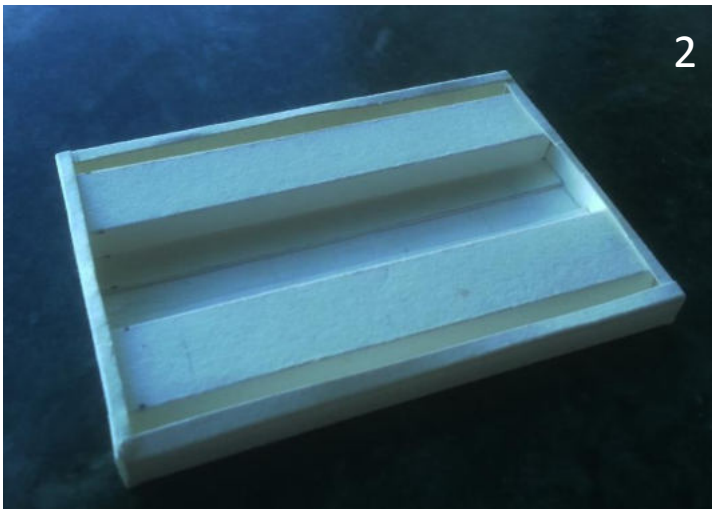
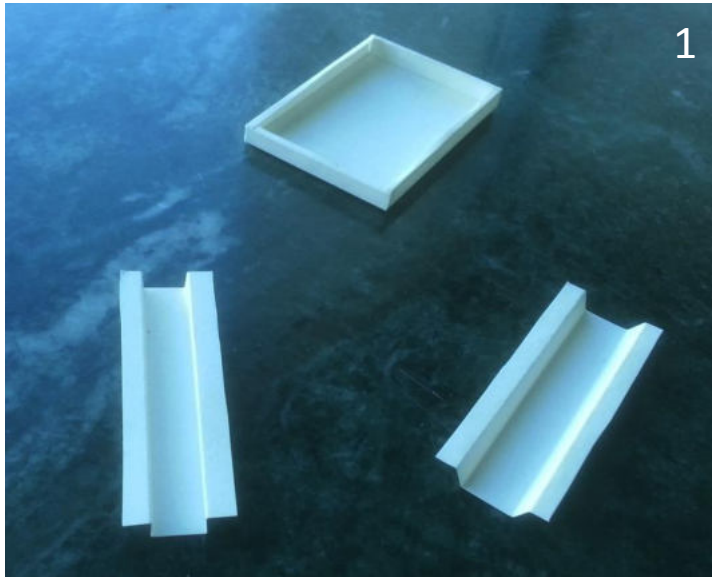


Decision to introduce single base to increase structural stability

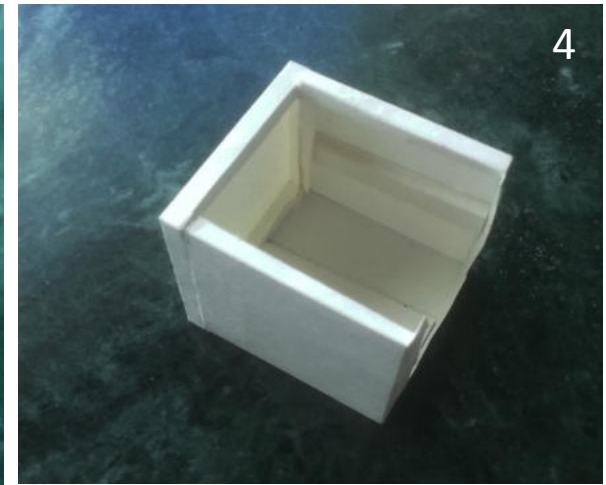
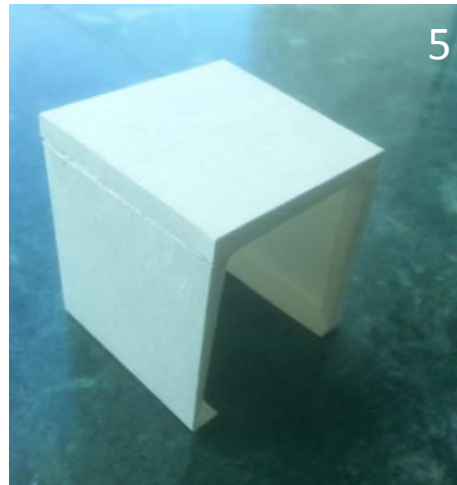
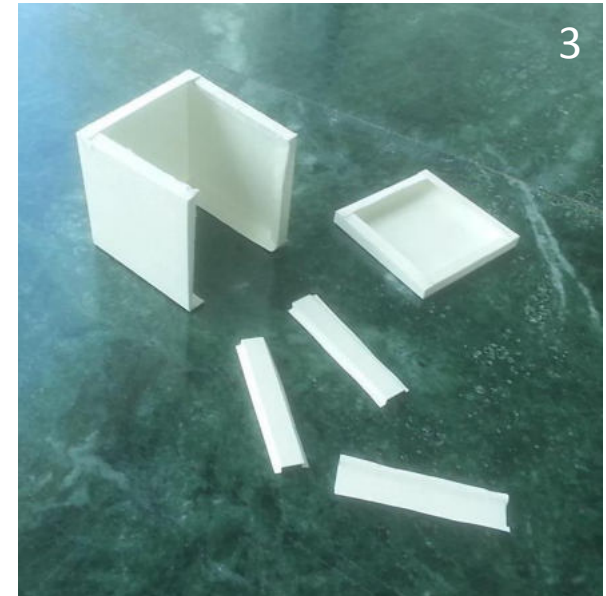


Knockdown product with interlocking and sliding joints

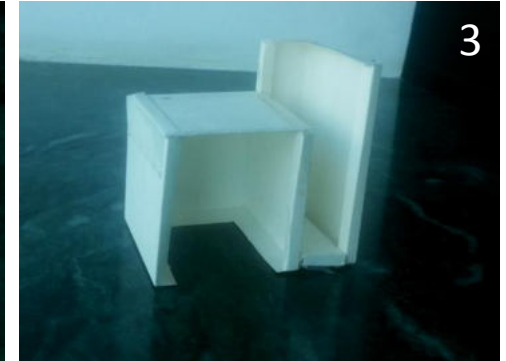
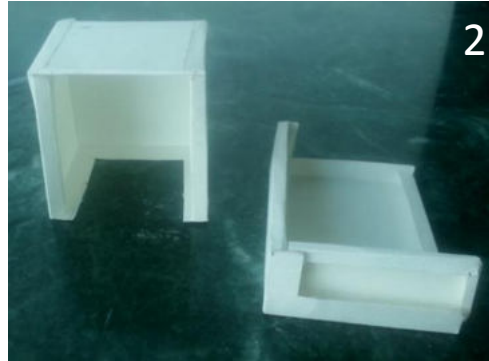
Strengthening of panels (Stiffeners)



1. Bent panel and stiffeners for base
2. Stiffeners spot-welded
3. Drawer case sides, top panel and stiffeners
4. Stiffeners spot welded
5. Top screwed to the body

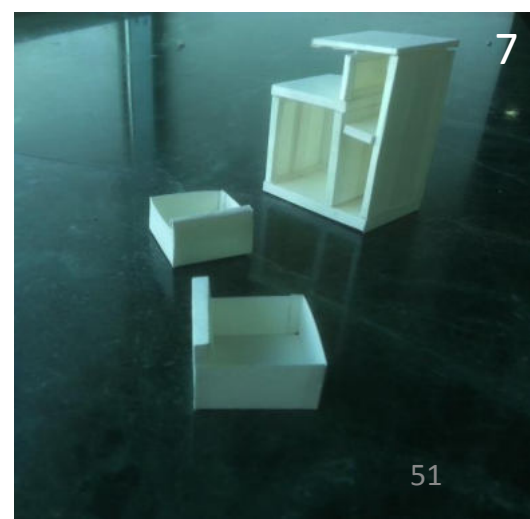
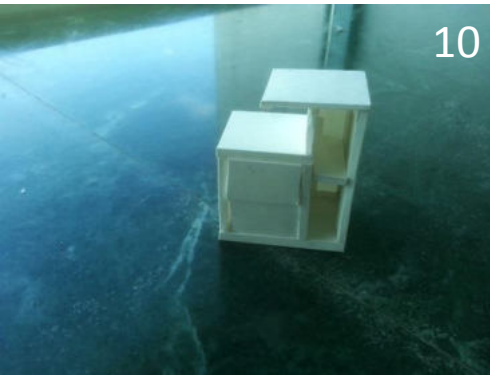
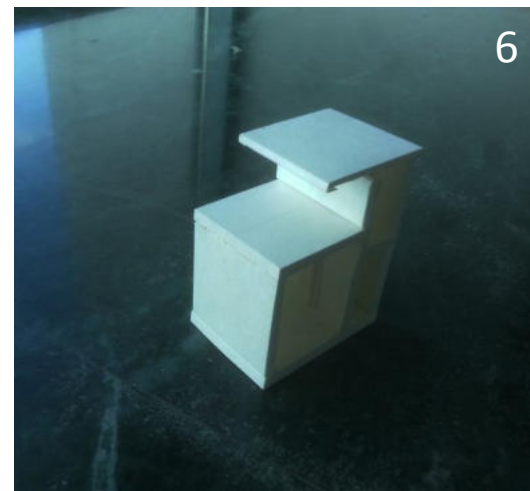
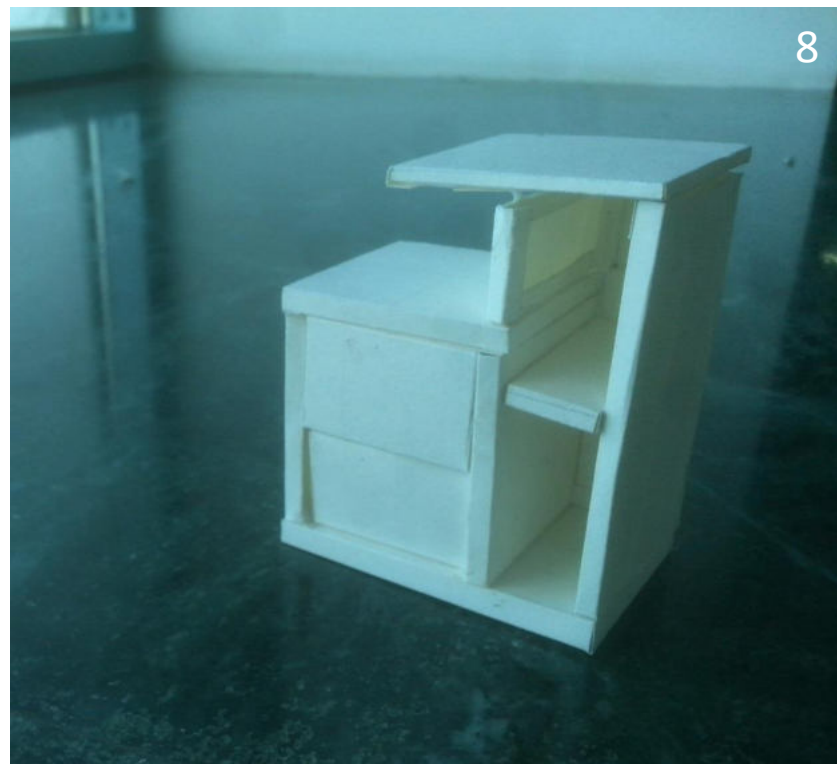
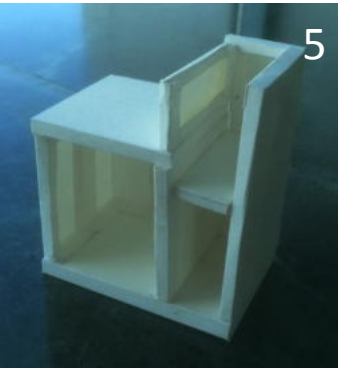
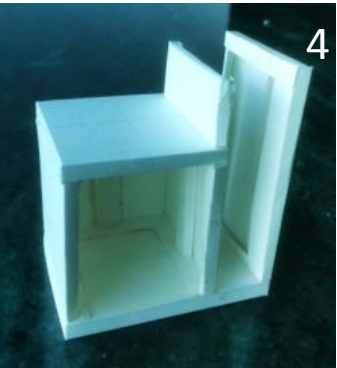
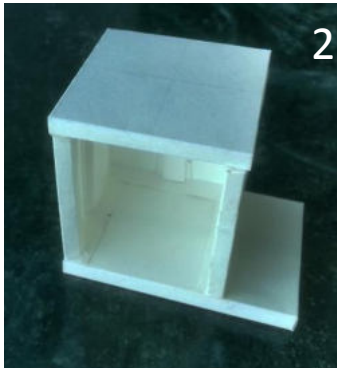


Assembly



Assembly Sequence (Initial):

1. Pieces of the assembly
2. Main pieces (drawer box and side shelf wall)
3. Assembled using snap fit
4. Top side fixed using snap fit
5. Top attached



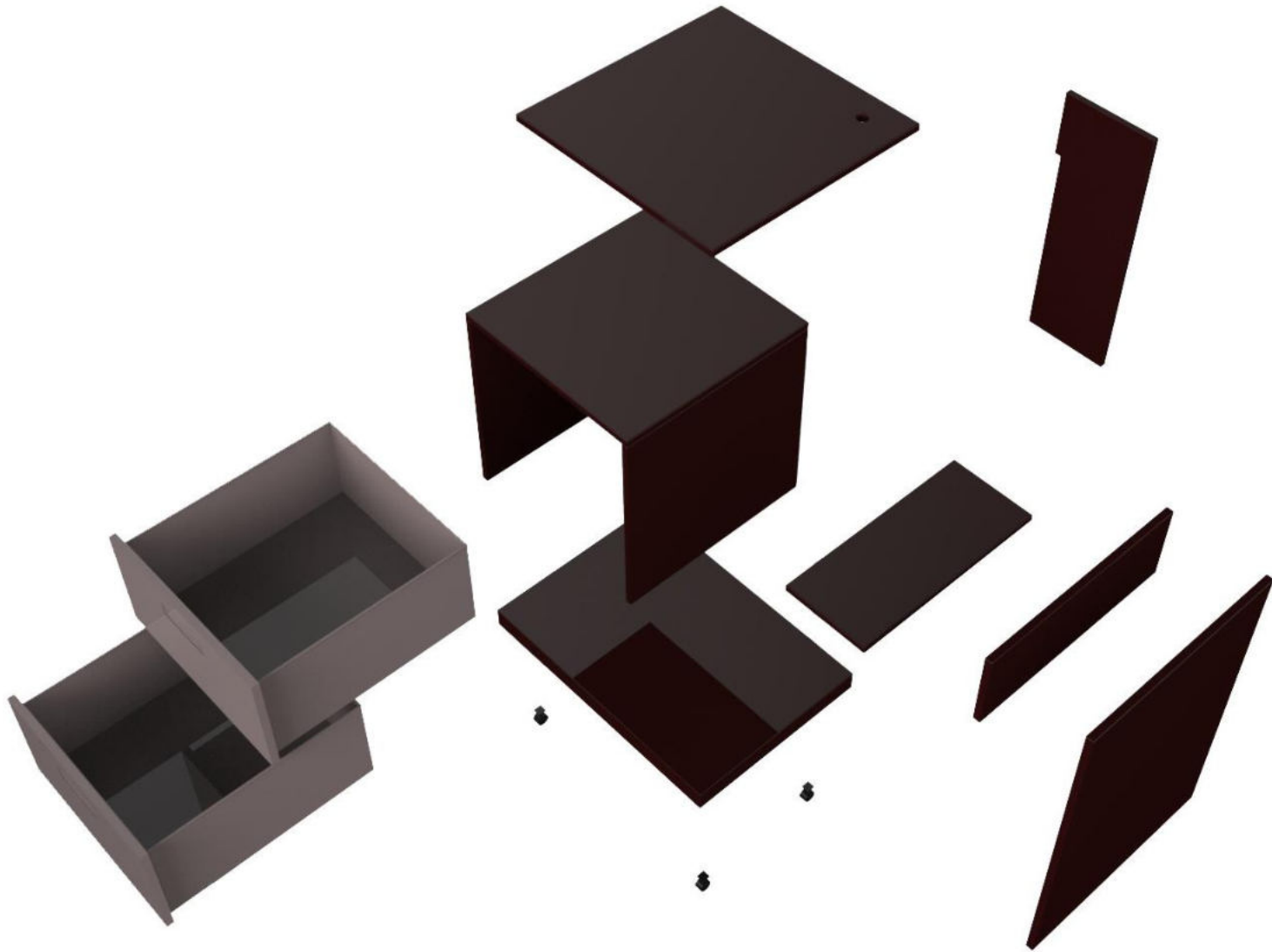
Assembly Sequence (Final):

1. Different pieces of bent sheet panels ready
2. Drawer enclosure unit fixed with base
3. side wall fixed to base
4. upper side wall fixed to drawer enclosure
5. back panel fixed
6. top panel attached
7. Drawers slid in
8. finished assembly
9. back view (horizontal lines enhanced)
10. front view of assembly

Views of assembled Bed-side Table



Exploded View



Color options



Key Learnings

The main objective from this internship was to understand working with sheet metal steel and tubes. In the short duration of 3 weeks I got exposed to:

Working and methodologies followed in corporate design office.

Sheet steel types, working with sheet metal, finishing of sheet metal, various joineries in sheet metal folded pieces.

Stiffening and strengthening of sheet metal.

Working drawings for factory manufacturing.

Knockdown products and assembly guidelines.

Designing of sheet metal furniture and taking key decisions to balance aesthetics, functionality, production and economics.

Conclusions

The 3 weeks of internship at Godrej interior design office gave me some exposure in metal furniture design part. Before the internship I had no exposure or knowledge about metal furnitures or how to work with metal furnitures but in the initial week at Godrej I had to read and do intensive research about the metal furniture workings and designs. This online research and showrooms visits gave me exposure and knowledge about working with sheet steel, different types of steel, processes of steel bending, joining, welding etc. The factory visits were another great opportunity for me to learn industrial process as me coming from architecture background am having no exposure to manufacturing and there I got to know about different processes and their advantages and limitations. Finally in the design part I had to design a simple bed side table since there was very short time for me. I did the concepts and knock down assembly sequence for the product. This was a great learning experience for me as I got some experience and exposure in designing with sheet metal. I am very sure this exposure will help me in carrying out my future projects as I am planning to work on Metal furnitures which have to be knock down. I had really great experience interning at Godrej interior and though my internship duration was short, I learnt many aspects of sheet metal furniture design. The office environment is really supportive and productive and lot of importance is given on keeping employees stress free and productive.

Contacts

People I mainly interacted with:

Mr. Ega Venkatesh urulu – Design Head
Ms. Vaishali Shah – Design lead
Mr. Nirav Shah – Project Manager
Ms. Nikhil – HR Manager
Mr. Aniket Patil – Manufacturing Manager
Mr. Kushal tejpai – Site Engineer

Address:

Second Floor, Plant 13A,
Godrej & Boyce Manufacturing Company Limited
Pirojshanagar, Vikhroli, Mumbai 400 079, India

Tel: +91-22-6796 5656 / 5959
+91-22-6796 1700 / 1800

Email: interio@godrej.com

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