Ribbon Complex

Ji Li

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of
Master of Architecture
in
Architecture.

Steven R. Thompson (Committee Chair)
William U. Galloway III
Mehdi Setareh

Dec. 7th 2011
Blacksburg, VA

Keywords: architecture, ribbon, panel folding

Ribbon Complex

Ji Li

Abstract

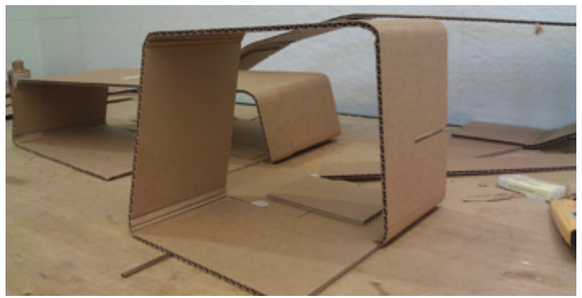
This thesis is a series of experiments performed on how ribbon-like bands of material can be folded to generate special volumes that can accommodate the functional aspects of a building program.

Content

The ribbon

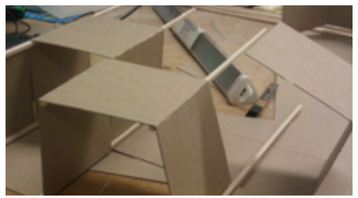
This thesis seeks to create architectural spaces with a single element, or combine the disciplined elements as much as possible, a certain element should be used to distribute the spaces with functional demands, construct the roofs and floors, and enclose the spaces.

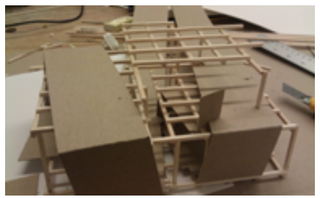
This element should satisfy all these functional requirements. This idea implies not points or lines but planes.

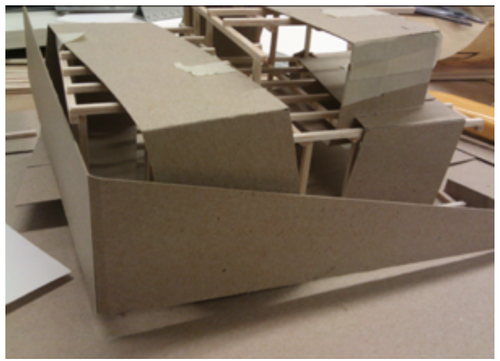


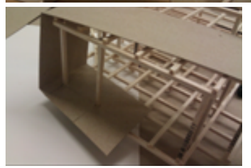
Some experiments on how a ribbon can work as part of an architecture language.

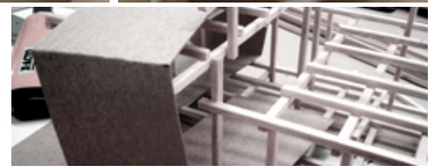
The page 1 model had an extrorinary cantilever which possibly required being built as a stressed-skin panel, similar to aircraft wings.
The supporting fram of the page 2 model scheme interfered with the ribbon syntax.
These experiments revealed that it was necessary to return to the very basic action of a ribbon: Folding



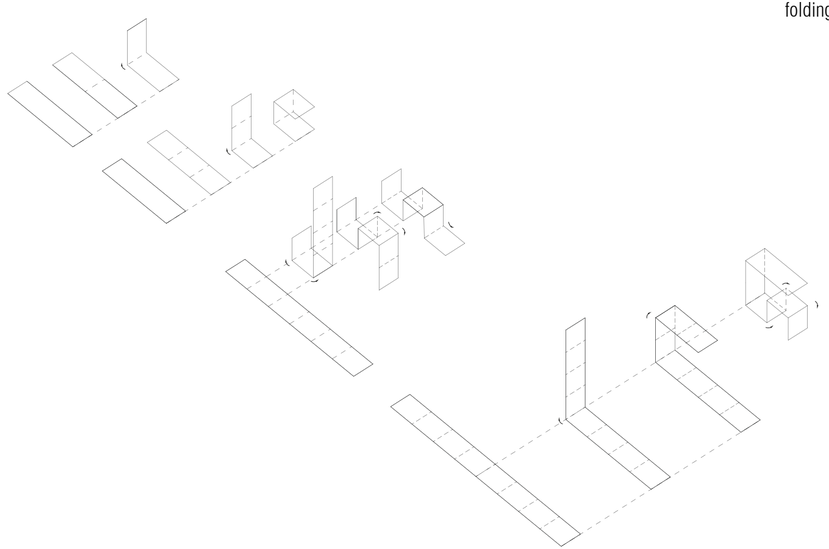








Folding

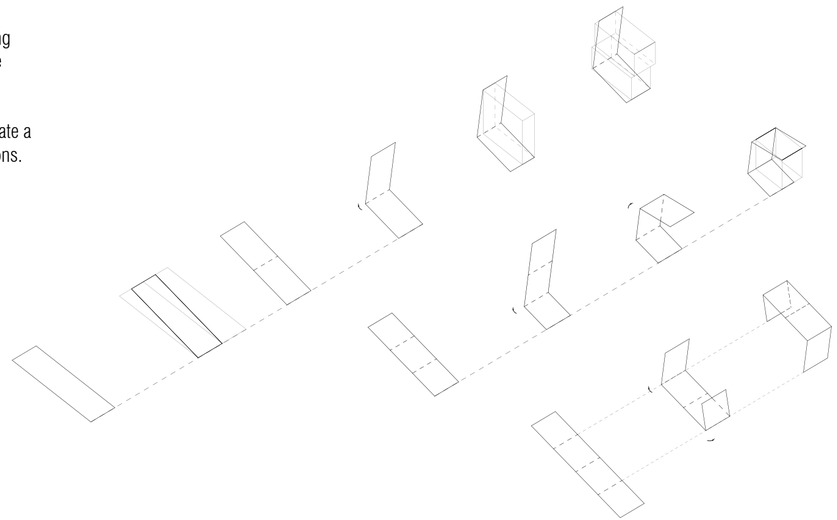


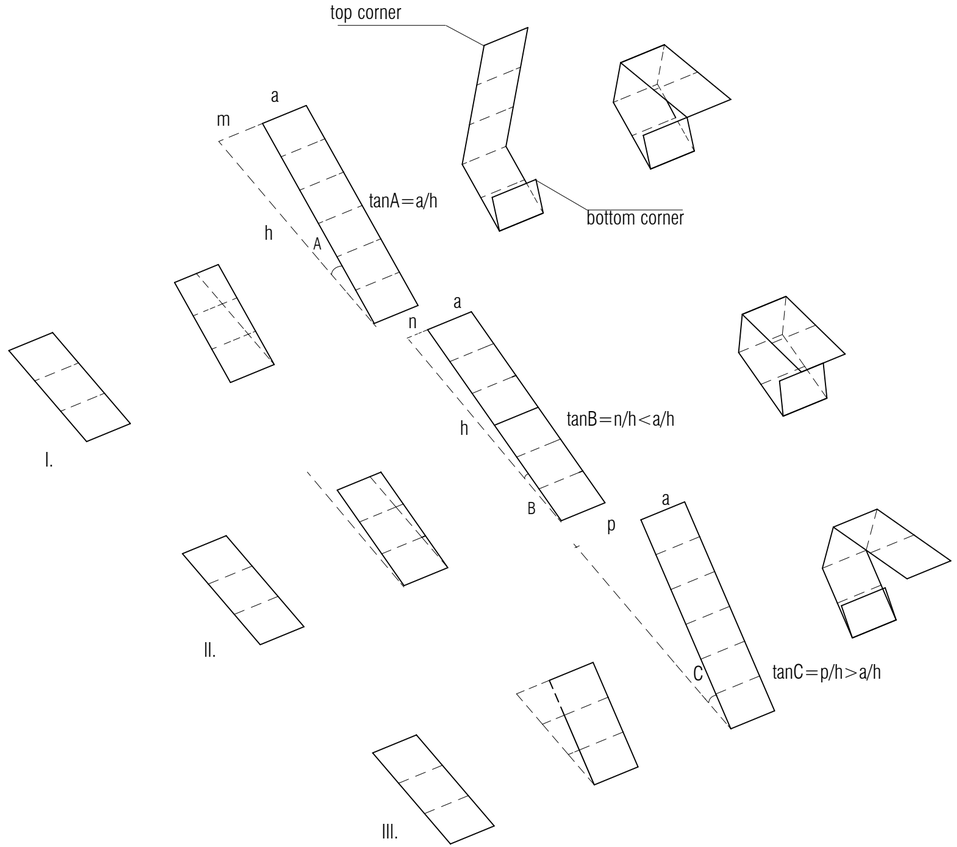
Start from a single plate=ribbon. It can be folded to form an envelope/half-envelope without full enclosure of a construction.

The folding is limited to a single section plane since the folding lines are perpendicular to the edge of ribbons.

If an inclination is given, the forms of folding and possible enclosing methods have to be changed.

More foldings are to be performed to generate a larger envelope with more continuous ribbons.





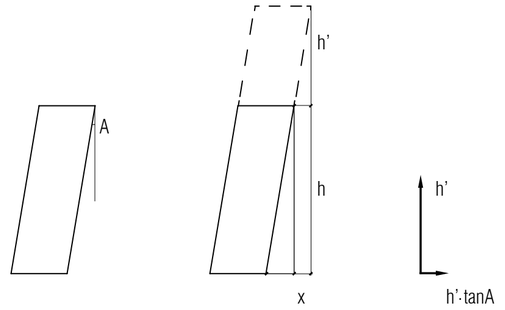
Here is an experiment on how ribbon band ends connect after folding.

Height of the ribbon (h)
Width of the ribbon (a)

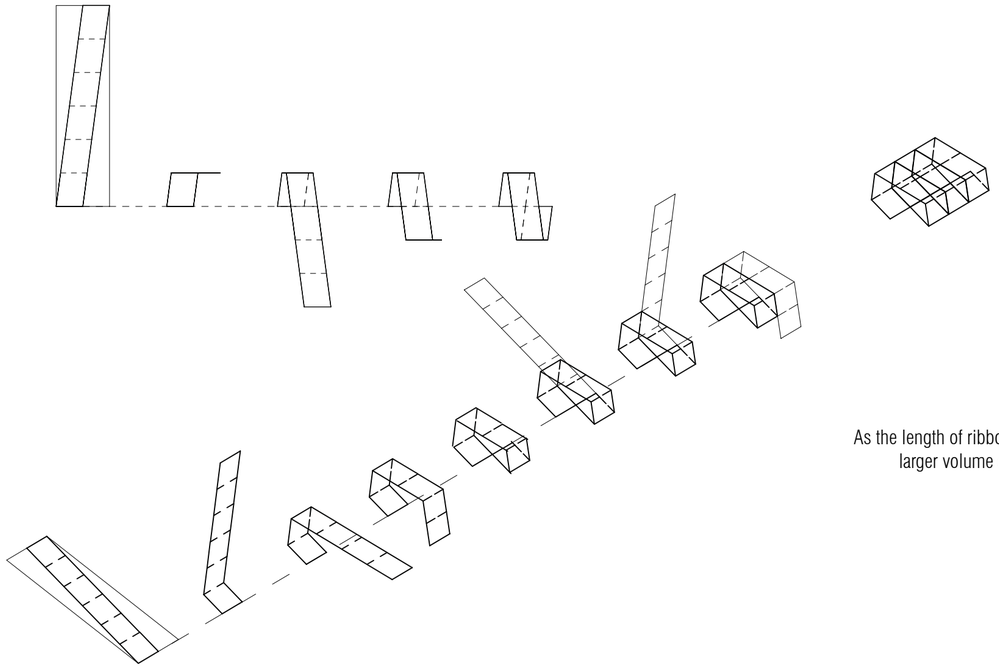
In case I, if length “a” shifts in the same dimension (m=a), the ribbon panel can connect the top corner to the bottom corner.

At this time, tanA=m/l=a/l

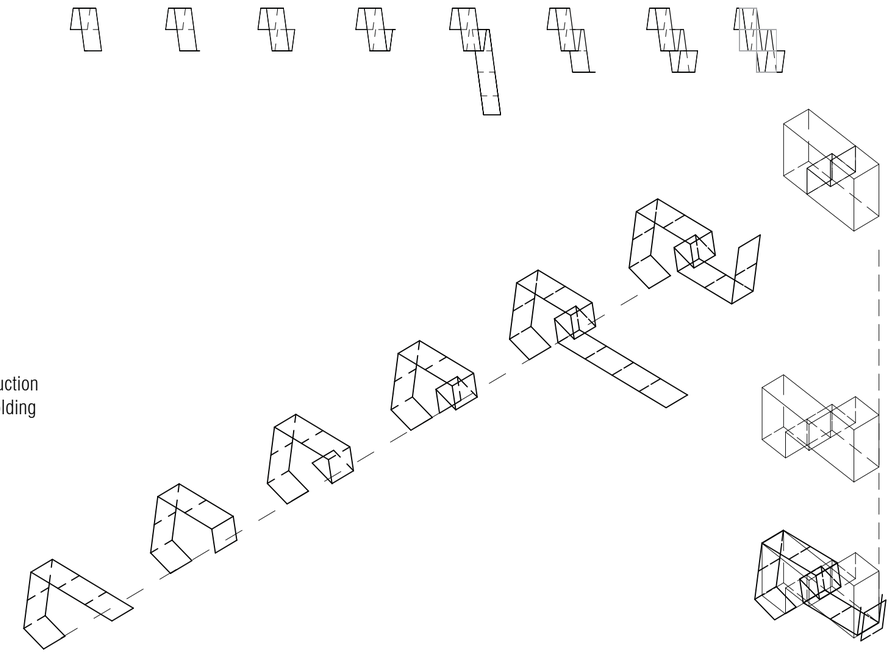
In other cases (II, III), the dimensions that “a” shifts are not the same as itself (n<a, p>a). The top and bottom corners can not connect.



If the inclined ribbon increases height by h’, the edge shift “x” will be h’ · tanA.



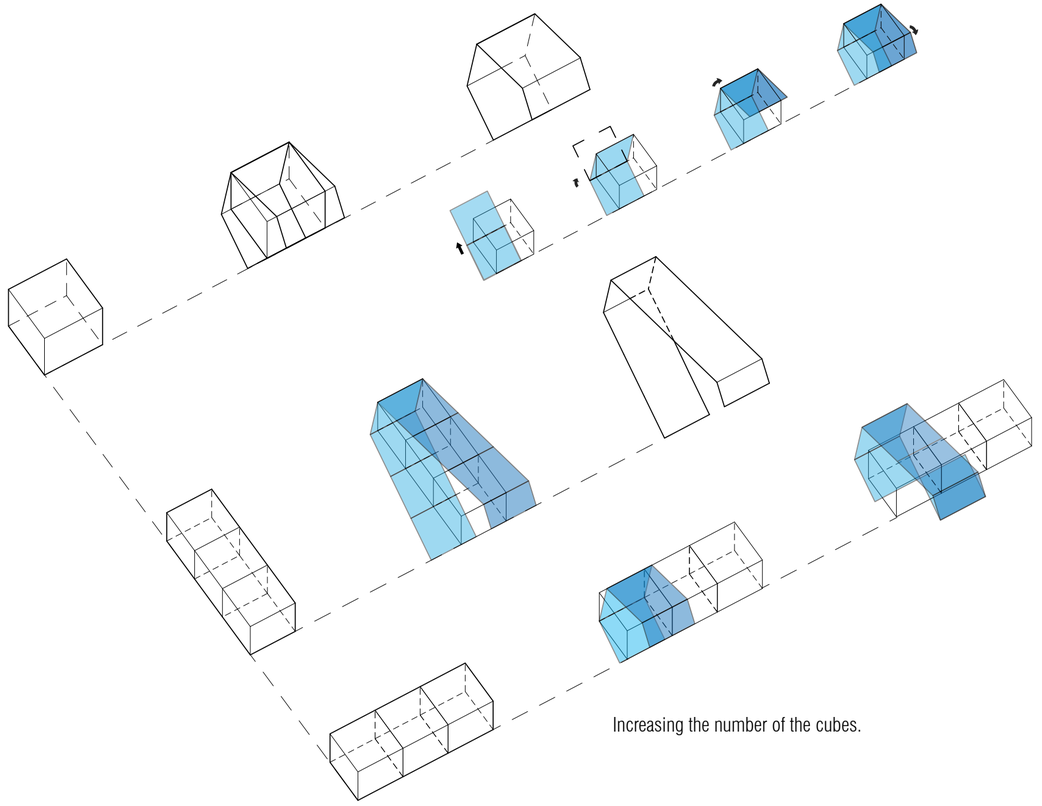
As the length of ribbon is increased, a larger volume can be enclosed.



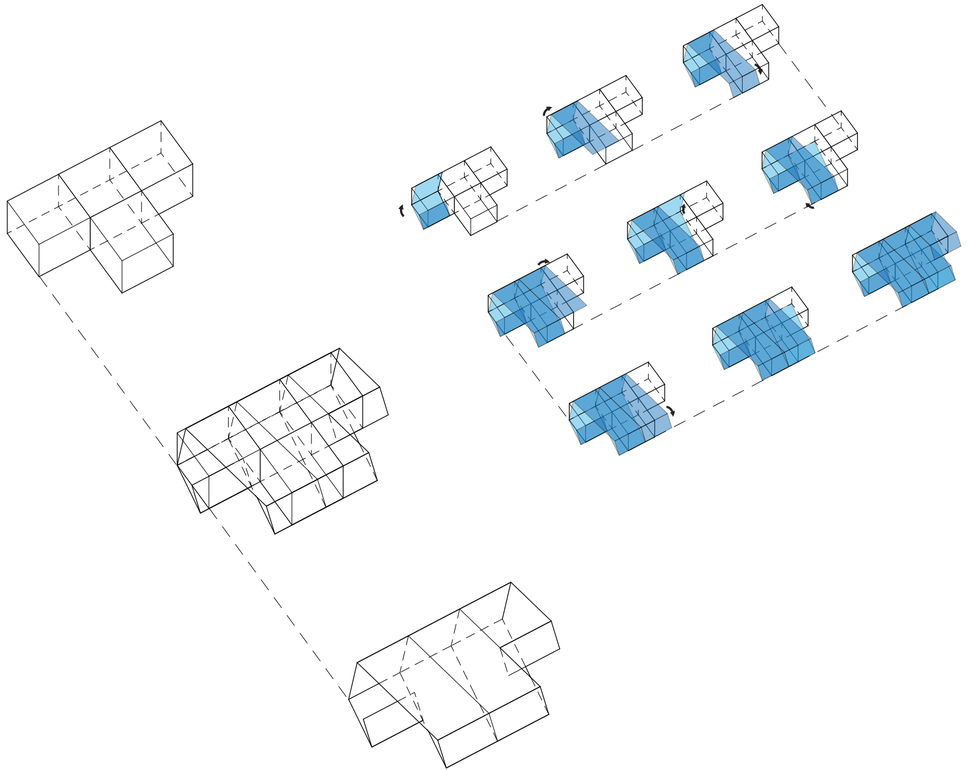
It is possible to create two-storey construction by folding a single ribbon with various folding positions and directions.

Wrap a cube

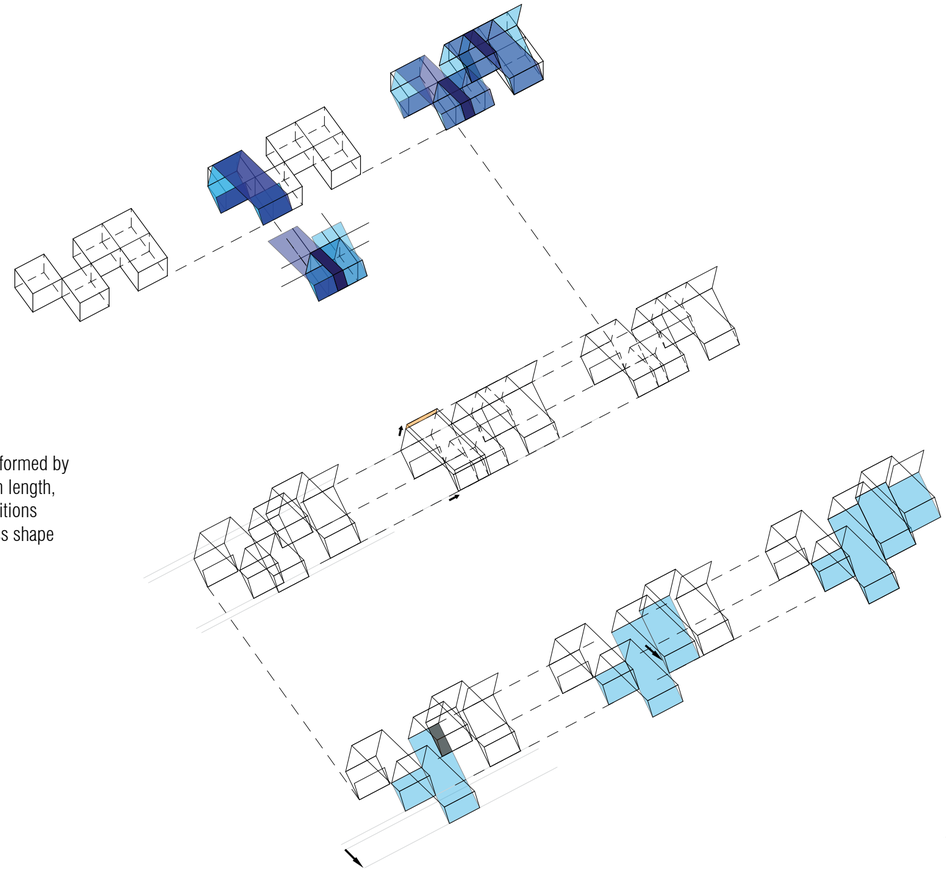
In this case, cubic spaces provide basic volumes representing the function distributions and different blocks of a building.

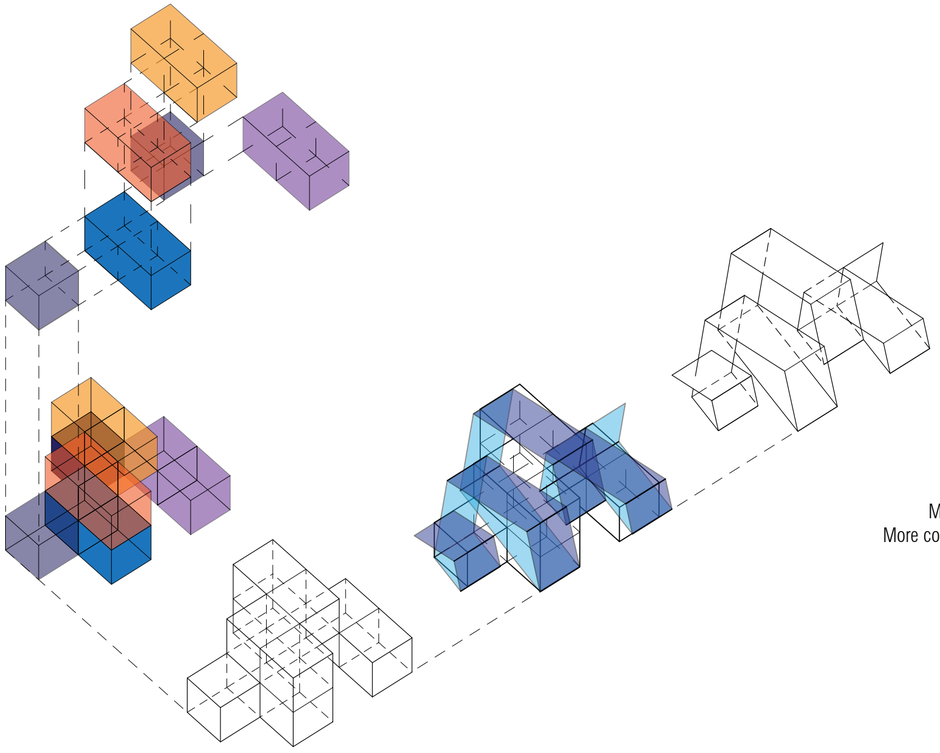


Increasing the number of the cubes.



Modifications are performed by increasing the ribbon length, changing folding positions to produce a seamless shape without overlaps.





More blocks added.
More foldings performed.
More complex shape generated.

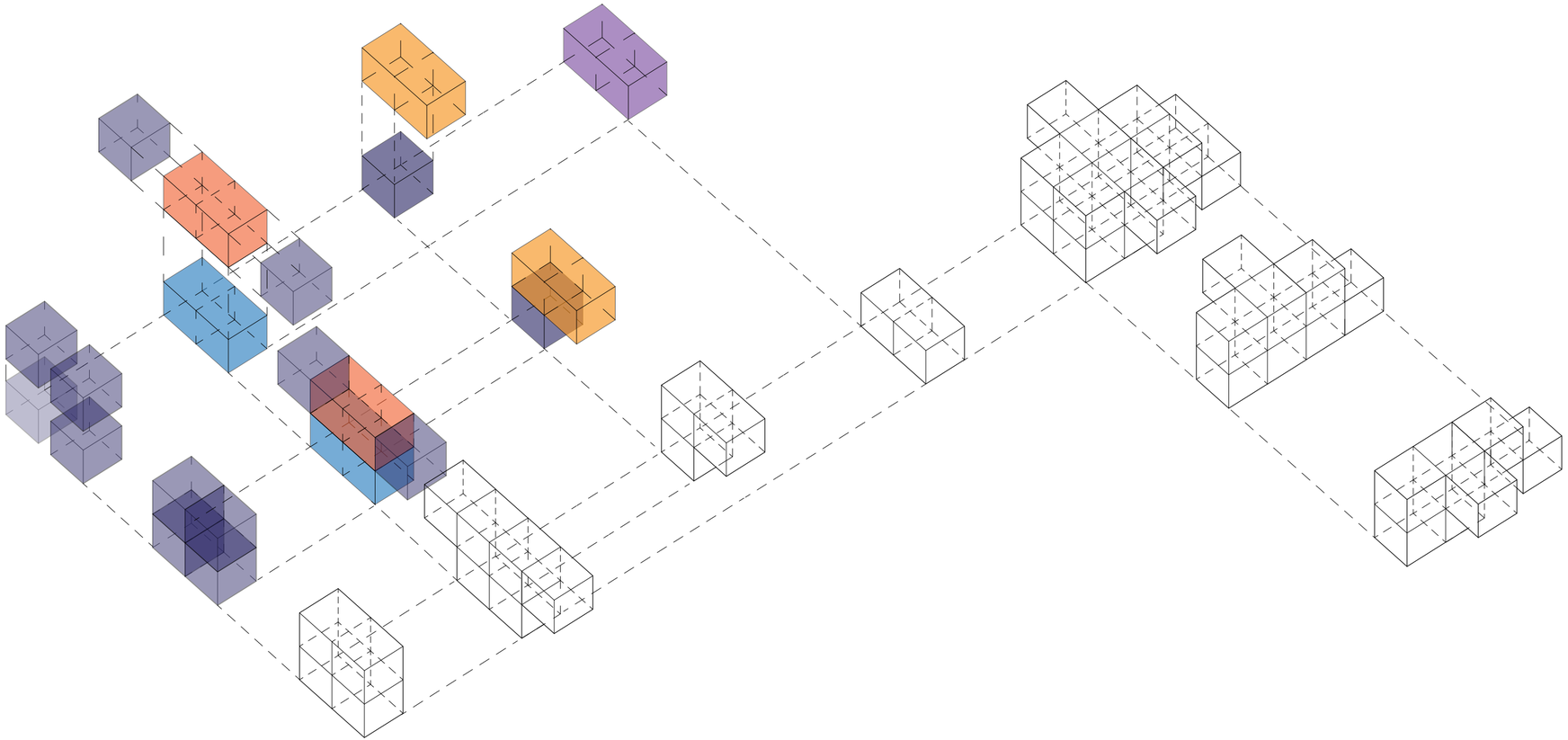
The project

This project uses ribbons, based on the folding concept discussed in the previous pages, to wrap functional spaces. A gallery/pavillion is used for this purpose.

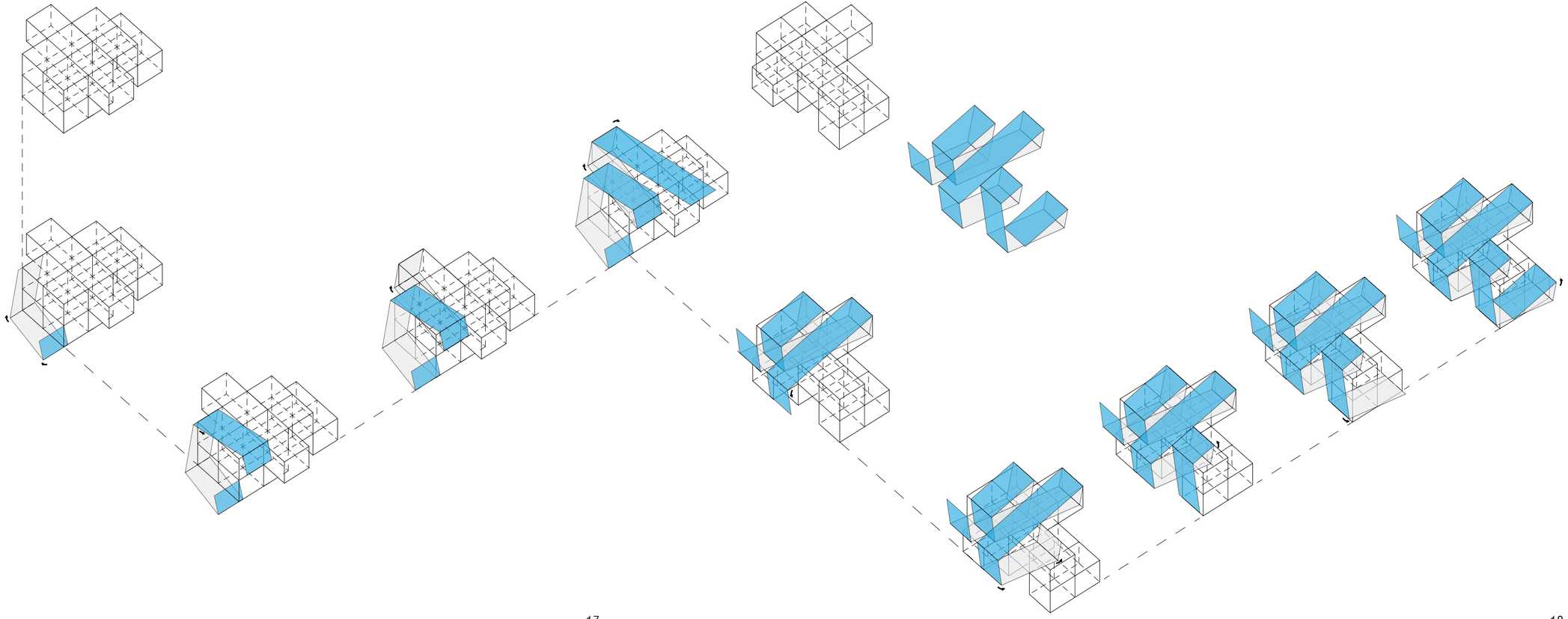
Exhibiting area is to be emphasized and more walls that needed for painting exhibits than typical buildings.

Ribbon= 15’ width / 3’ width stripe mdule by 5 counts
tan A=1/6

Different areas for the gallery are represented by cube groups. The next step is to assemble them into an entity and wrap it with continuous ribbons.



Wrapping the cube complex
from a bottom starting point
with continuous ribbon



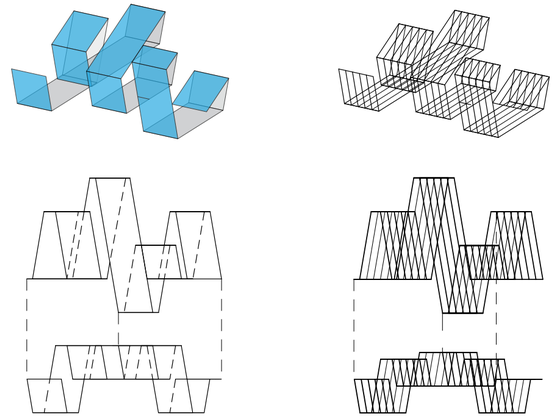
Ribbon modifications

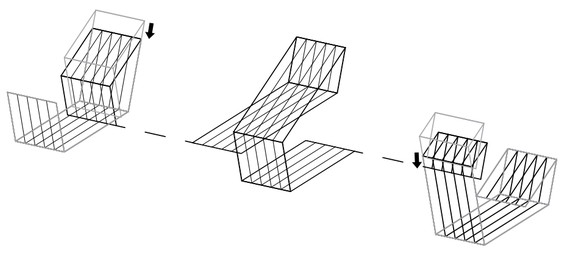
The main shape of the ribbon complex has been generated.

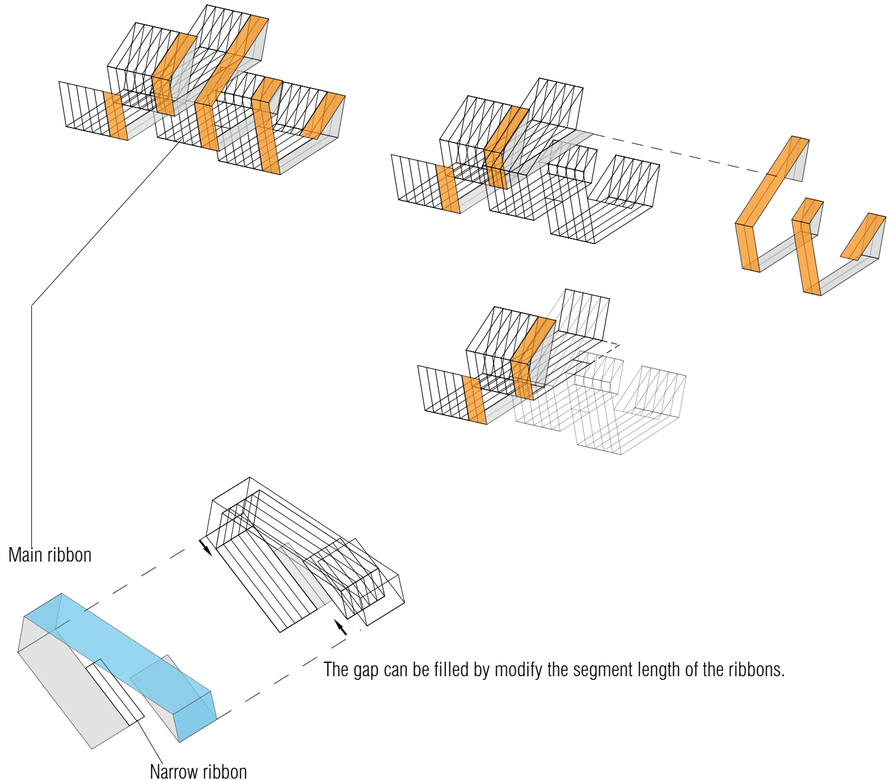
The next step is to refine the ribbon and bring in the area separation, structure consideration and finishes.

* To avoid overlappings as much as possible for the purpose of the ribbon forms.
* If two sections of ribbon meet each other along the edge other than the folding lines, the gap between the modules should be filled.

Height adjustments





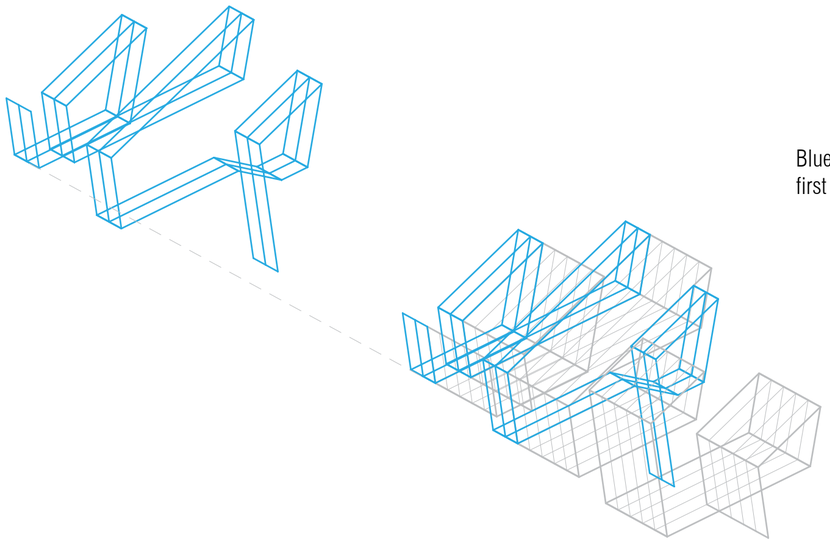


Vertical connection

A narrower ribbon with double 3’ width ribbon stripe (3’x2) is brought in to act as addition to the main structure.

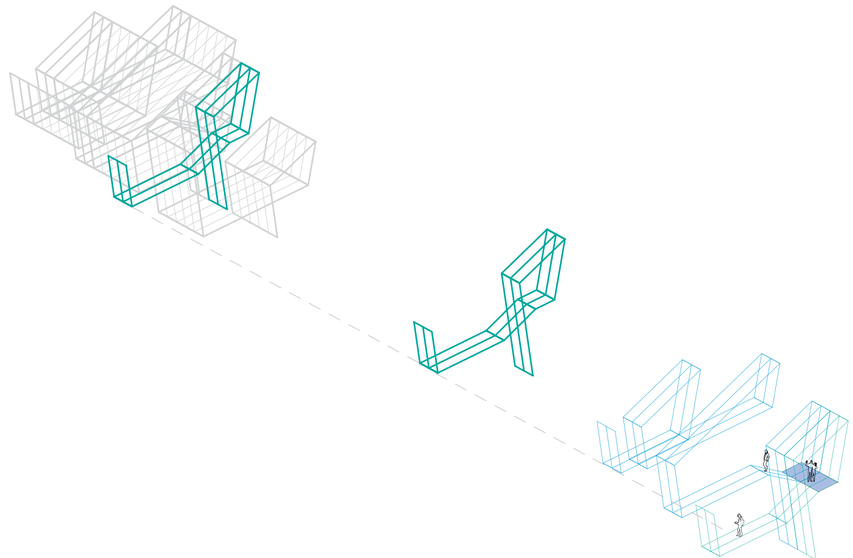
It produces enclosure and the vertical connection between the first and second floor can be used to accommodate the stair.

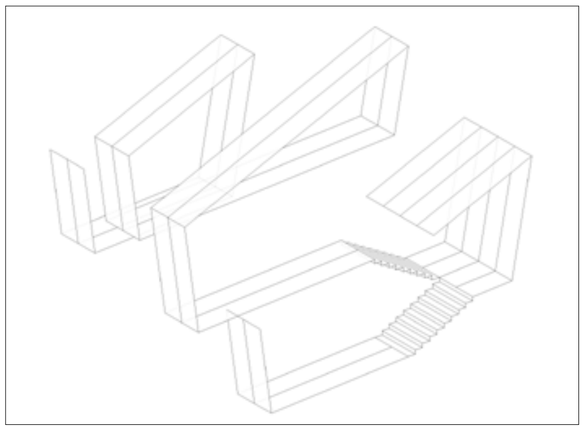
Main parts are modified to reduce the gap between the narrow ribbon addition and itself.

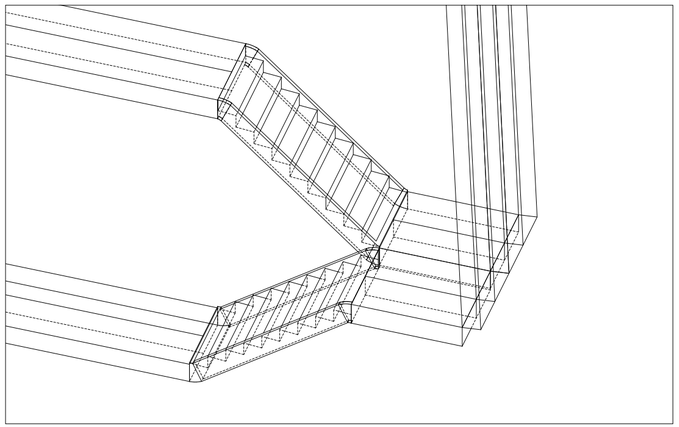


Blue ribbon carries the
first section (to the second floor) of the stair

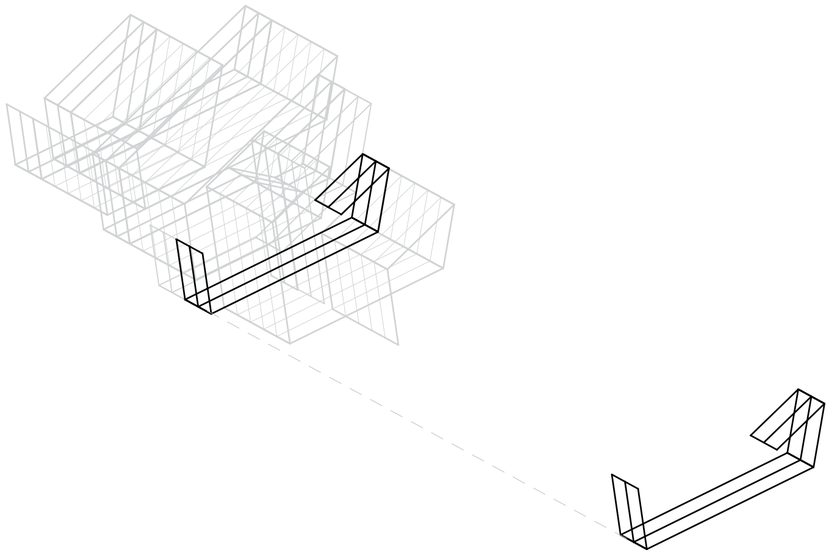
Green ribbon carries the second
section
(to ground) of the stair



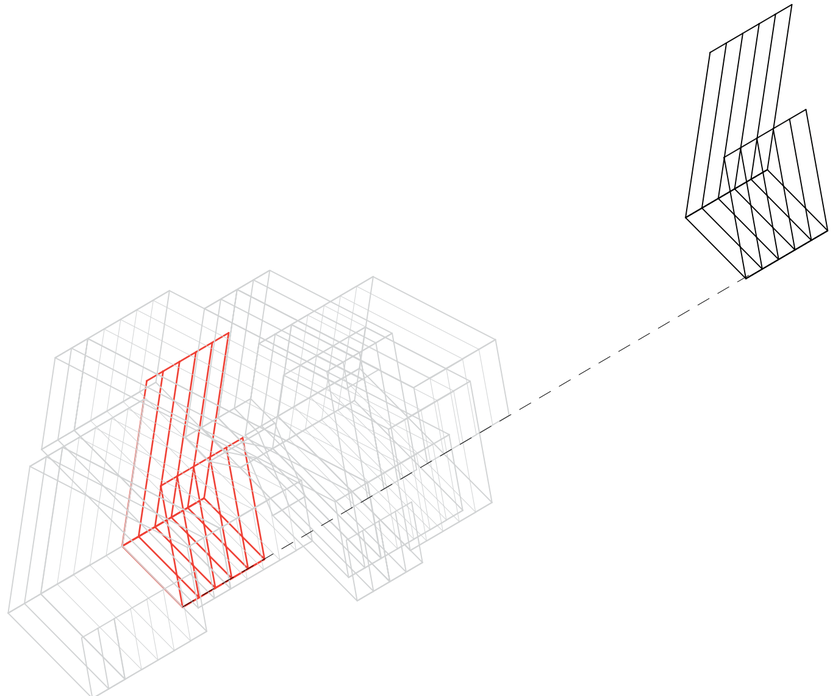


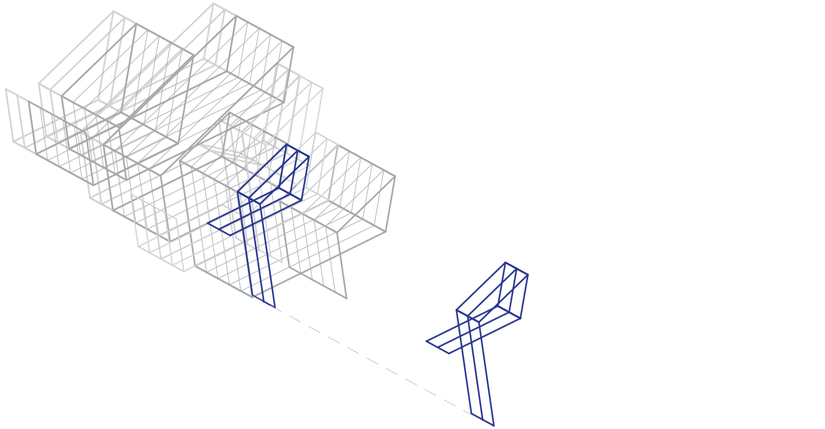


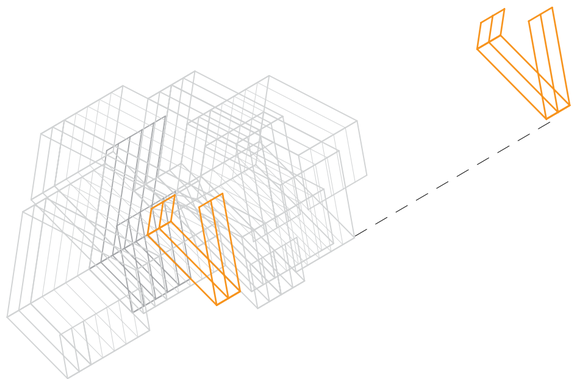
Stairs



Other additional narrow ribbons.

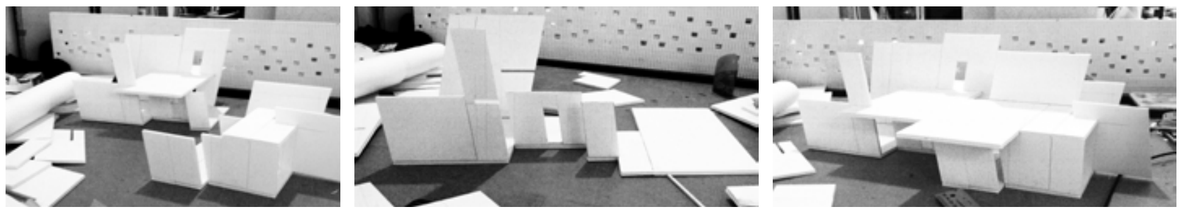






Thickness

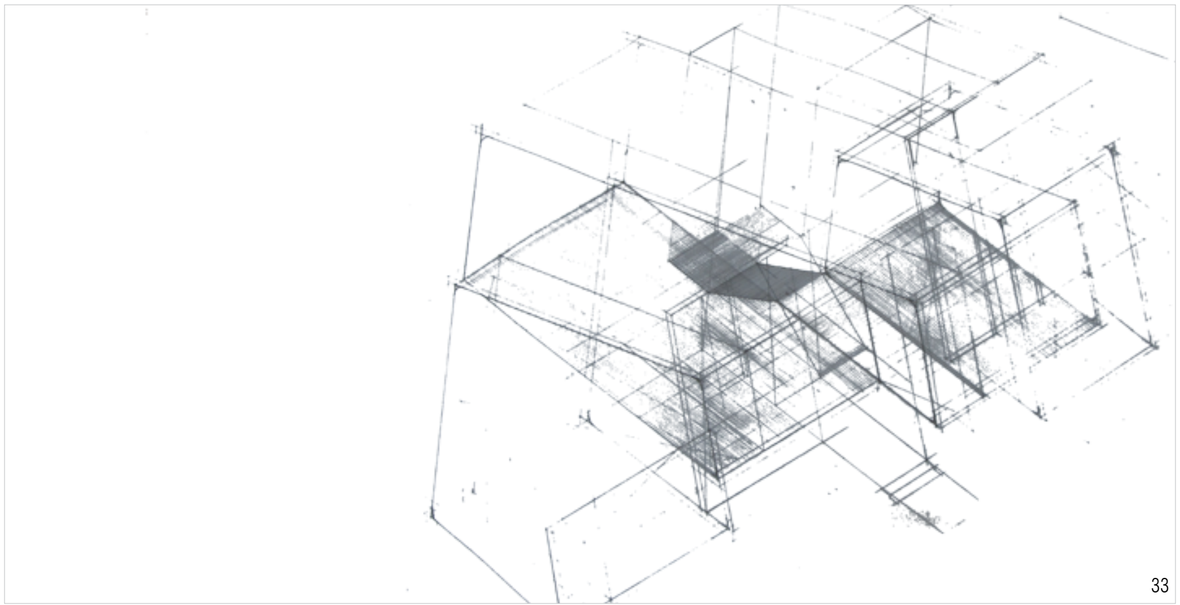
Ribbon s have consistant properties throught their lengths.Therefore, Structural Insulated Panels (SIP) can be used as walls, floors and roofs are used in this project. Reinforcements along the edge of the ribbon sections are required.

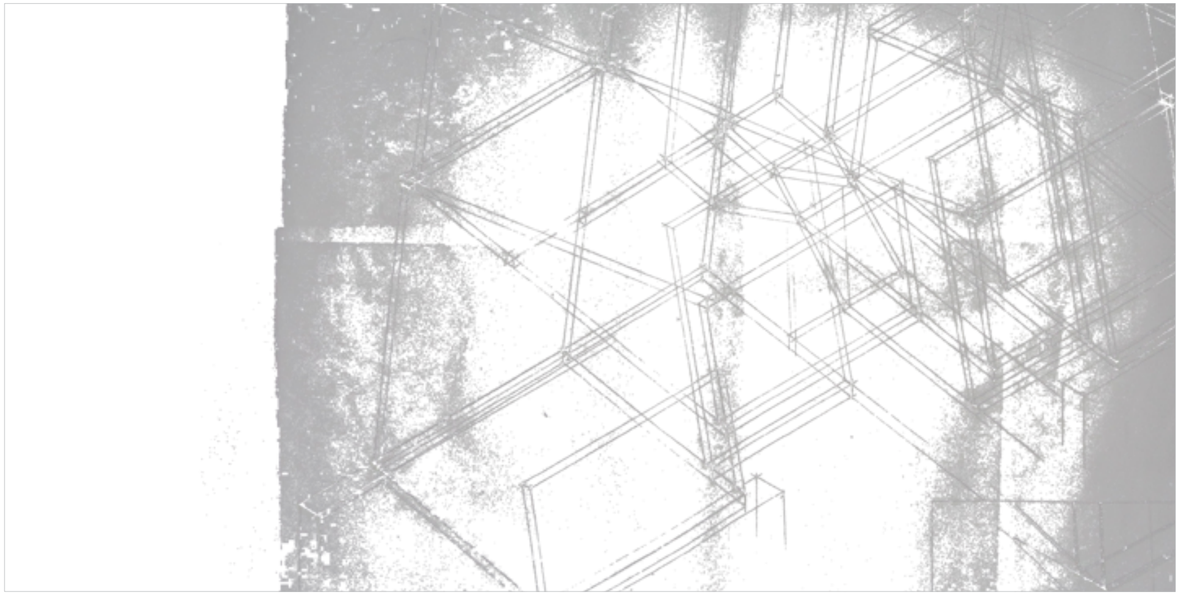


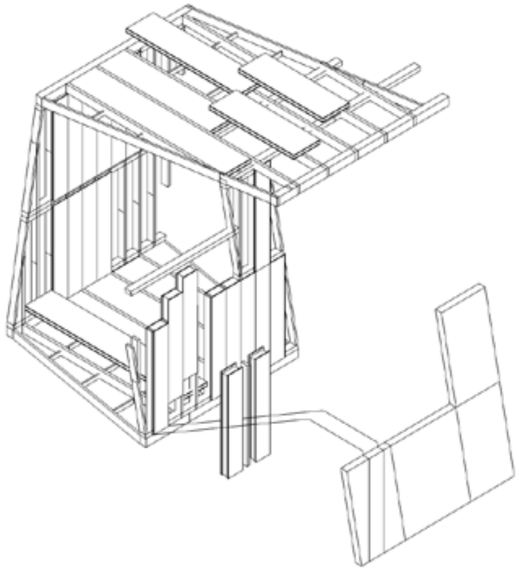
A physical experiment of ribbon complex with thickness.

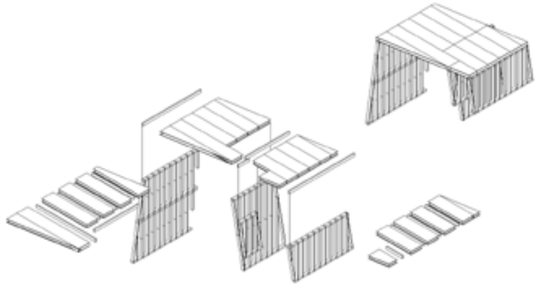
Assumptions with thickened ribbon panels

Drafts on the ribbon complex with thickness

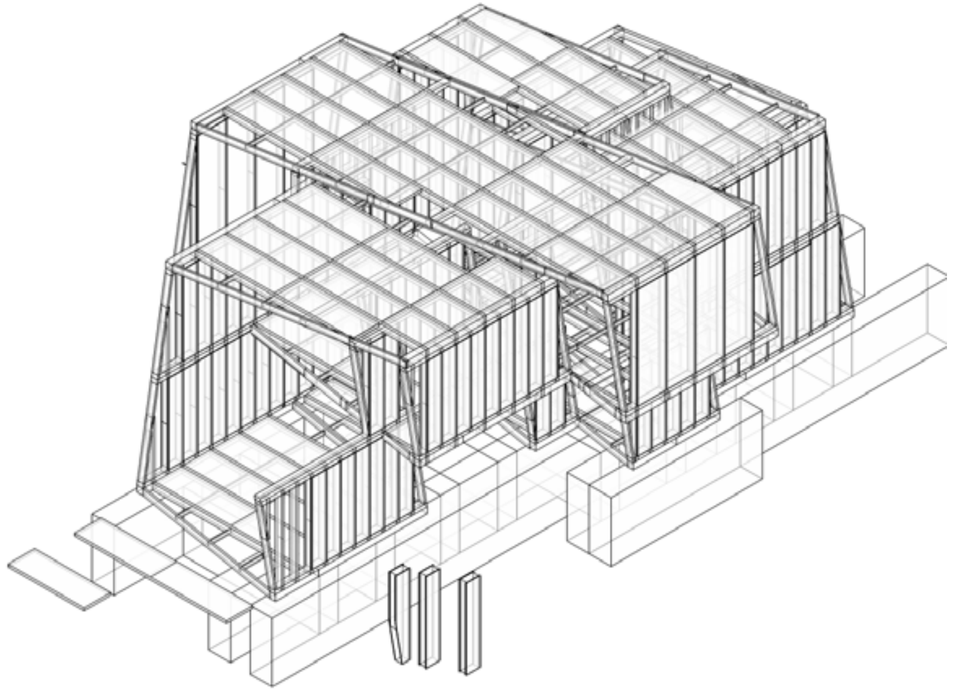


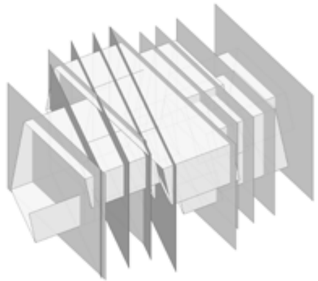




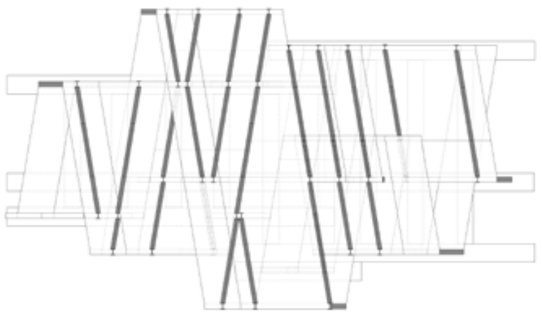


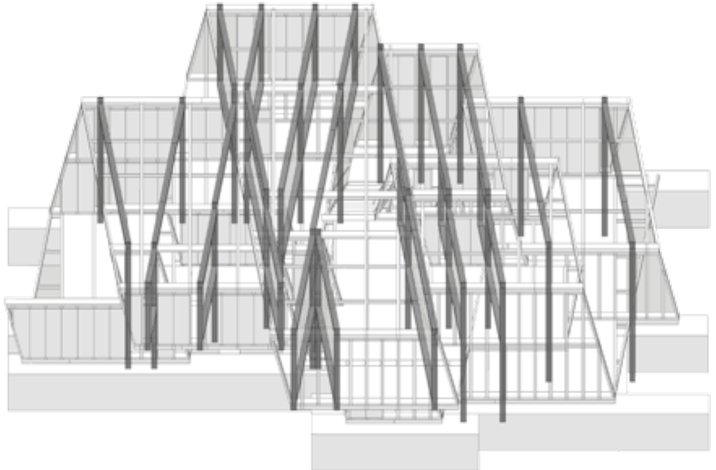
These images show how Structural Insulated Panels (SIP) can be put together to form the ribbon foldings. Steel members are added to provide the lateral stability to the structure.

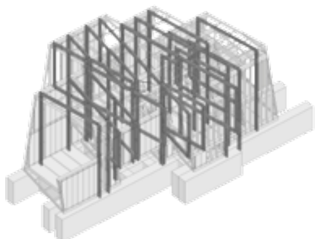


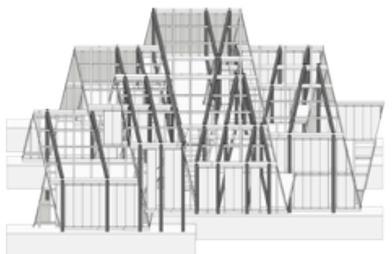


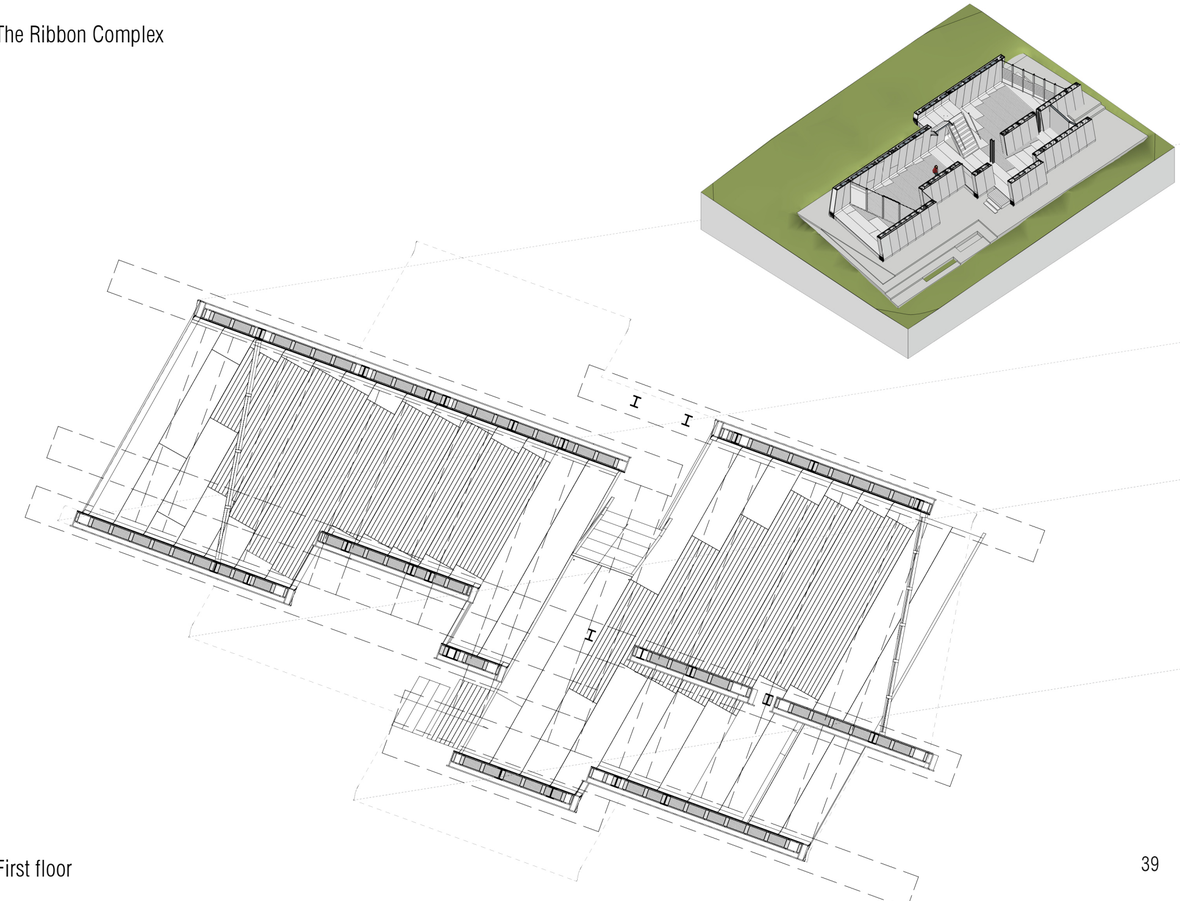
Based on the position of the vertical ribbon panels, steel sections were added to form moment frames to provide lateral stability against wind or earthquake loads.



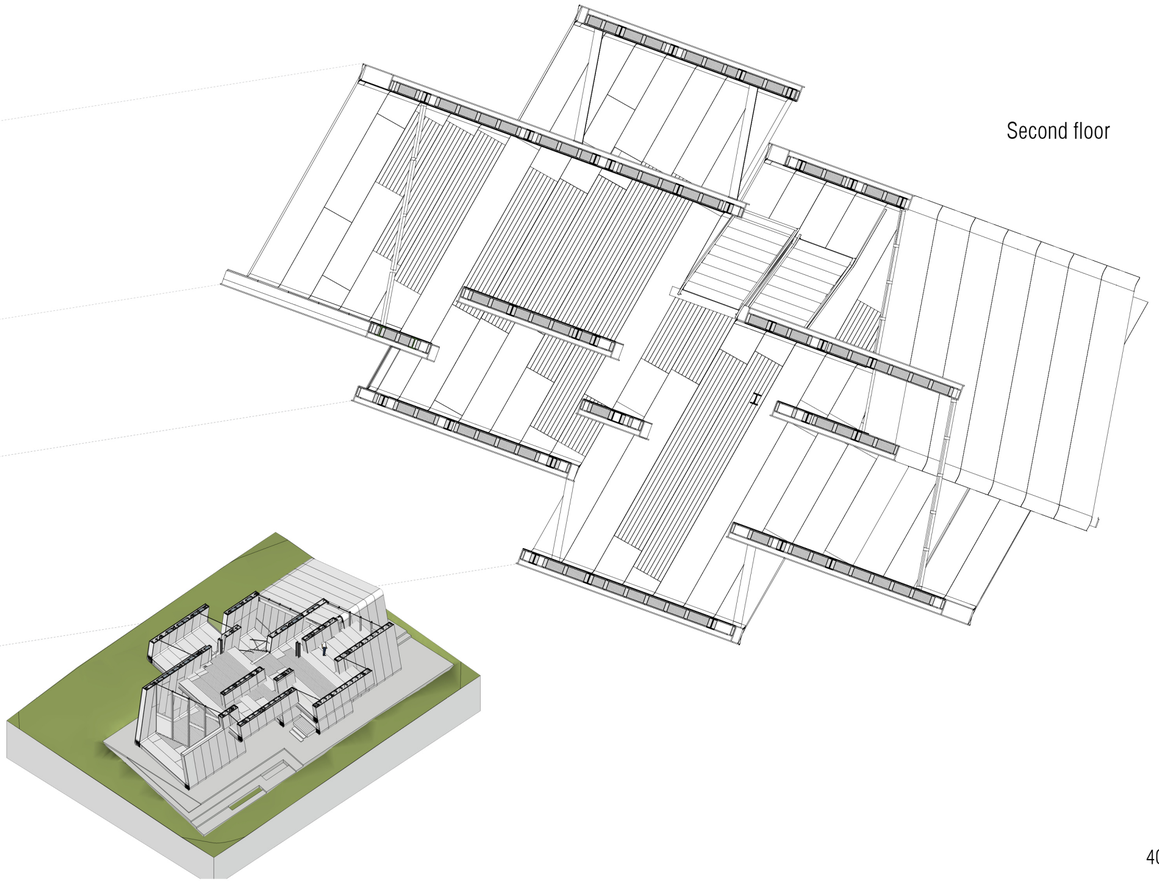




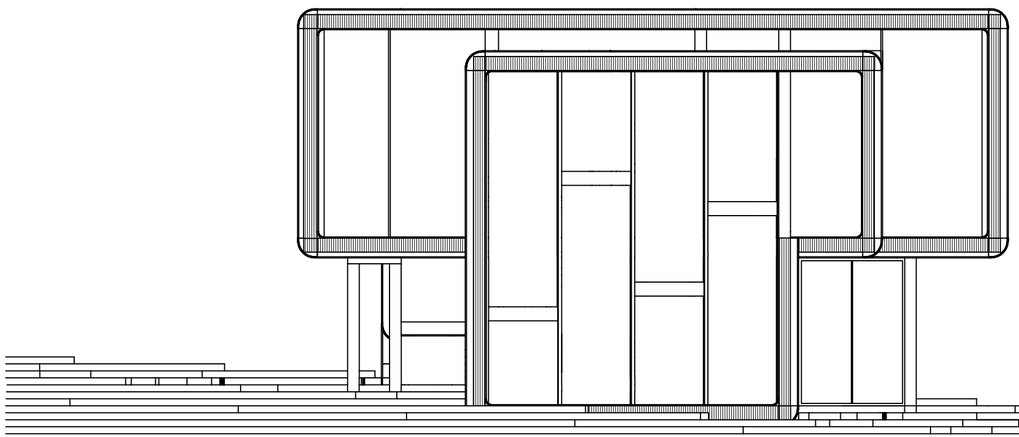




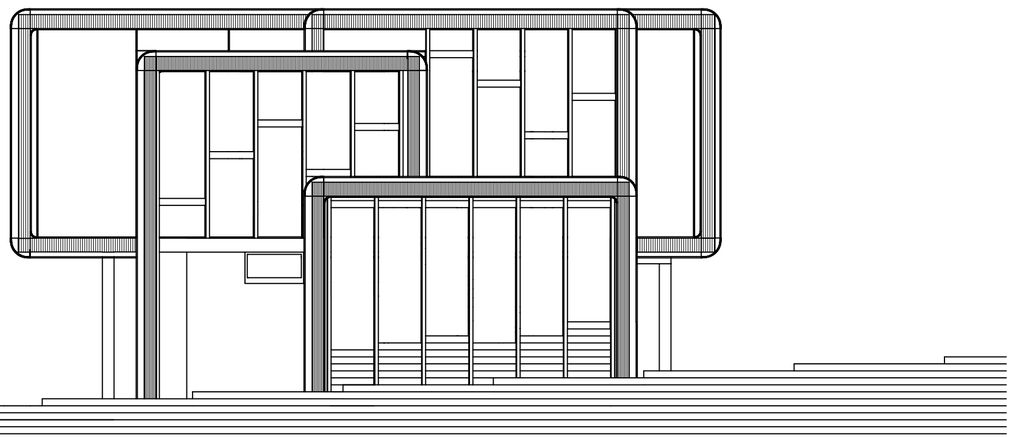
First floor



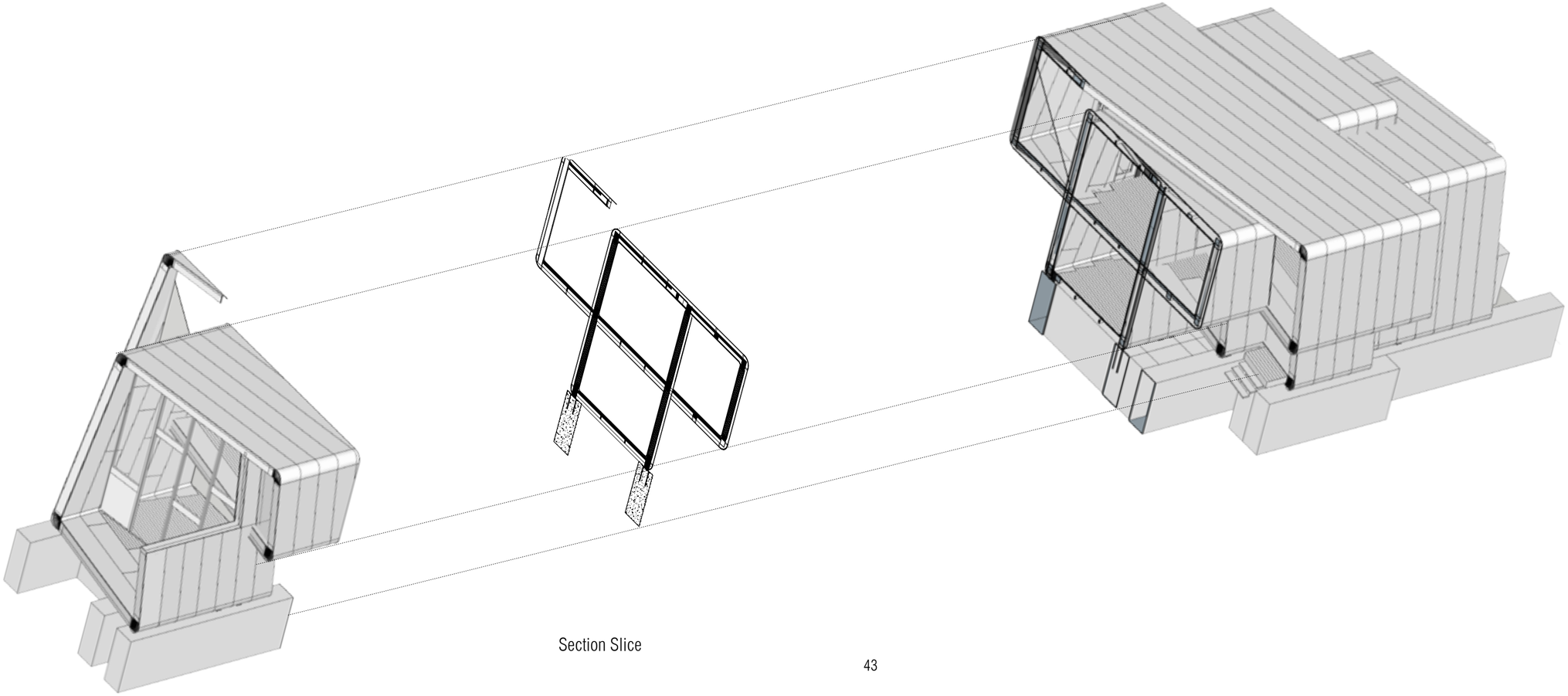
Second floor



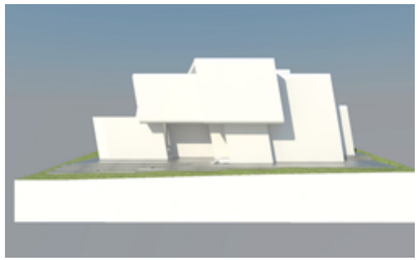
Elevation 1



Elevation 2

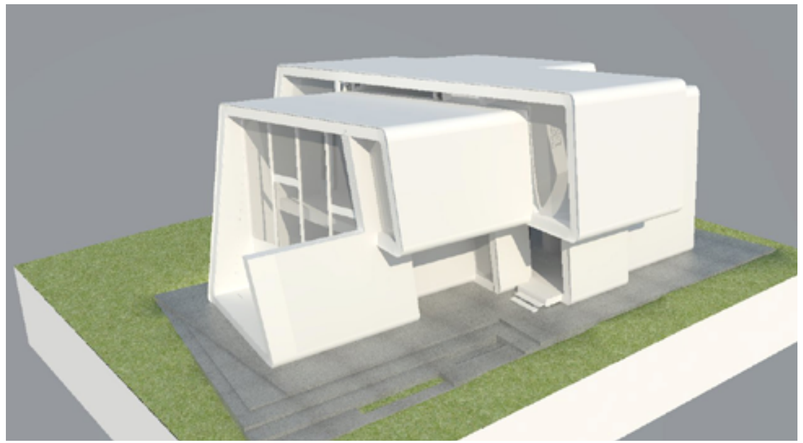


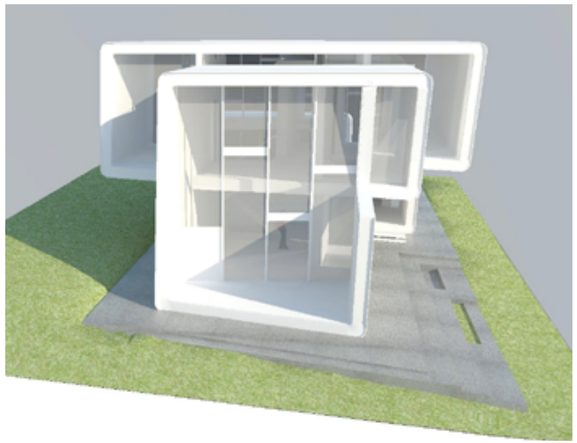
Section Slice



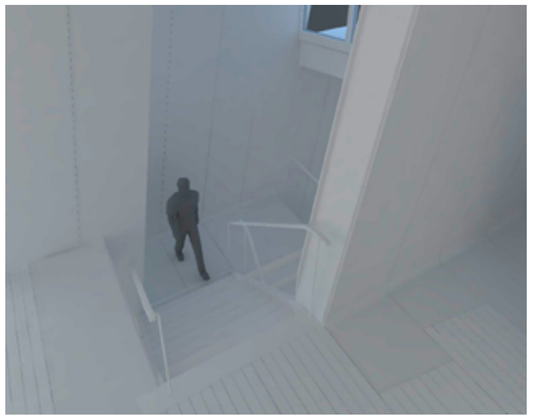
Views

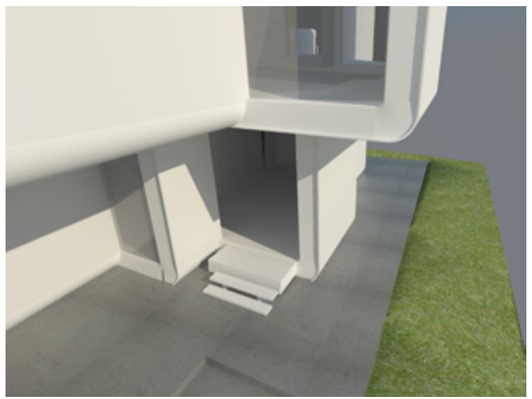
Views





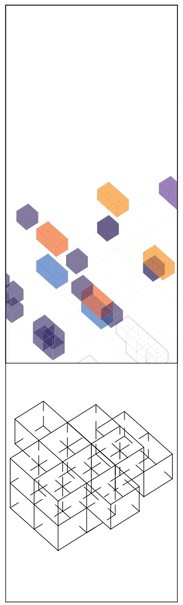
Interior

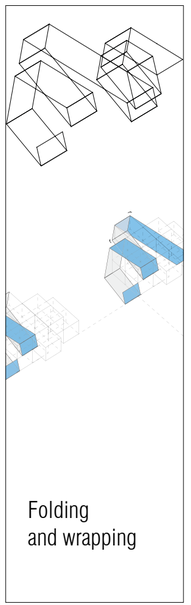




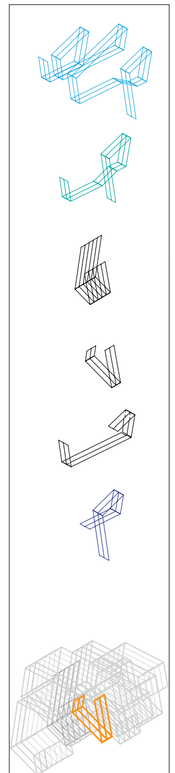
Corner

Cube group

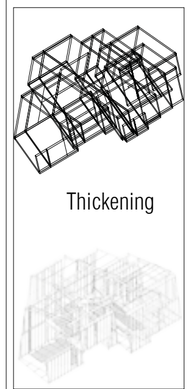




Folding
and wrapping



Ribbon
components



Thickening

Covering

Process summary