

Project Report : P3

Classroom to community : Adapting primary school furniture for elderly recreational activities

Guided by :
Prof: Purba Joshi

Submitted by:
Rijesh K | 22M2224 | M. des 2nd year

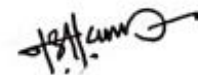


This is to certify that the industrial design project "Classroom to community : Adapting primary school furniture for elderly recreational activities" submitted by Rijesh K is approved for partial fulfilment for the Master of Design degree in Industrial Design.

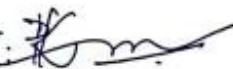
Prof. Purba Joshi:
(Project Guide)



External Examiner :



Internal Examiner :



Chairperson :



I, declare that this written report represents my ideas in my own words, and where others' ideas or words have been included I have adequately cited and referenced the original sources.

I also declare that I have adhered to all principles of academic honesty and integrity and have not falsified, misinterpreted or fabricated any idea, data, facts or source in my submission.

I understand that any violation of the above will be caused for disciplinary action by the Institute and can also evoke penal action from the source, from which proper permission has not been taken or improperly been cited.

A handwritten signature in blue ink, appearing to read 'Rijesh K', with a horizontal line extending to the right.

Signature:

Name of the student: Rijesh K

Roll No.: 22M2224

I would like to express my deepest appreciation to all those who helped me complete this report.

Heartfelt gratitude to my project guide, Prof. Purba Joshi, for her guidance from the topic selection till the end of design process. I would like to thank the professors at IDC for their valuable feedback during the discussions.

Also I would like to thank my wife, Dr. Dipika for her constant support throughout the project.



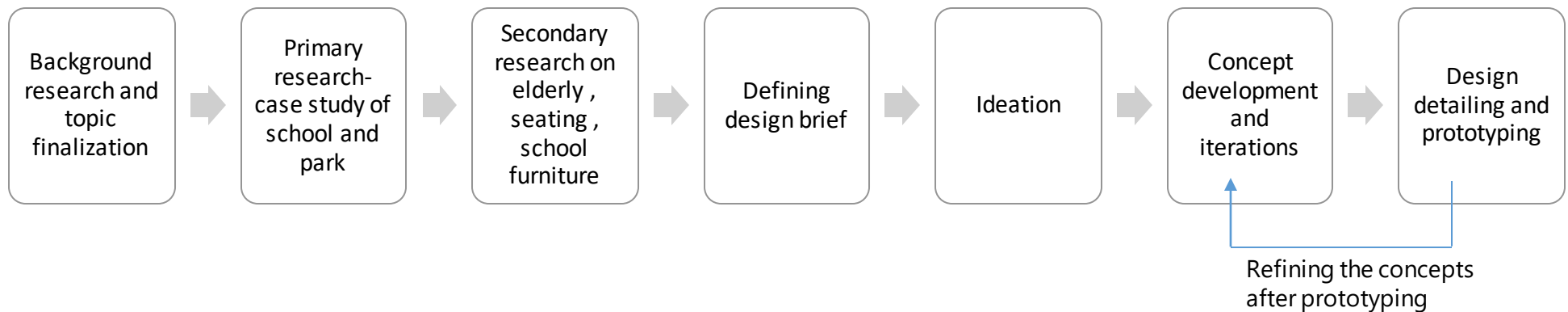
Aging is an inevitable aspect of life. With aging, we experience various changes in both our physical, mental and social well-being. While advancements in medical technology assist in addressing physical ailments associated with aging, we often overlook the impact on our psycho-social health.

Engaging in recreational activities and socializing are essential methods for addressing the challenges that elderly individuals encounter. However, public parks frequently lack adequate facilities or suffer from poor maintenance. Additionally, private recreation centers or clubhouses are financially out of reach for many elderly residents in low-income neighborhoods.

Although the government has proposed the establishment of public recreation centers, these plans remain largely theoretical and lack the necessary infrastructure. To tackle this issue, the Center for Policy Studies at IIT Bombay proposes a pilot project by repurposing a local corporation school for indoor recreational activities for the elderly.

Unfortunately, the classroom furniture in these schools, does not meet the physical and social needs of elderly users. This thesis project is an attempt to address this complex requirement of catering to the needs of two varied age groups and to arrive at a tangible solution.

approval form	i	Design brief	33
declaration form	ii	• Problem statement	
acknowledgement	iii	• Design objectives	
abstract	iv	• Priority analysis	
introduction	1	Ideation (stage 01)	35
• Elderly		• Operations	
• Aging		Design directions (stage 02)	48
• Socialization		• Direction 01: static share	
• Proposals		• Direction 02: movement wonder	
Primary research	7	• Direction 03: operation delight	
• Context : park		• Direction 04: configure freedom	
• Park – user observations		concept development (stage 03)	67
• Context : school		• Concept 01 : fantasy	
• School – user observations		• Concept 02 : old and new	
• Opportunity identification		• Concept 03 : enclosure	
Secondary research	22	Concept finalization (stage 04)	86
• Inspiration : 8-80 cities		Form finalization (stage 05)	92
• Inclusive design		Form refinement (stage 06)	101
• Seating and posture		Prototyping (stage 07)	108
• School furniture		User testing (stage 08)	113
		Further refinements	116
		References	125



Over the course of project the design brief underwent multiple iterations. The initial perspective was based on prioritizing the requirements of both children and elderly and arriving at a design solution that cater to both.

Eventually it was understood that both parties have complex requirement and hence I need to define the primary and secondary users. This opened up a new perspective where the primary focus was on the design of classroom furniture keeping in mind the need of the children and that can be adapted by the elderly.



Who are elderly?

Ageing, is commonly measured by chronological age and, as a convention, a person aged 65 years or more is often referred to as 'elderly' (WHO 2015). A "senior citizen" means any person being a citizen of India, who has attained the age of sixty years or above. (GOI, MoSJE)

As per Indian traditional knowledge, it forms the last of the 4 stages of life, referred to as Samnyasana (spiritually ready to renounce the world)

"The increased birth rate, decreased mortality rate, increased life expectancy is resulting in increased elderly population." Longevity by itself is to be celebrated, but increasing vulnerabilities of the elderly arising out of poverty, rural living, income insecurity, illiteracy, age related morbidity, dependency and decreasing support base requires attention." (Alam, et al., 2012, UNFPA report)

In India, like in many other countries, the elderly population is increasing due to factors such as improved healthcare leading to longer life expectancy and declining birth rates.

Elderly individuals in India face various challenges that can be broadly put under four domains as shown here. Some of the key issues faced by elderly are:

1.Healthcare: Many elderly individuals in India suffer from chronic health conditions such as diabetes, hypertension, arthritis, and heart disease.

2.Financial Security: Many elderly individuals do not have adequate financial resources to support themselves, leading to issues of poverty and financial insecurity, especially among widows and those without familial support.

3.Social Isolation: With changing family structures and increasing urbanization, elderly individuals in India often face social isolation and loneliness.

4.Elder Abuse: Unfortunately, elder abuse is a growing concern in India. This can include physical, emotional, or financial abuse, often perpetrated by family members or caregivers.

5.Access to Services: Access to services tailored to the needs of the elderly, such as geriatric healthcare, specialized housing options, and social support programs, remains limited in many parts of India.

PHYSICAL HEALTH

- sensory changes
 - Vision
 - Hearing
 - Smell/taste
 - kinesthetic
- general diseases
- disability
- chronic diseases

PSYCHOLOGICAL

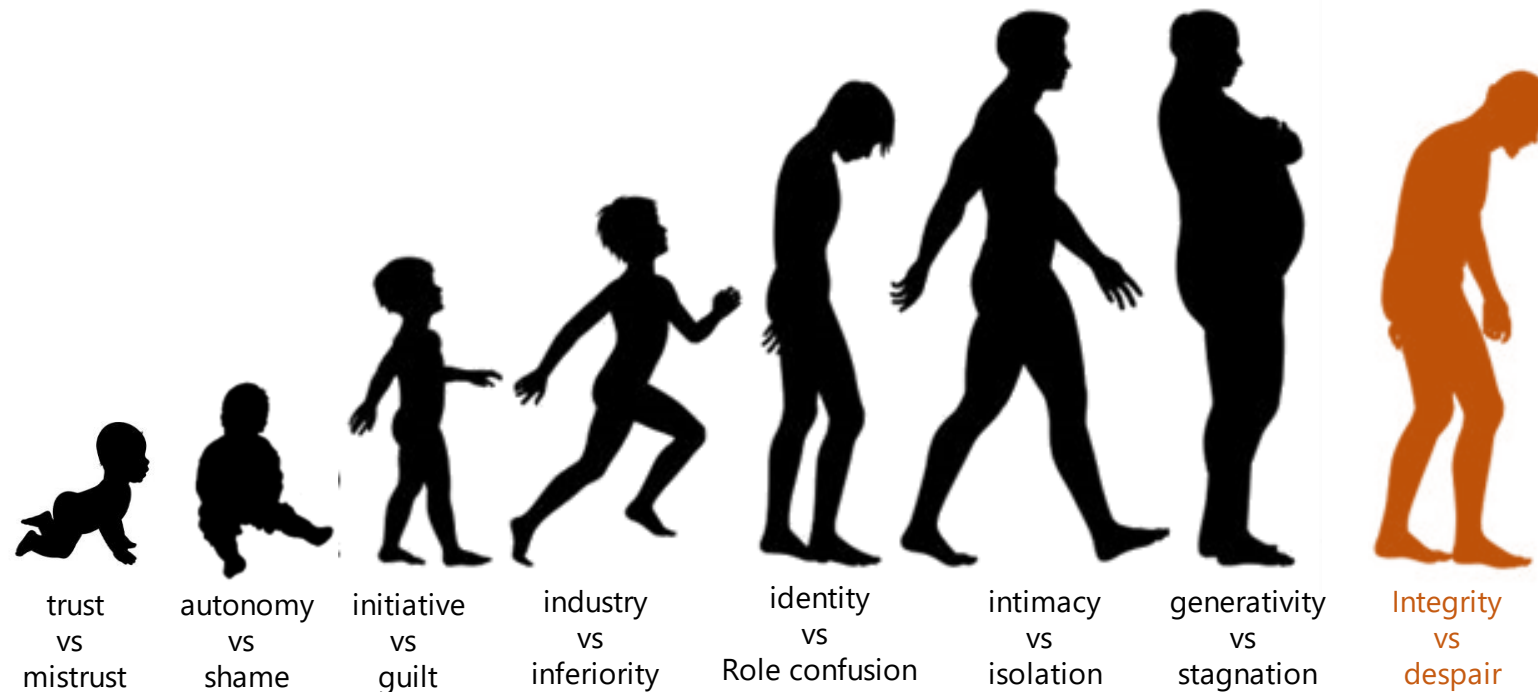
- slower reasoning
- decreased enthusiasm
- anxiety, frustration

ECONOMIC CONDITIONS

- Loss of income/status
- Pension related
- issues of property

SOCIAL STATUS

- living arrangements
- quality of life
- negligence/disrespect
- loss of status
- activities at home
- dependency



Erik Erikson's theory of psychosocial development outlines eight stages that individuals progress through from infancy to late adulthood. Each stage is characterized by a specific psychosocial conflict or crisis that individuals must resolve to develop a healthy sense of self and relationships.

Late adulthood culminates in the conflict of integrity vs. despair. Each stage represents a critical juncture where successful resolution contributes to healthy development, while unresolved conflicts may lead to psychological challenges later in life.

Psychosocial theories of aging focus on the psychological and social factors that influence the aging process and how individuals adapt to aging. These theories emphasize the importance of understanding aging as a dynamic interplay between biological, psychological, and social factors. Some key psychosocial theories of aging include:

1. Disengagement Theory: Proposed by Elaine Cumming and William Henry in 1961, the disengagement theory suggests that as people age, they gradually withdraw or disengage from society, and society reciprocates by disengaging from them.

2. Activity Theory: Developed as a response to the disengagement theory, the activity theory proposes that successful aging is associated with maintaining a high level of activity and engagement in life.

3. Continuity Theory: The continuity theory suggests that individuals maintain a consistent pattern of behavior, personality, and lifestyle as they age.

These psychosocial theories complement biological theories of aging by recognizing the influence of psychological and social factors on the aging process.



Based on the theories discussed earlier we understand the importance of socialization. Some of the important aspects that socialization helps the elderly are :

Mental and Emotional Well-being: Socialization helps prevent feelings of loneliness, isolation, and depression, which are common among the elderly.

Cognitive Functioning: Engaging in social activities and interactions can help maintain cognitive function and prevent cognitive decline in elderly individuals.

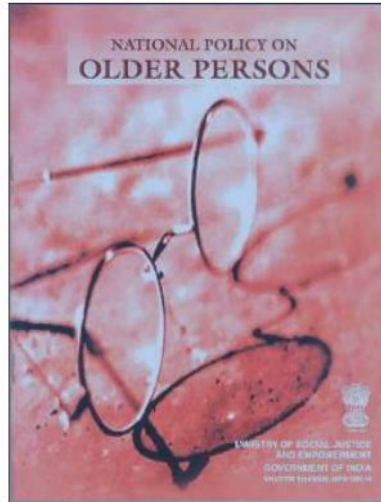
Physical Health: Socialization has been linked to better physical health outcomes in elderly individuals.

Sense of Purpose and Meaning: Socialization provides opportunities for elderly individuals to remain engaged and active in their communities, contributing to a sense of purpose and meaning in life.

Resilience and Coping: Social support networks provide a buffer against stress and adversity, helping elderly individuals cope more effectively with life's challenges.

Encouraging and facilitating social interactions, maintaining social networks, and creating opportunities for engagement and participation in meaningful activities are important for supporting the social needs of the elderly population.





Chairperson : Dr. Mrs. Mohini Giri
Members : Mr. M.M. Sabharwal
 Mr. K.R. Gangadharan
 Dr. Sheilu Sreenivasan
Member Secretary : Mr. P.P. Mitra

National Policy for Senior Citizens
 March 2011

MINISTRY OF SOCIAL JUSTICE AND EMPOWERMENT
 GOVERNMENT OF INDIA
 SHASTRI BHAWAN, NEW DELHI



Now, BMC planning to set up day care centres for senior citizens in Mumbai

Sanjeev Devasia / TNN / Updated: Aug 10, 2023, 07:41 IST



GOVERNMENT OF INDIA
MINISTRY OF SOCIAL JUSTICE AND EMPOWERMENT
DEPARTMENT OF SOCIAL JUSTICE AND EMPOWERMENT

An Umbrella Scheme for Senior Citizens.

National Action Plan for Welfare of Senior Citizens
(NAPSrC)

3.5	Preferences will be given to the Senior Citizens in the allotment of flats on the ground floor. Master Plans, where necessary shall be modified to provide for: 1. Lifts for upper floors senior residents, even without consent of GF residents by allowing extra FAR and sky-bridge to connect the house to the Lift facility. 2. Maintenance Kiosks in Residential just like Milk/Vegetable shops within the residential colony. 3. Day Care centres in Parks and in Community Centres/Religious institutions/Schools	Guidelines on the issue will be reviewed
-----	---	--

There are many proposals and policies as shown here, for the welfare of the elderly. Yet most of them are still unexecuted or given enough attention due to bureaucratic delays and lack of infrastructure.

One of the proposals suggests using schools centers for elderly, which forms the core motivation for the project.



We visited one of the parks in the neighborhood Powai, to understand the existing state of infrastructure for elderly recreation.

In S-ward, which includes Gokhale Nagar, there's a notable absence of recreational facilities catering to senior citizens. Despite the presence of an association comprising 80-90 members aged between 60 to 85 years, there are limited options available for their leisure activities. Currently, they gather in the evenings at the BMC park.

However, this park is in a state of disrepair, characterized by a central underground sump and motor room. Unfortunately, the design of the park lacks consideration for the elderly, offering no shelter or protection from adverse weather conditions and pollution. Furthermore, there are no facilities to support interactive sessions or facilitate get-together meetings, depriving the elderly population of much-needed opportunities for socialization and engagement.

user study : park - observations

First step as part of the study was to observe the users in the park and make notes/ sketches, recording the different user groups, activities and sitting postures. Some of the key observations was illustrated in the next few pages.



to meet friends

we call this garden

no space at home

need roof structure

discussion about
politics, sports

openness and nature



These are sketches made from photos taken from location

read newspapers



Need closed space for meetings

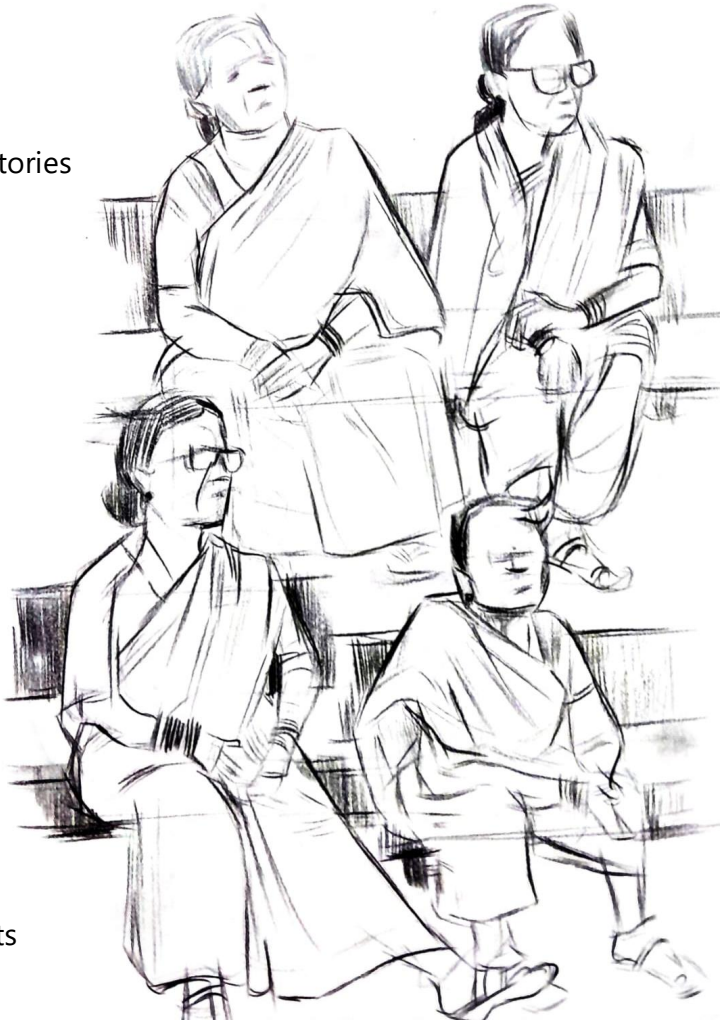


prefer sitting like this after long day

like to play carom board

These are sketches made from photos taken from location

listen to others stories



we need toilets



talk about family

listen to devotional songs

prefer sitting next to
each other

These are sketches made from photos taken from location



Existing benches and different sitting postures

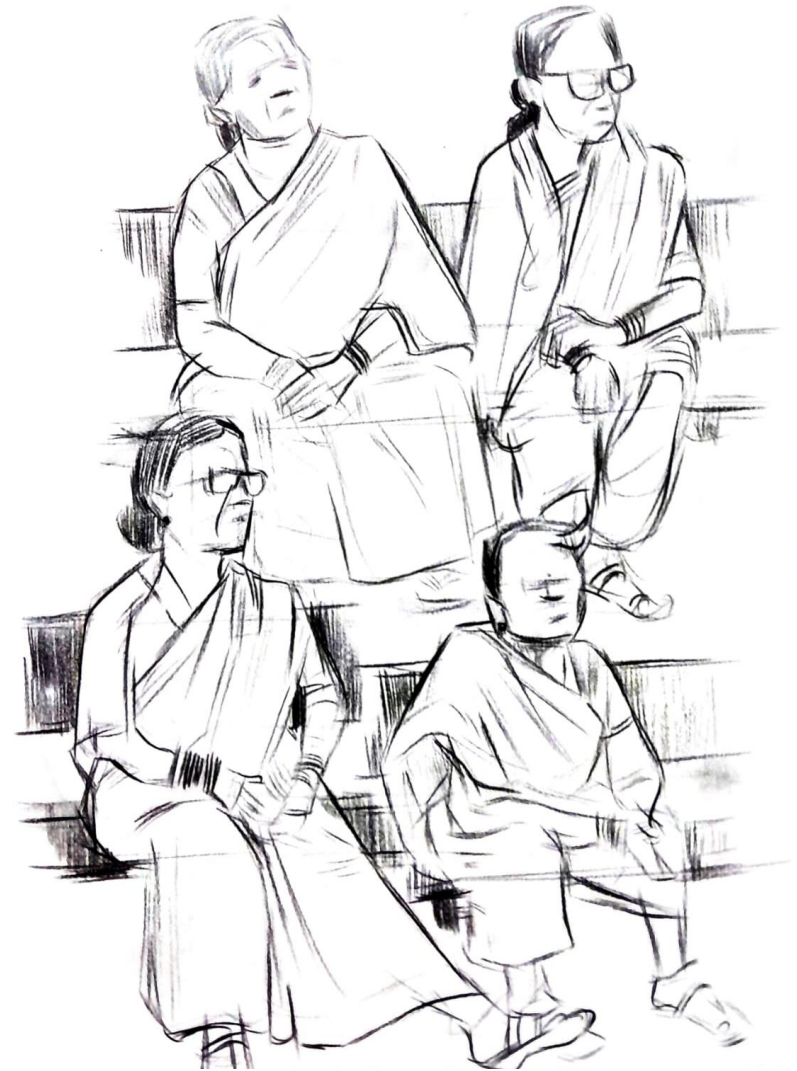
Elderly spending their evening in the park



- The existing layout of furniture was not suitable for group conversations, hence they choose the corners mostly.
- 3 different types of furniture made of MS and precast concrete
- The curved profile of the bench makes it difficult for them to get up
- Depth of the seat insufficient for different postures
- Lack of armrest for supporting
- Most of them prefer to rest their legs on the seat as per their habits
- The foot doesn't touch the ground for average height person

Some of the key insights from the visit are listed below:

- The elderly visit the park during evenings after 5 PM onwards
- The existing furniture was **not designed keeping in mind the needs of the senior citizens**
- They form groups of **6 – 10** people during interactions
- Their **sitting habits** are influenced by cultural aspects.
- They are provided with chairs, TV and carom board by the BMC, but they **don't have the room** to keep them
- Most of them come here due to the **lack of space in their homes** and interact with their friends
- They are from **marginal backgrounds** and hence cannot afford to use paid recreational activities
- They are predominantly men and 4-5 women
- There are **no wheel chair users or persons with disability**





The next step was to visit the school adjacent to the park to understand the infrastructure and how it can be adapted to meet the needs of the elderly for recreation.

The BMC school in Gokhale Nagar, Powai, S-ward, comprises three classrooms and a staff room. Among these classrooms, two contain different types of furniture to accommodate students from different grade levels. Specifically, one set of furniture is designated for junior classes, encompassing grades 1 and 2, while the other set is utilized for classes 3 through 8.



- The junior classes have wooden furniture with painted finish
- Most of the seats are un-occupied due to absence.
- Desk dimensions are 45 (h) x 41 (w) x 92 (l), seat – 30 x 30 x 30+30 (h)



Only one person was sitting upright as she was holding the book at an angle on the edge of desk.

One child was writing with note book on the lap



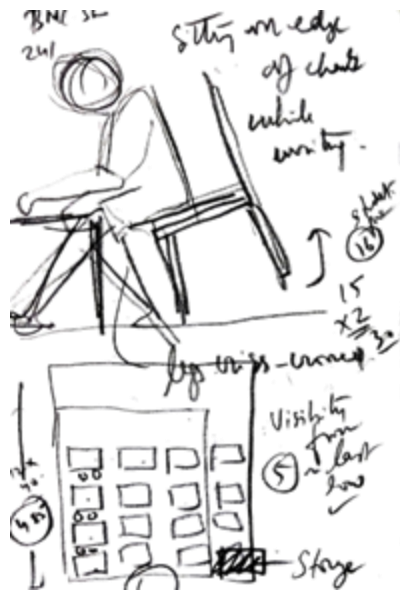
Most children were slouching on the desk while writing

Some were sitting on the desk while teacher not in class



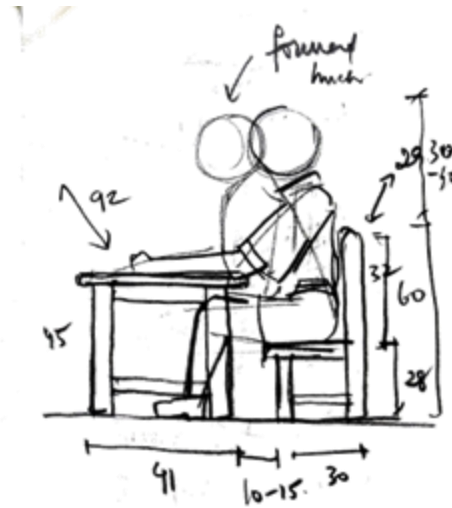
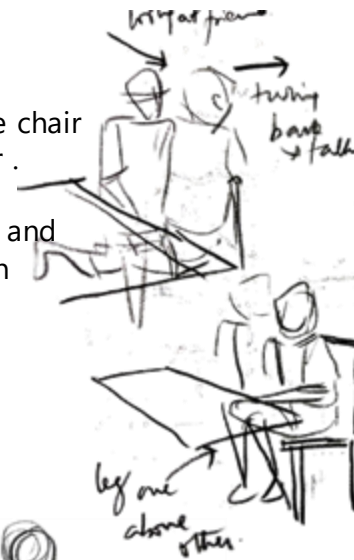
Most of them were tilting the chair towards the desk while writing.

Some brought the chair under the desk while writing.



They sit on the tip of the chair and fiddle with the chair .

Some kept turning back and talk to the other children



Since the chair was light weight and mobile, they took different positions

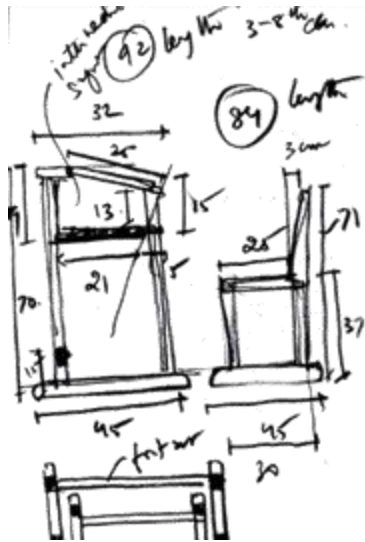
Their attention span was limited to 1 or 2 mins and kept changing positions regularly



When the children are not writing they are upright, yet because of the low height of seat for grown children, they had to fold the legs



- This classroom had solid wood desk and benches, that are almost 60 years old.
- This class was mostly occupied as the students from 3rd classroom was here.
- Desk dimensions are 70 (h) x 32 (w) x 92 (l), seat – 30 x 84 x 37+34 (h)



They were mostly sitting on the edge of seat while writing as the benches are heavy to move

Some had pulled the bench inside the desk but was difficult for ingress and egress

There was a huge variation in the age group and heights of students.



Taller kids were slouching though as the desk height was low for them.

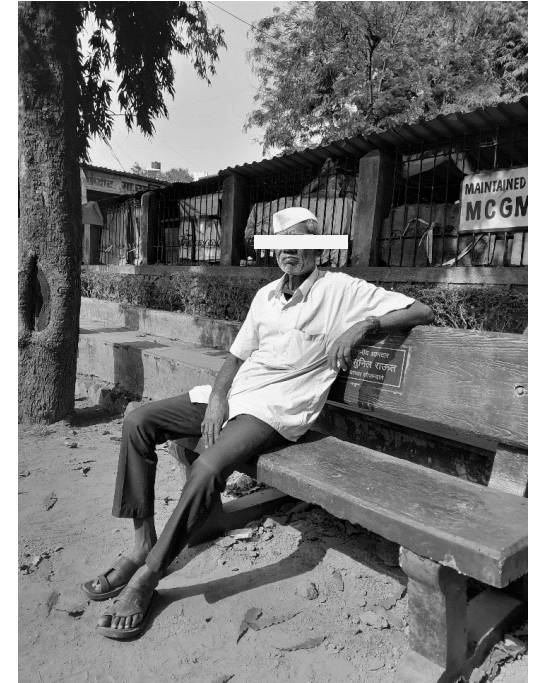
The width of the desk was insufficient for notebooks and the edges of the books were damaged while writing

Some of the insights from the visit are shown below:

- The children are provided the **bare minimum of facilities**
- There is a huge **variation in the age group and heights** of children using the same furniture
- Children can be seen **lethargic and inactive** during classes
- There is a **large number of absentees**
- The furniture are **bulky** though durable, doesn't allow for interactive sessions
- The children **do not follow healthy posture** due to the misfit of the furniture dimensions
- The younger children have **shorter attention span** and they keep turning around.
- There is **no sense of ownership** among the children of their furniture
- **The existing furniture in the classrooms cannot be used for recreation purposes for the elderly.**



?



The availability of **physical space**, the **time slot** and the **common governing body** , gives the opportunity to explore the possibilities of **integrating solutions** needed for the recreation for elderly with the needs of the school children.



880cities™

Services Work About 8 80 Cities Stories & Insights Resource Hub Contact Us f t i in

Creating cities for all.

Our mission is to ignite action and challenge the status quo to create healthier, more equitable, and sustainable cities for all people.

SEE OUR SERVICES

pedestrian subway in Kiev, Ukraine. (REUTERS/Konstantin Chernichkin)

We are guided by the simple but powerful idea that if everything we do in our cities is great for an 8 year old and an 80 year old, then it will be better for all people.



Creating Parks and Public Spaces for People of All Ages

8 80 Cities has partnered with AARP and TPL to highlight the importance of parks and give community leaders the tools to create ...



Kitchener Pop-Up Park

8 80 Cities and the City of Kitchener came together to launch the first-ever pop-up park in downtown Kitchener to build excitement...



One of the inspirations for this project was the 8:80 cities.

Guillermo Penalosa, the founder, is a Canadian urbanist, known for his 8 80 design philosophy, which uses 8-year olds and 80-year olds as a sort of indicator species to assess if a city works well, because if it works for them, it should work for everyone else.

This further led to the study of inclusive design, which is a design process in which a product, service, or environment is designed to be usable for as many people as possible, particularly groups who are traditionally excluded from being able to use an interface or navigate an environment.

Here are some key principles of inclusive design:

Equitable Use: Ensure that the design is usable by people with diverse abilities and characteristics.

Flexibility in Use: Provide multiple ways for individuals to interact with the design.

Simple and Intuitive Use: Make the design easy to understand and use for everyone, regardless of their prior knowledge or experience.

Perceptible Information: Ensure that important information is easily perceivable by all users, including those with sensory impairments.

Tolerance for Error: Design the system to minimize the risk and impact of errors.

Low Physical Effort: Minimize physical effort required to use the design.

Size and Space for Approach and Use: Provide adequate space and clearances to accommodate users of varying sizes, abilities, and mobility aids.

Accessible Information: Ensure that all users can access and understand relevant information.

Consideration of Context: Understand the context in which the design will be used and consider environmental factors, cultural norms, and social dynamics that may influence user interaction and experience.

Barrier-free modular sofa by Ella Westlund

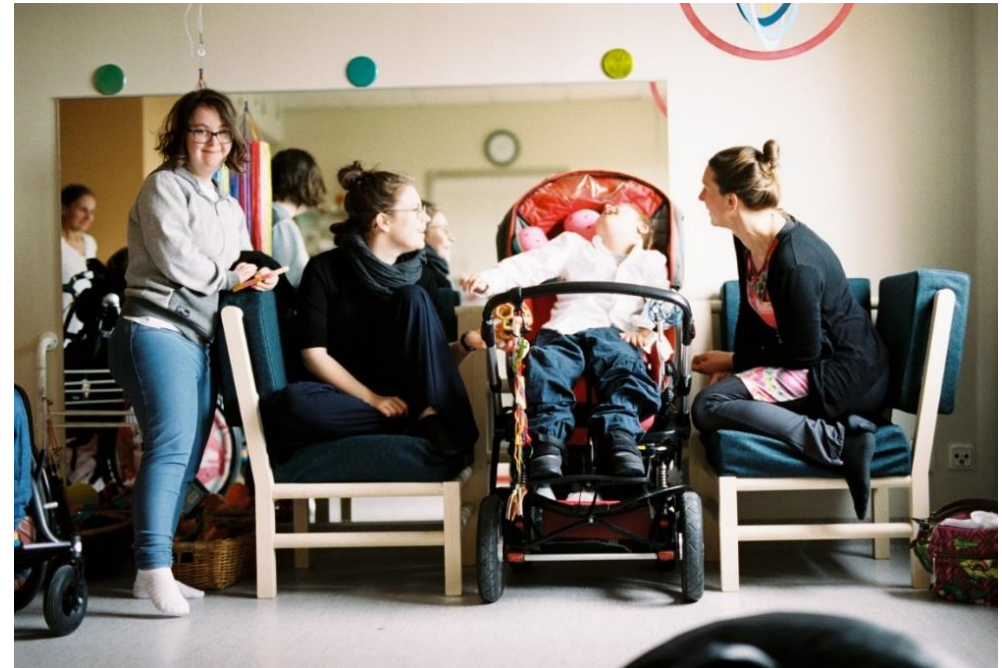
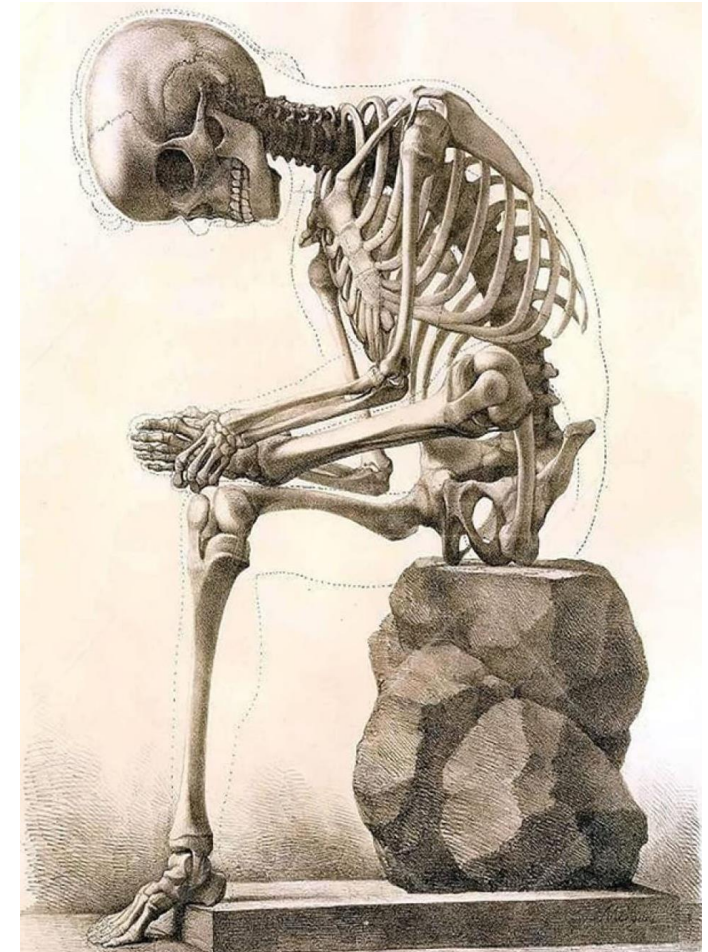




FIG. 1. A portion of the postural typology used in the compilation of data for this paper. Drawings are for the most part based on photographs in the ethnographic literature. Head and arm positions, unless stated otherwise in the accompanying discussion, are not typologically significant. No. 23, for example, could be standing with his left hand on his hip, or resting it on his left shoulder, and his standing posture would be considered the same for present purposes.

The next step was to understand seating and different postures

- **Human positions** refer to the different physical configurations that the human body can take.
- **Posture** means an intentionally or habitually assumed position
- A **resting position** or **rest position** is a default human position or pose assumed (typically deliberately) when a person is not engaged in an activity that demands some other pose, or between poses.
- Common resting positions of the body include **kneeling, leaning, lying, sitting, and squatting.**



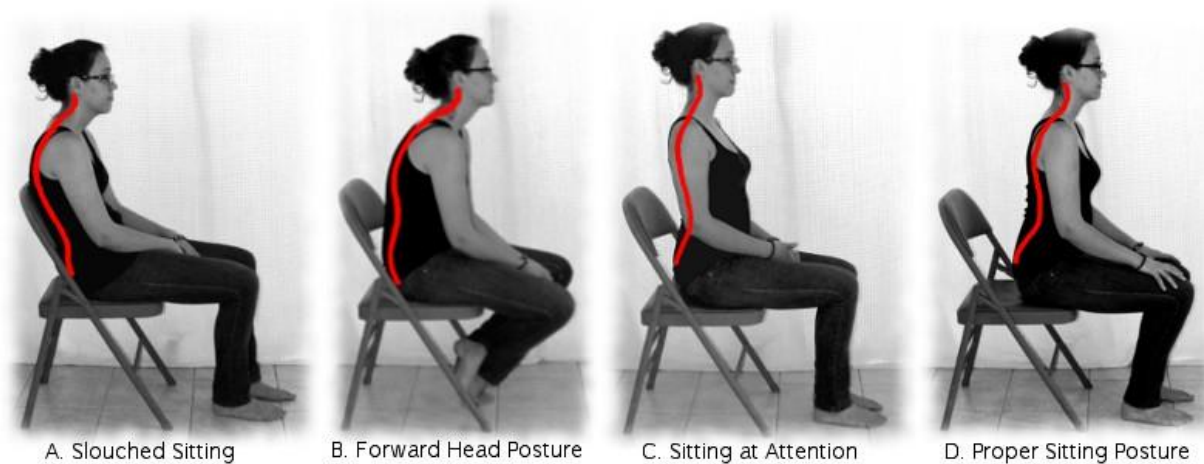
Sitting is a basic action and resting position in which the body weight is supported primarily by the bony **ischial tuberosities** with the buttocks in contact with **the ground or a horizontal surface** such as a chair seat, instead of by the lower limbs as in standing, squatting or kneeling.

Posture can provide a significant amount of important information through nonverbal communication.

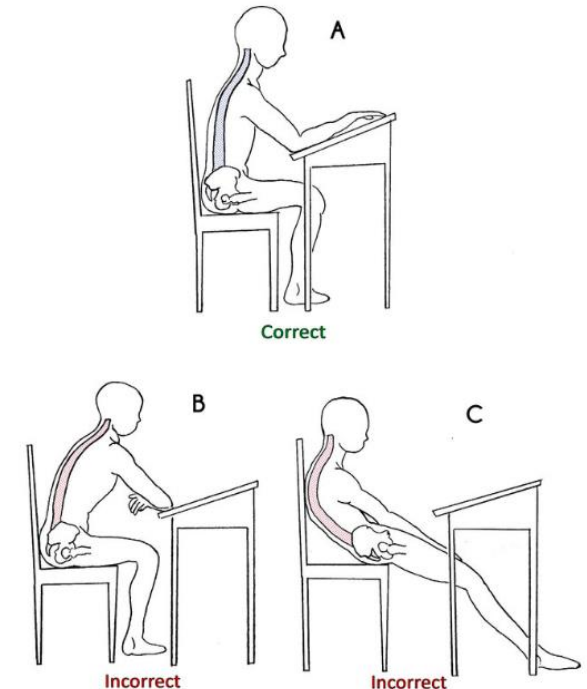
Psychological studies have also demonstrated the **effects of body posture on emotions**

Posture can signal both the enduring characteristics of a person (character, temperament, etc.), and his or her current emotions and attitudes.

- **Closed posture** is a posture in which parts of the body most susceptible to trauma are obscured. These body parts are: throat, abdomen and genitals. Closed posture often gives the impression of detachment, disinterest, and hostility.
- **Open posture** is a posture in which the vulnerable parts of the body are exposed. The head is raised, the shirt may be unbuttoned at the neck, a bag is held on the shoulder or at the side. Open posture is often perceived as communicating a friendly and positive attitude.

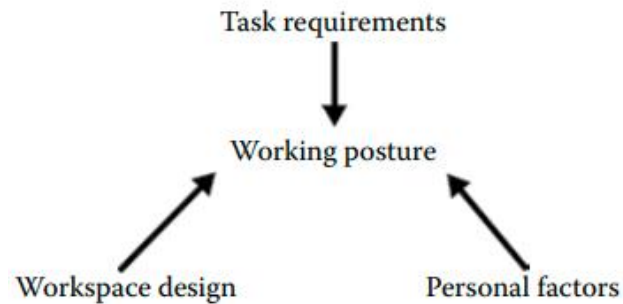


- Rest both feet flat on the floor and keep your knees level with your hips
- Sit back in your chair
- Ideally the chair should support your lower back's curve.
- Make sure your desk or table top is elbow high if sitting at a table
- Your upper back and neck should be comfortably straight
- Shoulders should be relaxed (not pulled backward or rounded)



The postural triangle

A person's working posture is a result of the requirements of the task, the design of the workspace, and personal characteristics such as body size and shape and eyesight.



Three factors affecting **workstation design** are :

- visual requirements
- postural (effector) requirements
- temporal requirements



Application of the postural triangle to workspace evaluation. The illustration depicts a monk transcribing a text.

School furniture: evolution



1881, The 'fashion' desk, John D. Loughlin



1895, The Rettig bench, Germany



Adjustable School Desk"
George H. Abbott on April 30, 1930



Jean Prouvé's school
desk, 1935



Alvar Aalto's school
furniture, 1950

It was important to understand the evolution of school furniture over the course of time. The study brings out how the furniture has evolved over the period of time in its material and aesthetics. There are many factors that determined this including social, cultural, political across different parts of the world. Also different schooling systems and learning pedagogies influenced the furniture systems across the world.

School furniture: evolution



Munkegaard School Desk and Mosquito Chair by Arne Jacobsen, 1950s



asilo sant'elia school chairs, 1960s



rectangular tubular steel and plywood desks, 1980s



VS PantoMove swivel chair with dynamic seat and Ergo-III height adjustable pupil's table, 1990s



One arm school desk, 1990s



Node chair, steelcase, 2010

Indian Standard SCHOOL FURNITURE, CLASSROOM CHAIRS AND TABLES — RECOMMENDATIONS (Second Revision)

IS 4837 : 1990

IS 4837 : 1990

1 SCOPE

1.1 This standard deals with the dimensional requirements of the chairs and tables for children in the age group of 5-17 years for use in the Indian schools. The chairs and tables have been divided into four sizes related to age groups of children. These have been formulated keeping in view the following considerations:

- To define a minimum space under the table which shall be kept clear for the knee space.
- To define minimum table lengths based on width between elbows of children when writing, to ensure adequate working space.
- To provide data on the reach and stretch of (children) arms to assist in the design of working surfaces, any storage space, inkwell positions, etc.

2 REQUIREMENTS

2.1 There are many postures that are adopted by students in school. However, to assess the fit of the student to chair and table it is necessary for the pupil to adopt the posture shown in Fig. 1. In the design of chairs and tables seven basic requirements as follows shall be completely fulfilled simultaneously.

A Feet flat on floor.

B Clearance between back of legs and front edge of seat

A Shod feet flat on floor.

B Clearance between back of legs and front edge of seat.

C No pressure at front of seat between seating surface and thighs.

D Clearance between thigh and underside of table for freedom of movement.

E Elbows approximately level with table top when upper arm vertical.

F Firm support for back in lumbar region and below shoulder blades.

G Adequate clearance between backrest and seat to ensure free movement of buttocks.

- No pressure at front of the seat between seating surface and thighs
- Clearance between thigh and underside of table for freedom of movement
- Elbows approximately level with table top when upper arm vertical
- Adequate clearance between backrest and seat to ensure free movement of buttocks

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply.

3.1 Seat

3.1.1 Height of the Seat

The height of the seat is measured to the highest point at the front of the seating area on the centre line.

3.1.2 Effective Depth of the Seat

The depth of the seat means the dimensions measured from front to back across the chair in the middle of the seat.

3.1.3 Minimum Width of Seat

The width of the seat means the dimensions measured from side to side on a line parallel to the front of the chair, and at the middle of seat.

3.1.4 Radius of Front Edge of the Seat

This is an approximate specification of the stop surface.

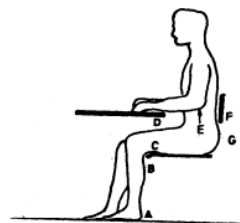


FIG. 1 FIT OF PUPIL TO CHAIR AND TABLE

1

Different standards for school furniture and research papers were studied for understanding the requirements for children.

Existing products in the market were studied through online resources that is listed in the next page

3.1.5 Maximum Angle of Seat Plane

The main part of the seating surface has to lie between the horizontal and maximum slope of 4°. The seating surface may be flat or include dishing. Any dishing has not to exceed 10 mm in depth and has to occur in the back 2/3 of the effective seat depth. The deepest part of the dishing has to occur 3/4 of the effective seat

depth back from the front edge.

3.1.6 Angle Between Seat and Backrest Planes

The angle between the seat and backrest planes is measured on the centre of the seat. For chairs of sizemarks 4 (see Table 1) designed for extended periods of sitting that is in lecture assembly halls, angle β may be increased up to a maximum of 106° (see Fig. 2).

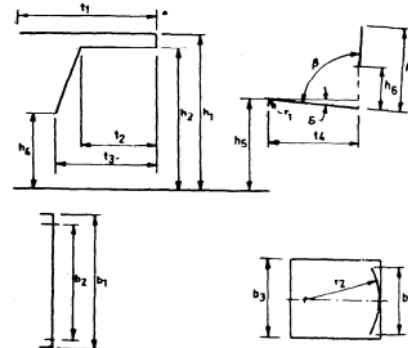


FIG. 2 DIAGRAMMATIC KEY TO DIMENSION

Table 1 Dimensions
(Clauses 3.1.6 and 4.1; and Fig. 2)

All dimensions are in millimetres unless otherwise shown.					
	Sizemark	1	2	3	4
Seat	h_s Height of seat	260+3	300+3	340+3	380+3
	t_e Effective depth of seat	250 to 270	280 to 300	320 to 340	350 to 370
	b_s Min width of seat	250	300	320	360
	r_s Radius of front of seat	30 to 40	30 to 40	30 to 40	30 to 40
	α Max angle of seat	4°	4°	4°	4°
Backrest	β Angle between seat and backrest	95° to 100°	95° to 100°	95° to 100°	95° to 100°
	h_b Seat plane to bottom of backrest	110 to 120	120 to 130	140 to 150	150 to 160
	h_t Seat plane to top of backrest	210 to 250	250 to 280	280 to 310	310 to 330
	b_b Min width of backrest	250	250	250	280
	γ Min angle of backrest	4°	4°	4°	4°
Tables	h_t Height of top	460+3	520+3	580+3	640+3
	t_t Min depth of top	450	450	450	450
	b_t Min 1 place length of top 2 place	450	450	450	450
	l_t Min 1 place length of top 2 place	1 050	1 050	1 050	1 050
Leg clearance	t_1 Min depth of knee zone	300	300	300	350
	t_2 Min depth of tibia zone	400	400	400	450
	h_k Min height of knee zone	400	460	520	580
	h_t Min height of tibia zone	250	250	300	300

2

Ergonomics
Vol. 50, No. 10, October 2007, 1612-1625



Lack of conformity between Indian classroom furniture and student dimensions: proposed future seat/table dimensions

C. S. SAVANUR, C. R. ALTEKAR and A. DE*

TIFAC CORE in Ergonomics & Human Factors Engineering,
National Institute of Industrial Engineering (NITIE), Vihar Lake,
Mumbai - 400 087, India

Children spend one-quarter of a day in school. Of this, 60-80% of time is spent in the classroom. Classroom features, such as workspace and personal space play an important role in children's growth and performance as this age marks the period of anatomical, physiological and psychological developments. Since the classroom is an influential part of a student's life the present study focused on classroom furniture in relation to students' workspace and personal space requirements and standards and was

Ergonomics
DOI: 10.1080/001401306005858

REGULAR ARTICLE

Complaints arising from a mismatch between school furniture and anthropometric measurements of rural secondary school children during classwork

Prakash Chandra Dhara · Gurucharan Khaspuri ·
Soudeep Kumar Sau

Received: 23 December 2006 / Accepted: 29 September 2008 / Published online: 13 November 2008
© The Japanese Society for Hygiene 2008

Abstract

Objectives: The present investigation aimed to evaluate the extent of mismatch between different dimensions of school furniture and the respective anthropometric measures of school children. Assessment of health problems as well as postural pattern among the school children while attending their classes in relation to the classroom furniture was the other aim of this study.

Methods: For this purpose, 621 male school children (age range 10-15 years) were selected at random from rural secondary schools ($n = 20$) in nine districts in the state of West Bengal, India. The subjective evaluation of health

problems of school children's bodies. It can be concluded that an ergonomic intervention is required to redesign the classroom furniture for school children of different age groups in order to reduce furniture-related health complaints.

Keywords: School furniture · Body dimensions · Health problems · Posture change

Introduction

school furniture: existing products



Okplay little master Desk
Rs. 4000/ unit



Okplay jack in the box
₹ 4800/ Unit



Okplay little scholars
₹ 6400/ Unit



Okplay dual desk
₹ 6800/ Unit



Nilkamal Amazer 02 Brown Desk & Bench
₹ 9,900/ Piece (replica @4,000)



Nilkamal Orville 01 Desk & Chair
₹ 7,200/ Unit (replica @3,000)



Godrej Discover Classroom Seating Bench
₹ 5,130/ unit

School furniture: BMC schools



Also existing classroom furniture in BMC schools were studied through online resources to understand the layout, design and material used.

Based on the primary and secondary research the problem statement was made that can be spilt into 2 parts namely :

Problem (macro- level)

The **lack of shelter** for recreational activities for senior citizens in the neighborhood

Problem (micro- level)

The **lack of appropriate furniture** for students in the classrooms that can accommodate the senior citizens for recreational purpose

As part of this project the micro level problem is considered the scope.



To design a **furniture** system for **primary classroom** (1st and 2nd class) children of age **5- 6 years** for BMC schools that can be used by **elderly** after school hours for **socializing**.

Function: sitting, reading, writing, drawing facing board/ group works (and playing) for children and sitting/ conversations for elderly facing each other.

Dimensions: based on the minimum BMC classroom size (5 X 7 m) and ergonomics of children and elderly with sufficient space for circulation during moving/ transforming furniture

Accessibility: From the entrance to classroom (hence primary class) . Welcoming/inviting, less time and effort for adapting/transforming and using the furniture for both children and elderly.

Durability: Considering the usage by different age groups and activities, the furniture should be durable and repairable

Form: it should appeal to both child and elderly at the same time and blur the semantics of classroom and elderly furniture

Sustainability : In terms of the concept to be adopted across all schools and material/ manufacturing process

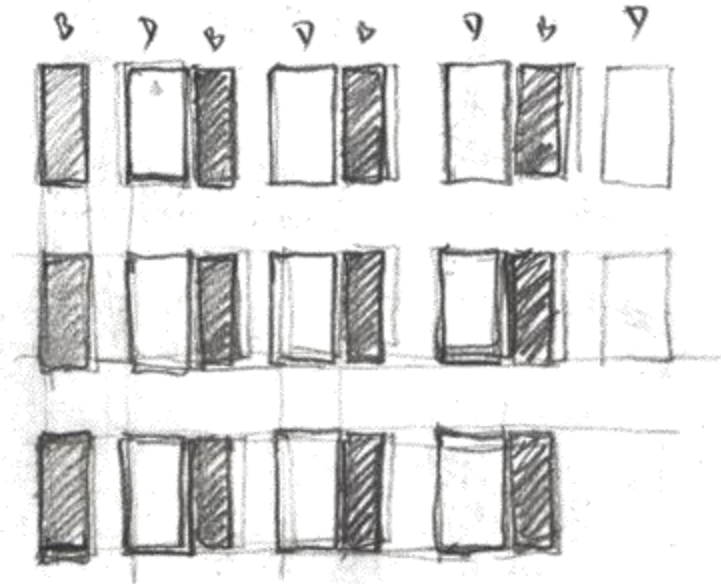
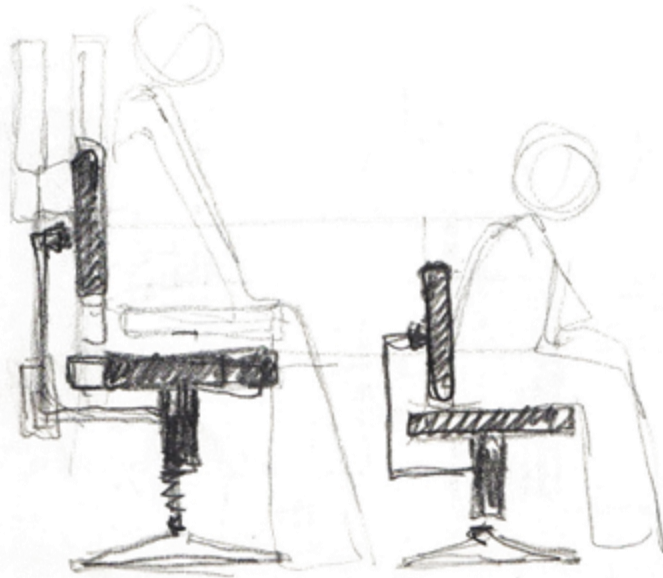
Safety : should consider the structural stability and hazards

Affordability: cost effective material and manufacturing process for making it a viable option to be adopted in schools by BMC

In order to understand the key requirements for the project, priority analysis was as shown below. This helped in the future course of the project as well

	MUST HAVE	SHOULD HAVE	COULD HAVE	WOULD NOT HAVE
PRIMARY FUNCTION : CHILD LEARNING	5	5	5	5
SECONDARY FUNCTION : ELDERLY CHAT	4	4	3	3
OTHER FUNCTIONS : PLAY EAT SLEEP	4	3	3	4
LESS MOVABLE COMPONENTS	5	5	3	3
DIMENSIONS AS PER STANDARDS	4	4	4	4
FLEXIBILITY OF LAYOUTS	4	5	3	5
ACCESSIBILITY : IN AND OUT	5	5	4	4
COG/PHY EASE/DURATION OF TRANSF.	5	4	3	2
STABILITY IN FUNCTIONS POSTURES	5	4	3	3
SAFETY HAZARDS	5	4	3	3
DURABILITY/REPAIRABILITY	5	4	3	3
CLEANING/MAINTENANCE	5	4	3	3
STORAGE – STACKABILITY/FOLDABILITY	4	5	3	4

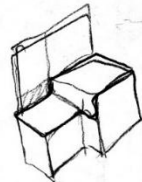
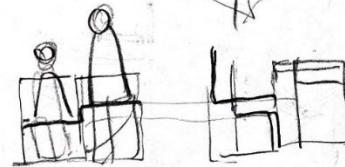
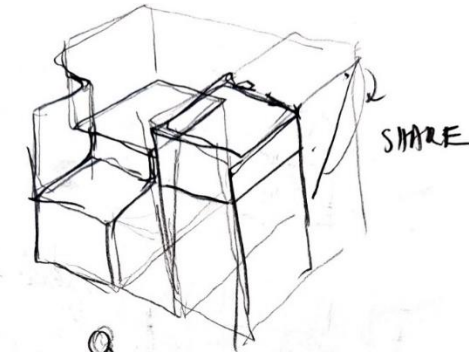
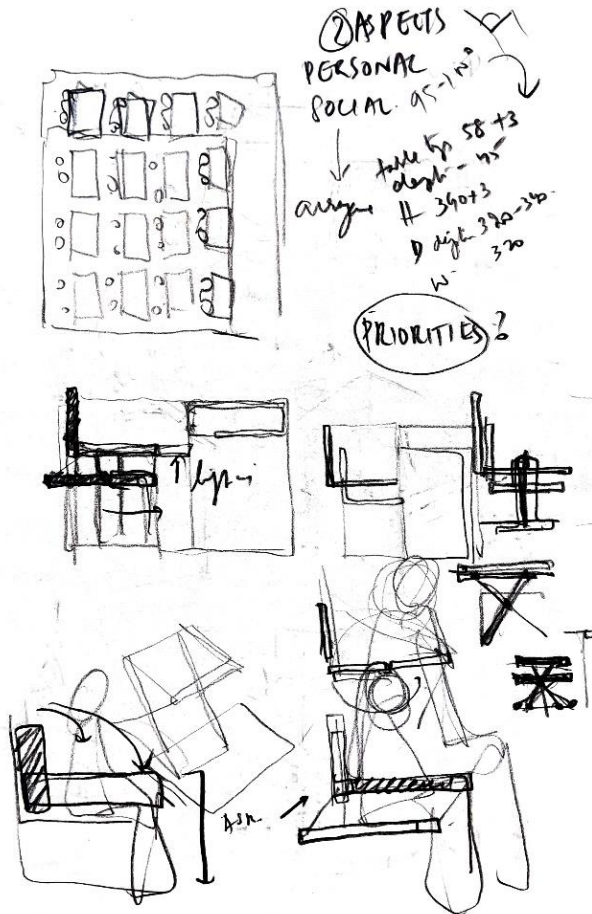
The stage 01 of the ideation involves identifying the physiological and psycho- social needs of both children and elderly.



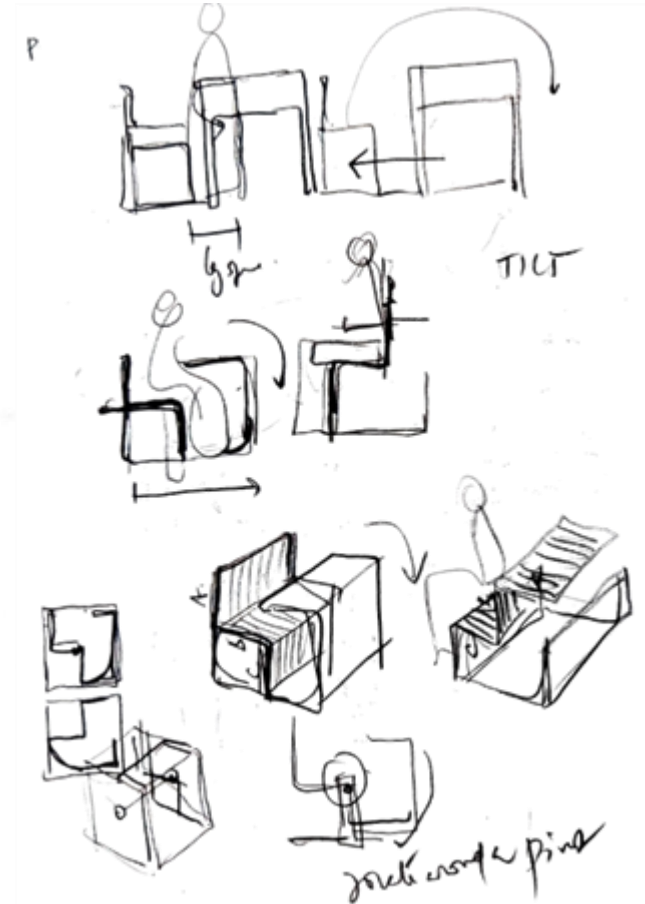
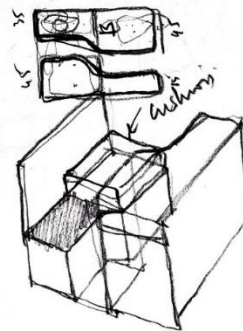
- **Physiological** needs like ability to make **seating adjustments**
- Maintain mobility and independence
- Sit to stand transfer and comfort
- Transformability and ease of operations

- **Psycho-social** needs like ability to **adjust seating layout** for conversations and interactions
- Flexibility to do other activities like playing carom, read newspaper etc.
- Self-respect and ownership

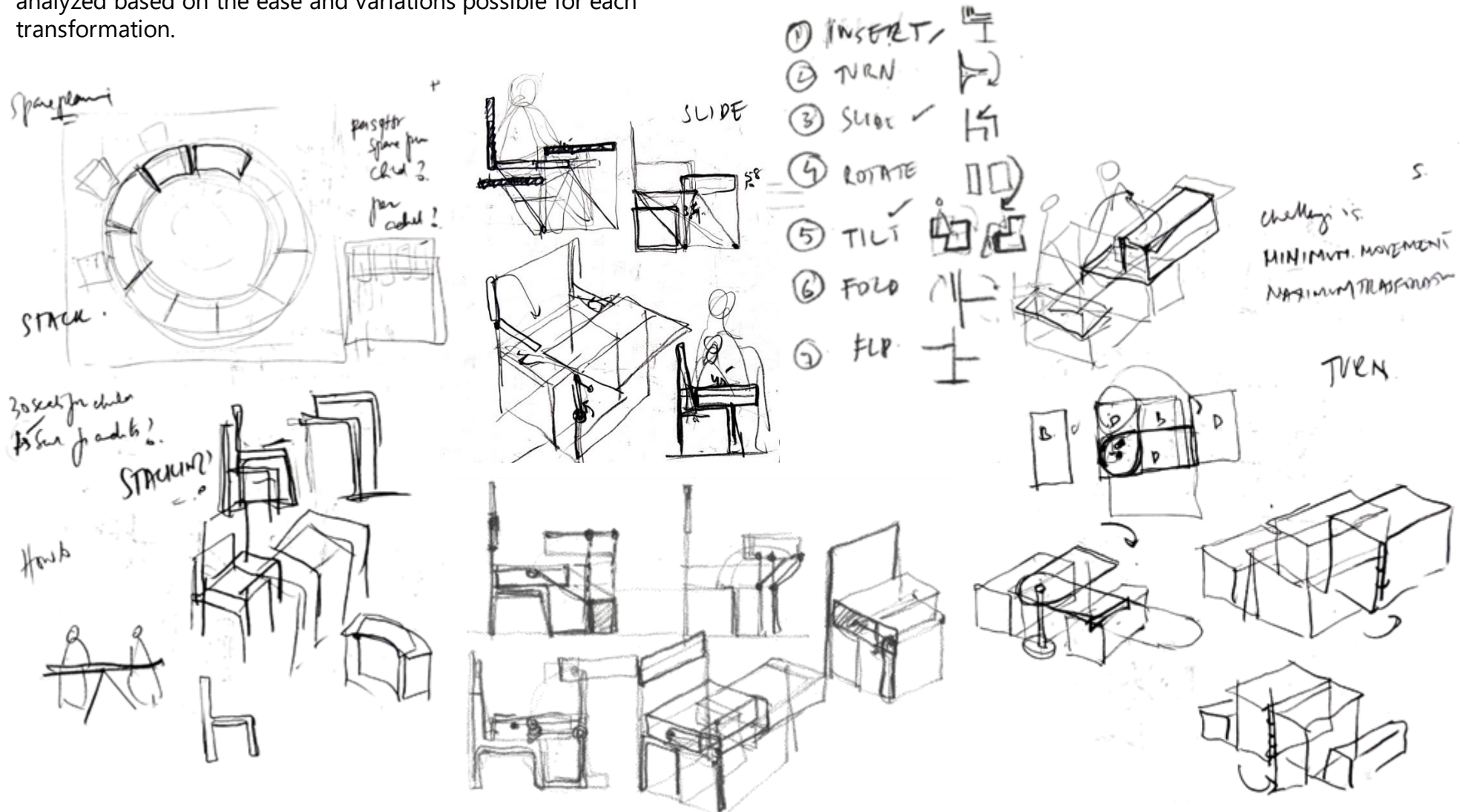
Different ideas were developed for transforming the furniture for both user groups based on both the physical and psycho- social requirements.

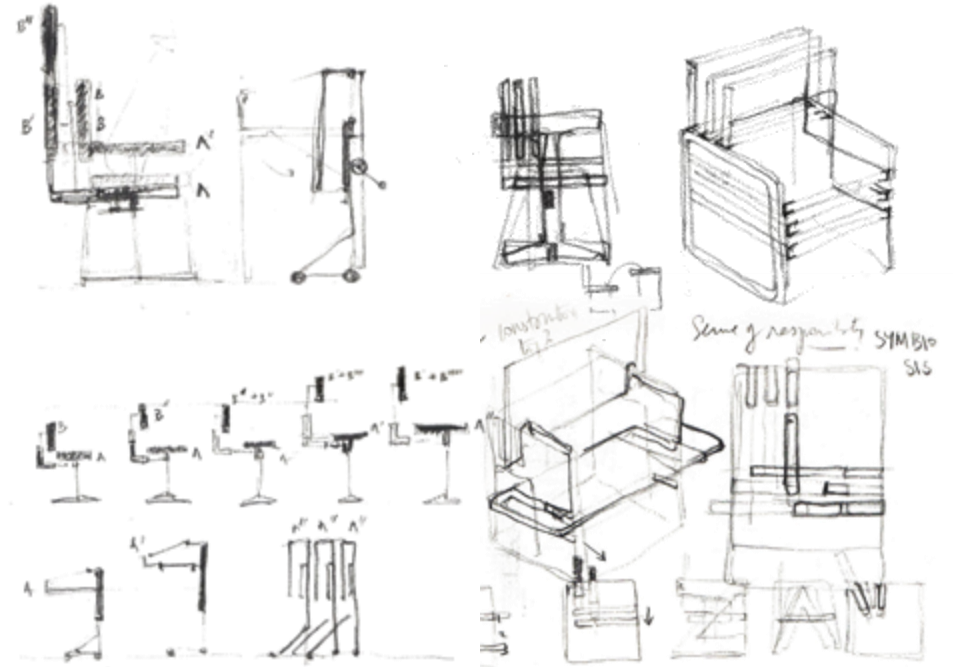
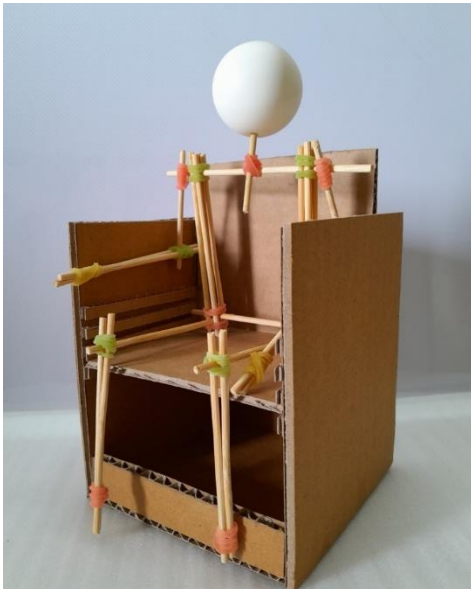
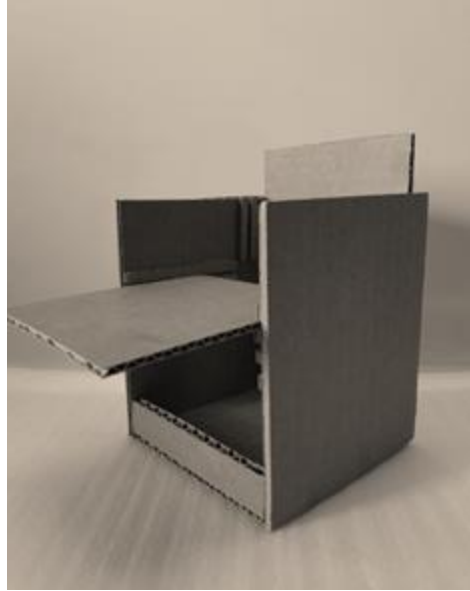


Height uniform +
for new for child

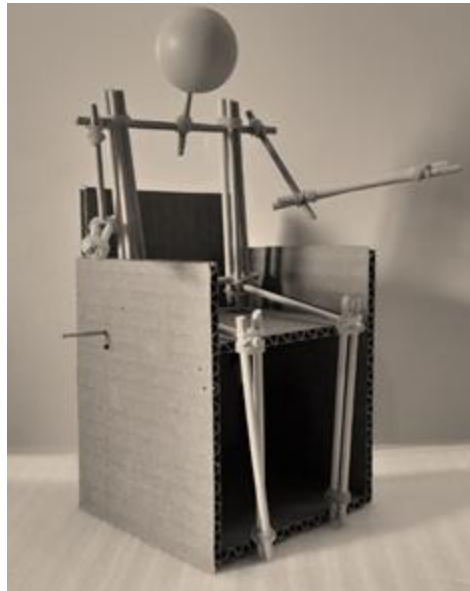
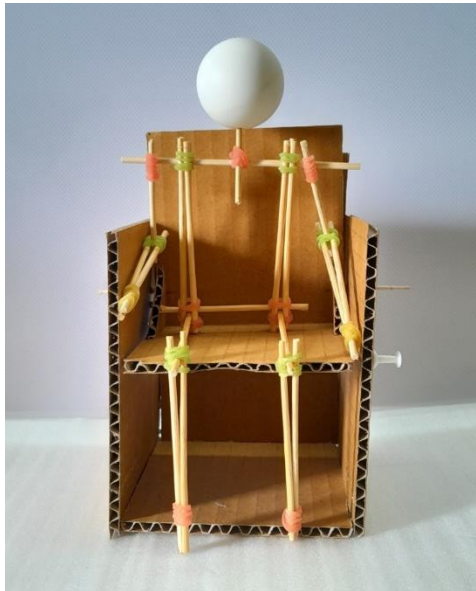
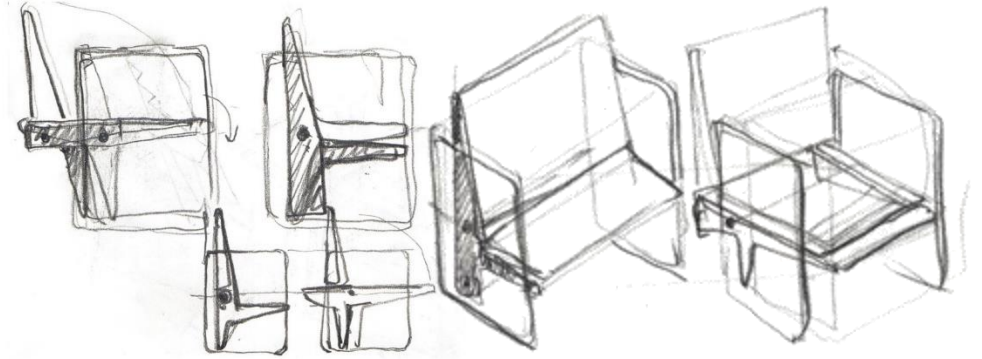
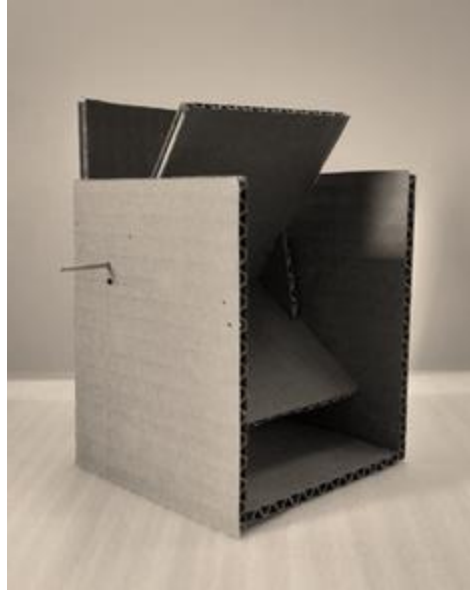


These ideas were later grouped under specific categories of physical operations and was explored further. These are later analyzed based on the ease and variations possible for each transformation.

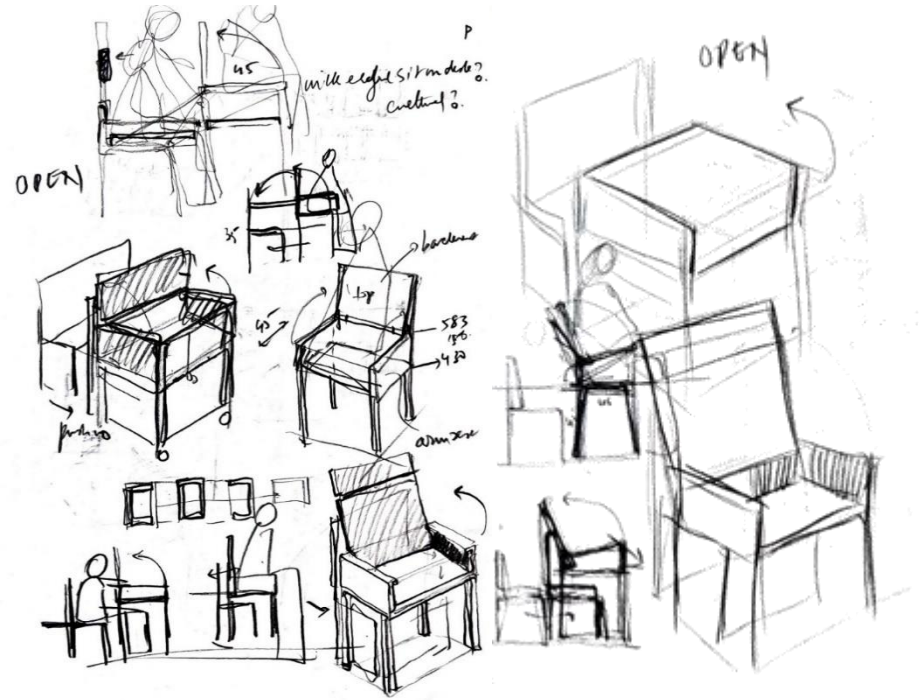
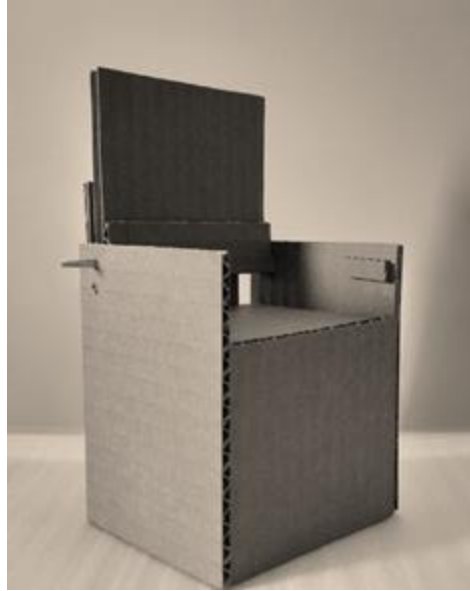




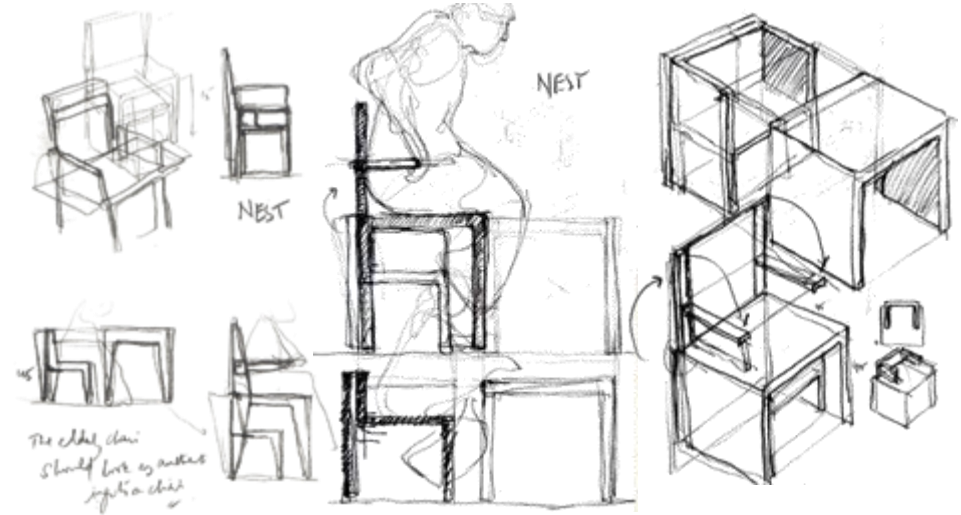
This option gives the flexibility to adjust the height and depth of the seat for children and elderly by sliding in the horizontal and vertical elements that act as the seat and backrest. The table is not considered as part of this option.



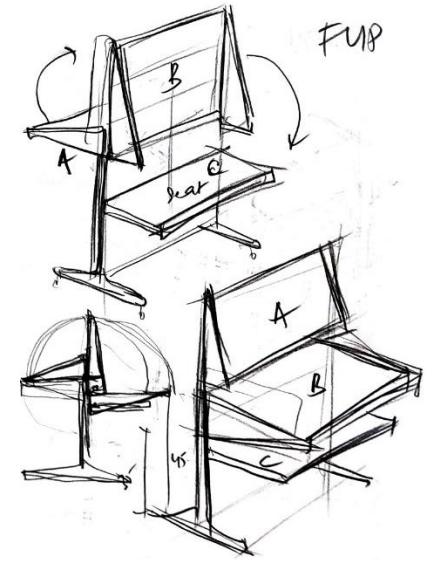
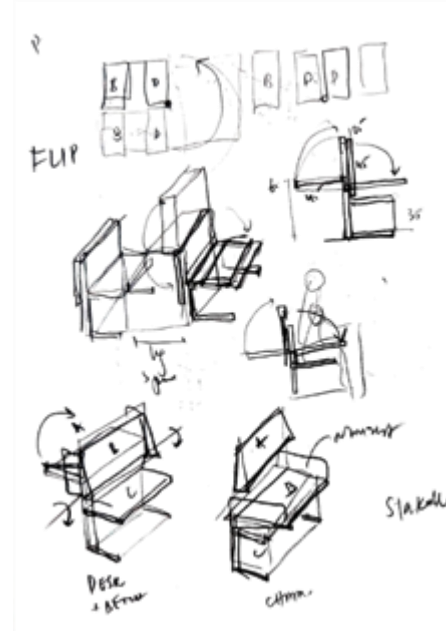
The seat has an internal part that when turned forms a secondary seat which is high and deep enough for elderly. The desk is independent.



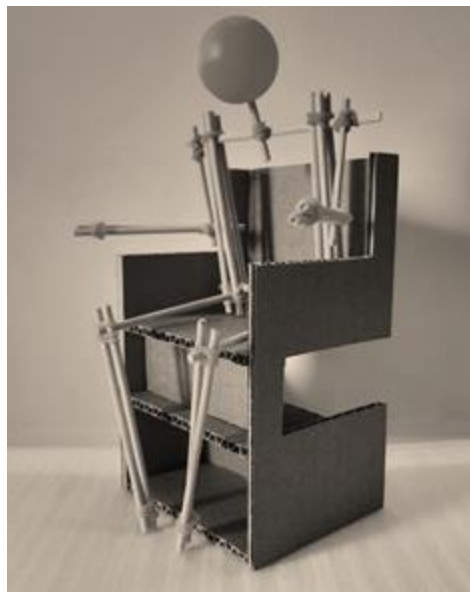
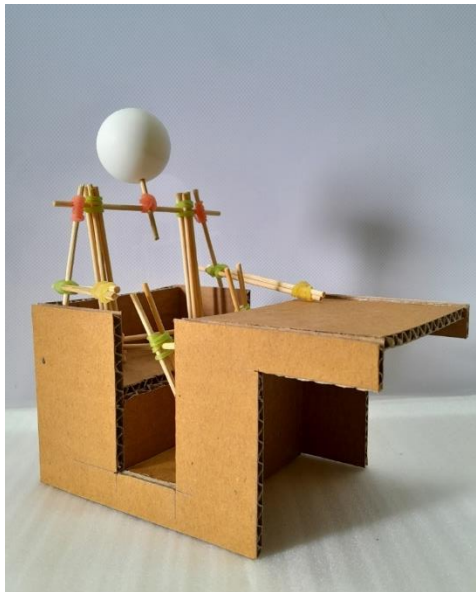
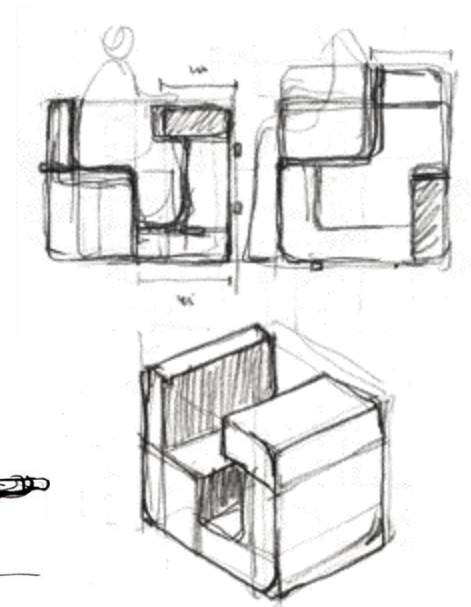
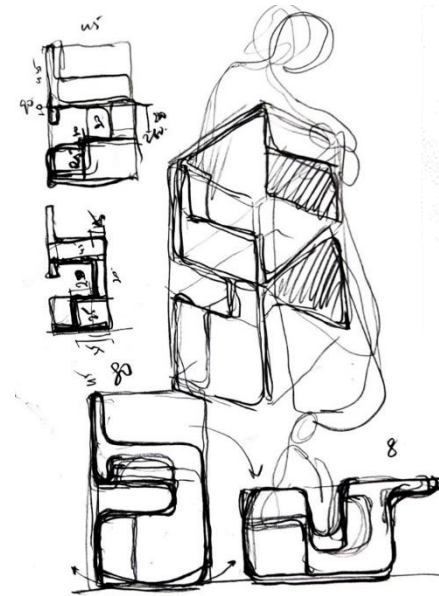
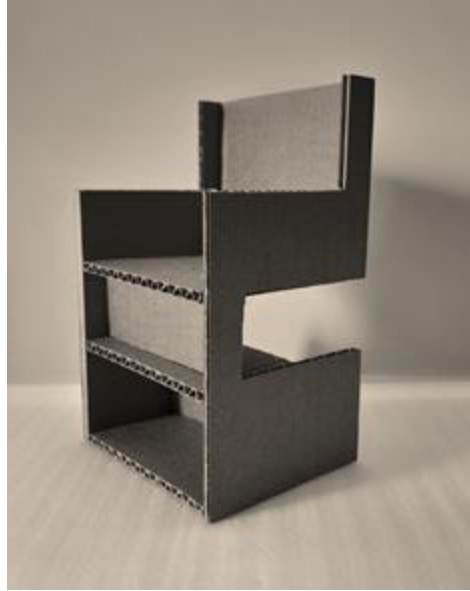
In this option the desk opens up as a chair for the elderly. The height of the inner shelf becomes the height of chair. The seat for the child is independent.



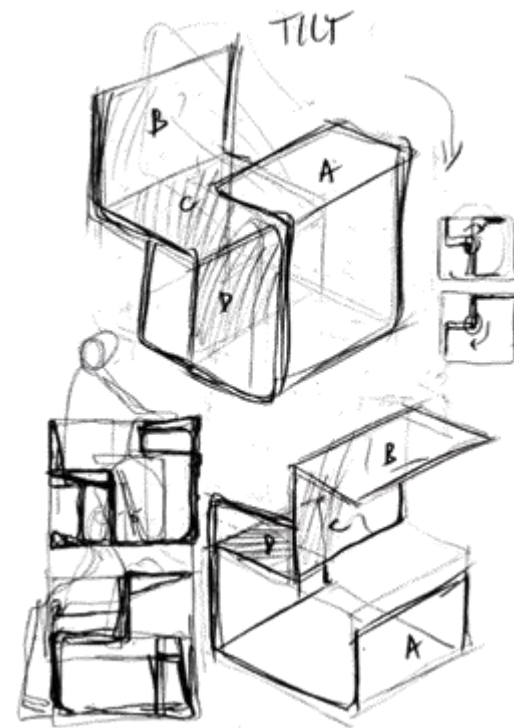
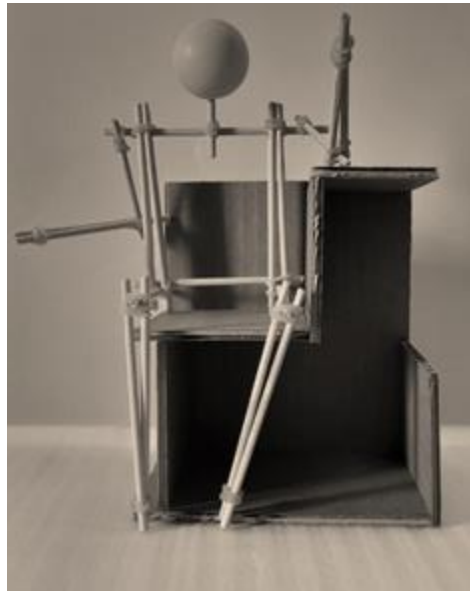
This is for lower primary classroom where the desk of the child becomes the seat for elderly and the chair of child can be nested inside the desk.



This option has the common element that has the seat in the front and desk behind. When flipped it becomes the chair for the elderly.

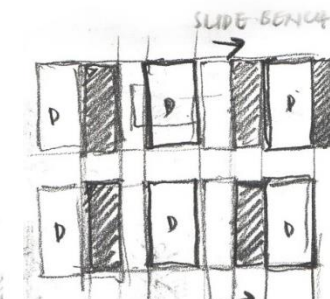
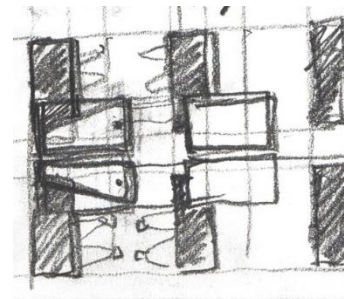
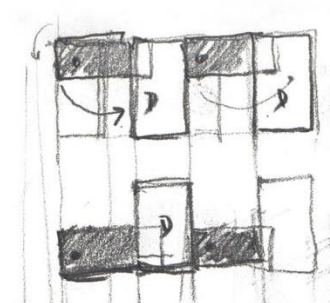
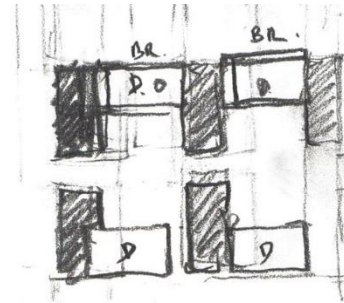
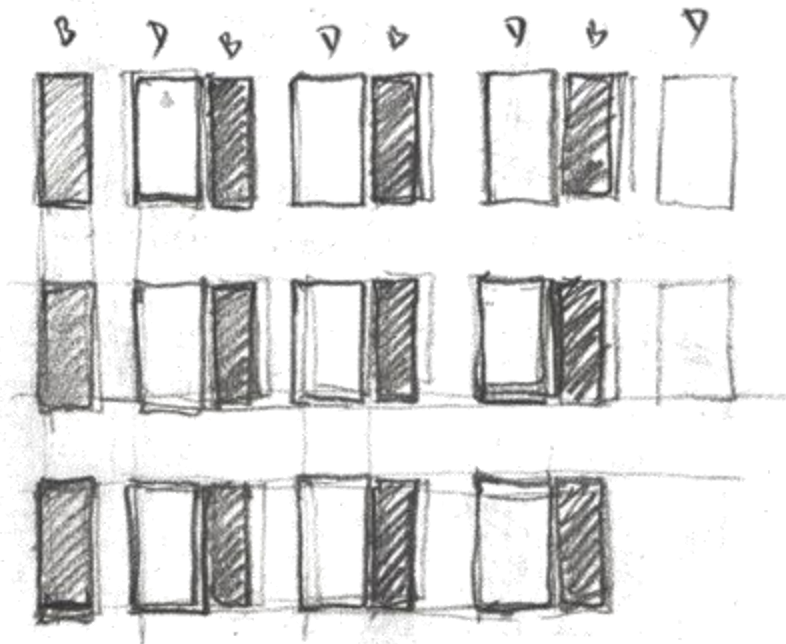


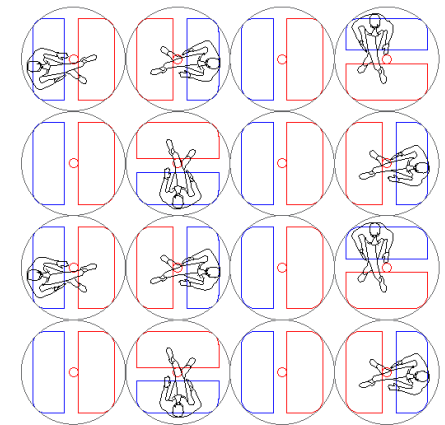
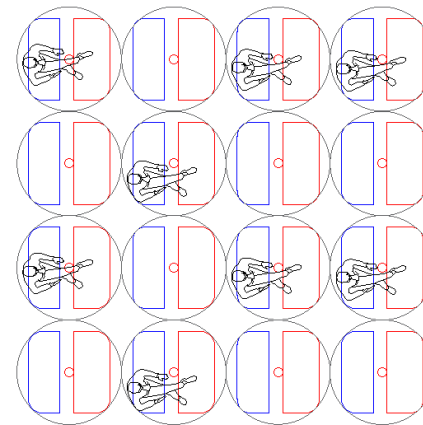
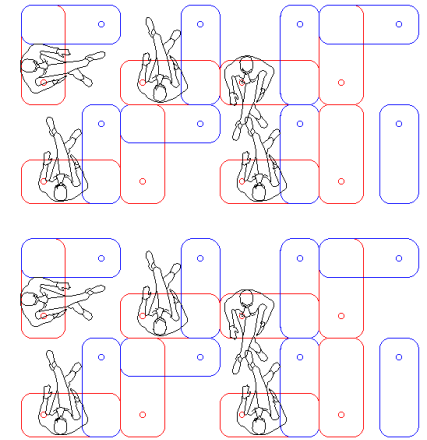
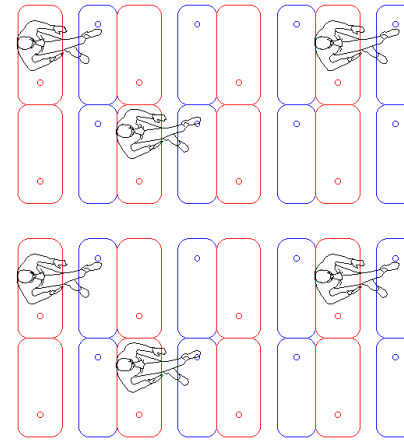
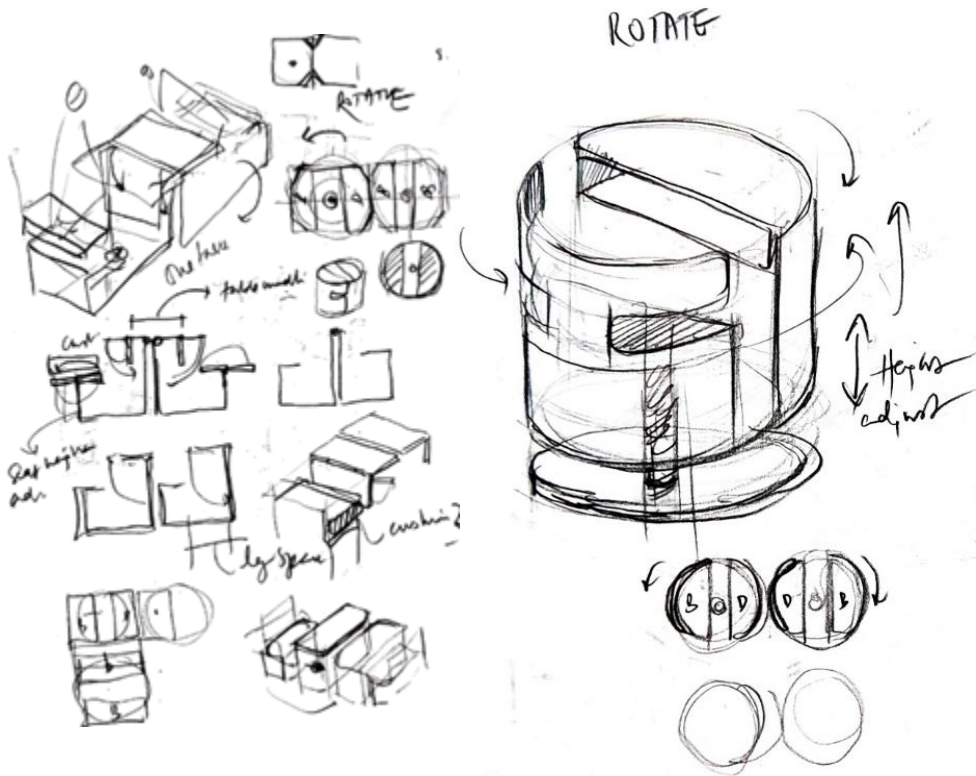
In this option the desk and chair is for lower primary children. And when tilted it becomes a chair for elderly.



In this option the desk and chair is for lower primary children. And when tilted it becomes a chair for elderly.

The previous explorations focused on transforming the furniture to achieve the required heights and depths for seating for children and elderly. The next step was to find ways to achieve different orientation and layouts possible. For the children the orientation is towards the blackboard, whereas for elderly they need to forms groups or sit face to face for conversations. Hence different layouts were explored.



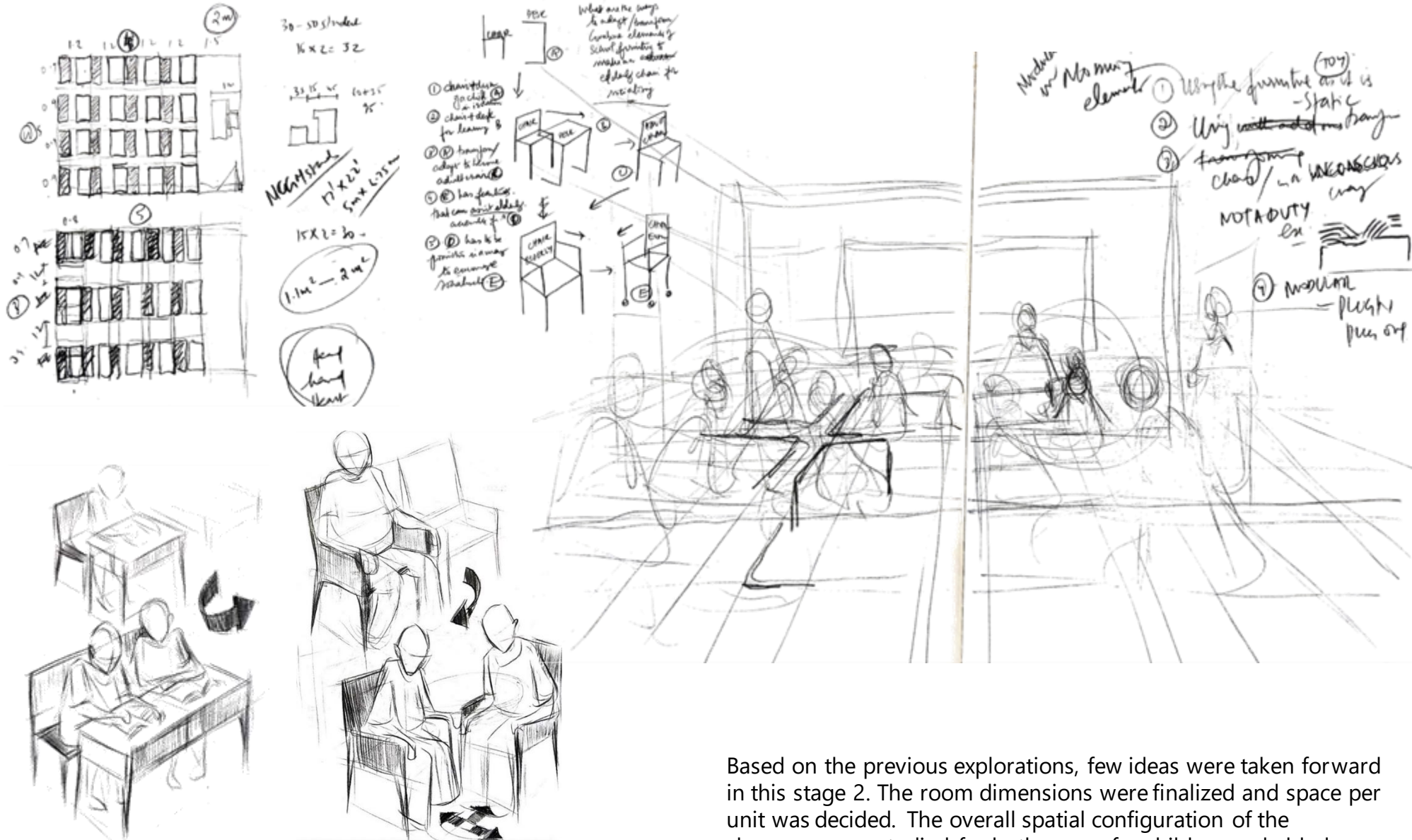


In this option the seating is meant to rotate for the elderly to sit face to face or at 90 degrees. Different layout were explored to understand the possibilities, but considering the practical issues this was not taken further.

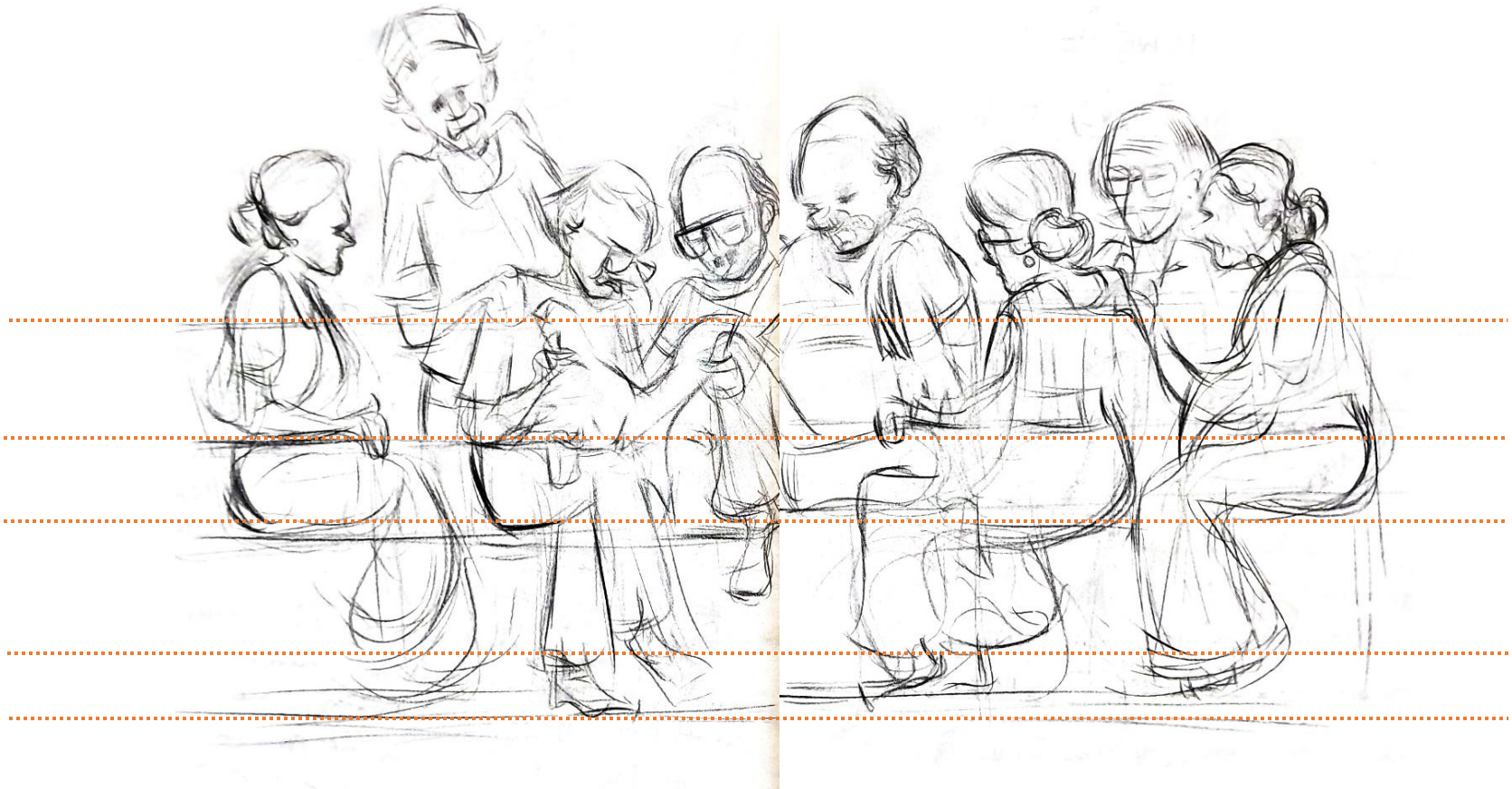
All the operations are compared and analyzed based on the criteria of chair/ desk transformation, space utilization, ease of operation, number of adjustments. The tilt option satisfies most of the criteria and few of the features of other options were taken forward for the second stage of ideation.

	Chair/ desk transformation	Space utilization	Difficulty of operation	Adjustments	Flexibility of layouts	Class/ group of children
Slide	Chair only, desk to be separate	Takes up space of chair and desk	Seat and backrest to be lifted and slid	3 levels of adjustments	Single orientation	8-13
Turn	Chair only, desk to be separate	Takes up space of chair and desk	Adjusted in single operation of turning	2 levels of adjustment	Single orientation	10-13
Open	Desk transforms to chair	Takes up space of desk	Adjusted in single operation of turning	2 levels of adjustment	Single orientation	13-15
Nest	Desk and chair combine to chair	Can be nested when not in use	Multiple operations	2 levels of adjustment	Can be oriented as required	5-7
Flip	Desk transforms to chair	Can be stacked horizontally	Multiple operations	2 levels of adjustment	Single orientation	10-13
Tilt	Desk becomes the chair	Can be stacked	Single operation of tilting but heavy	2 levels of adjustment	Can be oriented as required	5-7 /10-13

stage 2 : design directions



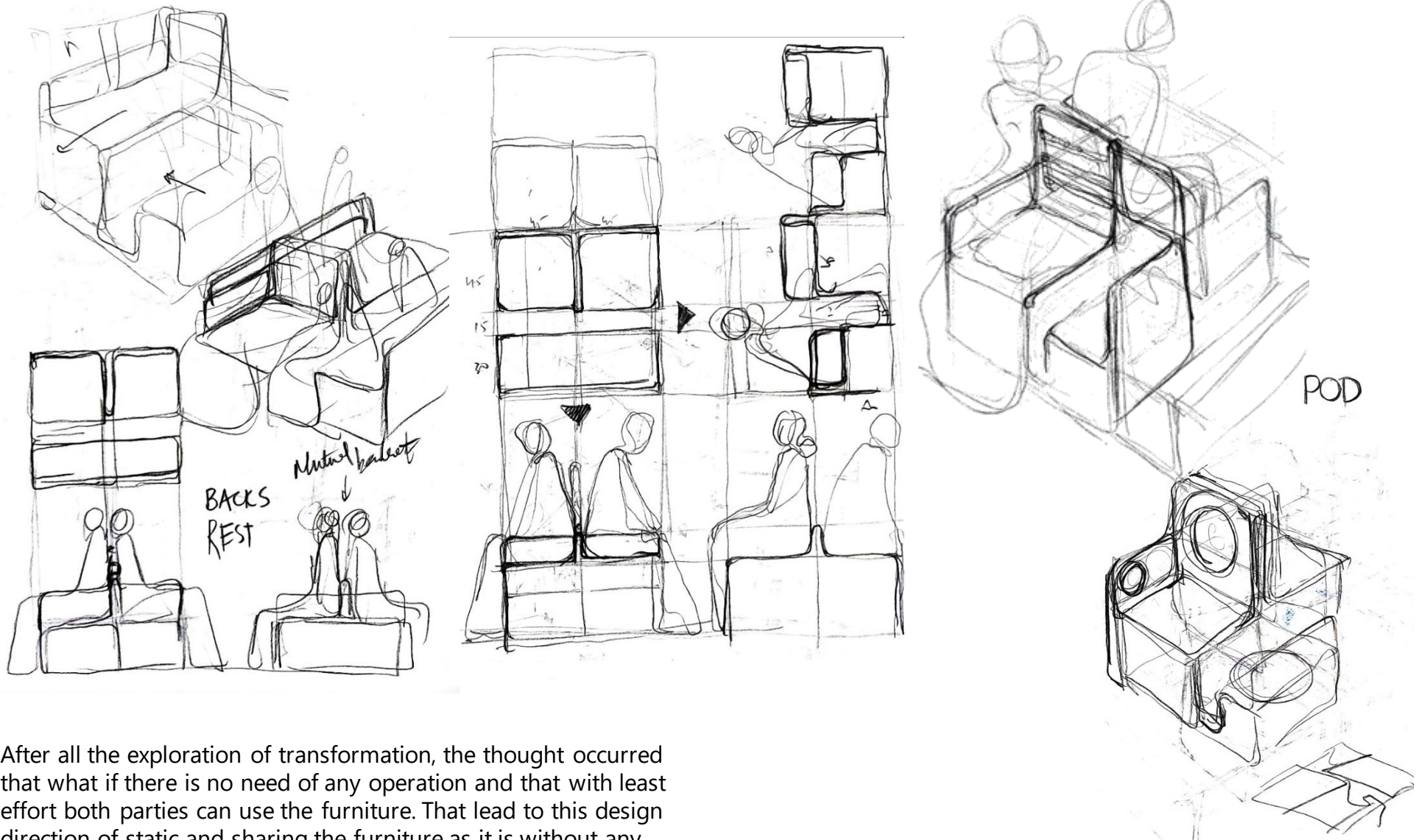
Based on the previous explorations, few ideas were taken forward in this stage 2. The room dimensions were finalized and space per unit was decided. The overall spatial configuration of the classroom was studied for both usage for children and elderly.



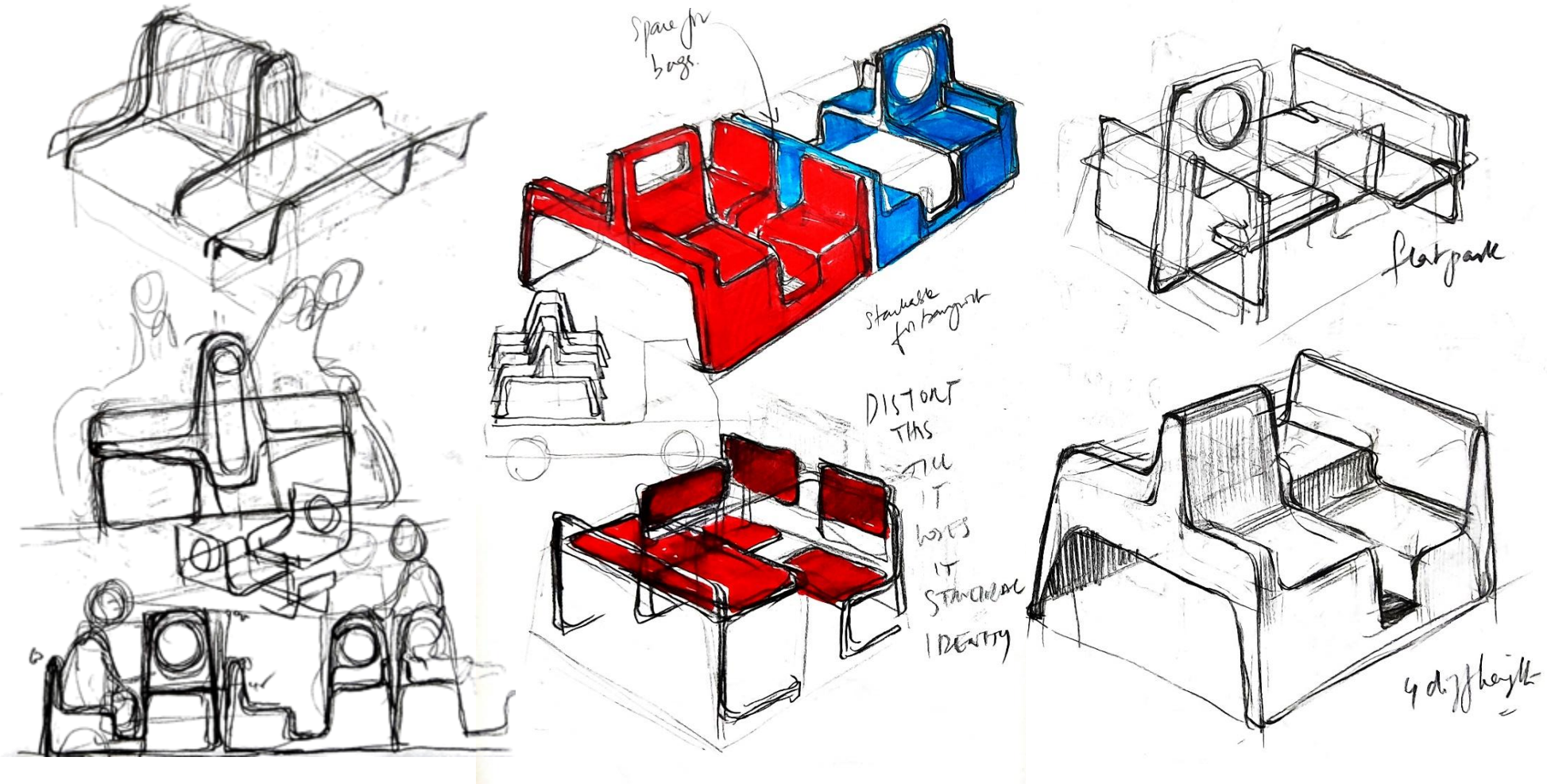
During the studies it was observed that there are 5 critical lines of interaction namely, ground, foot rest, seat, arm rest, back rest. These primary levels were considered and the different options were explored for seating.

These further led to 4 main design directions as shown below :

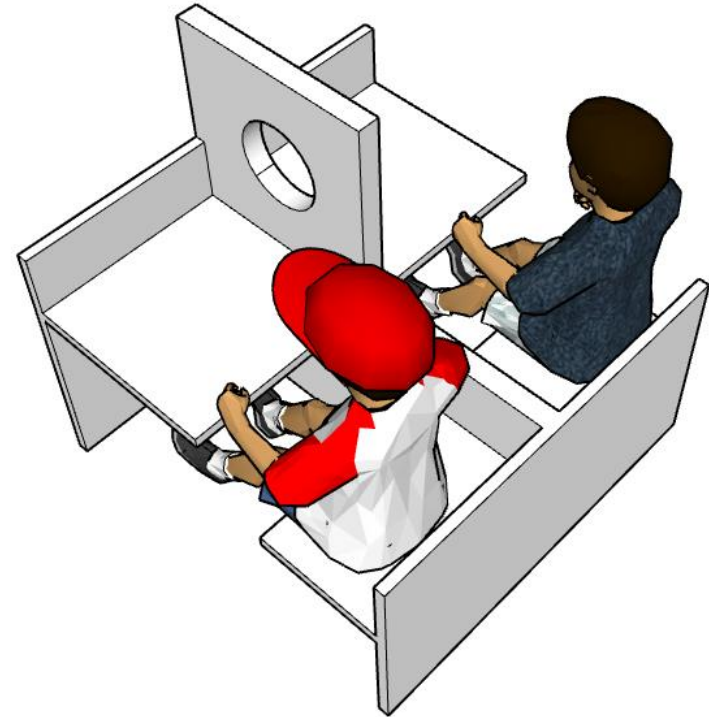
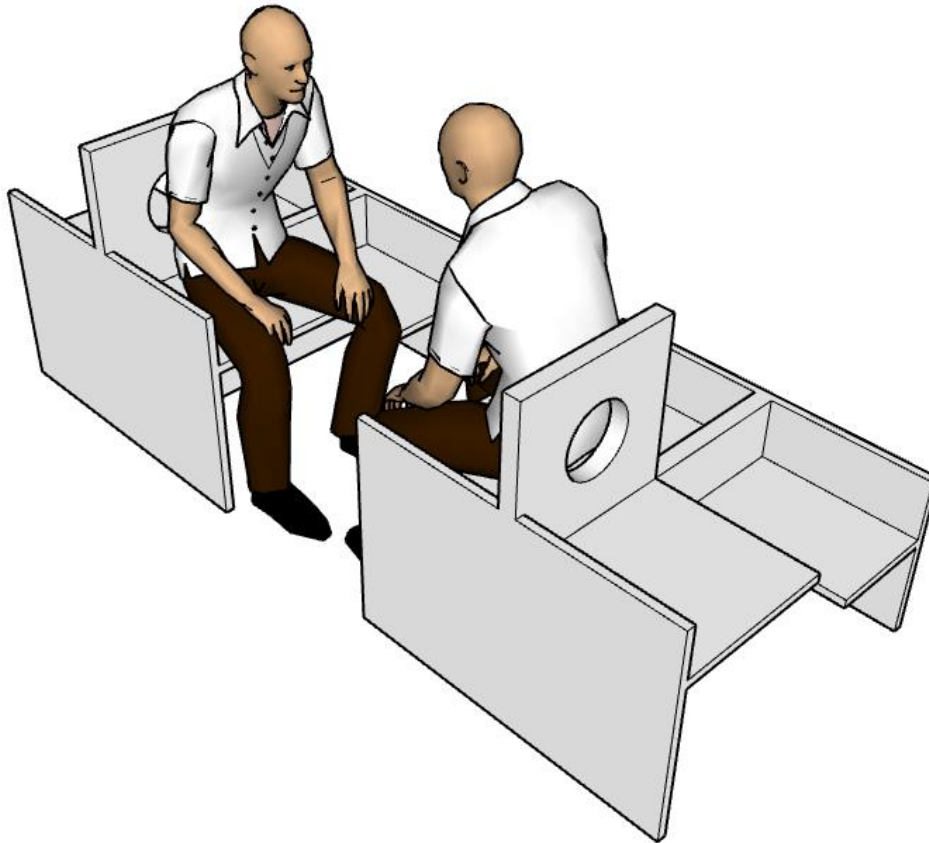
- 01 : **static | sharing**
- 02 : **movement | wonder**
- 03 : **operation | delight**
- 04 : **configure | freedom**



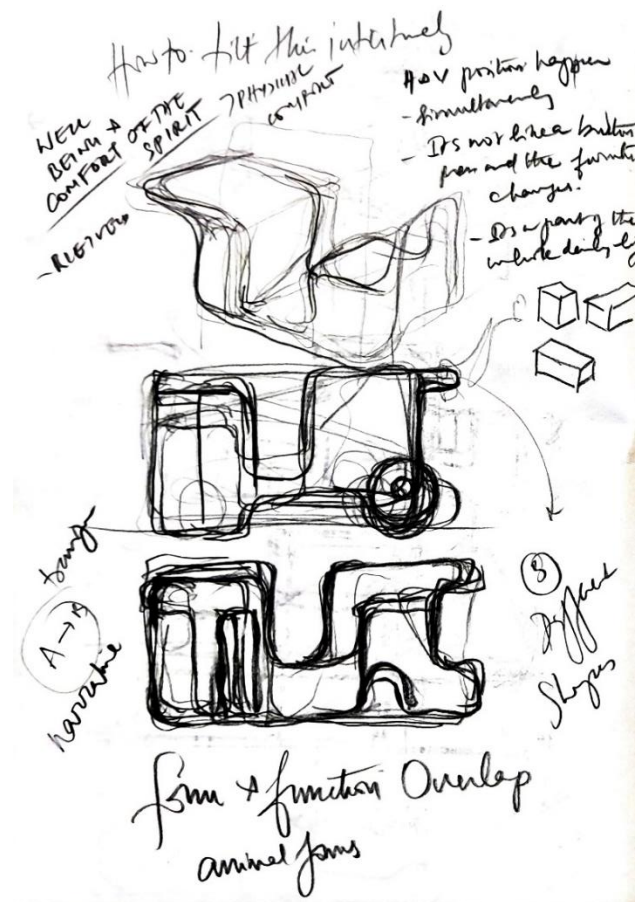
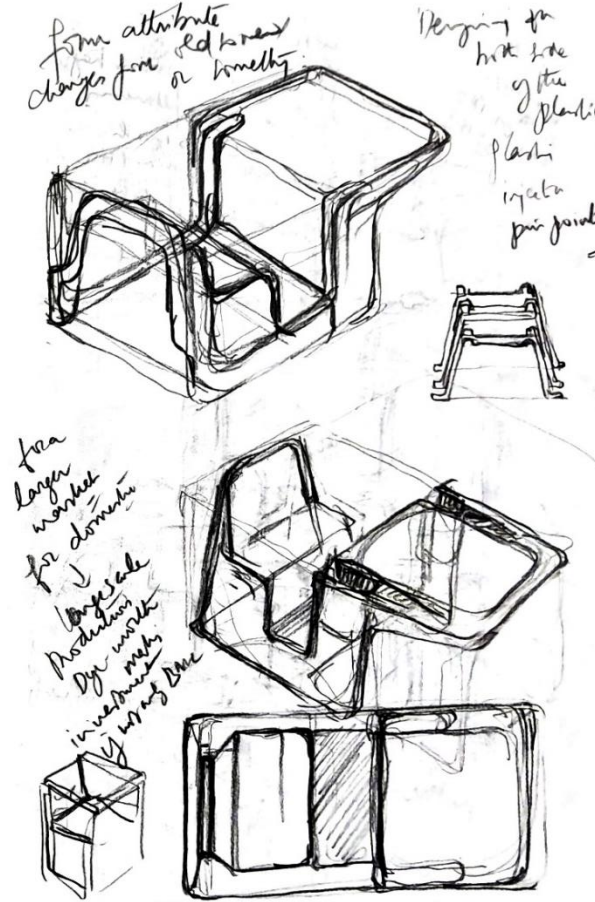
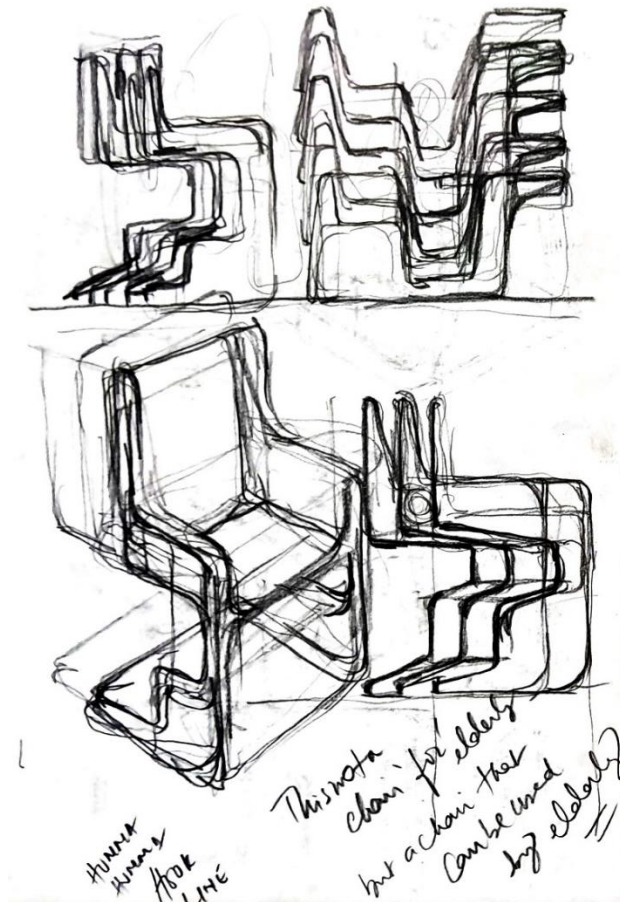
After all the exploration of transformation, the thought occurred that what if there is no need of any operation and that with least effort both parties can use the furniture. That lead to this design direction of static and sharing the furniture as it is without any transformation.



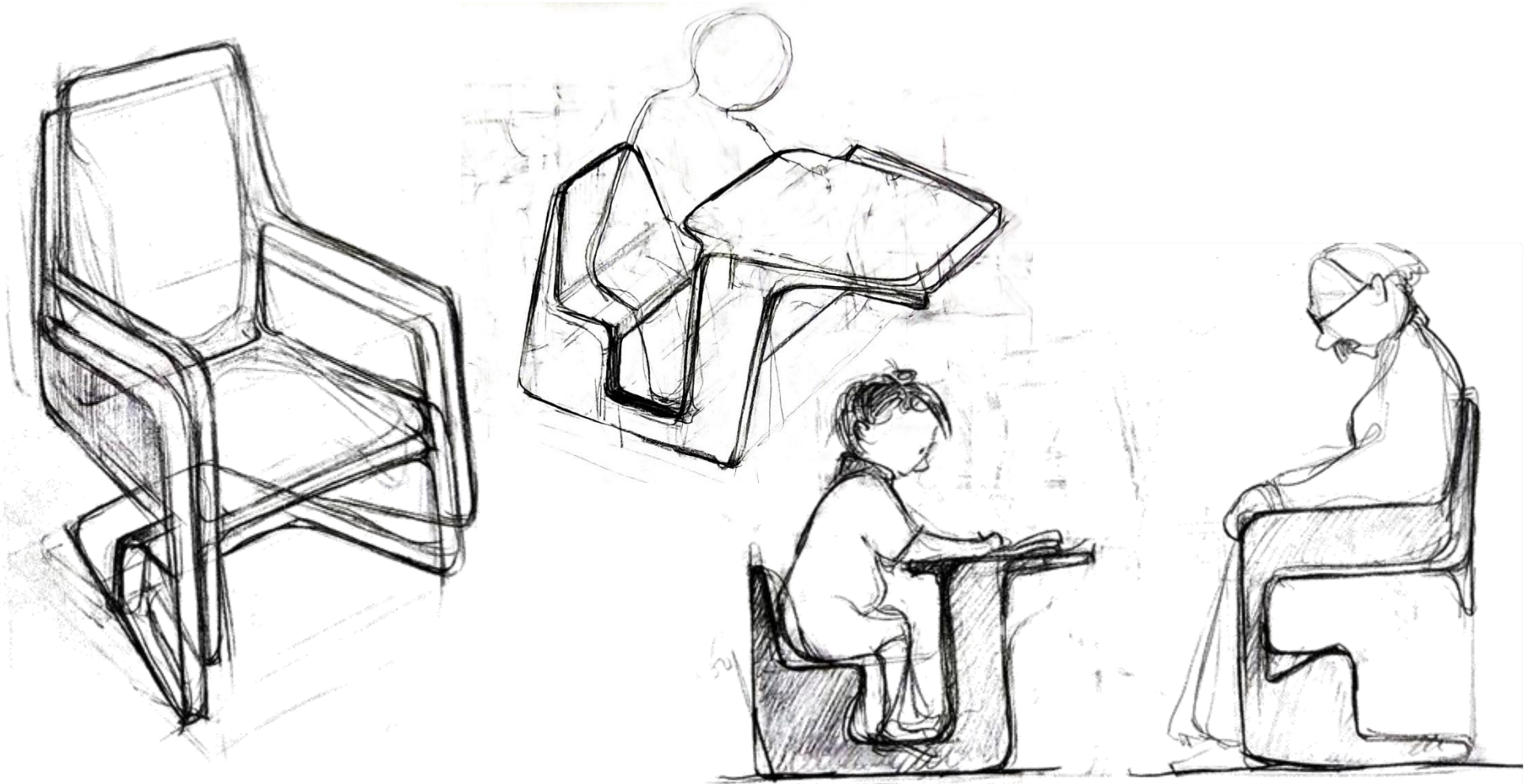
This furniture is for the lower primary classroom where the desk height is 46 cm which matches the height of the chair for elderly. This became the core idea and the form was explored further.



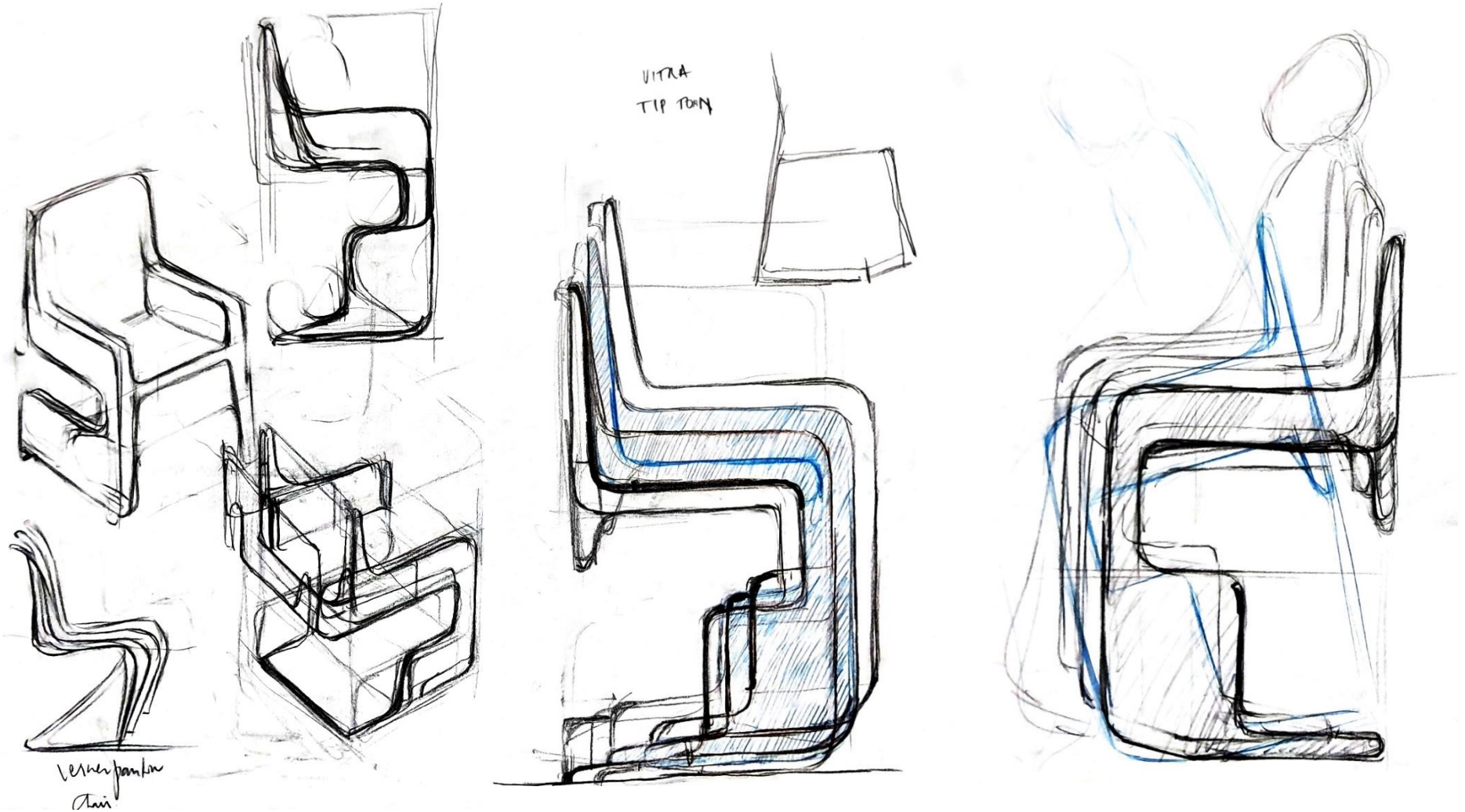
The orientation of the seating for elderly is perpendicular to the desk of children which help the elderly to sit facing each other for conversations.



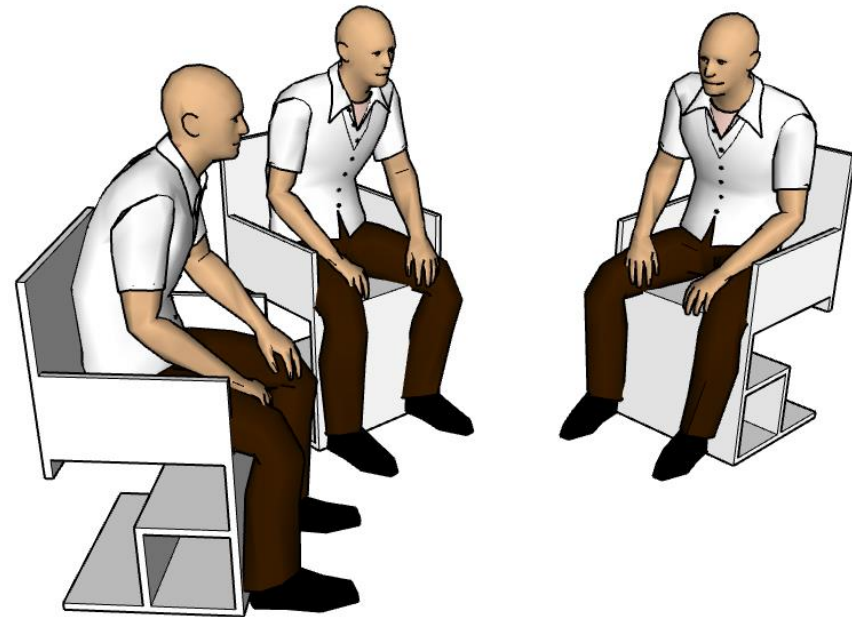
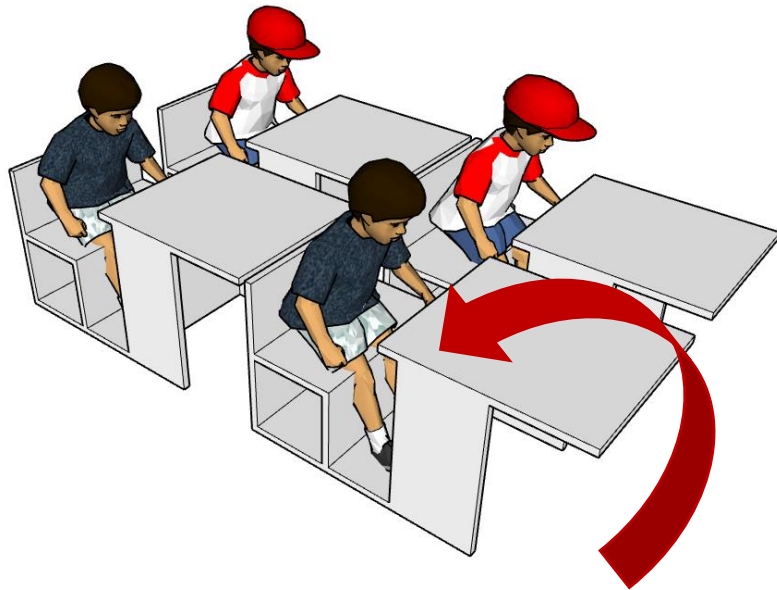
The second direction involves some movement for usage by either parties and it leads to sense of wonder while making this change.



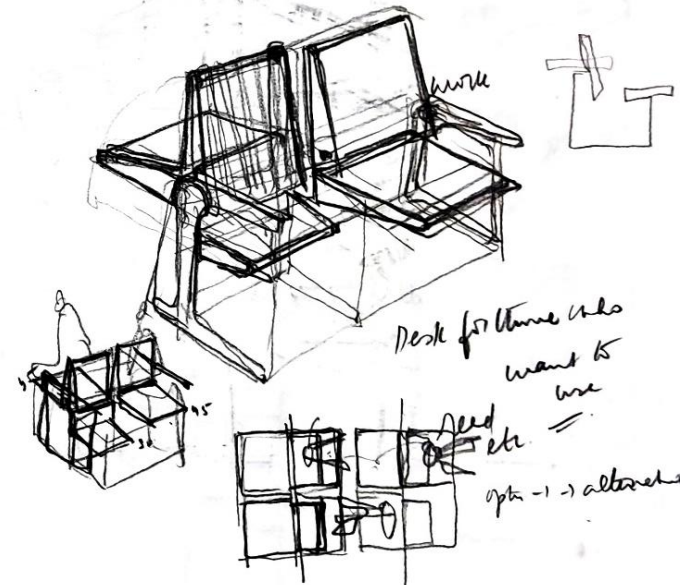
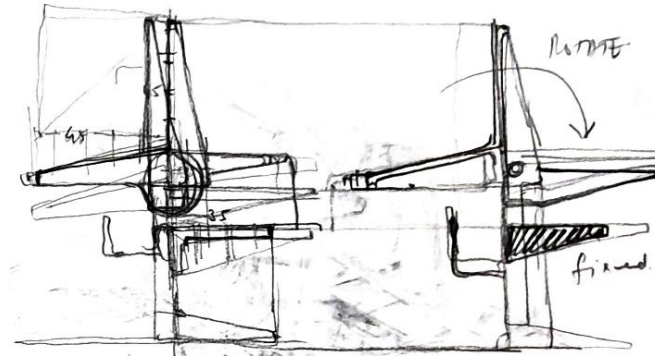
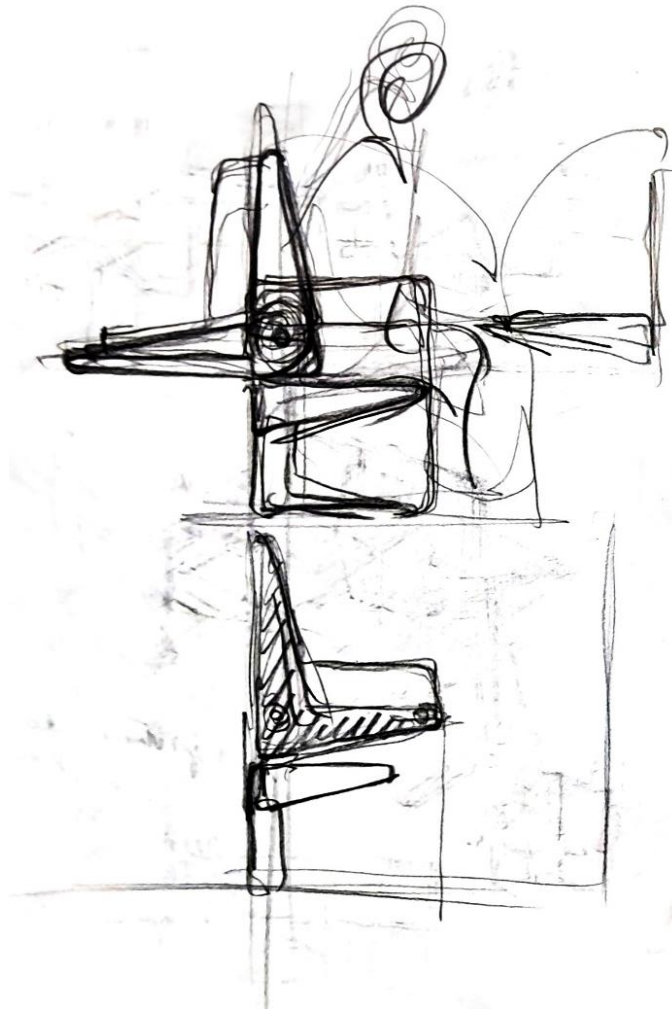
In this direction the desk and chair arrangement of the child changes into a normal looking chair when tilted



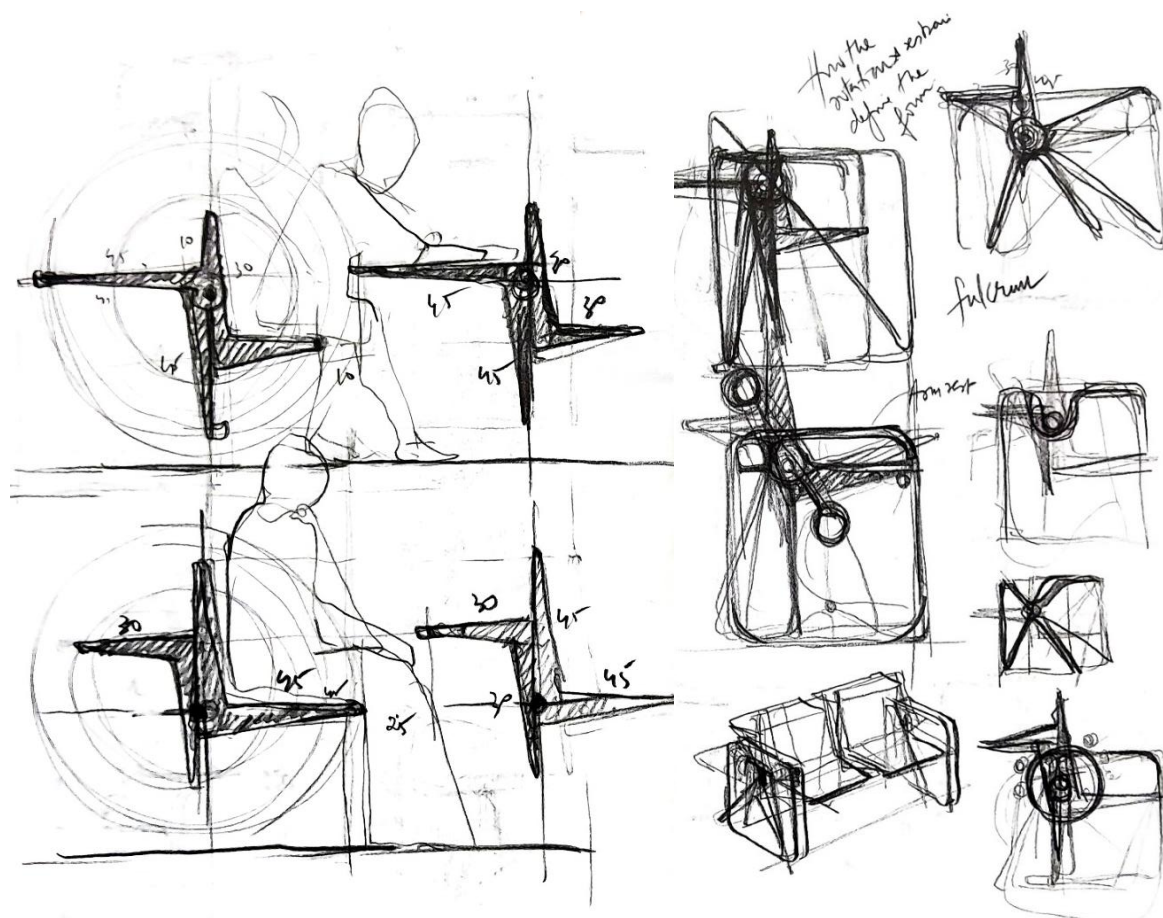
These can be designed as stackable chairs for storage. These are light weight and can be oriented as per the requirement of both parties.



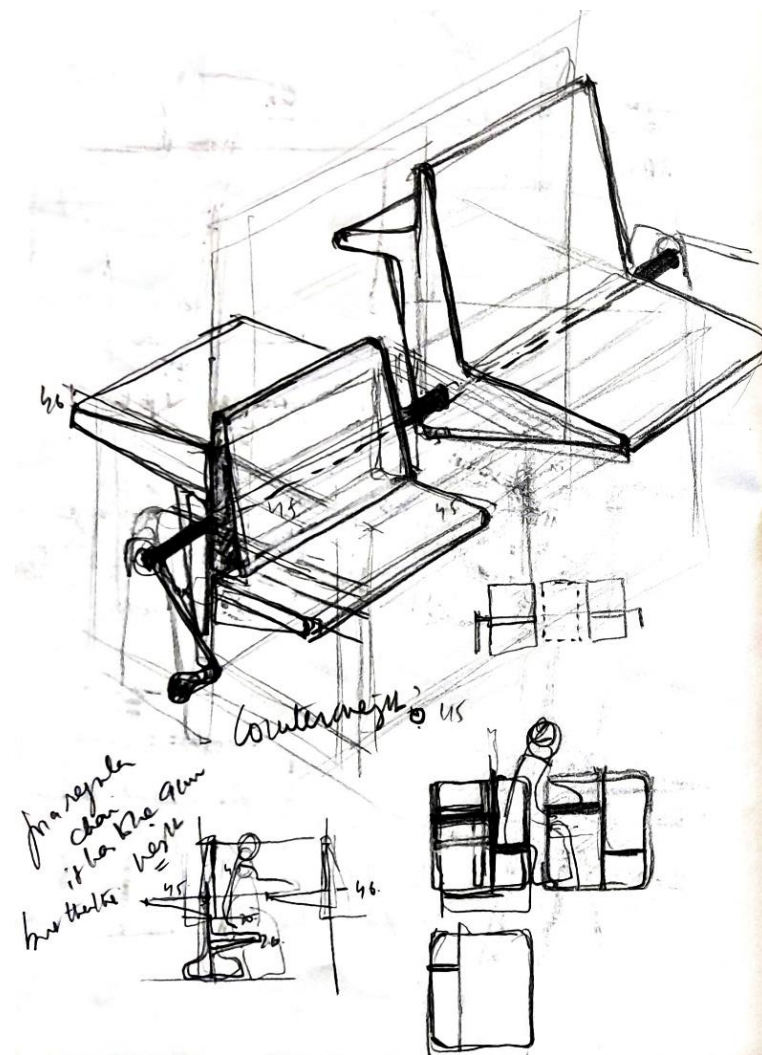
Tilting the furniture after every session of usage will be a task and can become a problem especially for critically weak elderly people.

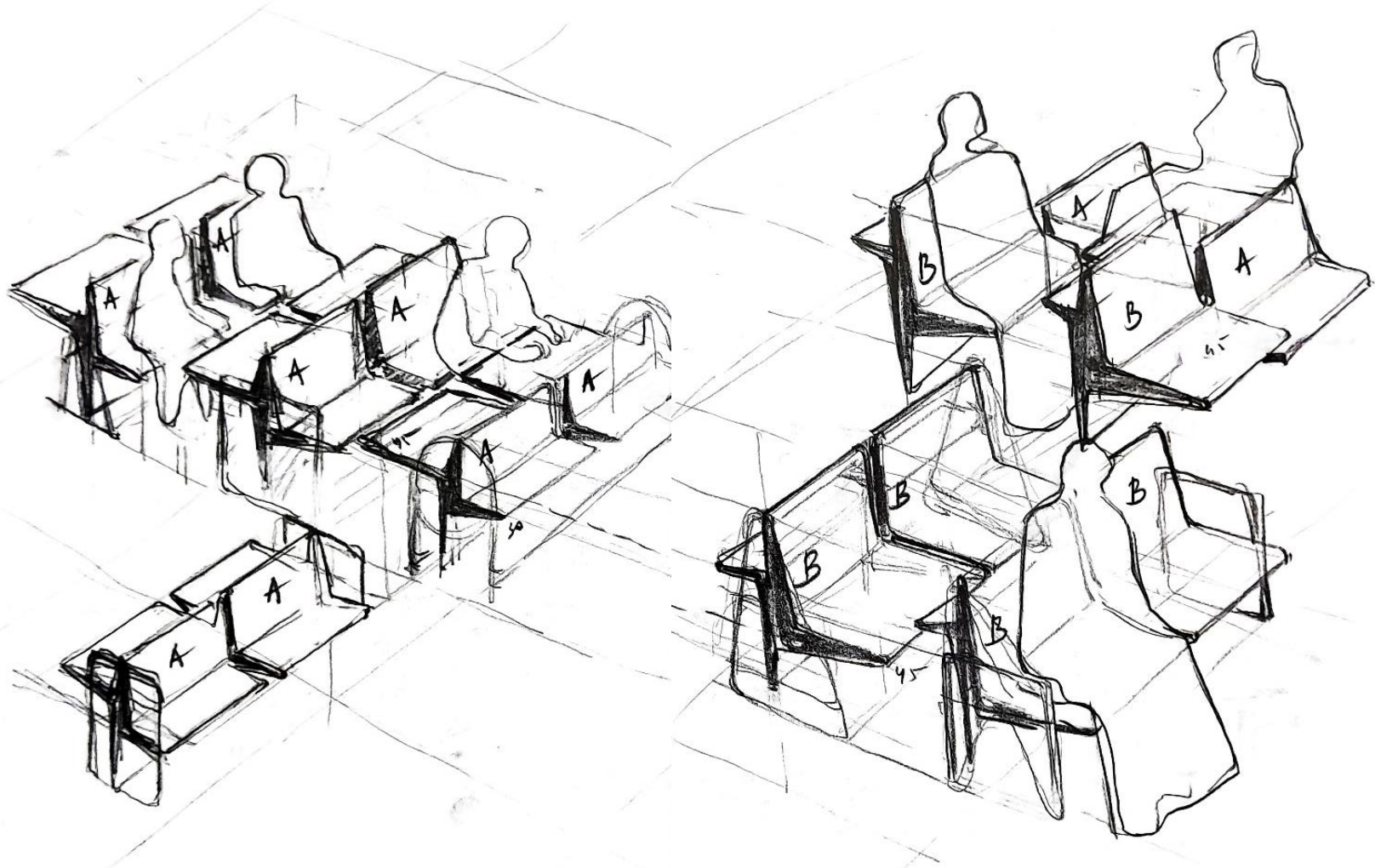


The third direction involves more effort for operation than the last 2 direction. This is a refined version of one of the operations discussed earlier.

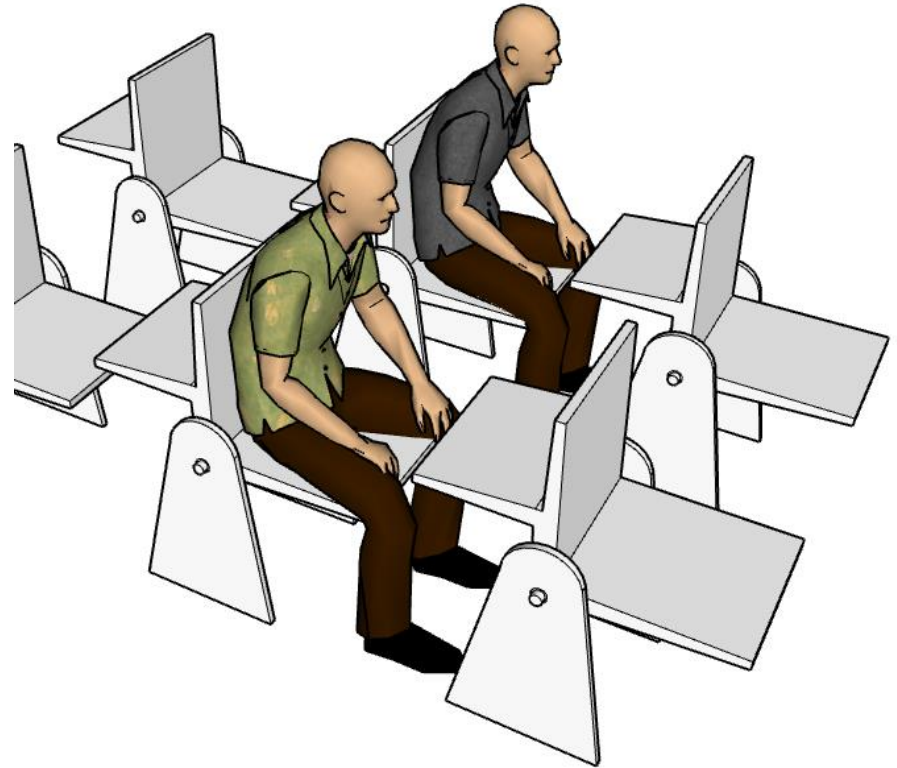
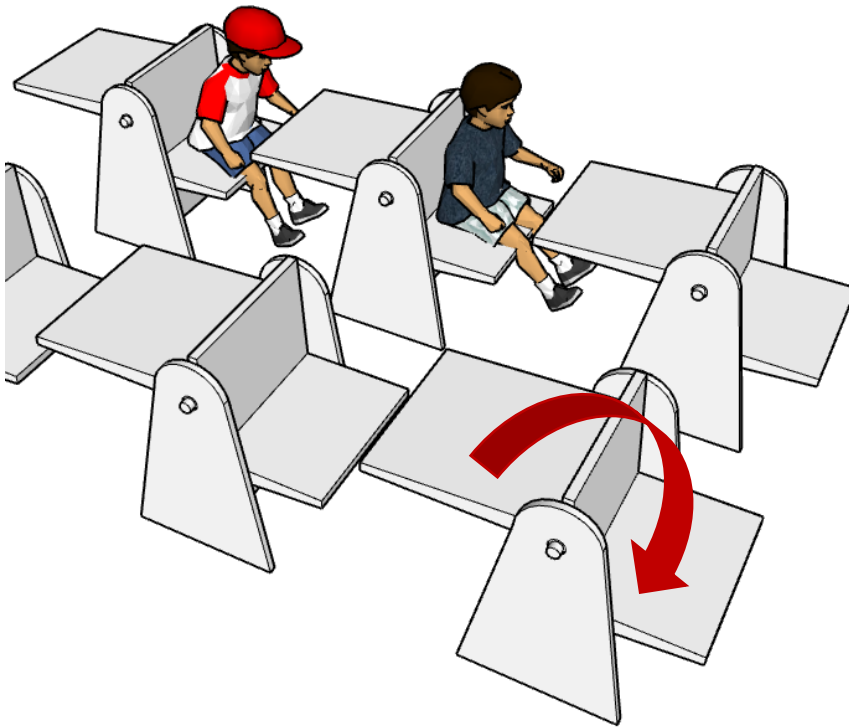


Here the desk and seat are fused into a single component which when tilted forms the chair and desk for children, and chair for elderly.

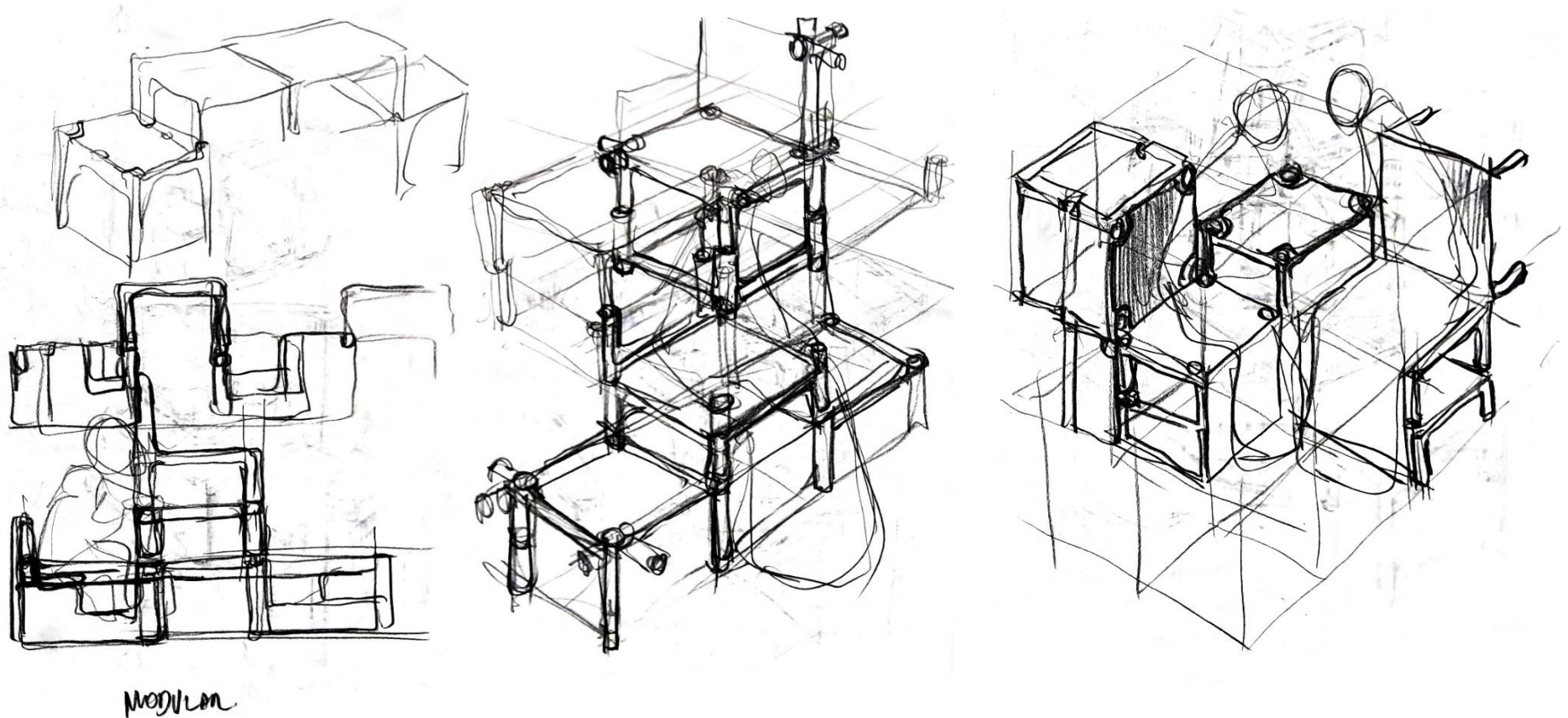




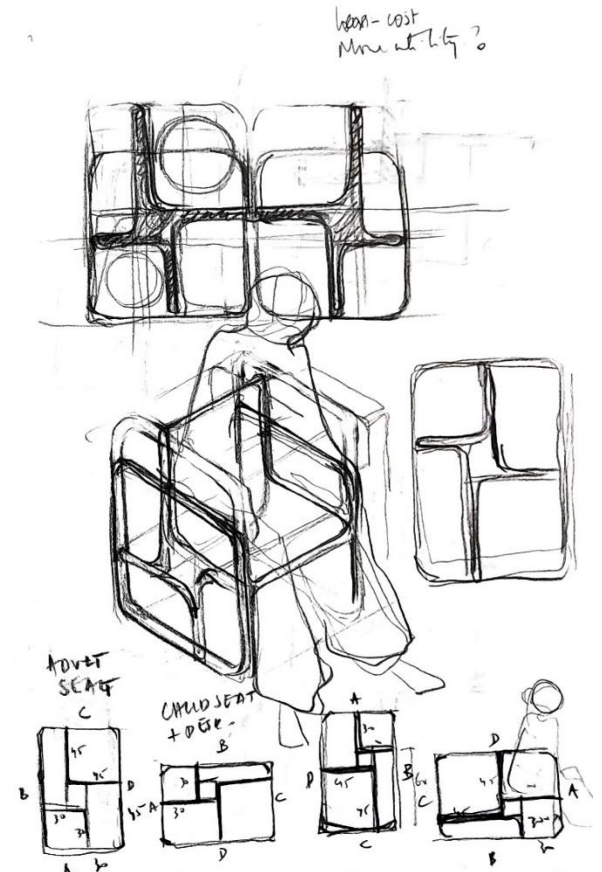
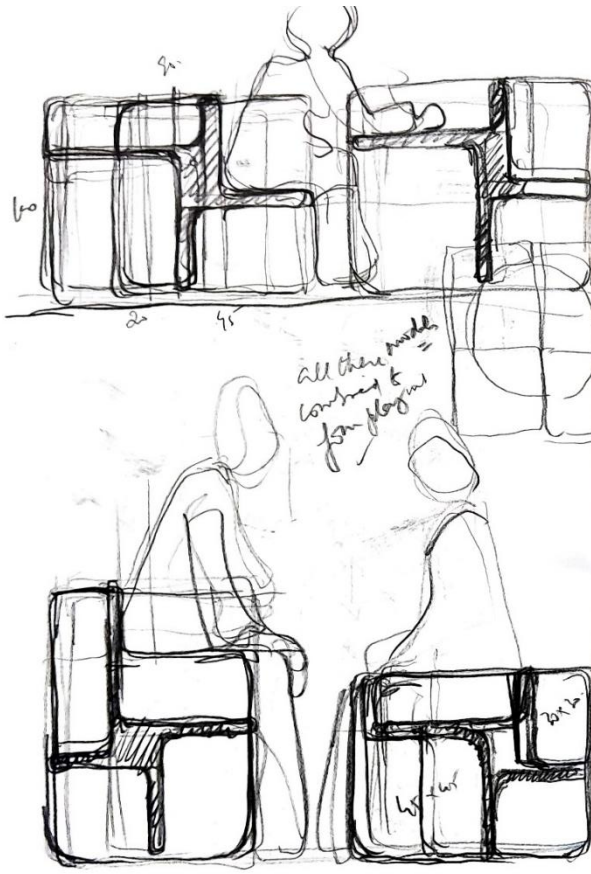
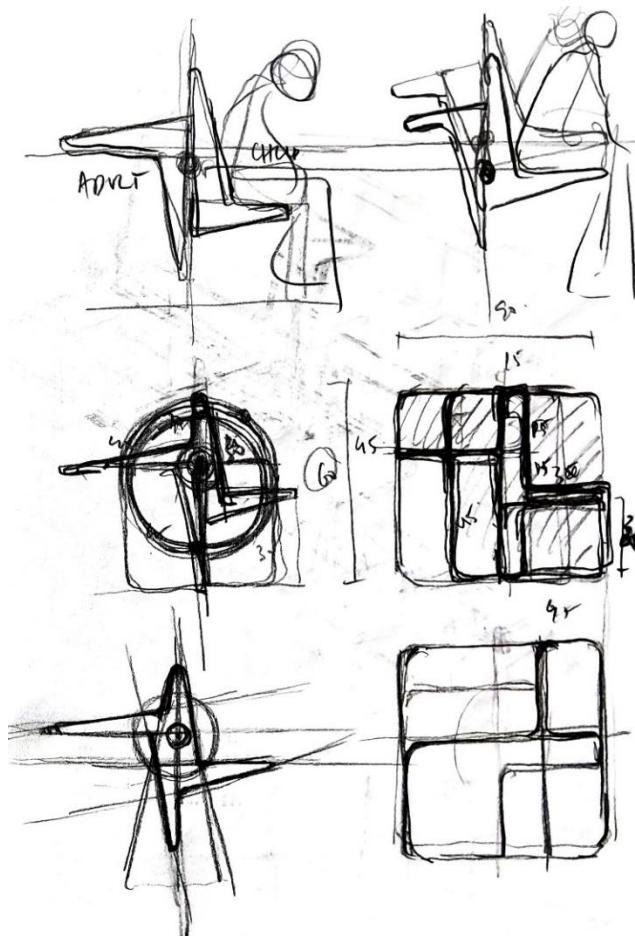
There will be a frame on which the tilting operation happens and the operation has to be something that is delightful and welcoming to use.



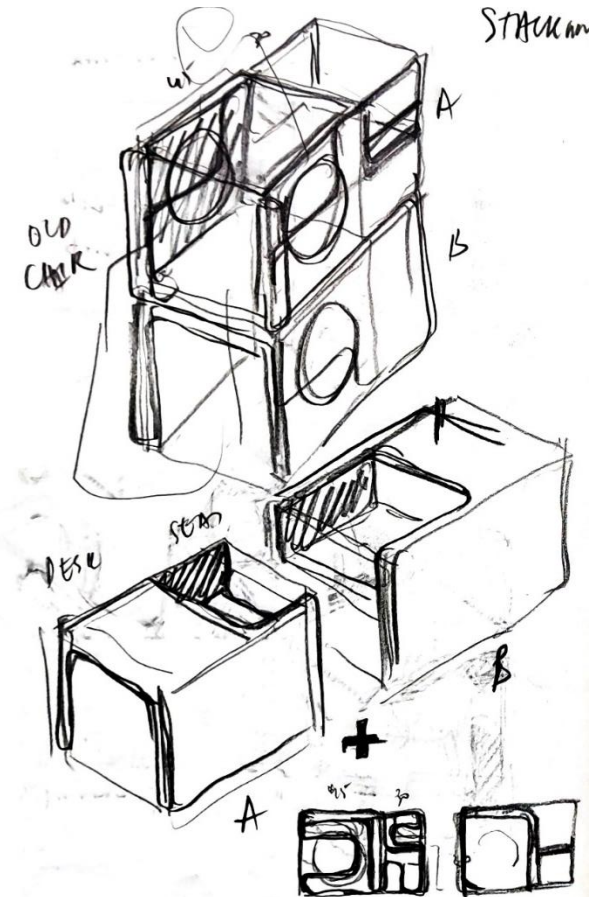
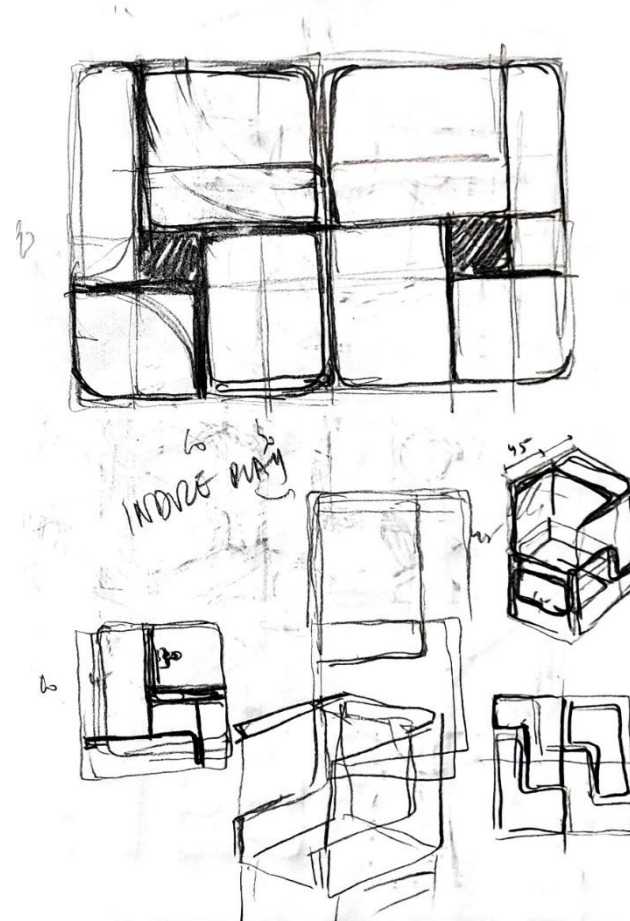
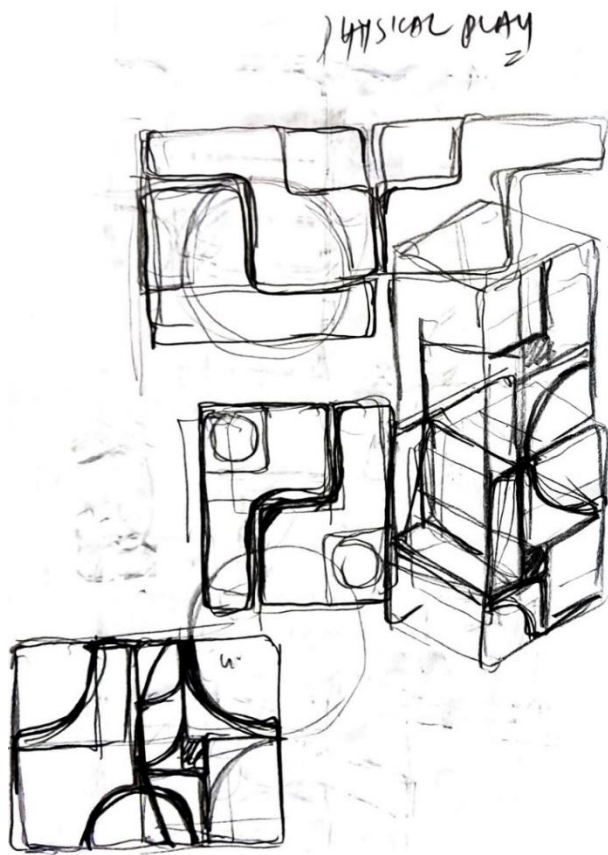
The layout doesn't allow for face to face conversation for elderly and there are chances of children mishandling the mechanisms.



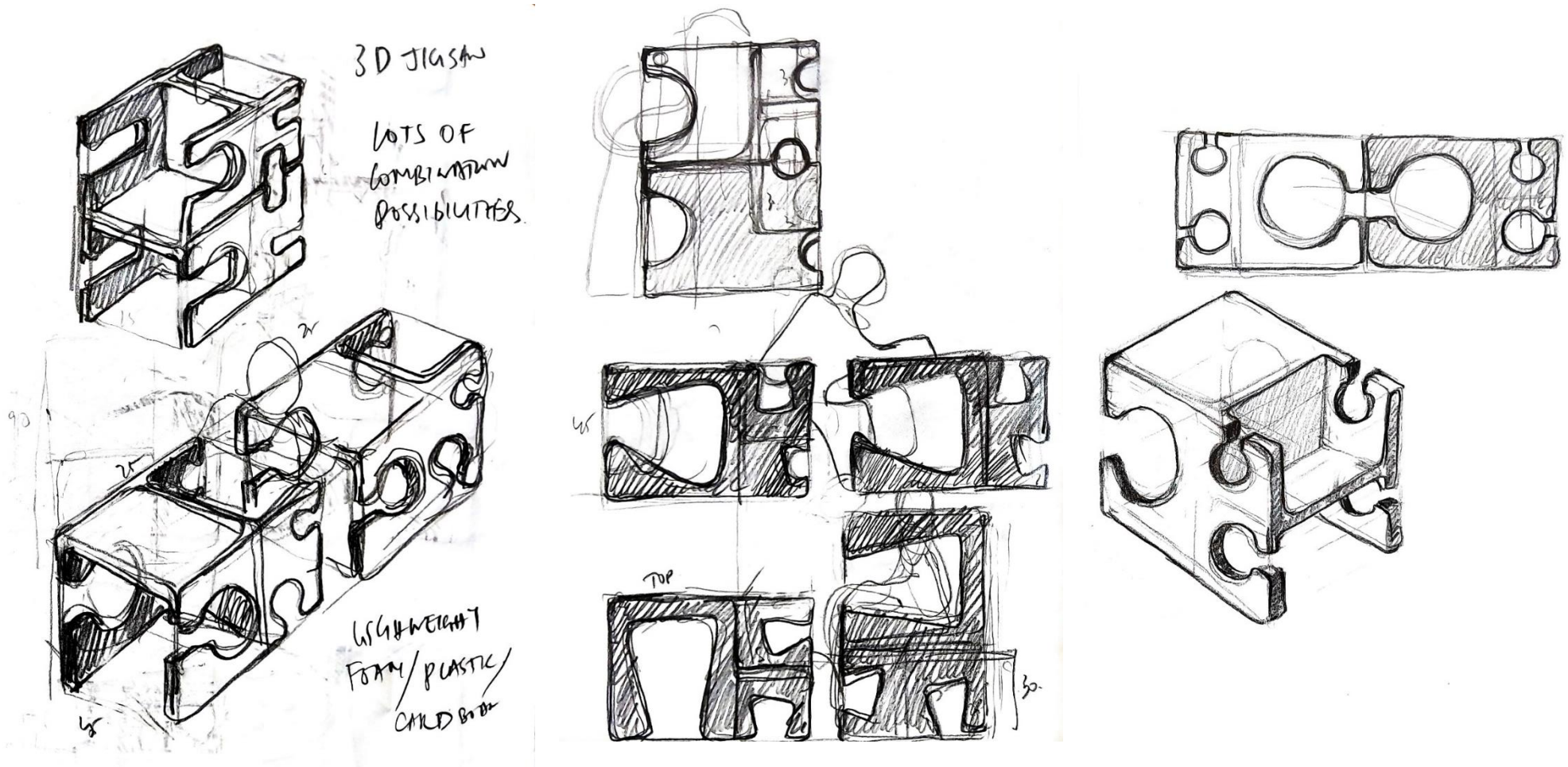
The last direction is where the user has all the freedom to configure the furniture of their needs. These are modular units that can be place one above other or next to each other.



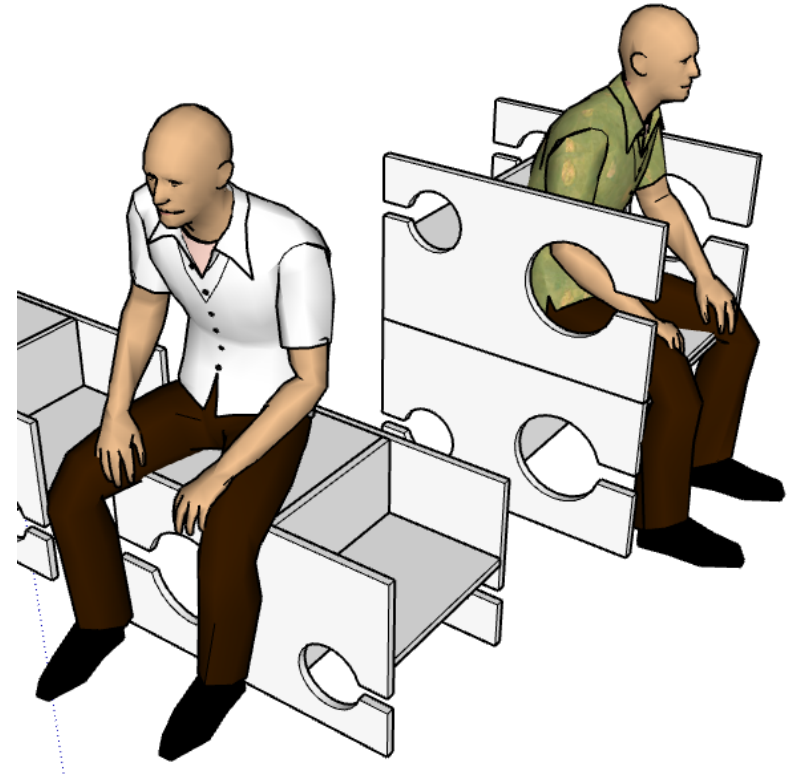
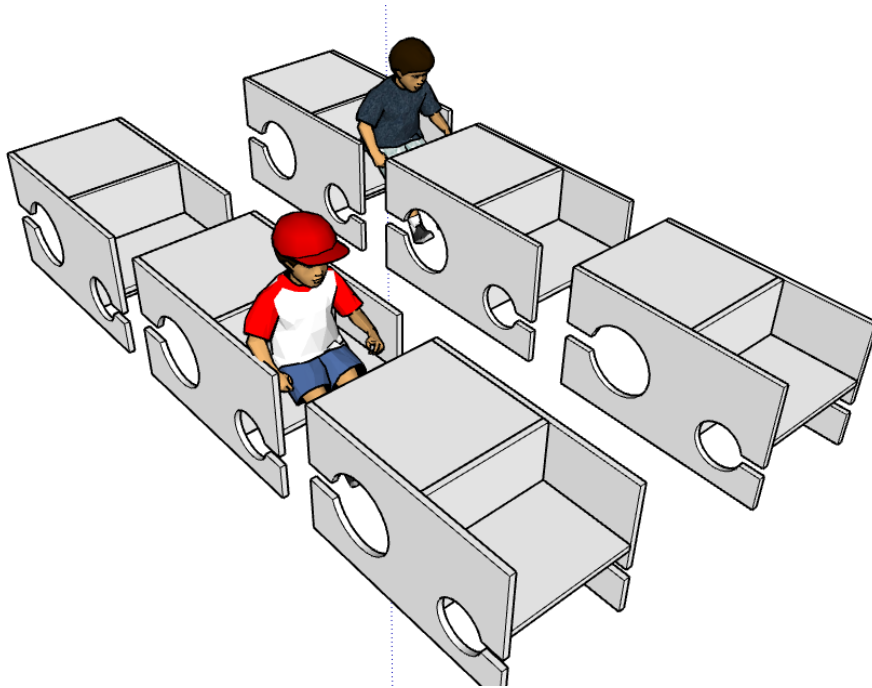
These individual modules will have planes of different heights and depths that can fit for elderly and children. These can be light weight material that helps in configuring.



These can also become part of play experience for children by combining and assembling them.

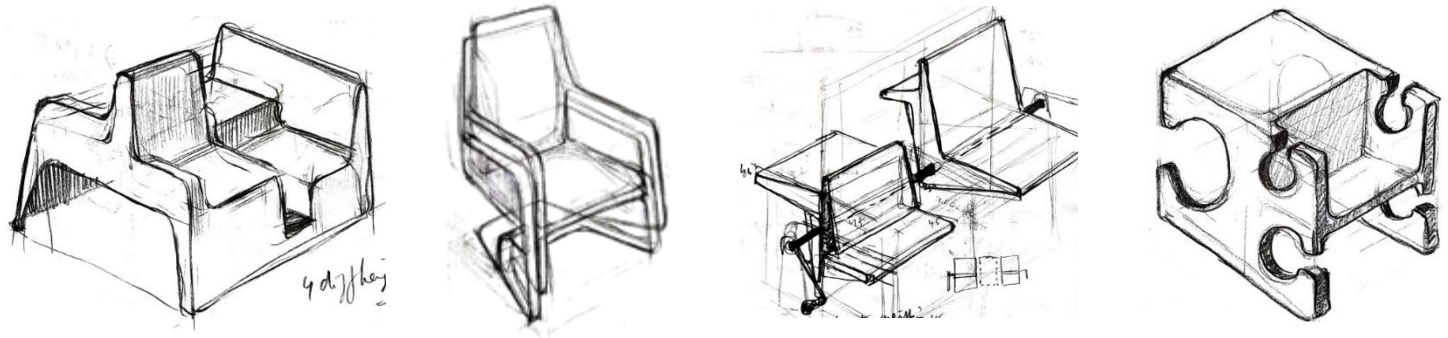


It can take interesting visual language to enhance the quality of assembly and also the weight of the furniture.

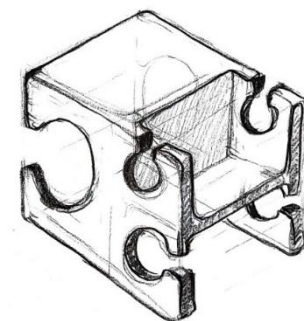
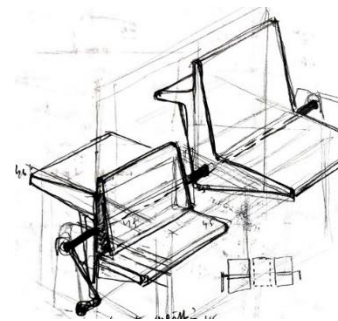
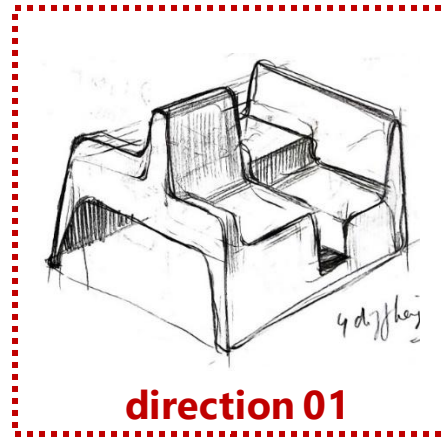


The detailing of assembly and connections are important as these are used by children and elderly. Also it might become tedious for them to assemble them without any assistance.

All these four directions were evaluated based on the criteria defined in the design brief and the static / share direction satisfies most of the criteria.



	01- STATIC SHARE	02- MOVEMENT WONDER	03 - OPERATION DELIGHT	04 – CONFIGURE FREEDOM
PRIMARY FUNCTION : CHILD LEARNING	5	5	5	5
SECONDARY FUNCTION : ELDERLY CHAT	4	4	3	3
OTHER FUNCTIONS : PLAY EAT SLEEP	4	3	3	4
LESS MOVABLE COMPONENTS	5	5	3	3
DIMENSIONS AS PER STANDARDS	4	4	4	4
FLEXIBILITY OF LAYOUTS	4	5	3	5
ACCESSIBILITY : IN AND OUT	5	5	4	4
COG/PHY EASE/DURATION OF TRANSF.	5	4	3	2
STABILITY IN FUNCTIONS POSTURES	5	4	3	3
SAFETY HAZARDS	5	4	3	3
DURABILITY/REPAIRABILITY	5	4	3	3
CLEANING/MAINTENANCE	5	4	3	3
STORAGE – STACKABILITY/FOLDABILITY	4	5	3	4
TOTAL	64	59	47	50

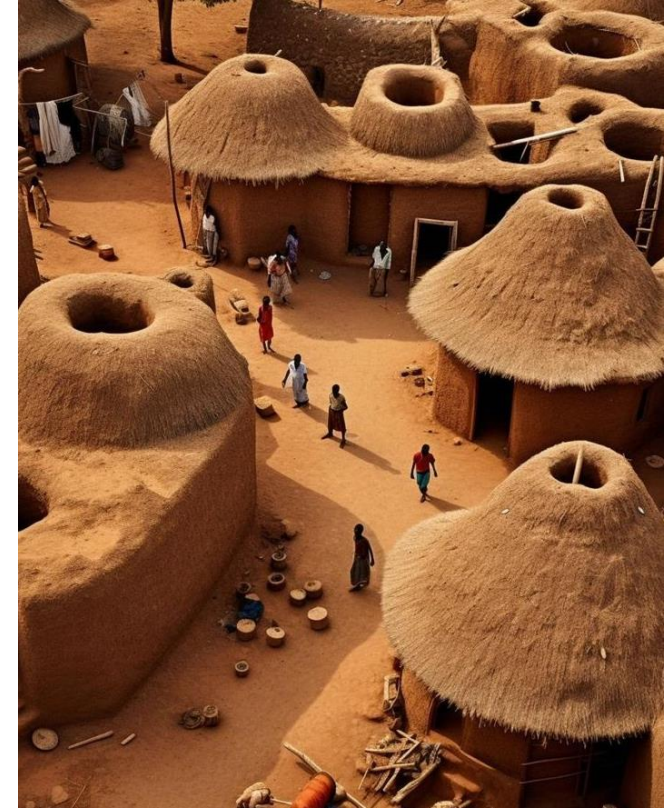


concept 01

concept 02

concept 03

Based on the analysis direction 1 was chosen to take forward and then 3 different concepts were arrived at base on the form and material explorations



Images source : Pinterest

The concept is to create a micro-environment for children which is like an element of fantasy with which they interact with. Also the elderly adapts this to their needs .



FOCUSED. INTIMATE MICRO ENVIR.



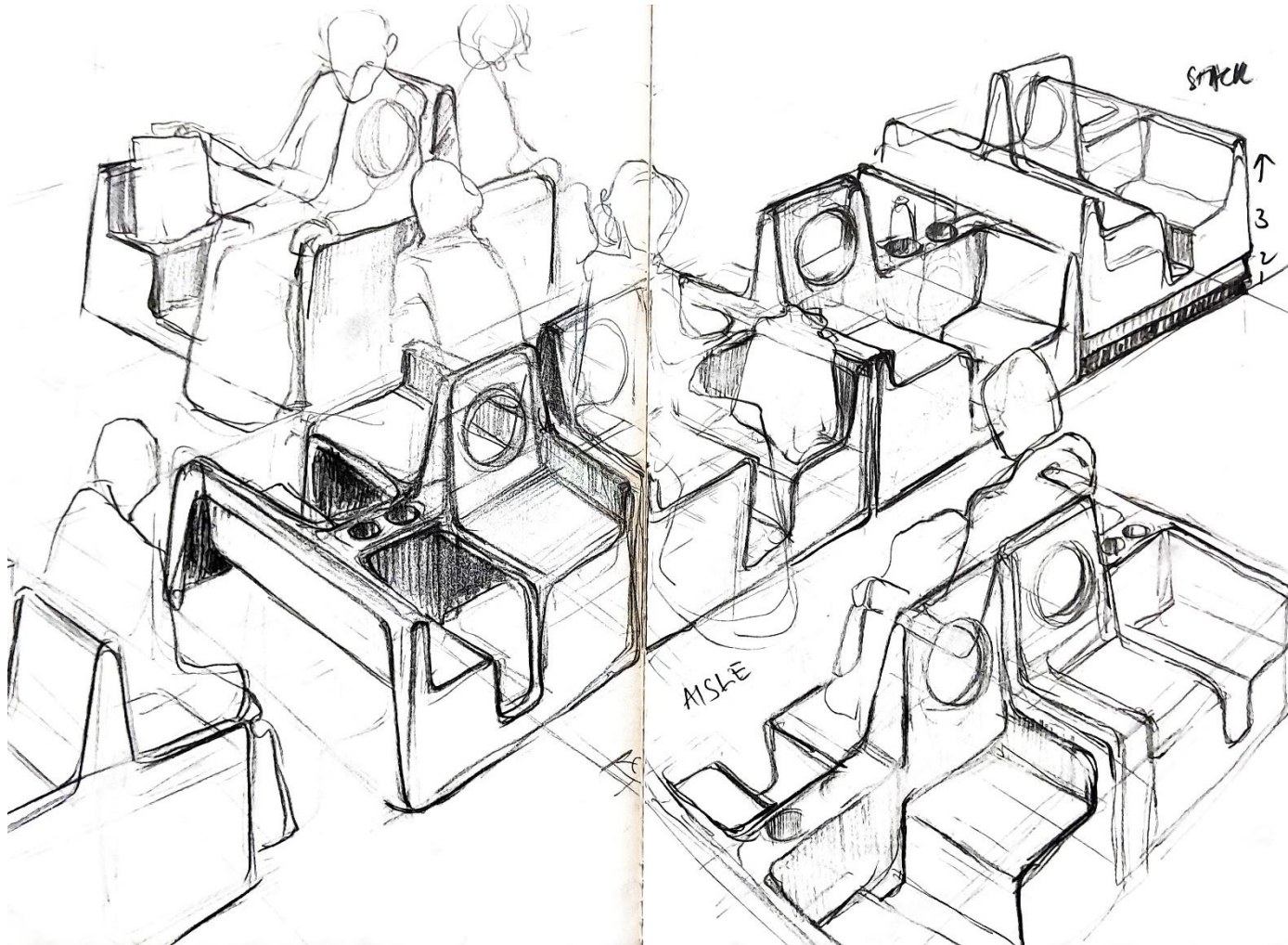
IMAGINATIVE INTERACTIVE



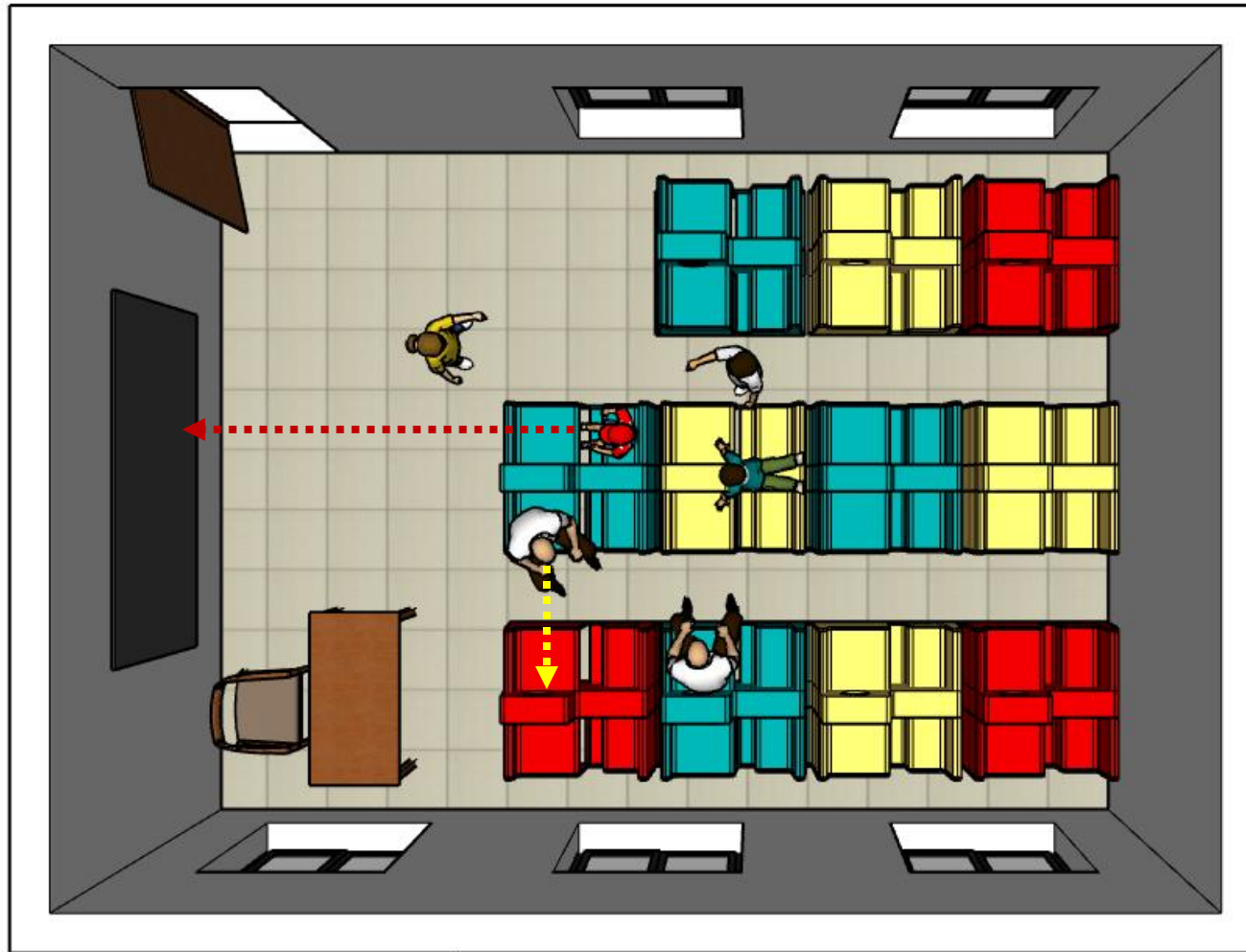
The central element is the backrest of the chair for elderly that becomes a space divider, the circular hole becomes an element of interest for children and makes it visually lighter.



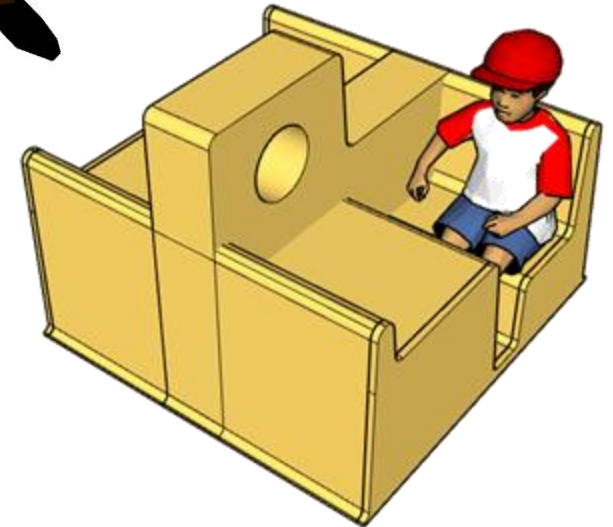
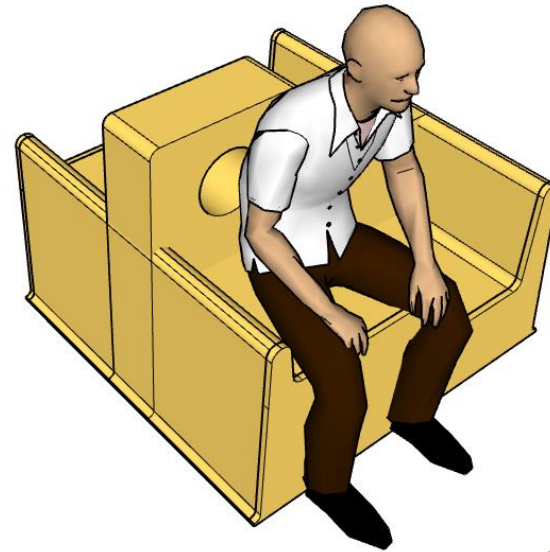
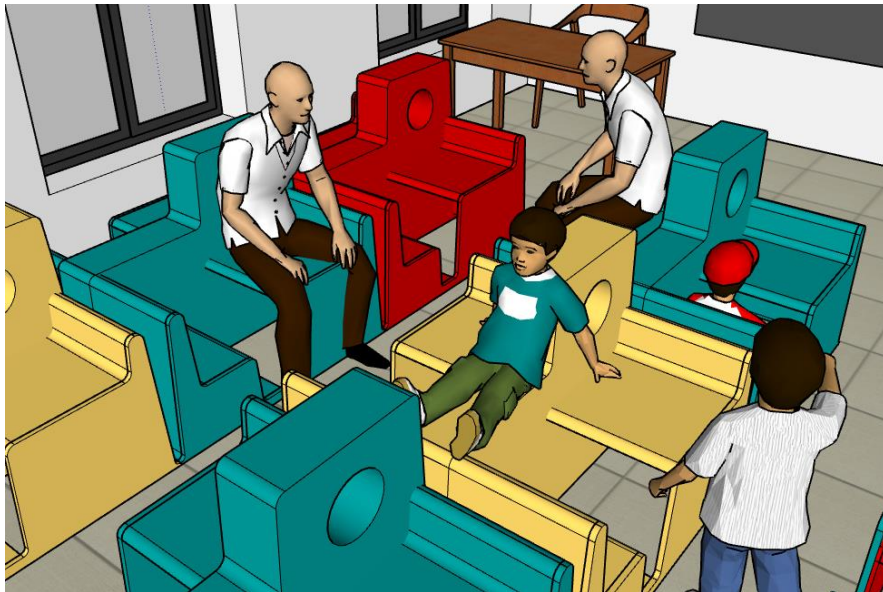
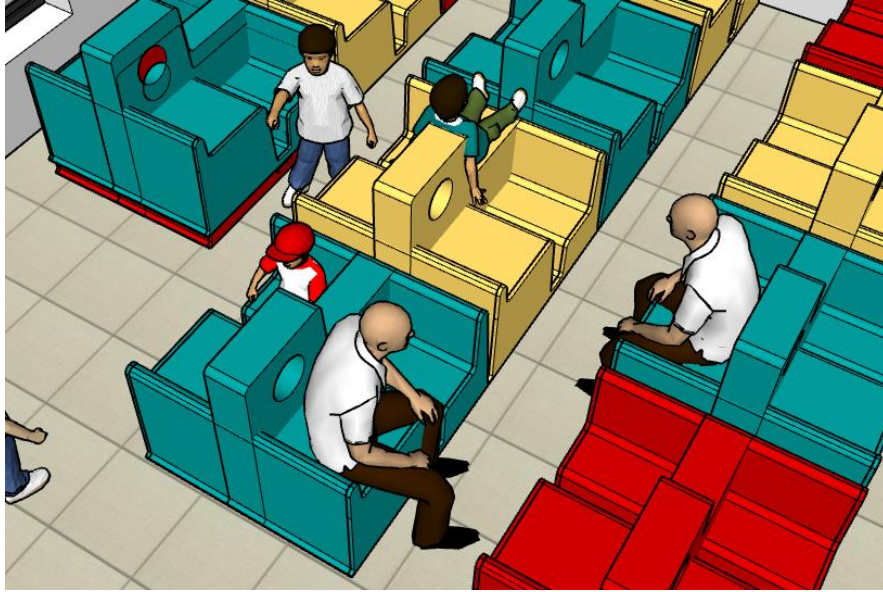
The elderly can sit in different postures as per their comfort and can also express their sense of playfulness and humor through this furniture.



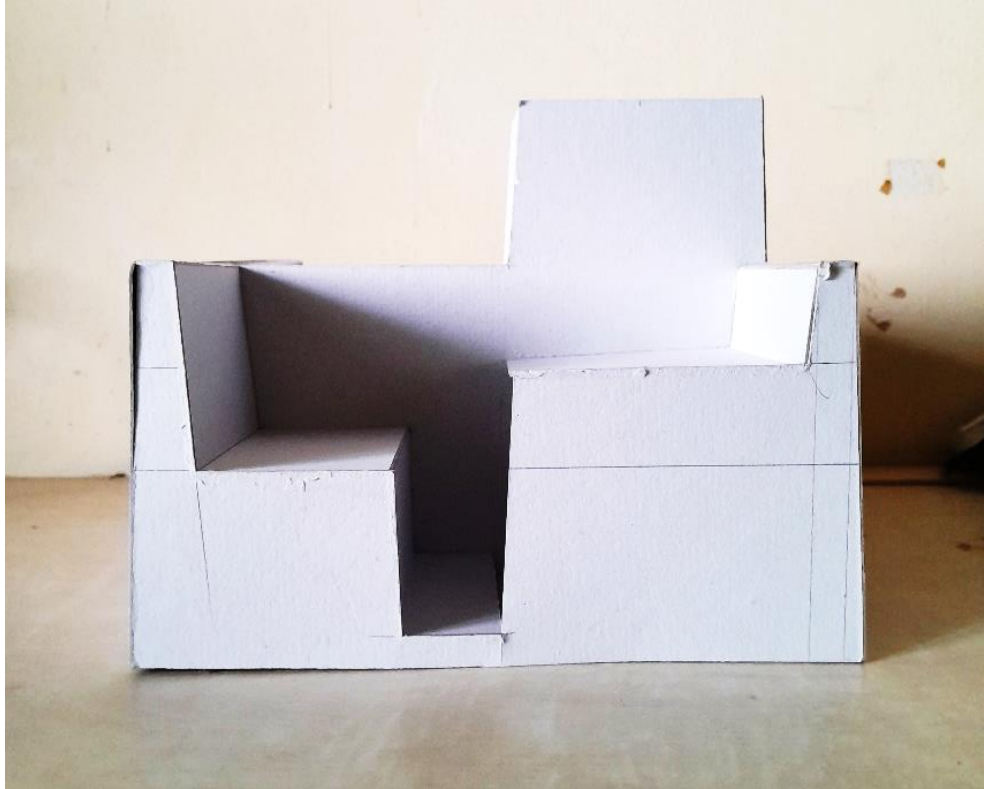
The furniture allows for face to face interactions for elderly and can form clusters. The central element can also contain storage.



The units can be stacked one over the other and that gives additional space for activities for elderly. The red line indicates the orientation for children and the yellow lines for the elderly to engage in face to face conversations.



The material for this concept is molded plastic that can take these curvilinear forms and also will be light weight for moving and stacking. This can be made in different colors for interest for children.



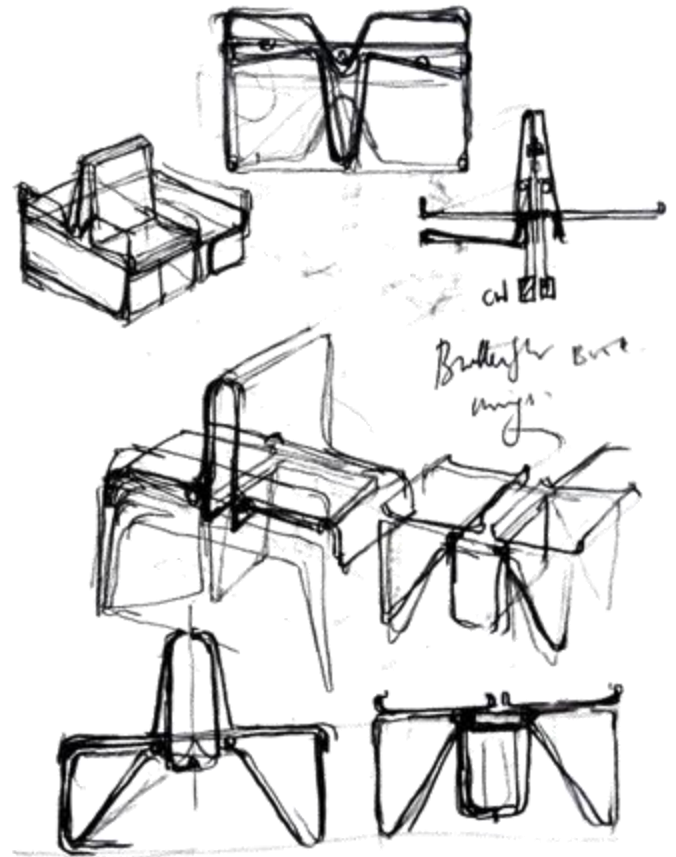
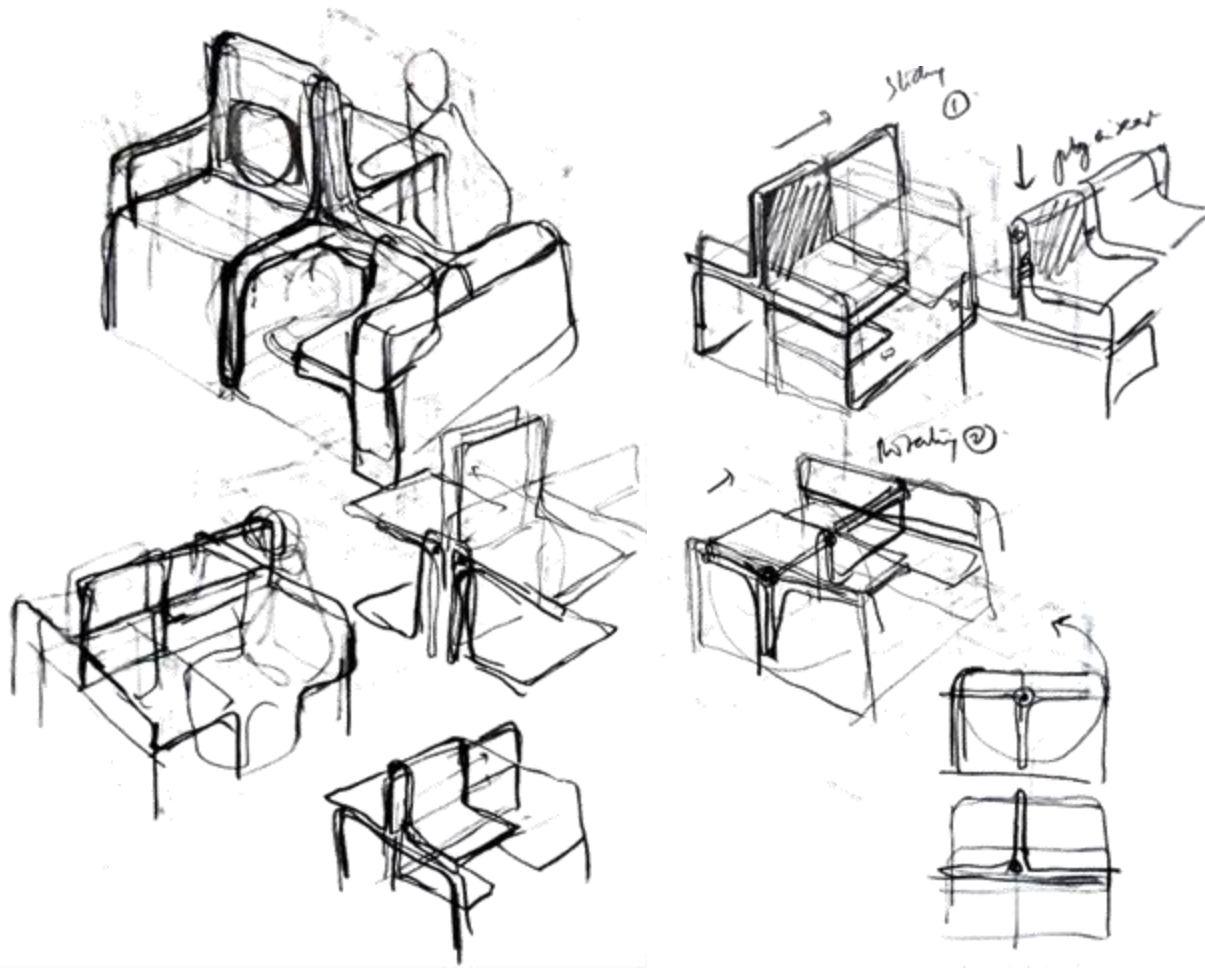
3D and physical model was made to study the overall volumes with respect to the classrooms and it was understood that though these create defines spaces, considering the limited size of the classrooms these appear bulky. This led the next concept.



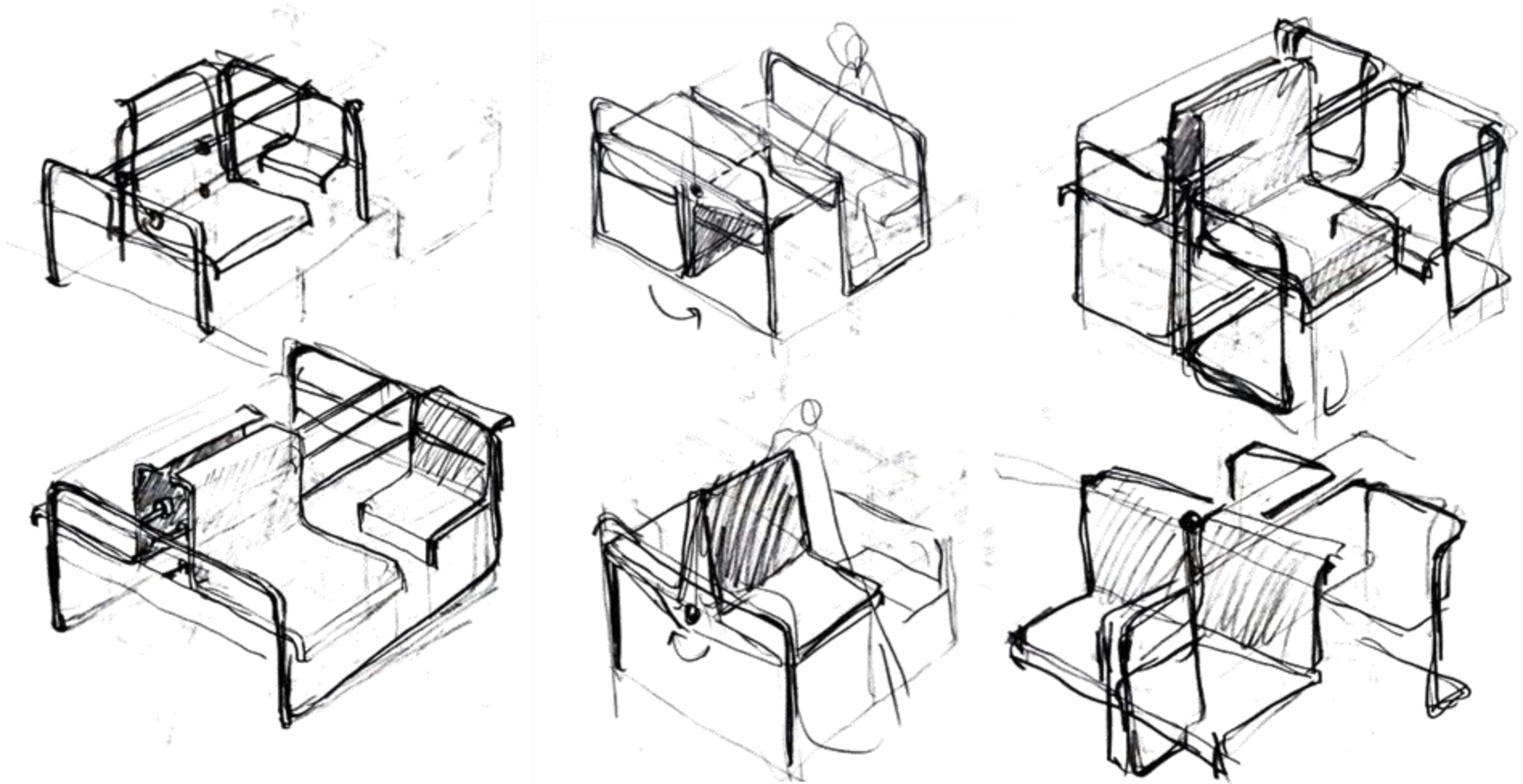


Images source : Pinterest

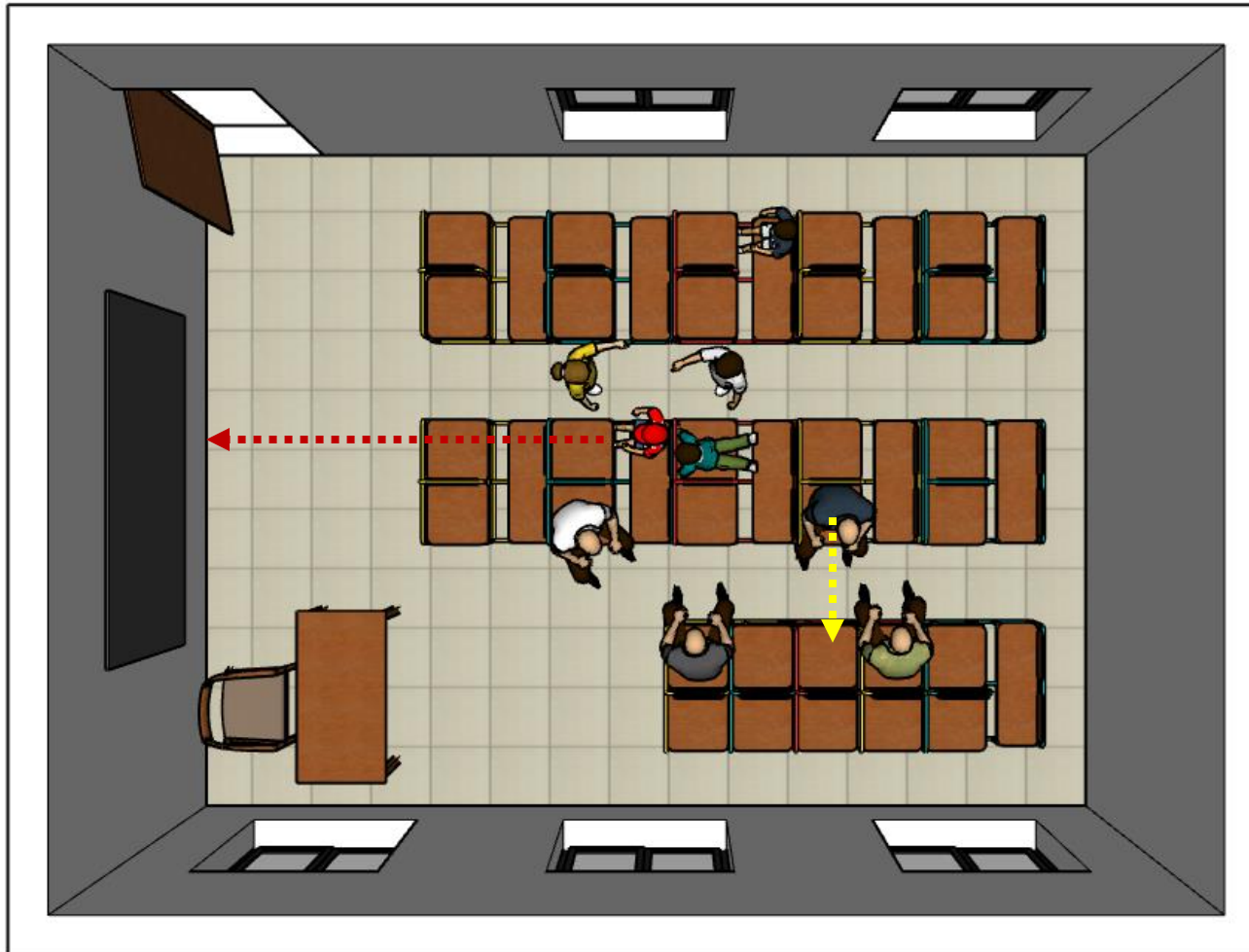
This concept is inspired by the dichotomy of the characteristics of child and elderly i.e., new and old. The tenderness of both users are reflected through thin lines of steel tubes that gives a lighter appearance for the furniture.



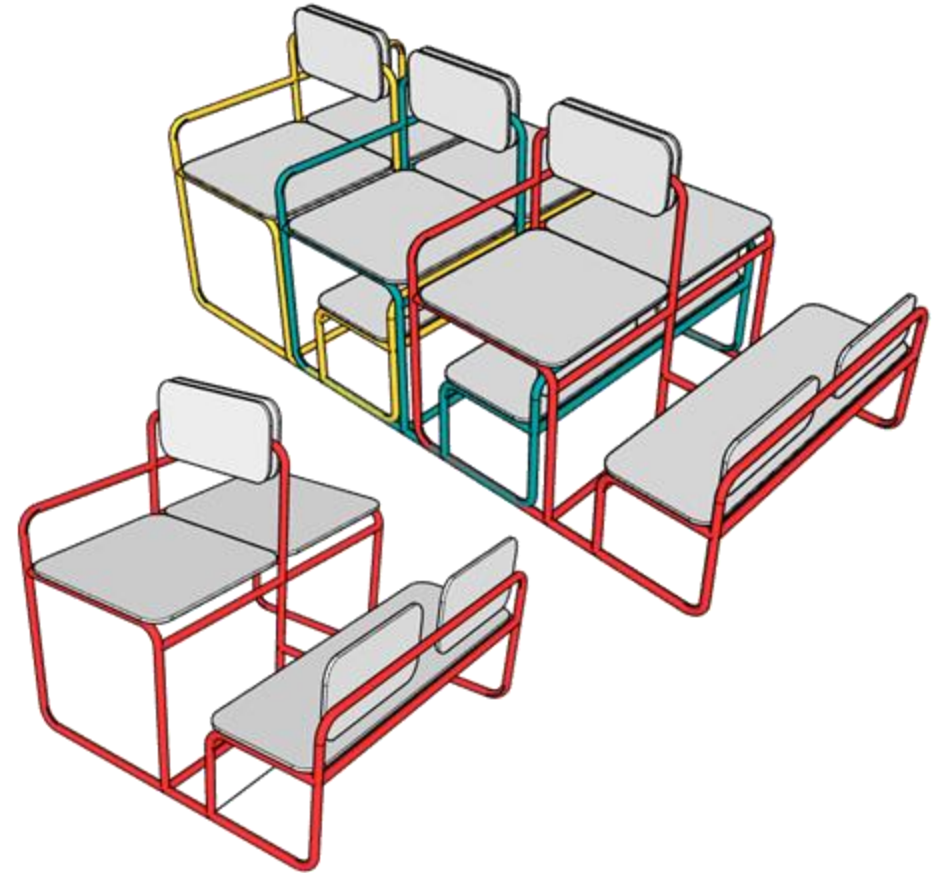
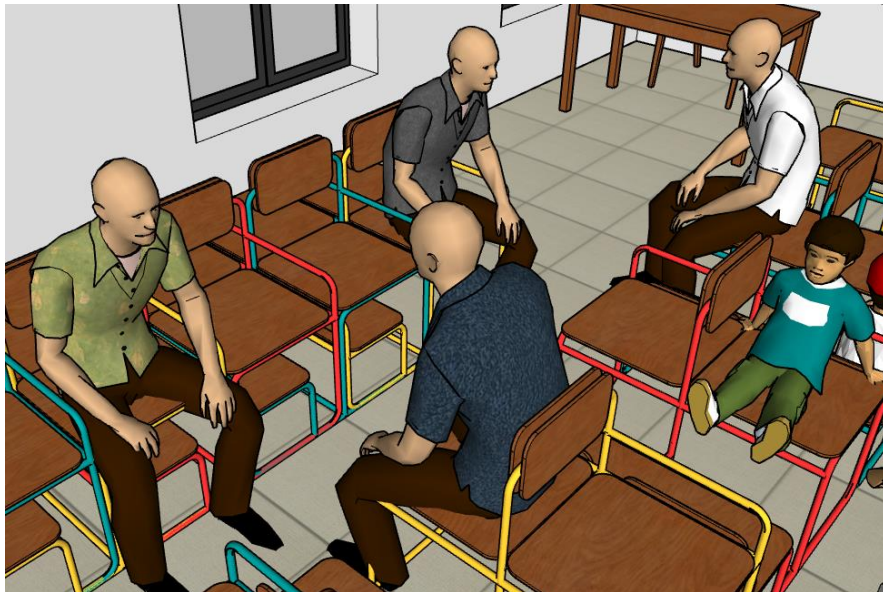
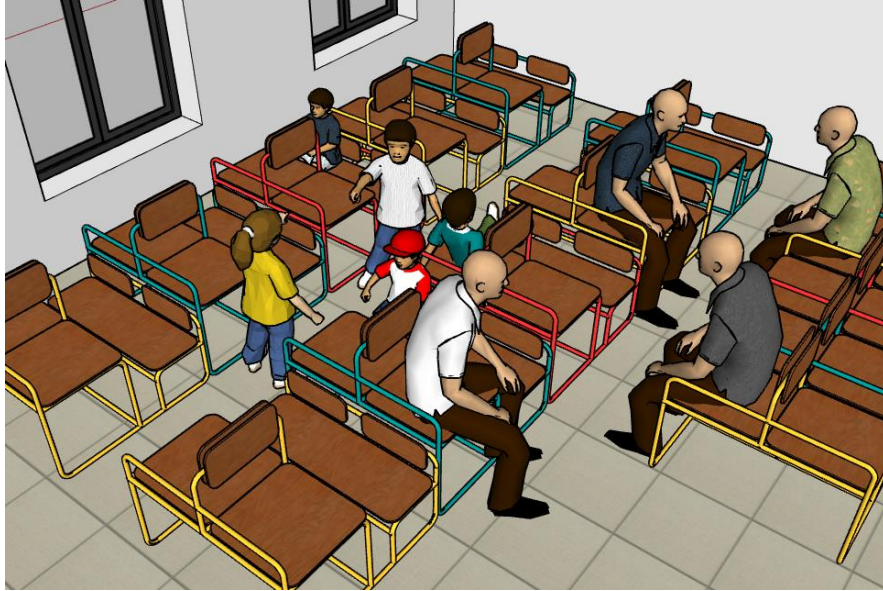
Different ways of treating the backrest for elderly was explored since it can become a hindrance for the children when placed at a higher level. This included a tilt able / rotating table top that gives a flat table top and the back rest appears when required.



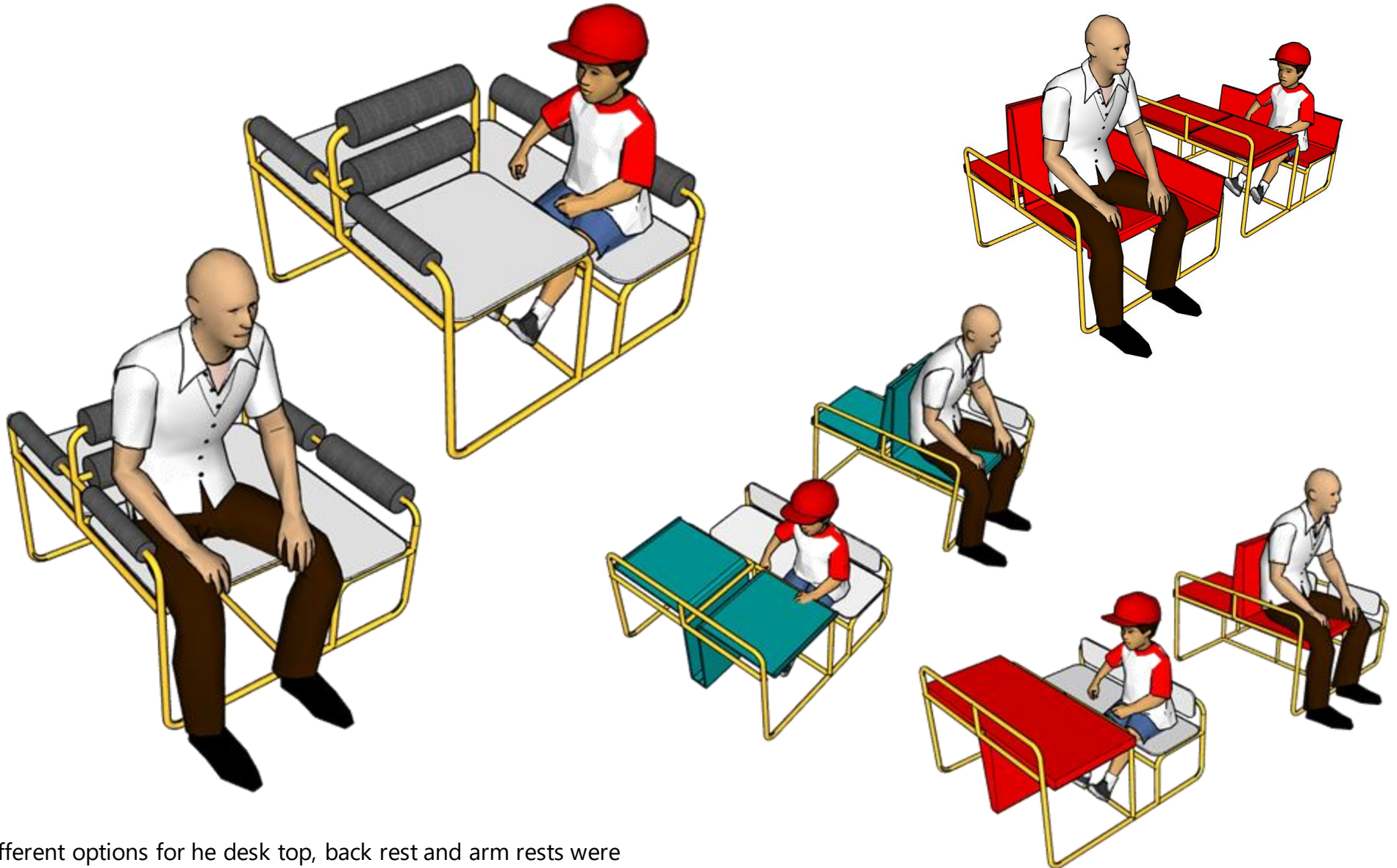
Different configuration for the structure frame was explored and one of the options allowed rotation of the seats for the elderly. But considering that the core design direction was to have a static furniture the ideas involving different operations was not taken forward.



The furniture occupies less space compared to the earlier concept and can be stacked horizontally when required. The red line indicates the orientation for children and the yellow lines for the elderly to engage in face to face conversations.



The units can be arranged next to each other by stacking and forms individual chairs for the elderly. The chair of the children go under the desk.



Different options for the desk top, back rest and arm rests were explored.

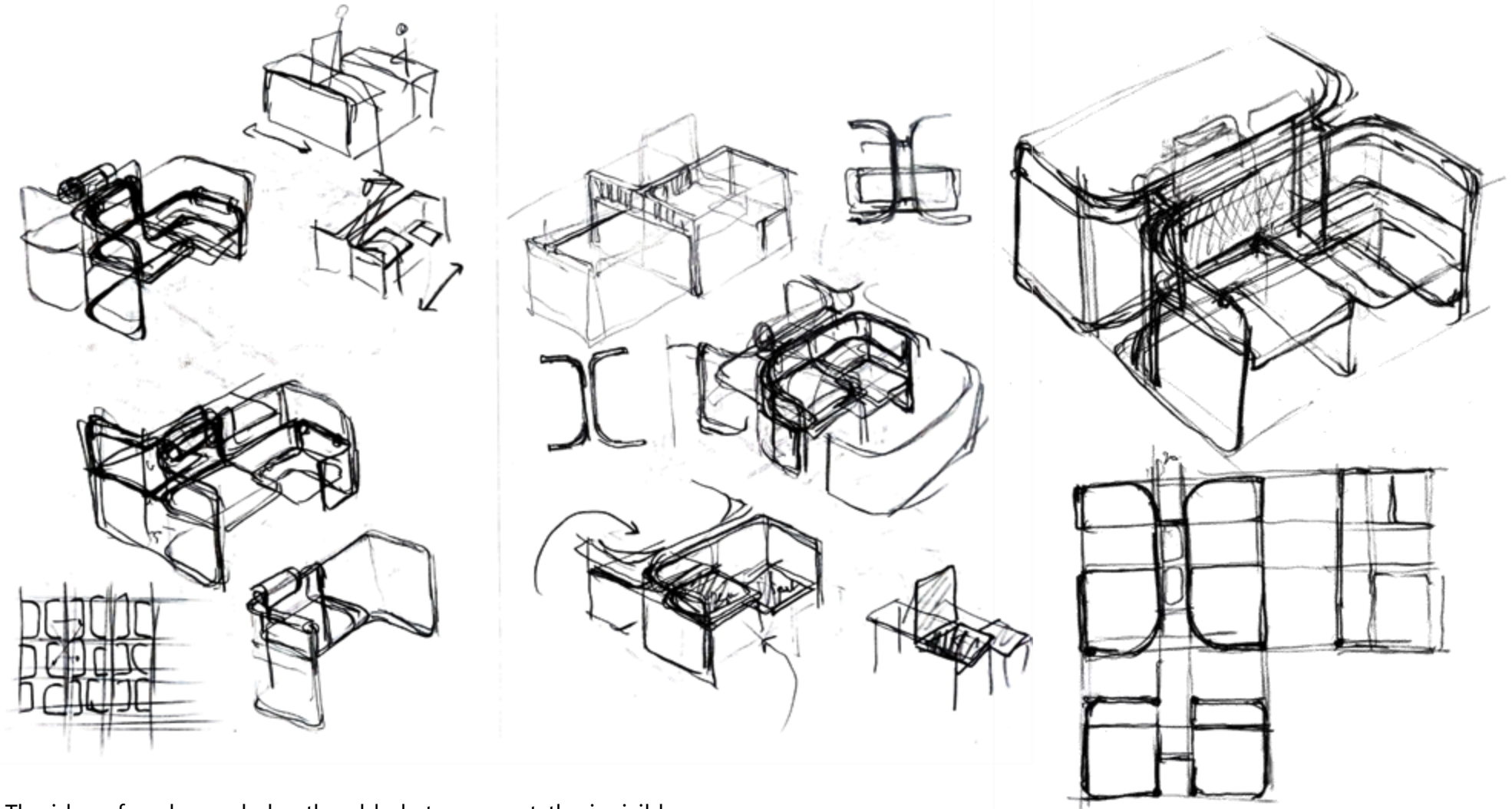


A rig was made out of PVC pipes to understand the scale of the furniture and the spatial configurations were studied.

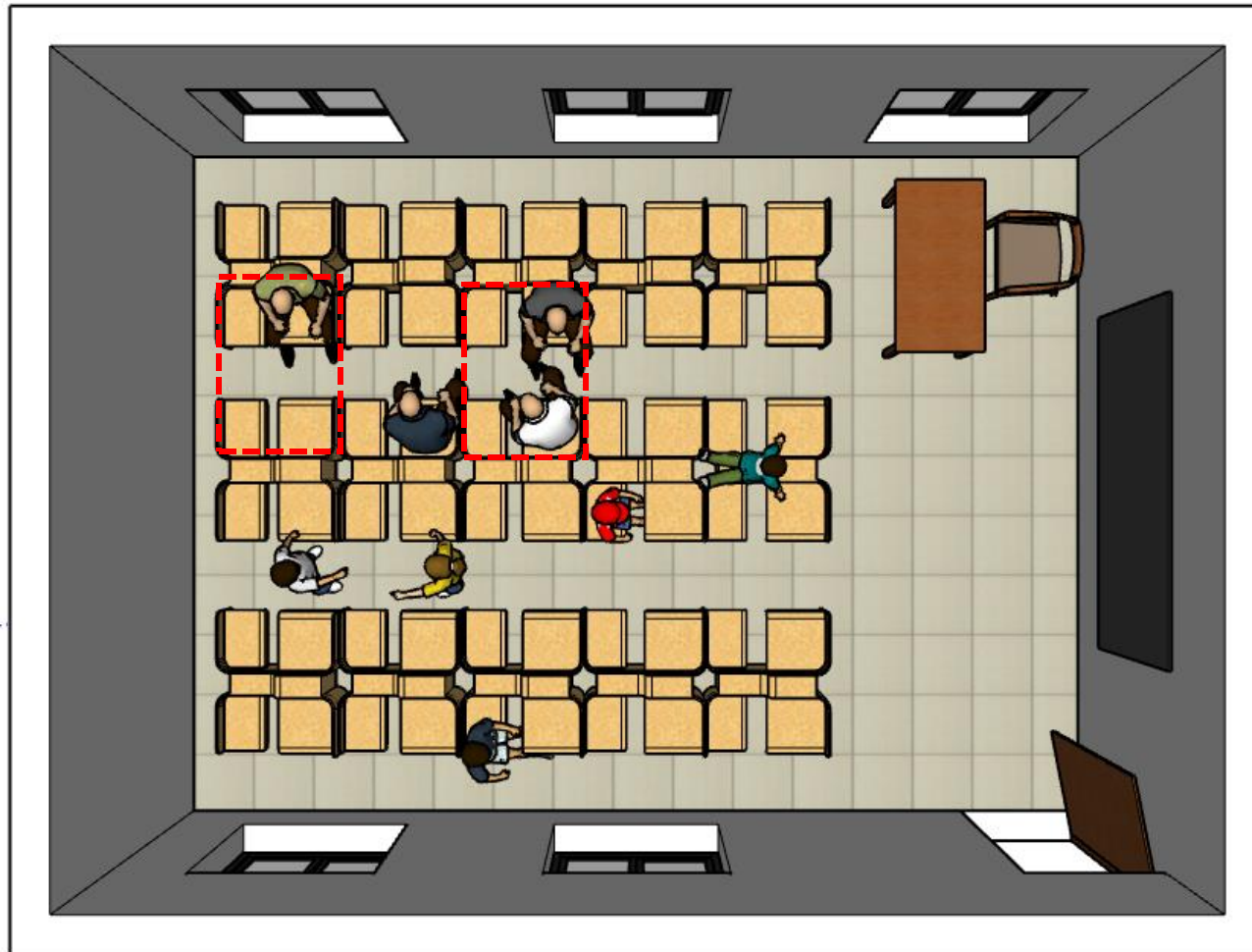


Images source : Pinterest

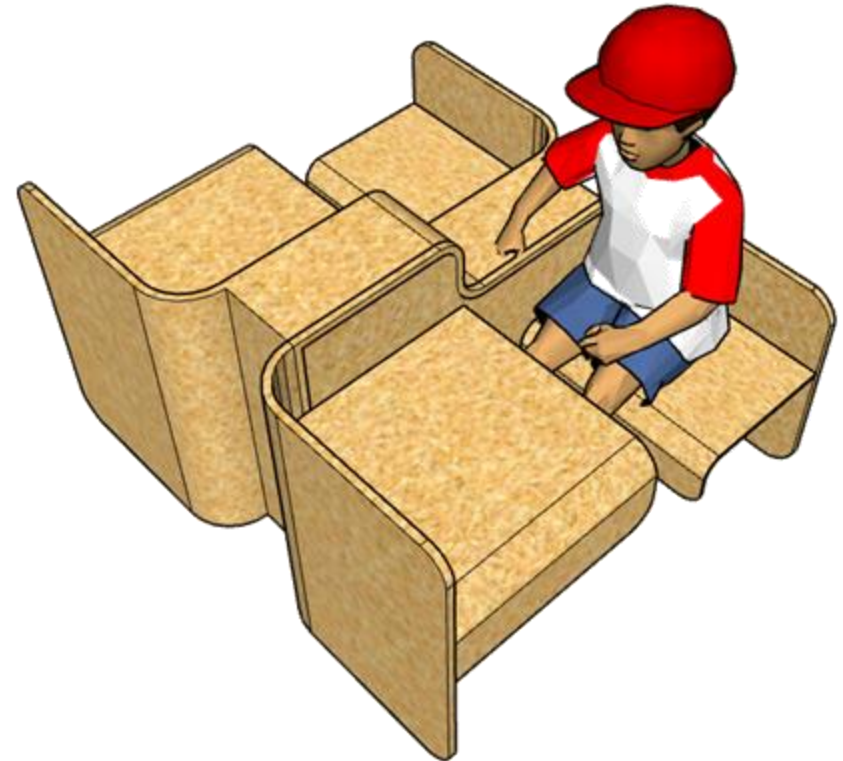
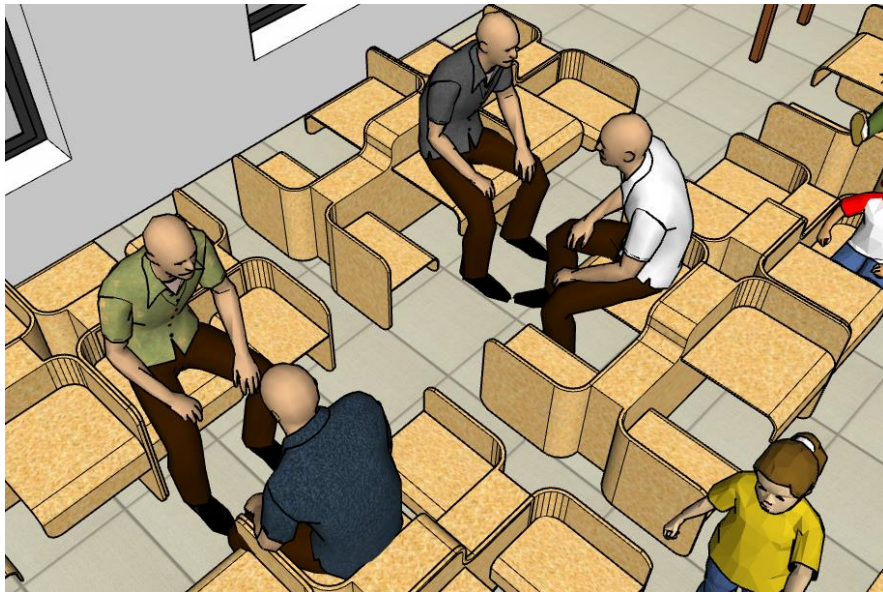
The third concept tries to break the semantic of the children's desk and bench. In order to make the elderly relate to this furniture it is required to change the perception of the furniture by highlighting the chair of the elderly as the primary form.



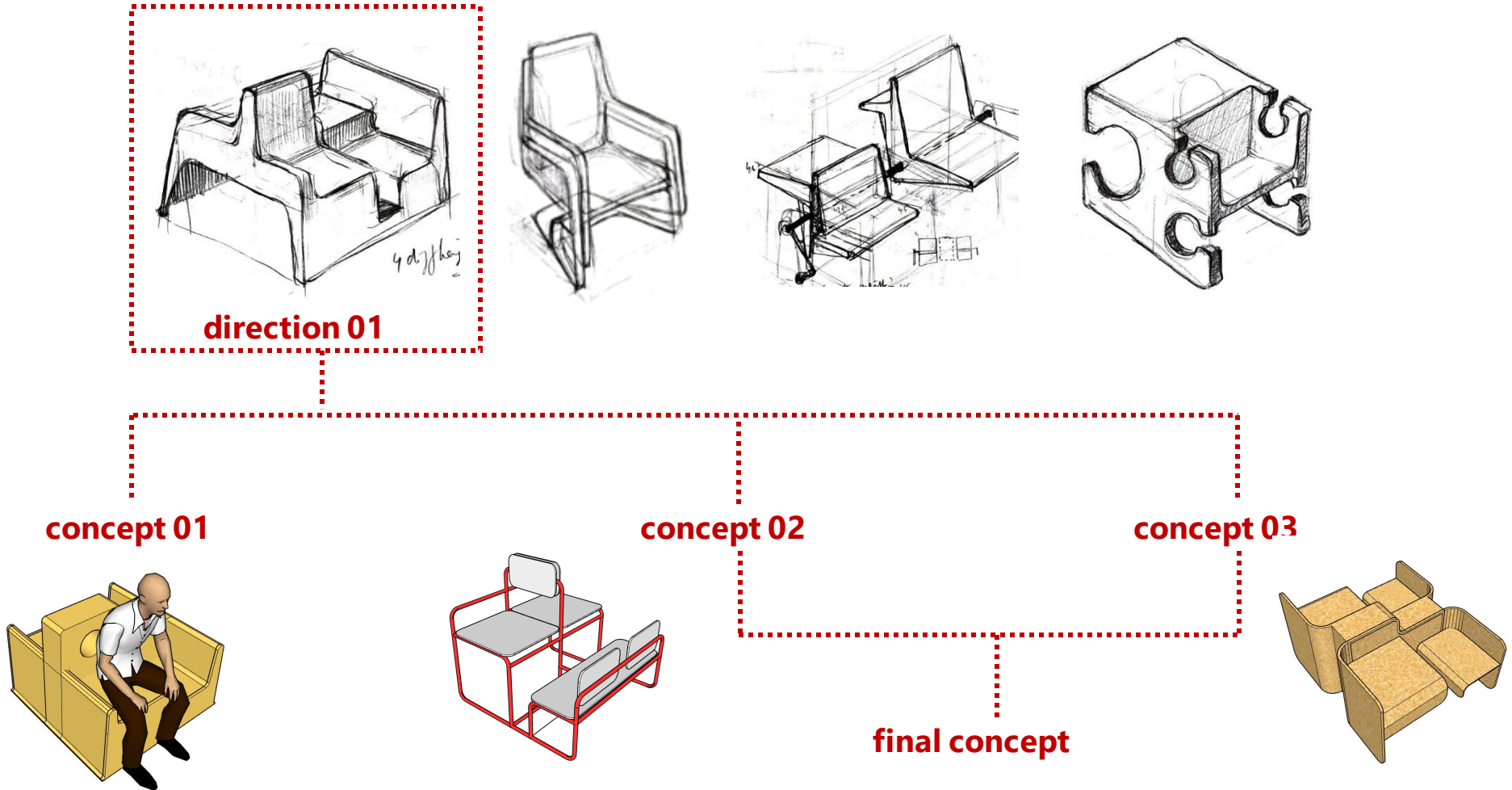
The idea of enclosure helps the elderly to connect the invisible cluster formed by the arrangement of the units. This is achieved by emphasizing the two halves of the unit vertically by defining the curved edges of the volumes created which they relate to as a bench.



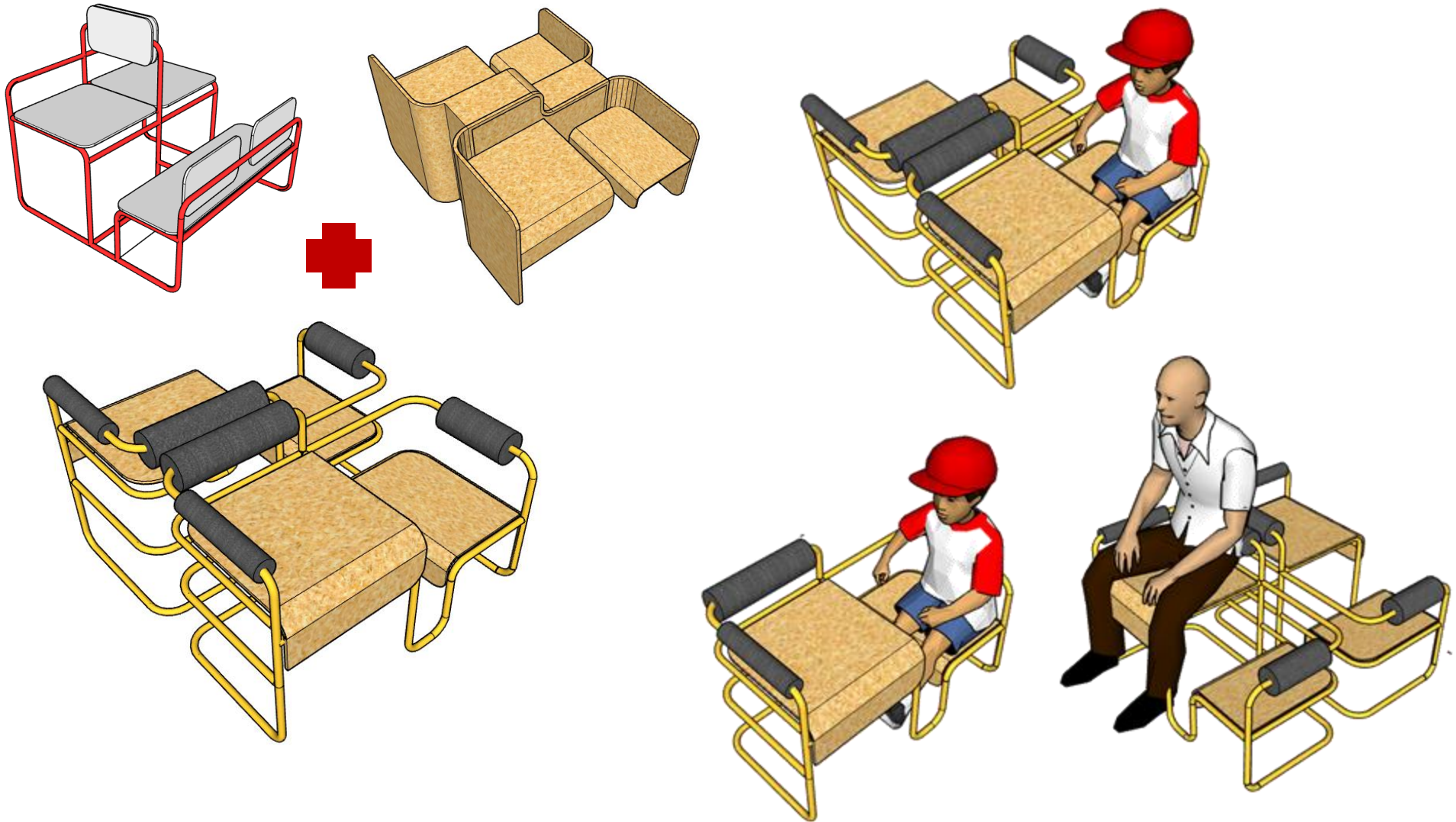
Defining the furniture as two halves create a sense of enclosure for the elderly that breaks the semantics of the classroom furniture.



The initial idea was to use plywood as the material for this concept but considering the bulky appearance it was further developed.



Different aspects of the concept 02 and 03 were studied and taken forward for further development and feedback.



The tubular frame from concept 2 and the enclosure idea from concept 3 are combined to form these variants. The desks are isolated and single seater was derived from this configuration.



Rough models are made to study the singular seat arrangement. The L shaped armrest/ backrest is the only addition that would be required to add on to a conventional desk to achieve this concept.



An actual scale rig was made to understand the structural stability and configuration. The armrest/ backrest becomes the additional element in the inventory, hence need to be detailed out so that it can be used in both left and right configurations.

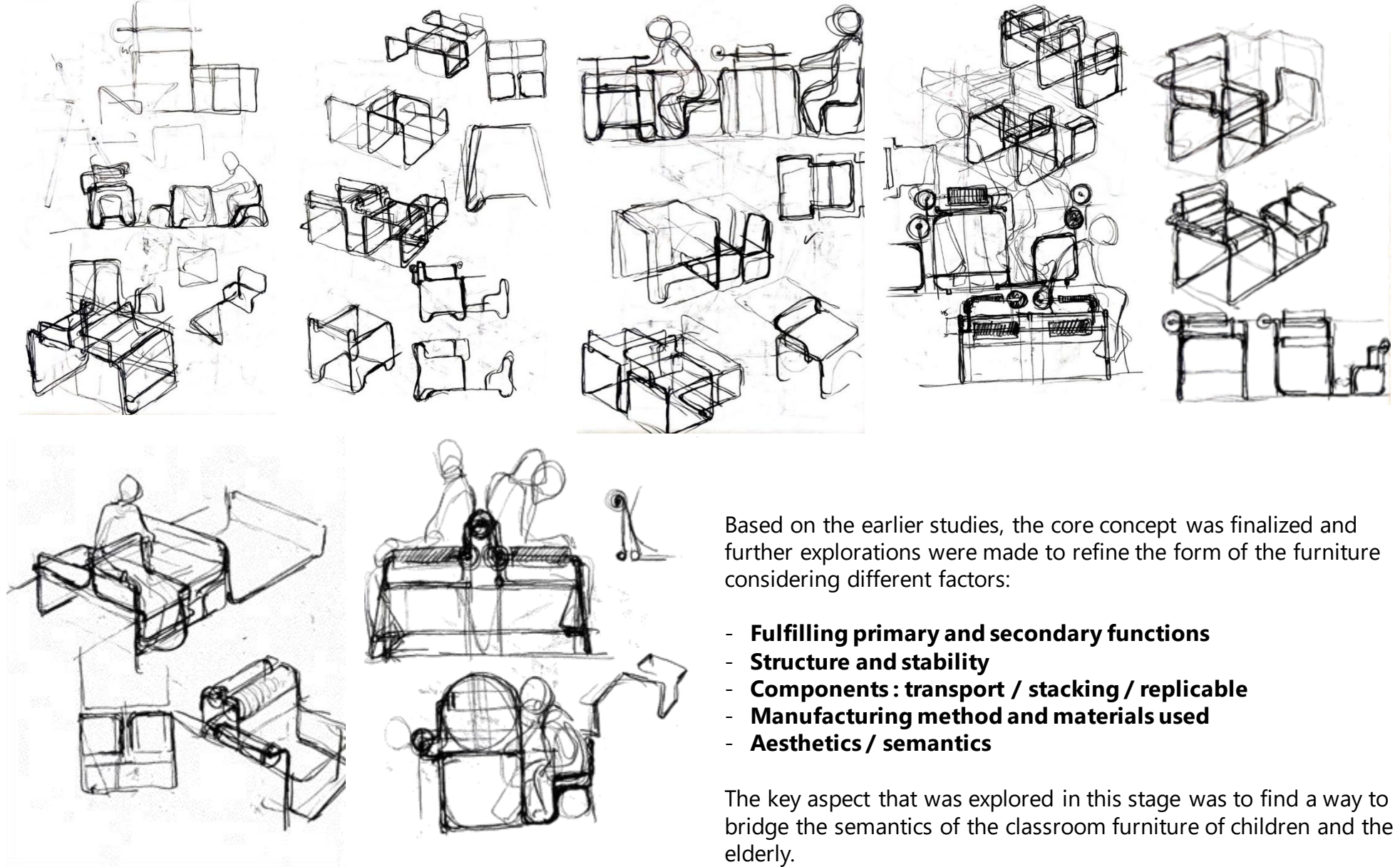


The rig and mockups were discussed with the elderly people in the neighborhood park. The feedback was positive for the concept and they liked the idea that the furniture offers seating for both users without any transformations required. They didn't not have any issue pertaining to using the desk for seating from cultural perspective.

stage 4 : concept finalization



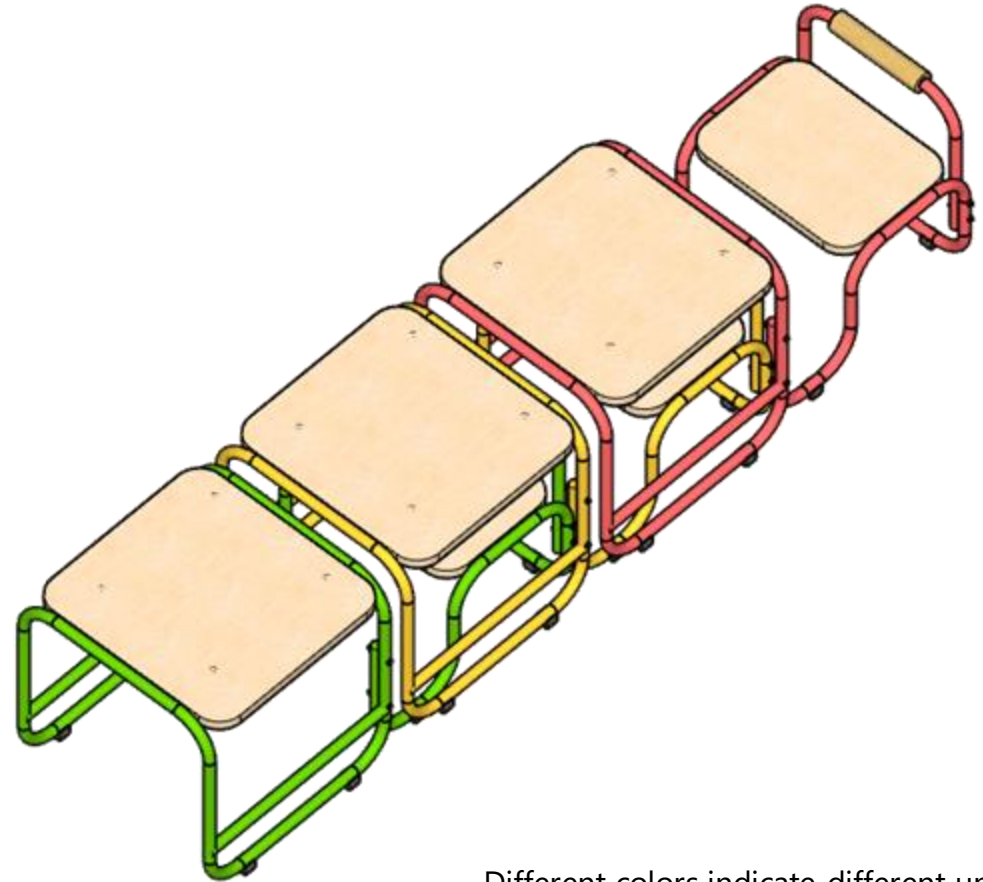
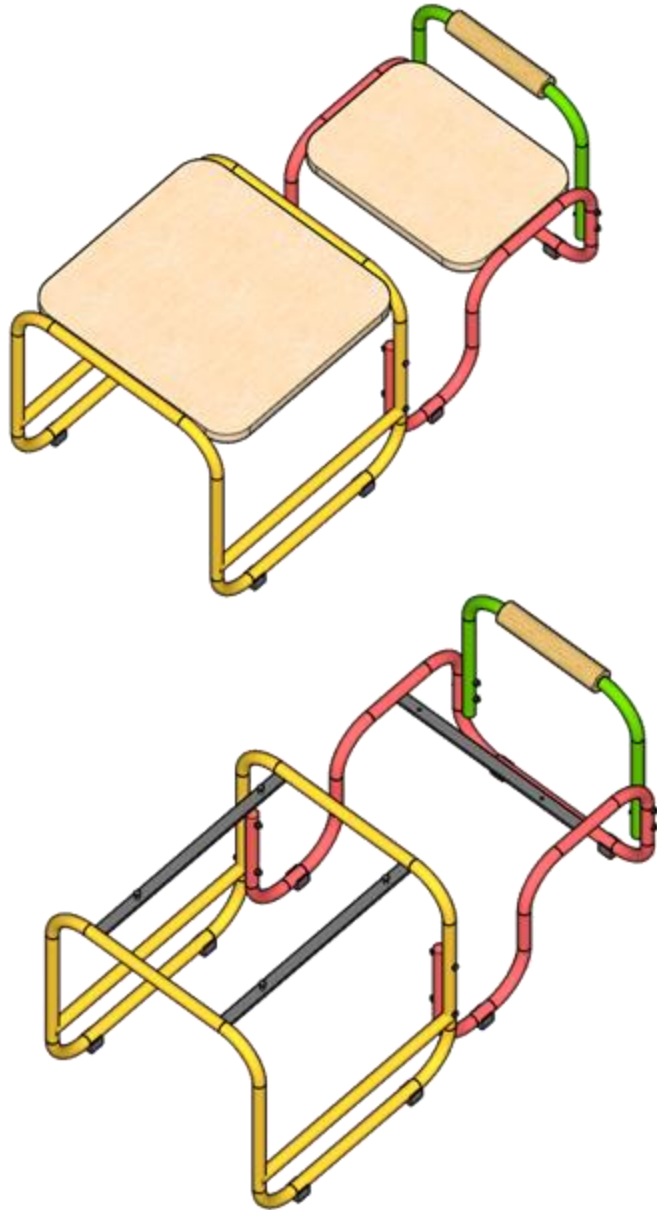
The next step was to make a rig that was primarily for checking the dimensions and ergonomics for both children and elderly. Role play was done to understand the sitting posture and accessibility for both parties.



Based on the earlier studies, the core concept was finalized and further explorations were made to refine the form of the furniture considering different factors:

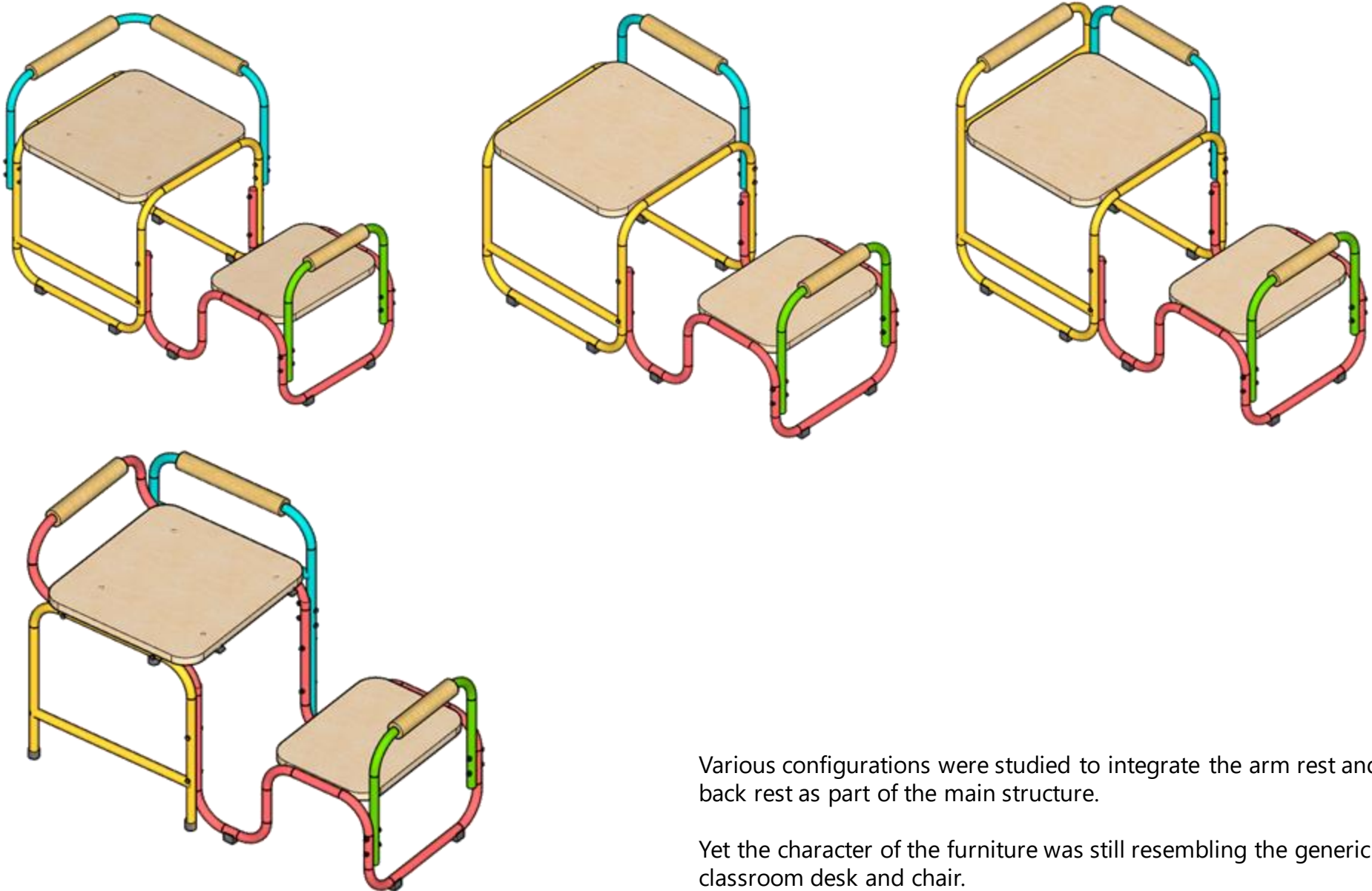
- **Fulfilling primary and secondary functions**
- **Structure and stability**
- **Components : transport / stacking / replicable**
- **Manufacturing method and materials used**
- **Aesthetics / semantics**

The key aspect that was explored in this stage was to find a way to bridge the semantics of the classroom furniture of children and the elderly.



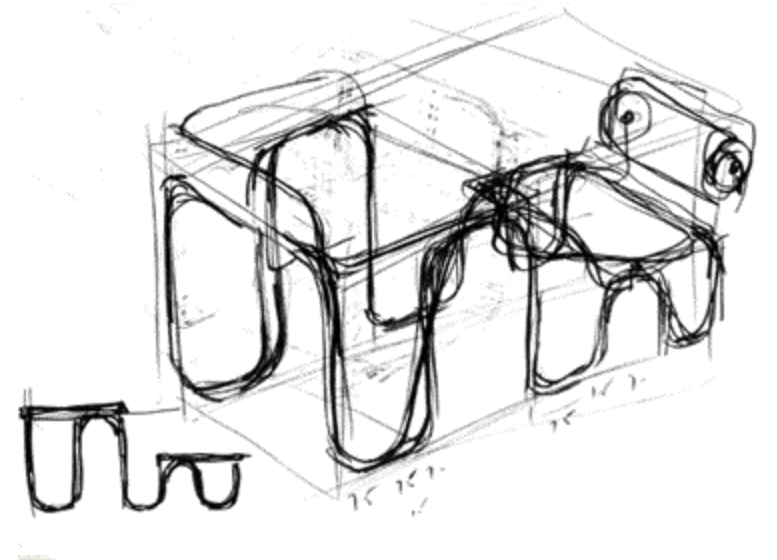
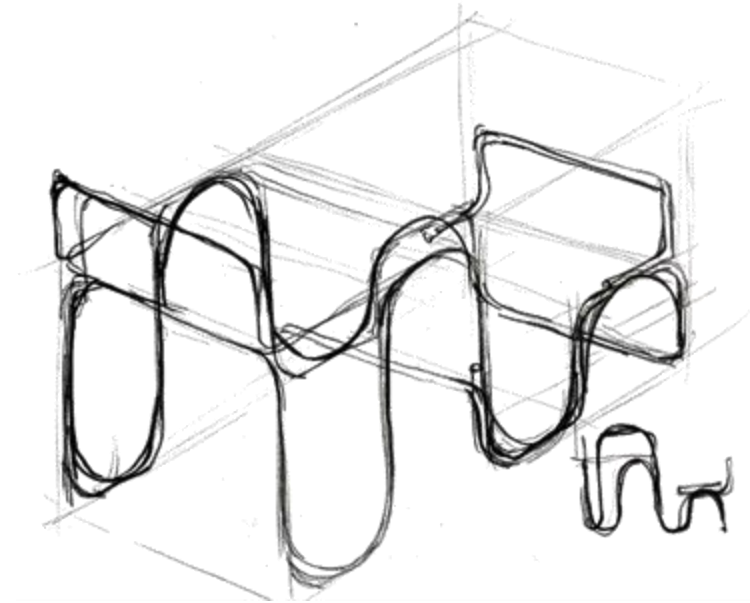
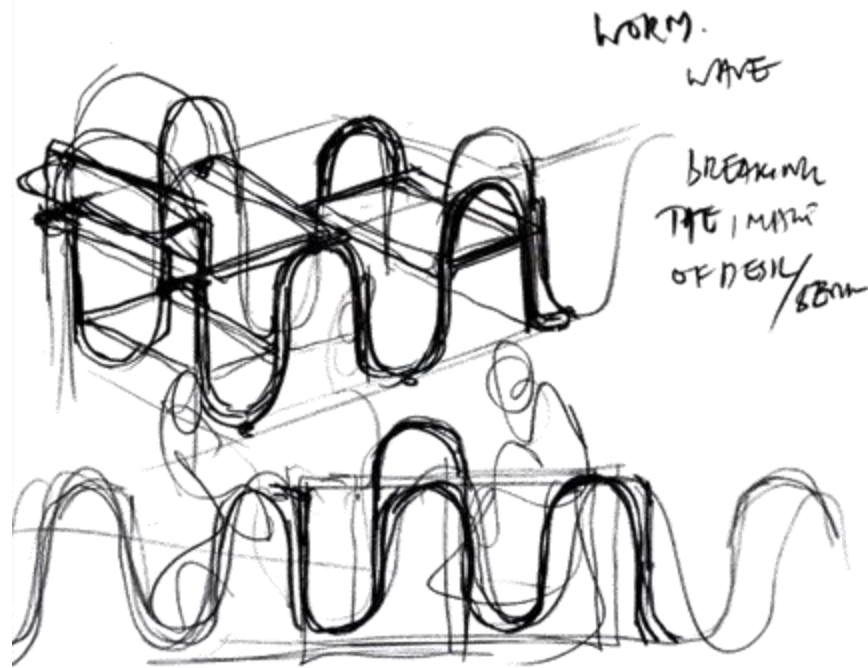
Different colors indicate different units that are identical and can be joined using welding / bolting to achieve the overall structure.

The above image shows how the desks can be stacked over the seats so that the elderly can sit next to each other.

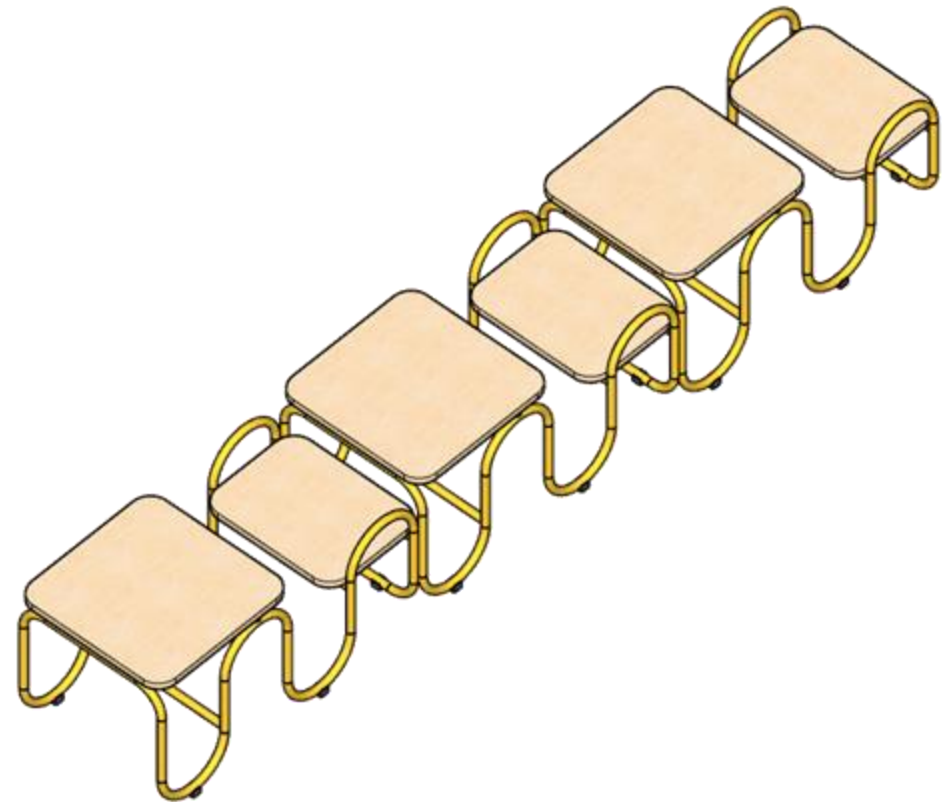
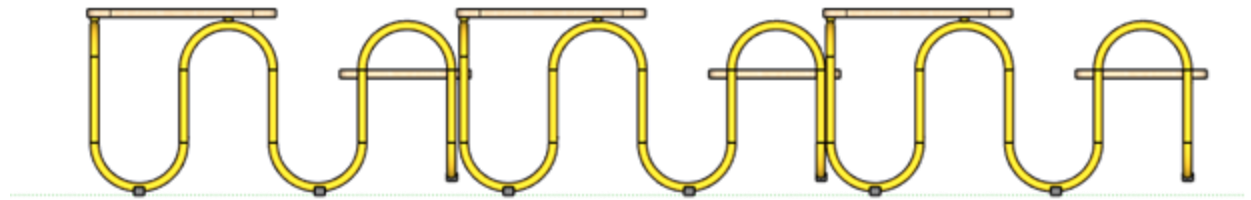
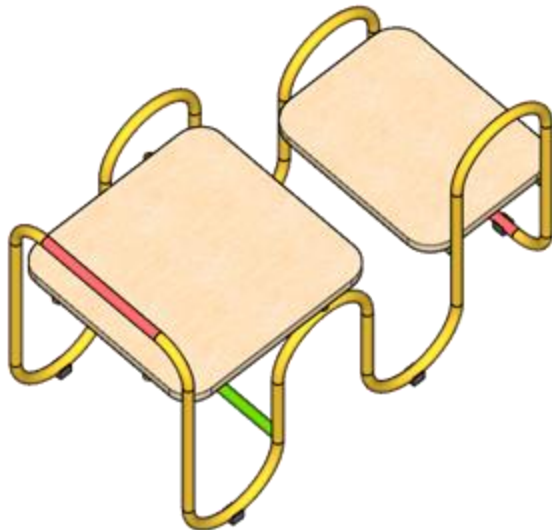
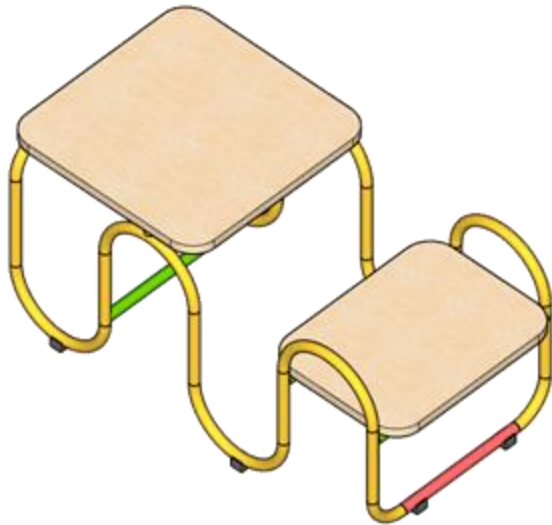


Various configurations were studied to integrate the arm rest and back rest as part of the main structure.

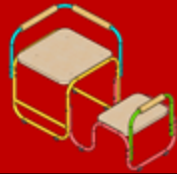
Yet the character of the furniture was still resembling the generic classroom desk and chair.



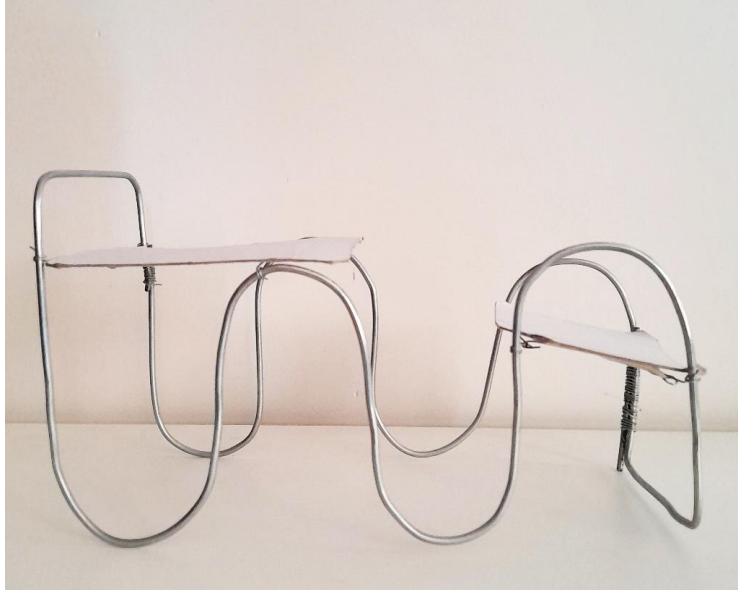
The next form was to explore the structures by using wave form as the main feature that tries to give a semantics away from a school furniture.



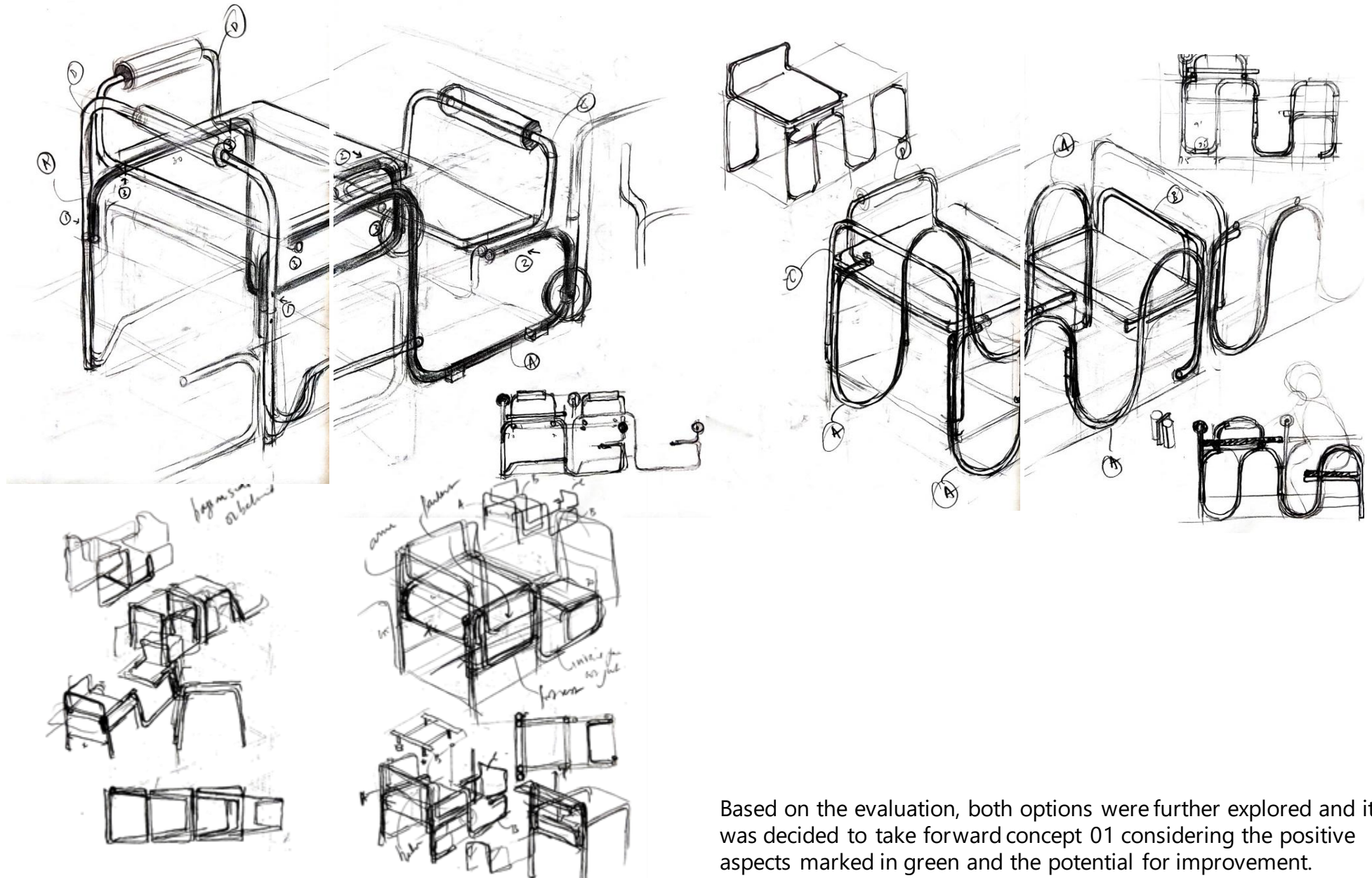
The lines of the waves created a unique character for the furniture as shown above with more playfulness.

	FORM 01 	FORM 02 
PRIMARY FUNCTION : CHILD LEARNING	satisfied	satisfied
SECONDARY FUNCTION : ELDERLY CHAT	satisfied	Not fully satisfied
INVENTORY/ COMPONENTS	Hand rest/arm rest will be add on	Hand rest/arm rest cannot be integrated to form
ERGONOMICS / STANDARDS	desk /seat dimensions for 1 st / 2 nd grade + elderly to sit	desk /seat dimensions for 1 st / 2 nd grade + elderly to sit
FLEXIBILITY OF LAYOUTS	Can be used for left and right side orientation	Can be used for left and right side orientation
ACCESSIBLTY : IN AND OUT	Accessible for both	Accessible for both
TRANSFORMATION	no effort required for transformation	no effort required for transformation
STABILITY IN FUNCTIONS POSTURES	Stable for both users	Might be unstable if too much load on the edge
SAFETY HAZARDS	Exposed joints/bolts to be taken care	No visible joints hence safe
MATERIAL CONSUMPTION	MS pipe overlaps can be solved	Relatively more material consumption due to bends
MANUFACTURING PROCESS	Pipe bending with regular 50 mm dye	Pipe bending with customized dye
DURABILITY/REPAIRABILITY	bolted joints might weaken over period	Lesser bolted joints hence durable
MAINTENANCE	Bolted joints might require tightening often	Lesser joints and easy maintenance
TRANSPORT/ STORAGE	Parts can be dismantled and stacked	Cannot be stacked/dismantled
AESTHETICS	Generic bent pipe desk aesthetics	Wave form creates playful character
SEMANTICS	Has classroom furniture semantics but less inviting for the elderly	Wave form blurs school furniture semantics and no definition for elderly chair

xxxx: positive | xxxx: negative | xxxx: can be improved

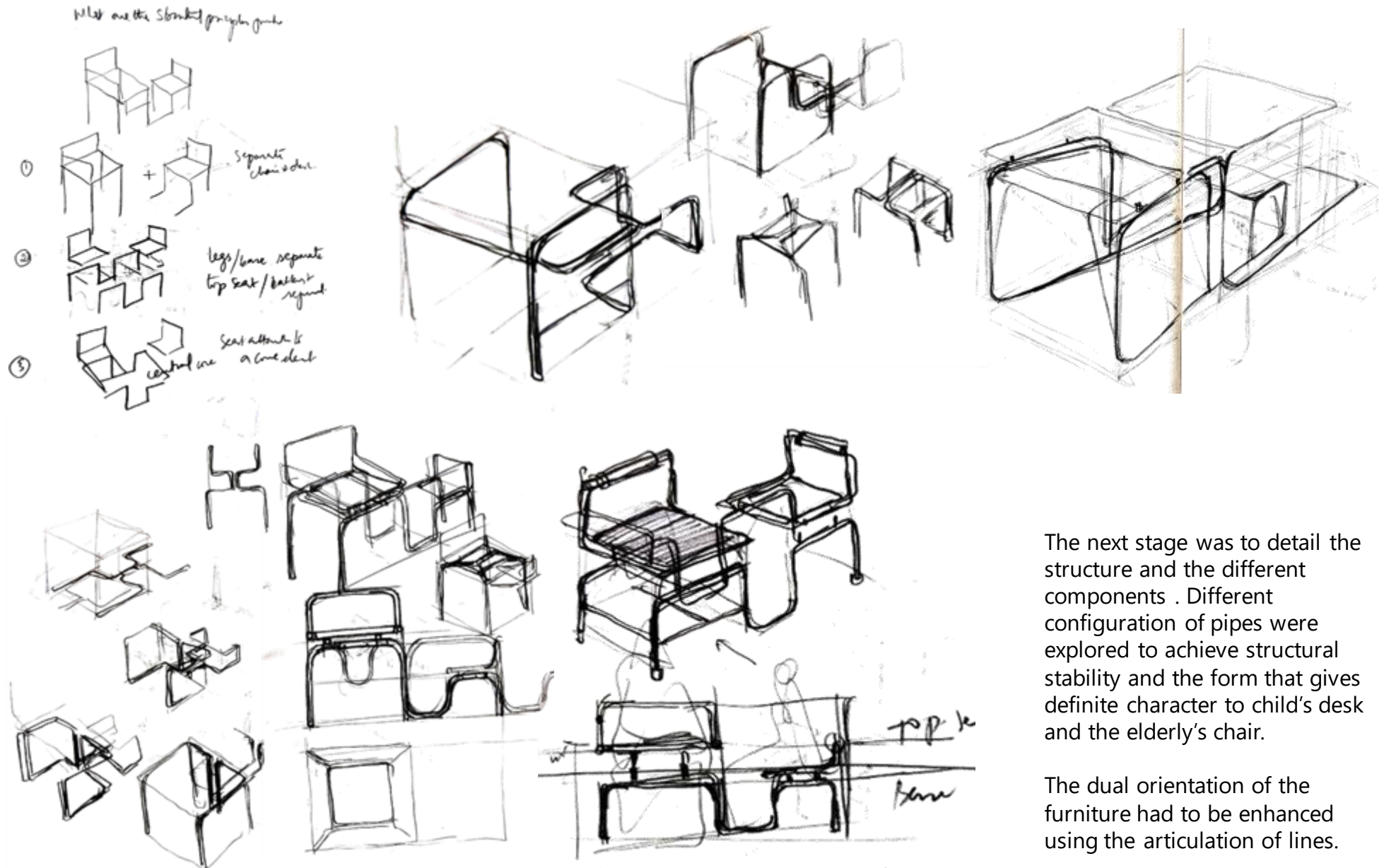


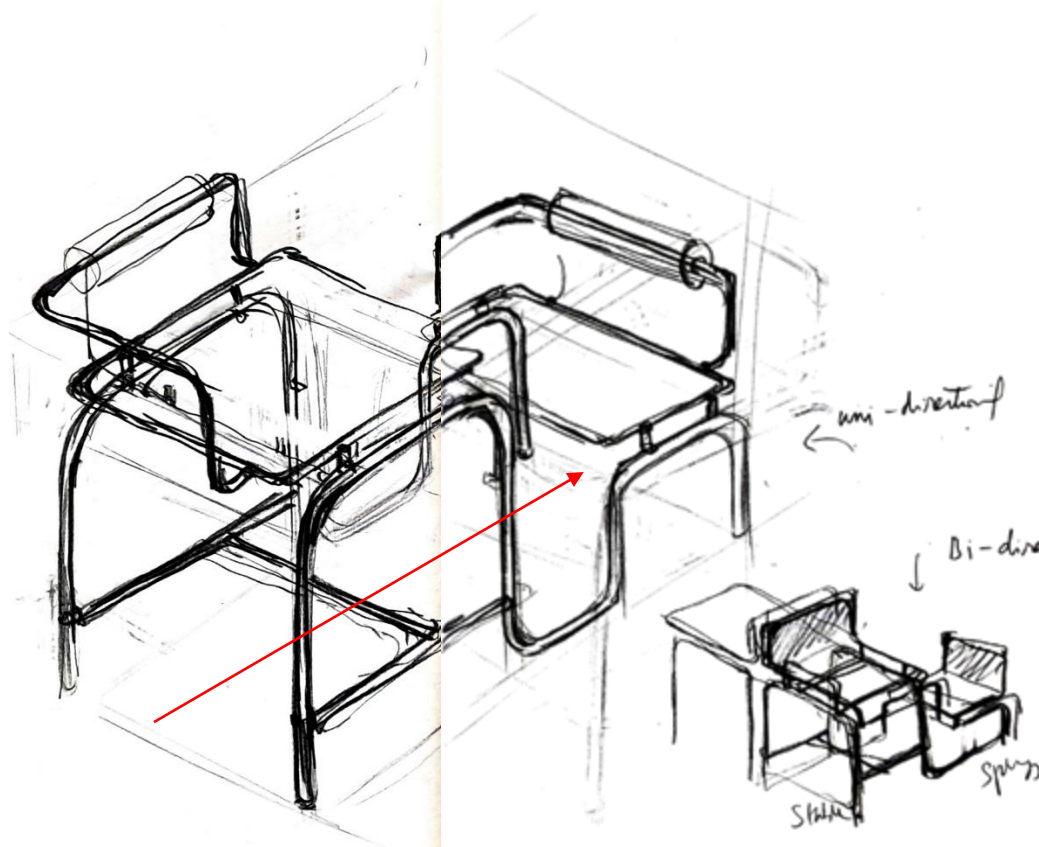
Wire models of both the options were made to study the structure and other details of how the seat and desk can be positioned.



Based on the evaluation, both options were further explored and it was decided to take forward concept 01 considering the positive aspects marked in green and the potential for improvement.

stage 6 : refinement

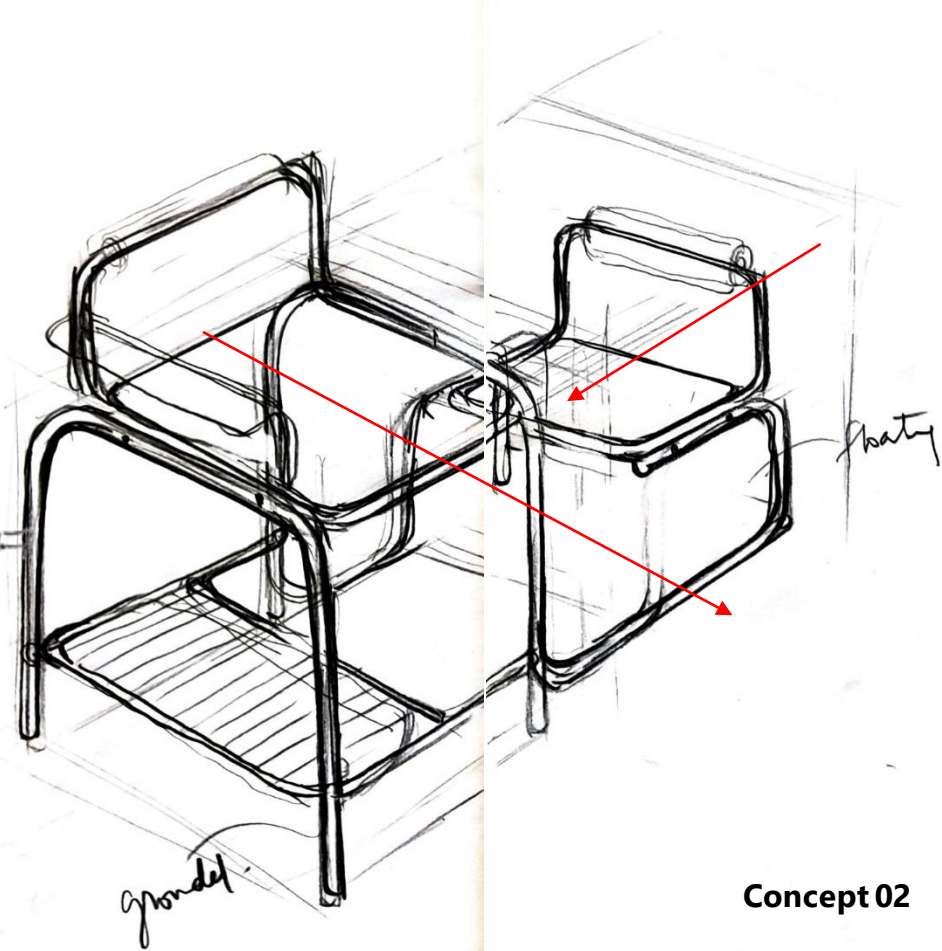




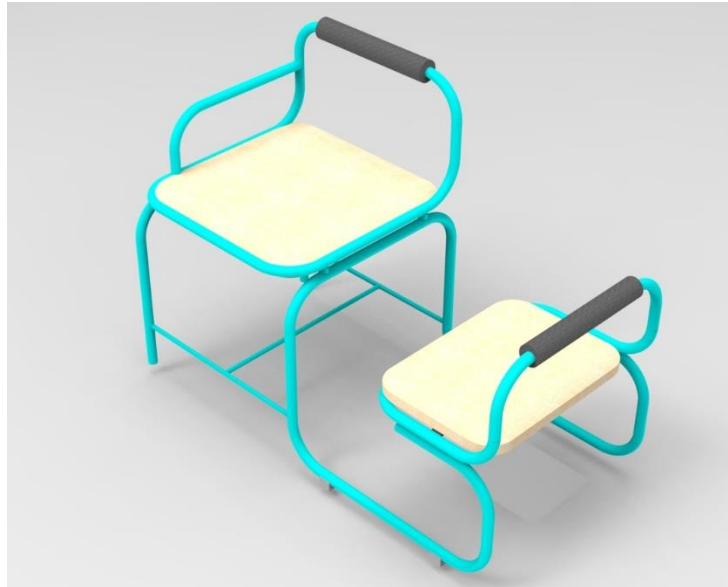
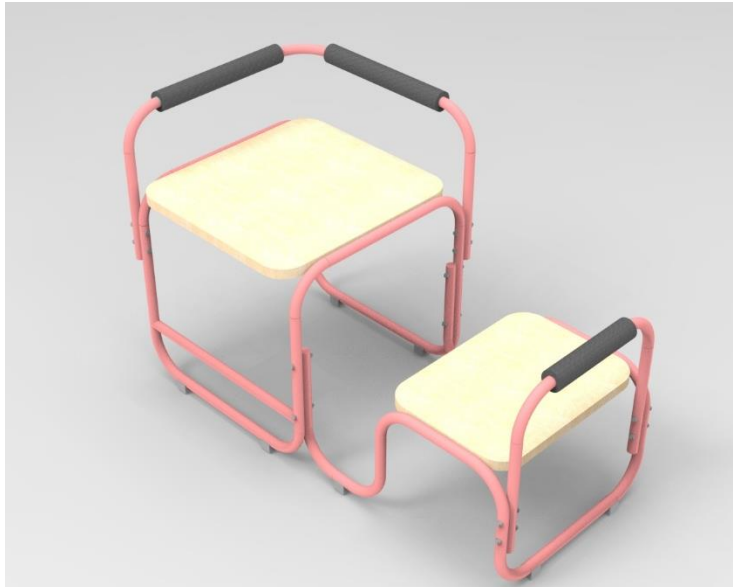
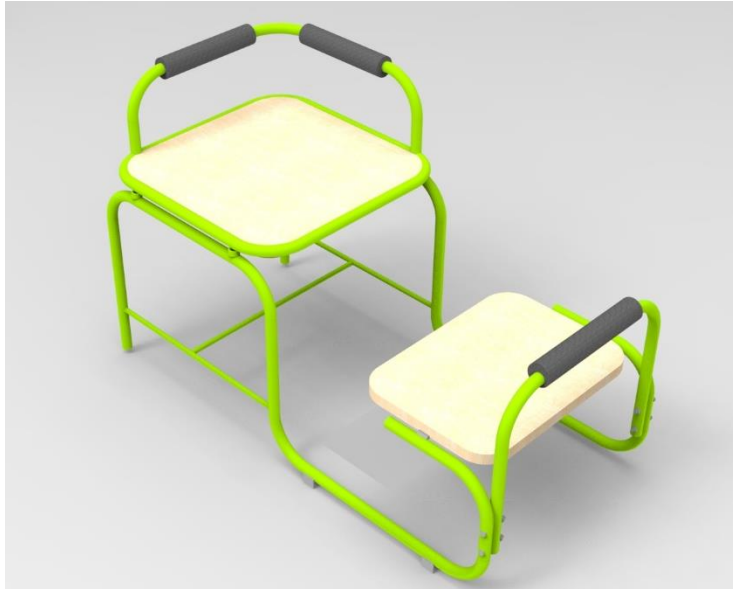
Concept 01

This led to two sub-concepts where concept 01 had a linear profile that connects the desk with chair but the definition of the elderly chair was not distinct.

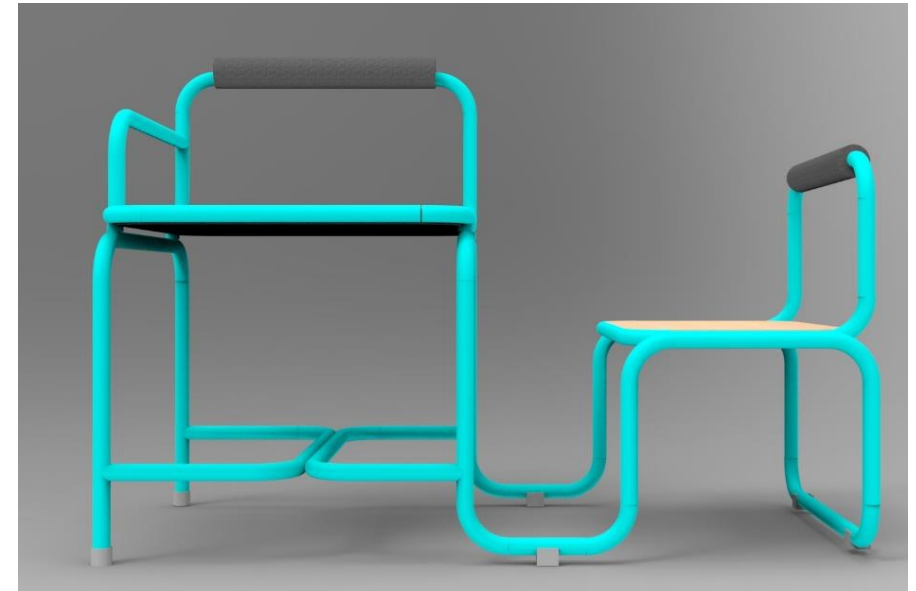
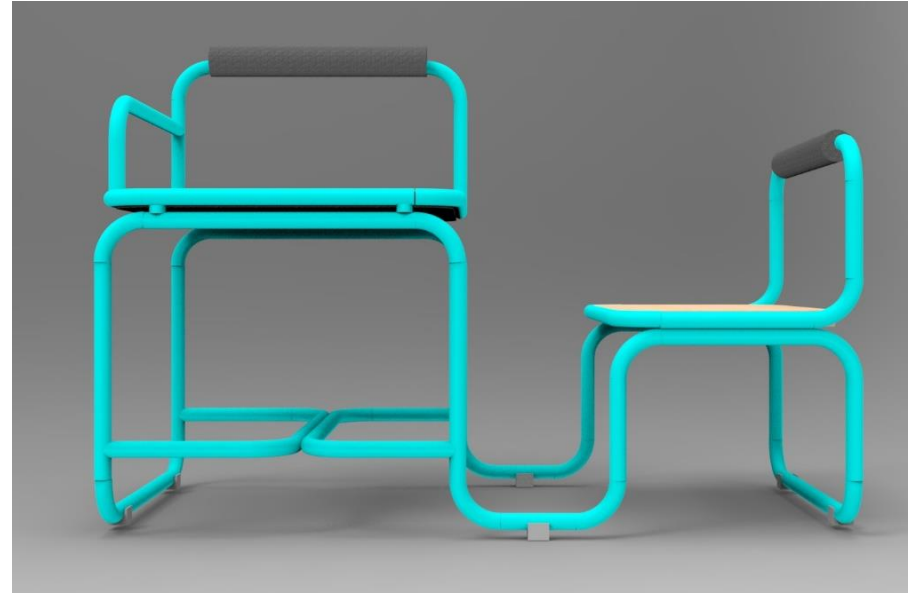
This led to the concept 02 where the legs of the elderly chair are perpendicular to the child's chair creating an interesting overlap of lines, at the same time giving character to each unit.



Concept 02



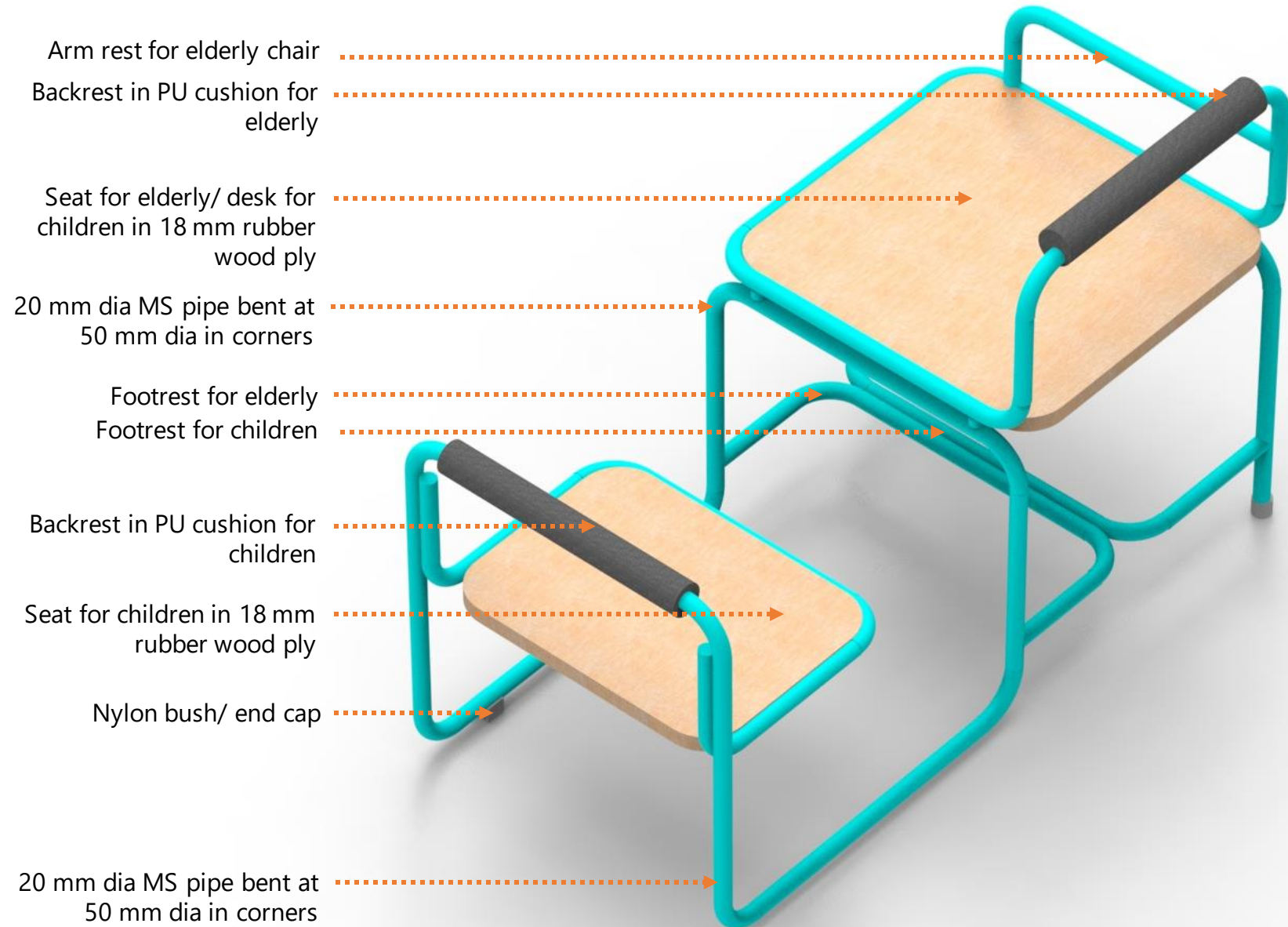
Next step was to create 3D visuals to understand the formal characteristics and the structural understanding. Different variants of concept 01 were tried and the concept 02 in blue was taken forward to the next stage of refinement of form.

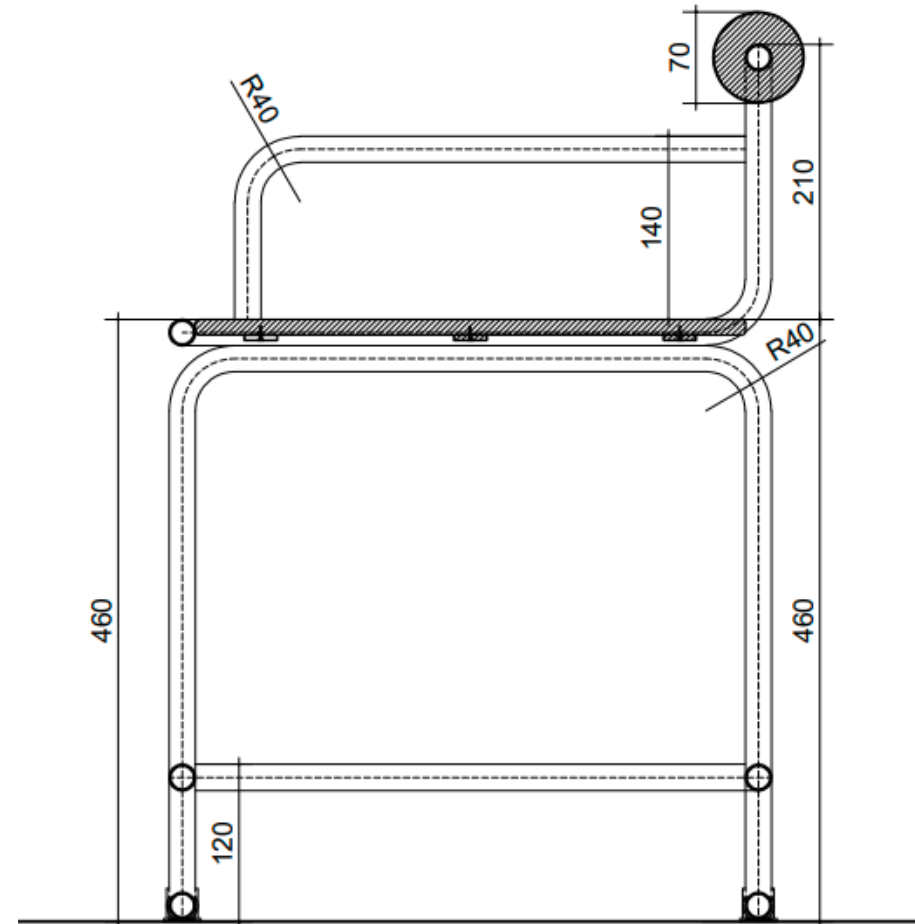
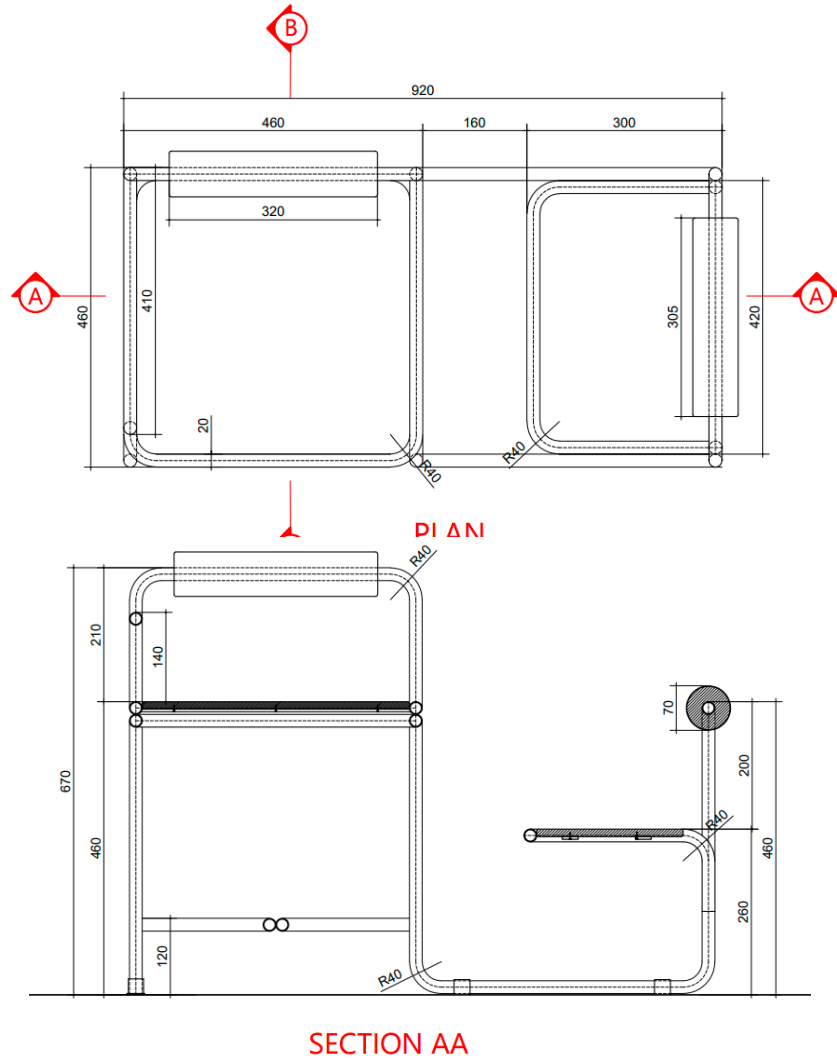




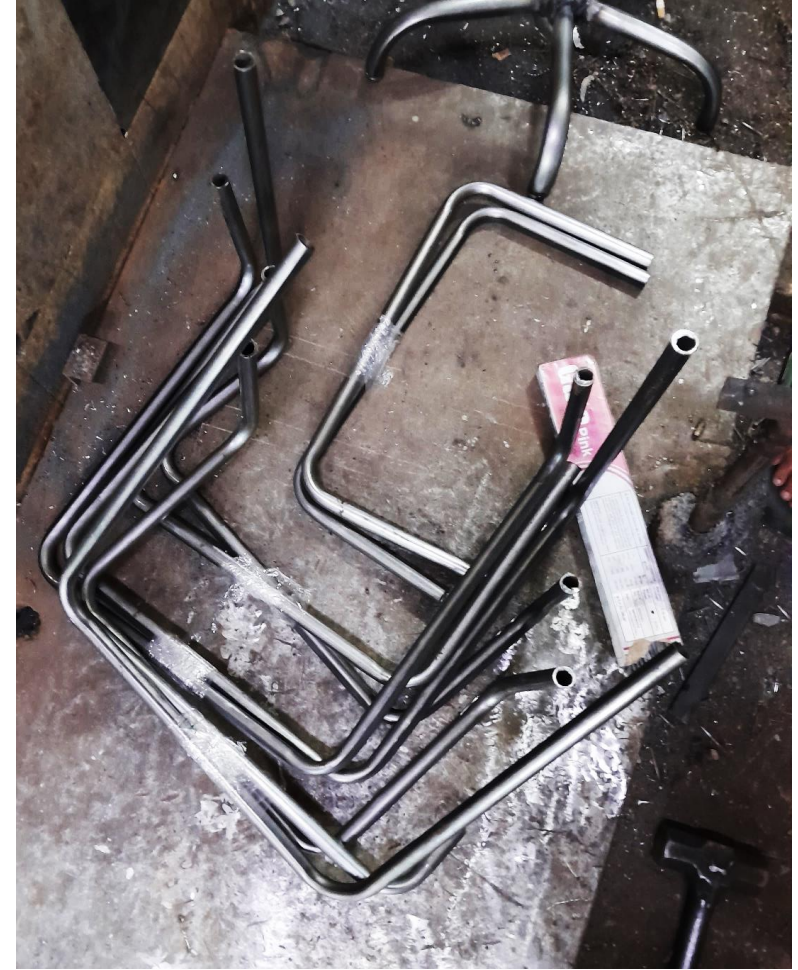
Different ways of articulating the lines were explored and this design was finalized . As seen in the images the elderly chair has a raised backrest and the legs are aligned with the legs of the person sitting giving the character of a stable and safe chair for elderly.

The chair of the child is cantilevered to express the youth and both these lines merge at the middle bringing out the contrast of the matured elderly and the young child through the nature of the lines.



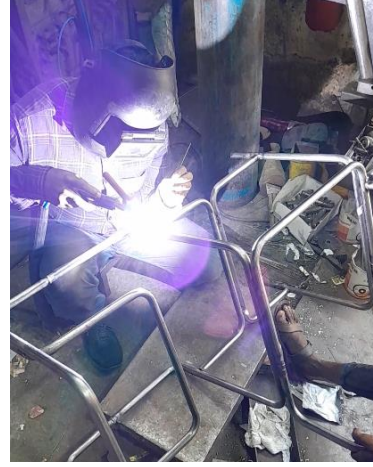
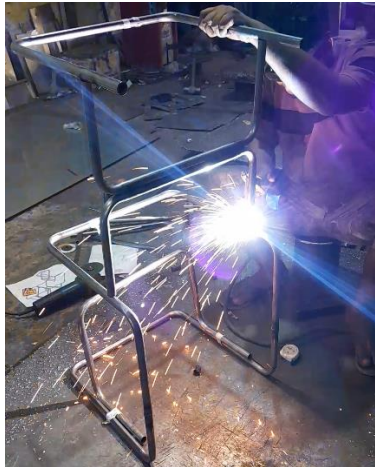
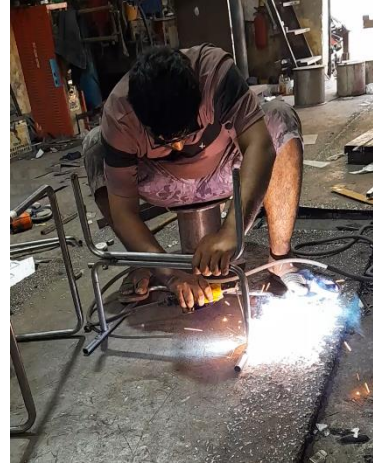
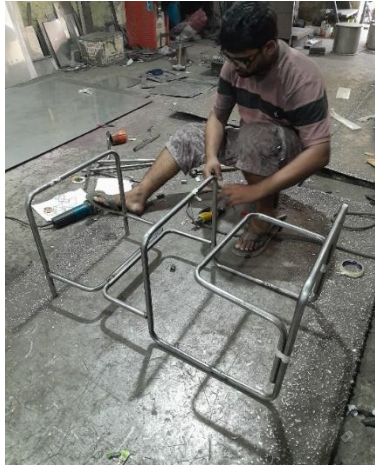


Measurements were finalized and working drawings were made for prototyping.



The first stage of prototyping involved sourcing of 20 mm MS pipes and bending them to profiles as per measurements. They were divided into smaller parts that can be handled easily for working.

stage 07 : prototyping

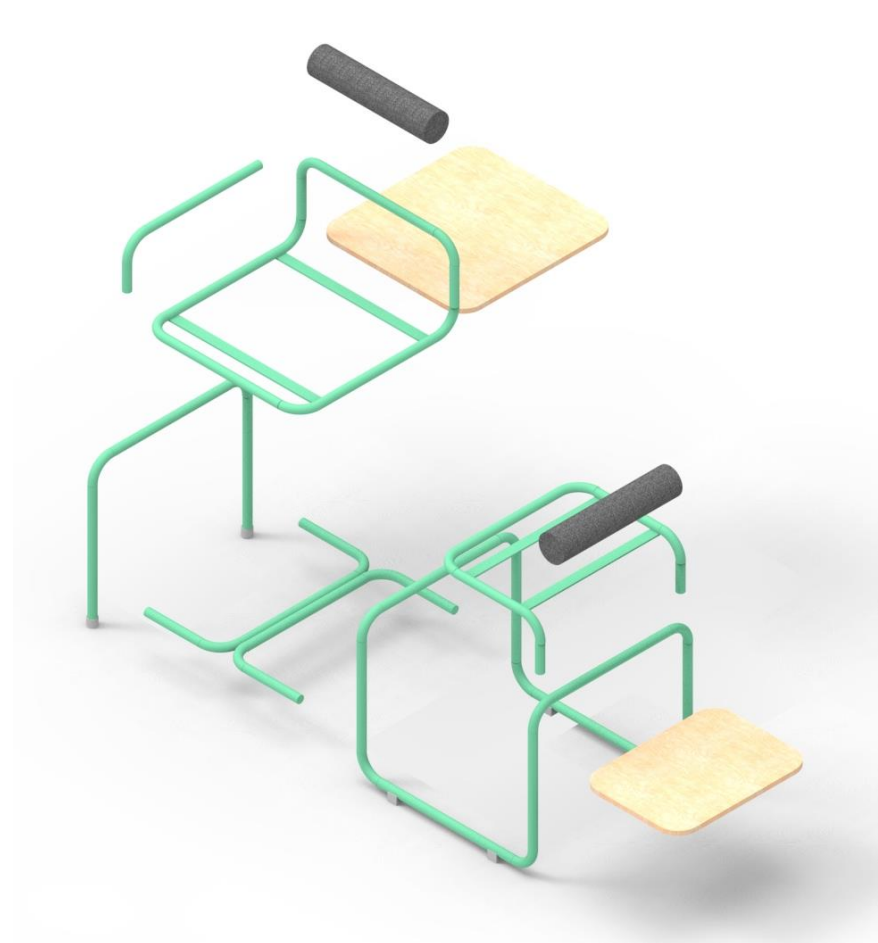


The next stage was to weld them together by tack welding initial and checking. There were alignment issues since these were done by two different vendors. The misalignments were corrected and final welding was done and finished by grinding.



The welded frame was taken to the powder coating workshop. There were limitations in the colors and the available color was chosen. Upholstery was done with another vendor using PU foam and rexine fabric. 12 mm Birch ply was used for the seat.

S.no	Item	Quantity	Unit	Rate (Rs)	Amount (Rs)
1	MS PIPE FRAME				
	Material cost :				
1.1	20 mm OD MS pipe 2mm thick	10.26	kg	70	718.20
	RM = 10.8 m, 0.95 kg/m				
	Process cost :				
1.2	MS pipe cutting and bending	25	bends	80	2000.00
1.3	MS Pipe joint welding/grinding	24	joints	40	960.00
1.4	MS pipe powder coating	404	inch	4	1616.00
1.5	Inspection				1000.00
2	WOODEN SEAT				
	Material cost :				
2.1	12 mm rubberwood ply	3.75	sqft	120	450.00
	Process cost :				
2.2	Plywood cutting	3.75	sqft	250	937.50
2.3	Edge filleting				
2.4	sanding and PU polish				
3	PU BACKREST CUSION				
	Material cost :				
3.1	50 mm dia inner hard PU	0.75	m	200	150.00
3.2	15 mm thick soft PU foam	2	sqft	40	80.00
3.3	2 mm thick faux leather (rexine)	0.5	m	200	100.00
	Process cost :				
3.4	Cutting/gluing/stitching				400.00
4	OTHERS				
4.1	Accessories				200.00
4.2	Packaging and transportation				
4.3	Overheads			10%	
4.4	Profit			7%	
5	TOTAL AMOUNT			Rs.	8611.70



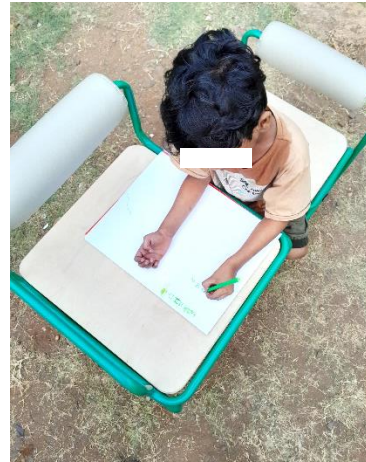
The table shows the different items including the material and process costs. The total amount came to around Rs.8600 per piece. The same can be made with approx. Rs.4000 – Rs.5000 for larger numbers (quoted by the same vendor)

- In manual bending larger frames are **split into parts** and welded
- Some cases these welded joints are not uniform
- A single part containing up to 4 bends is easy to work
- Without **jigs** the alignment of the parts are imperfect
- Have **identical** measurements/ components as much as possible
- The **curvature** of the bends are not exactly uniform, hence the wooden seat inset will leave gaps
- When all the components are welded it is difficult to **stack** them or carry them in between processes
- Structural frames can be welded and the non-structural components can be **bolted** or riveted on site
- There should be provision for **hanging** the frames during powder coating, else leave marks of the hooks
- **Wooden seat** detailing might have to be revised so that the uneven gap between the frame is avoided
- **Backrest** cushion to be detailed so that it is easy to mount yet difficult for children to remove.





The finished prototype was taken to the neighborhood park where the elderly and children from the nearby school gather during the evenings. The product was tested with the elders and they found it easy to sit and get up without exerting much stress.



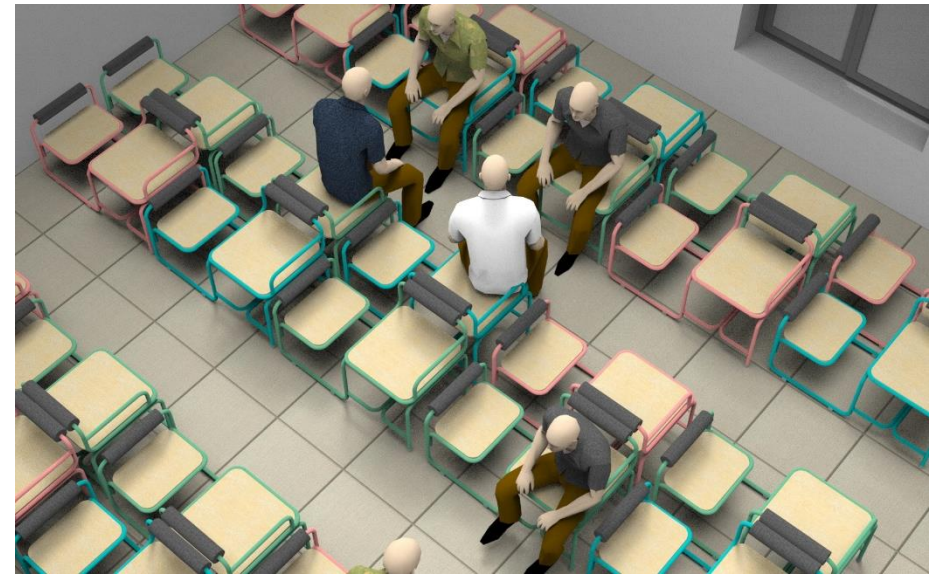
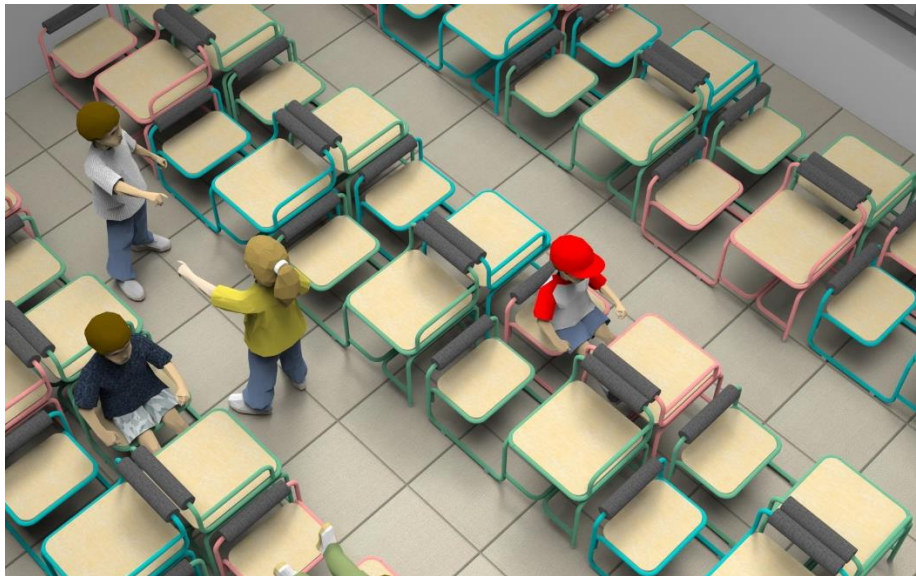
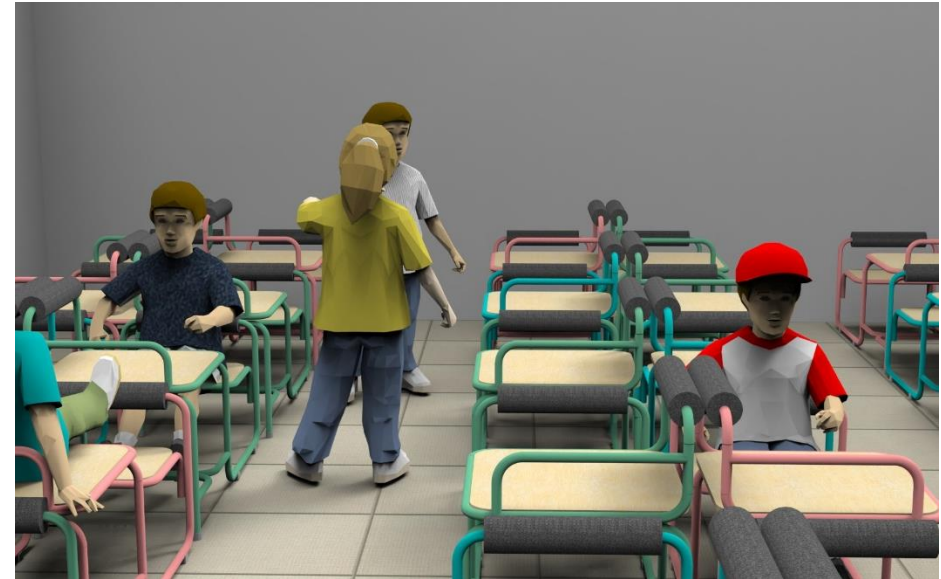
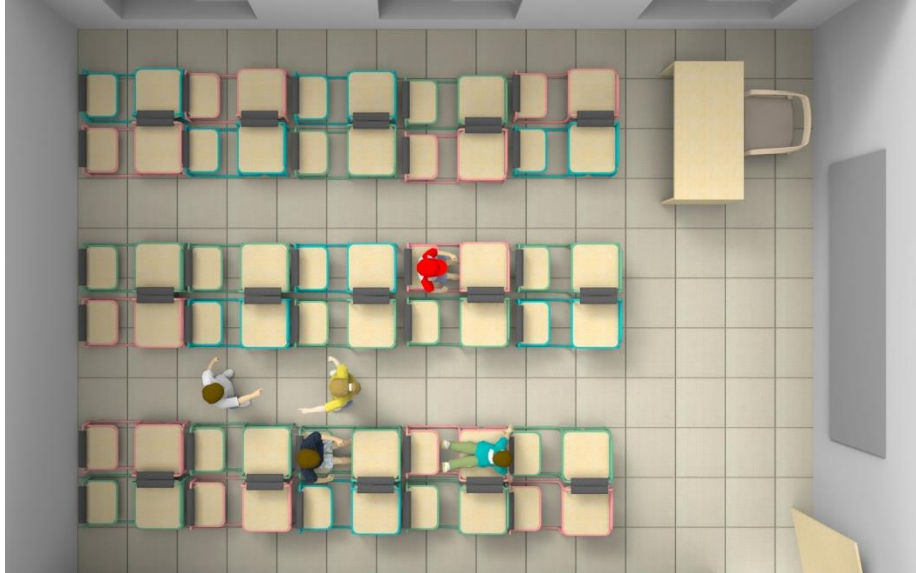
Children were curious about the new product yet they could identify with the desk and chair and started using them intuitively.

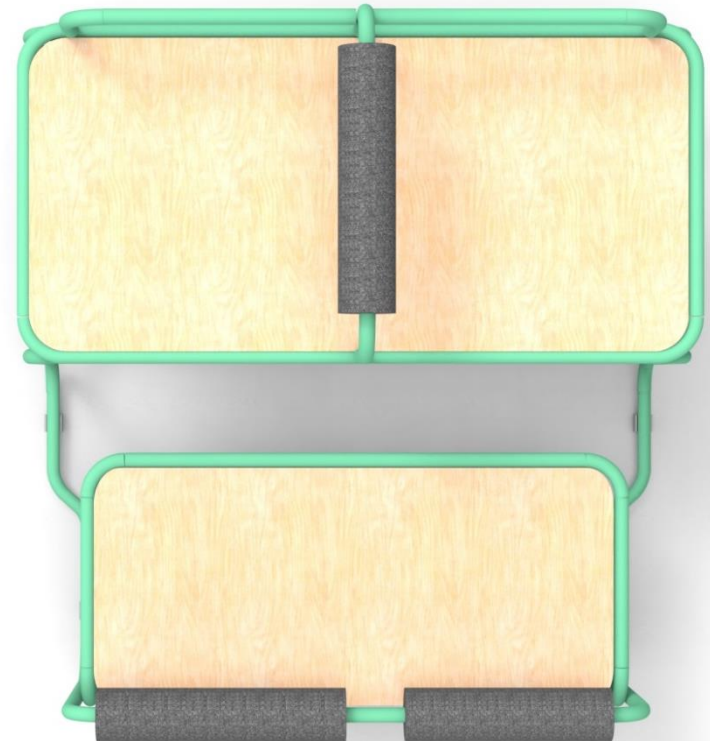
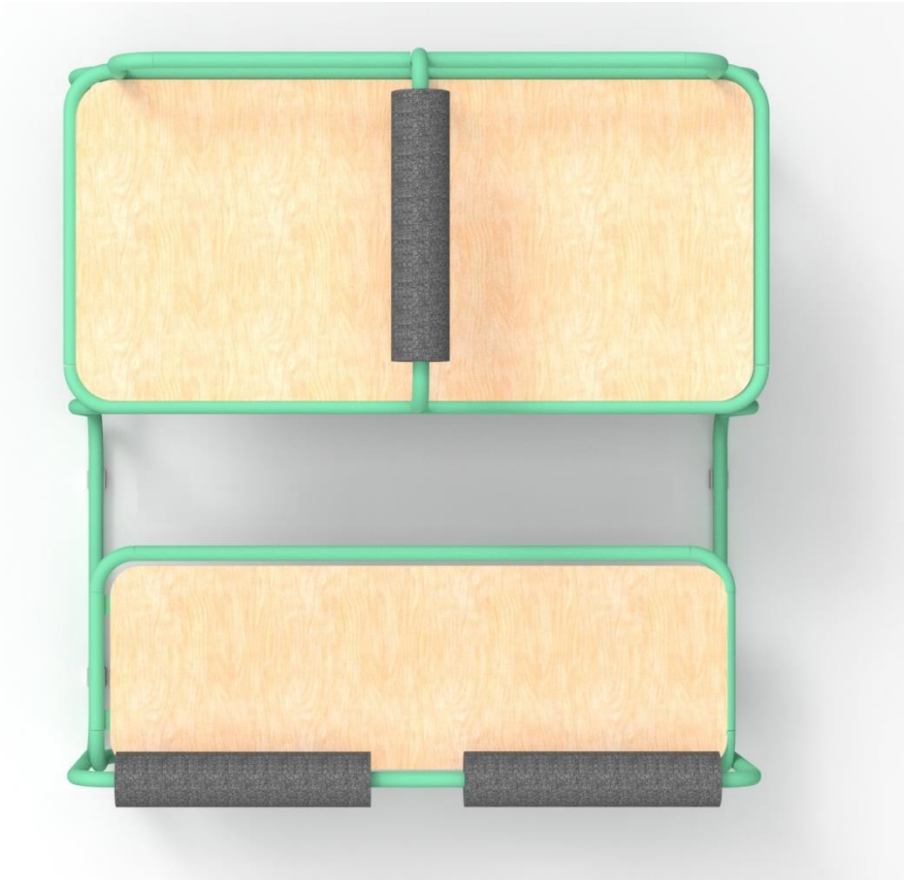


- Testing done with 5 elderly persons and 5 children, of different body shapes
- In first look few could **identify** this as a chair for adult and desk for children
- Most elderly found the seat depth, height, width **comfortable**
- For children the seat was slightly away from the desk and had to **slouch** while writing
- The gap between seat and desk was convenient for **ingress** and standing
- The backrest with cushion was good support for **lumbar** region, some suggested having higher **back rest**
- The hand rest was lower than arm height but they used it for **getting up**, but this also prevented from using the child's seat as footrest
- Shorter persons used the **footrest** and felt comfortable, children though dint use it unless mentioned
- The furniture remained **stable** even when there is unequal weight distribution
- The elderly could **lift** the furniture with both hands without much effort by holding the chair seat.
- The **color** was liked both by children and elderly

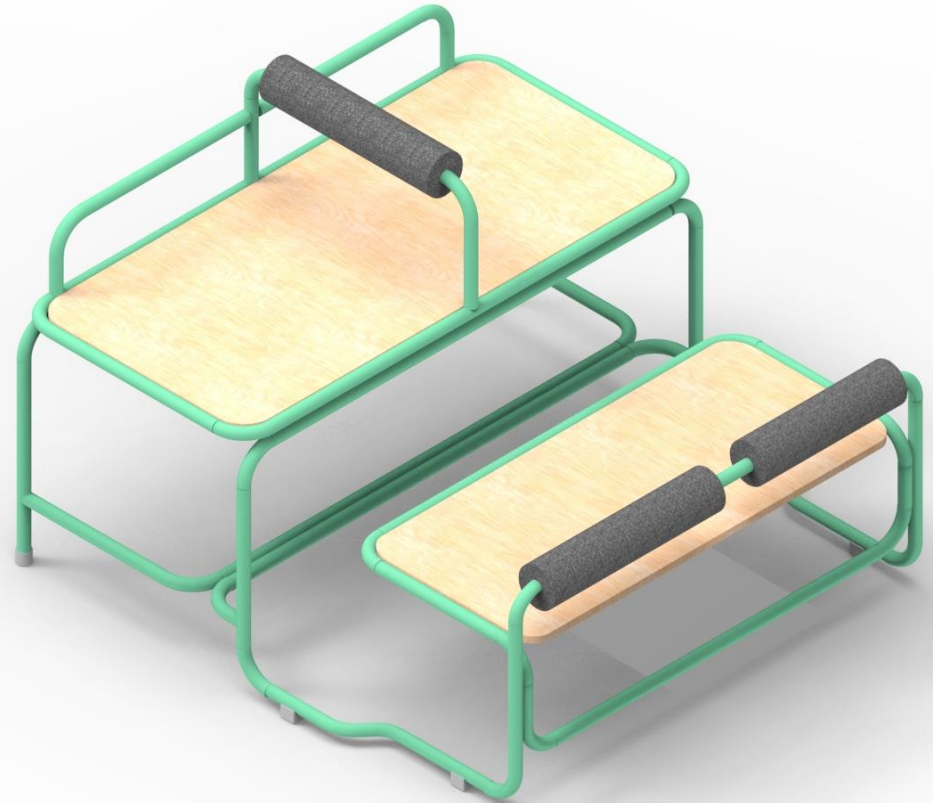
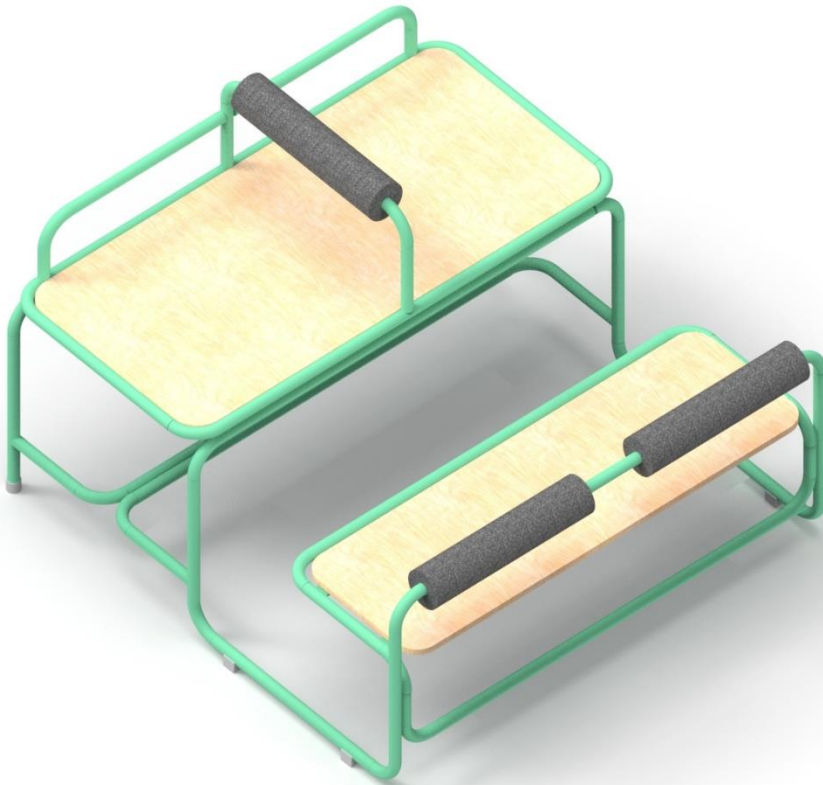


After the testing , few refinements were explored including first variant with pastel shades. The model was placed in the classroom arrangement and spatial arrangements were studied.

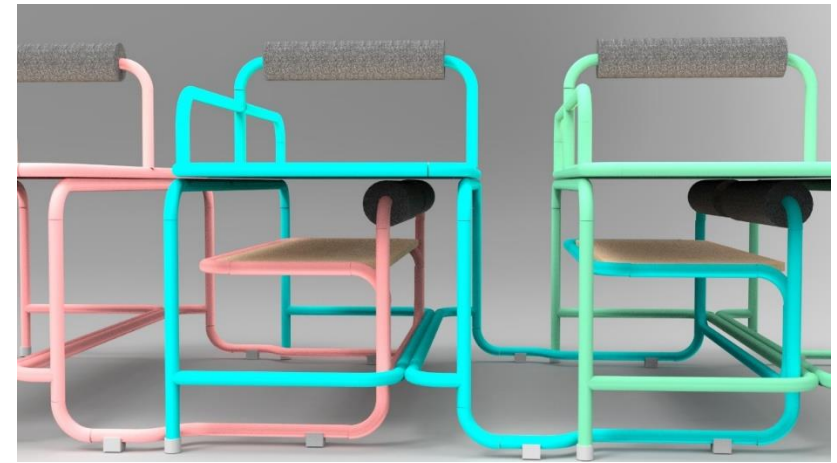
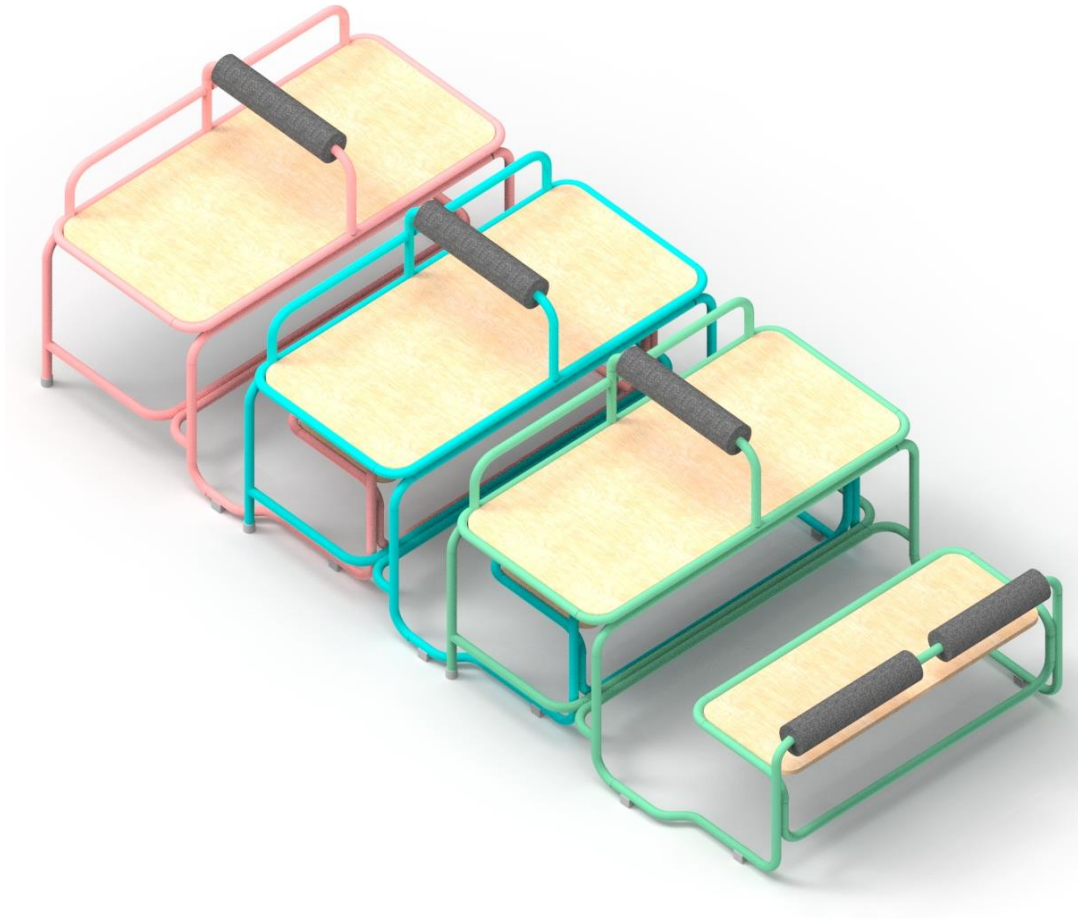




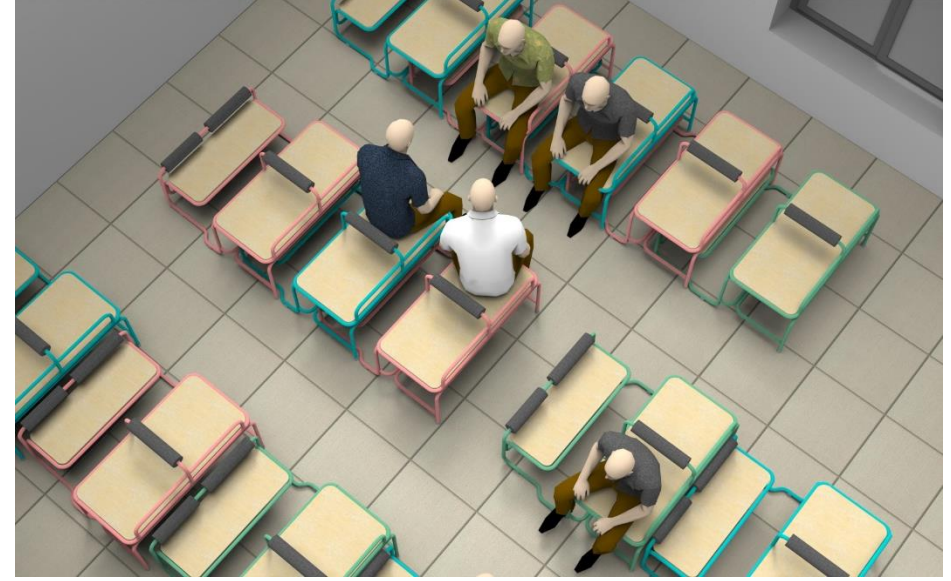
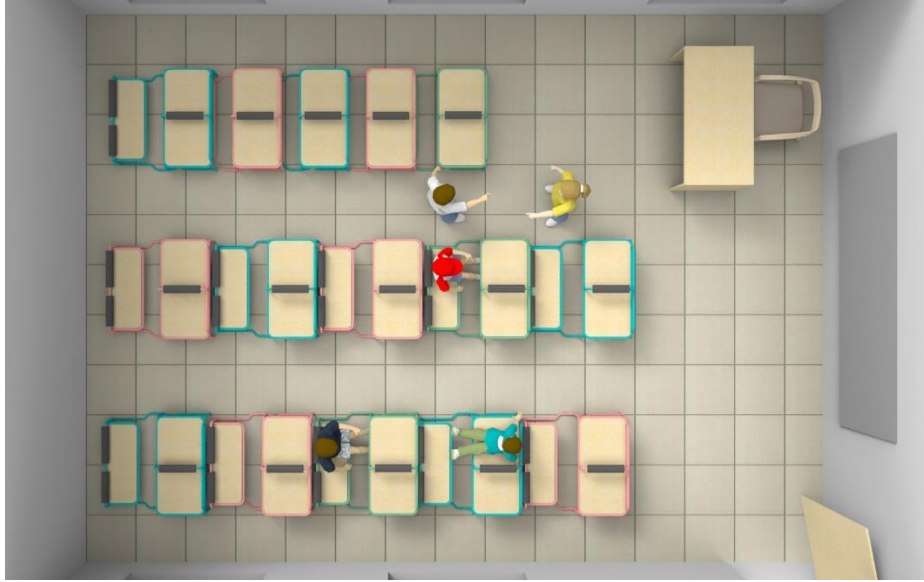
The next variant was a double seater option where the children seat can be pushed under the desk while the elderly sit together.

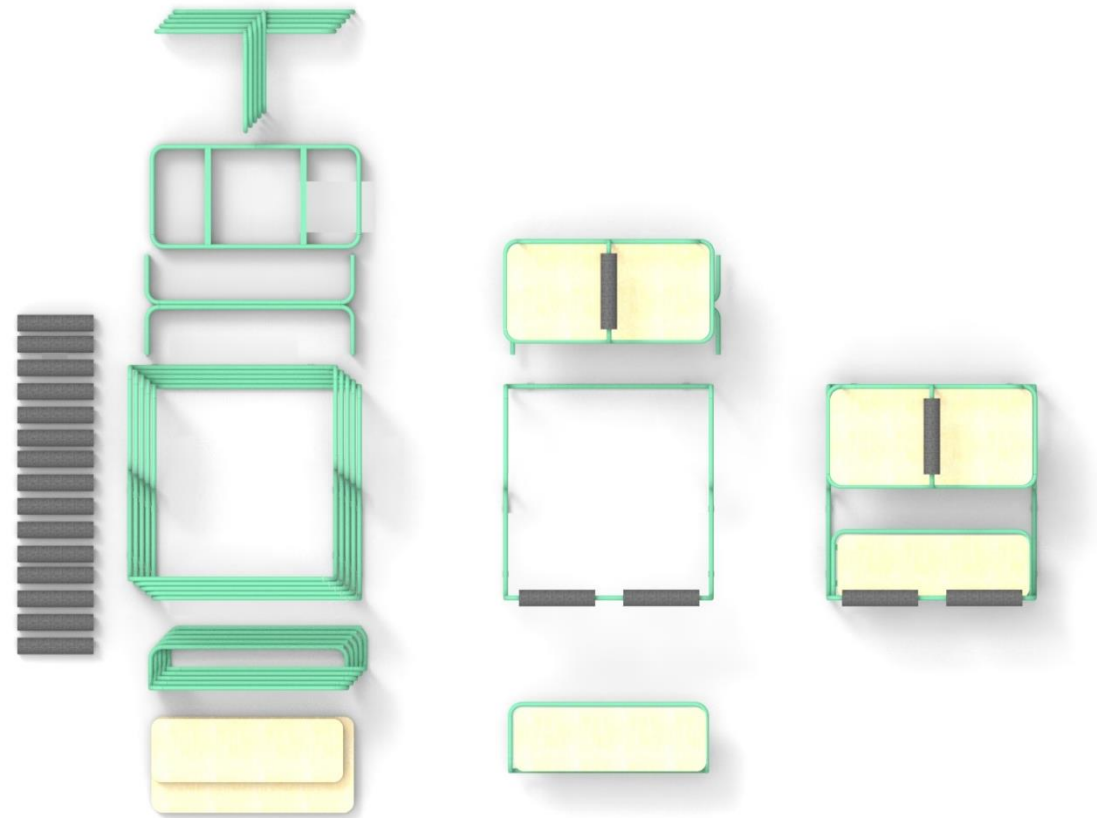
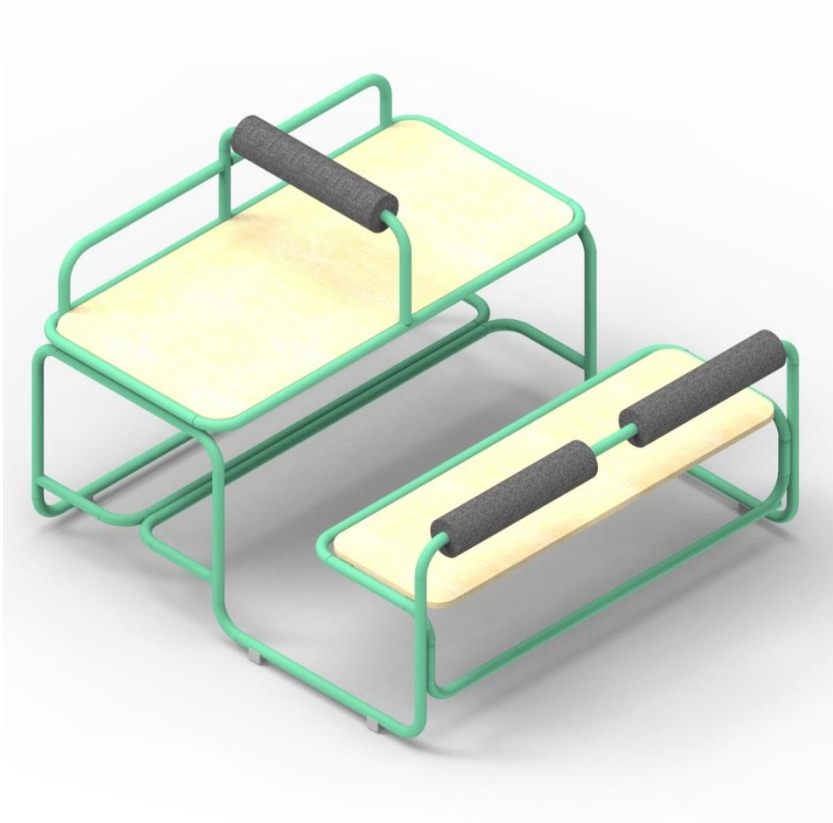


This reduced the number of parts of the frame and in turn can reduce the cost.

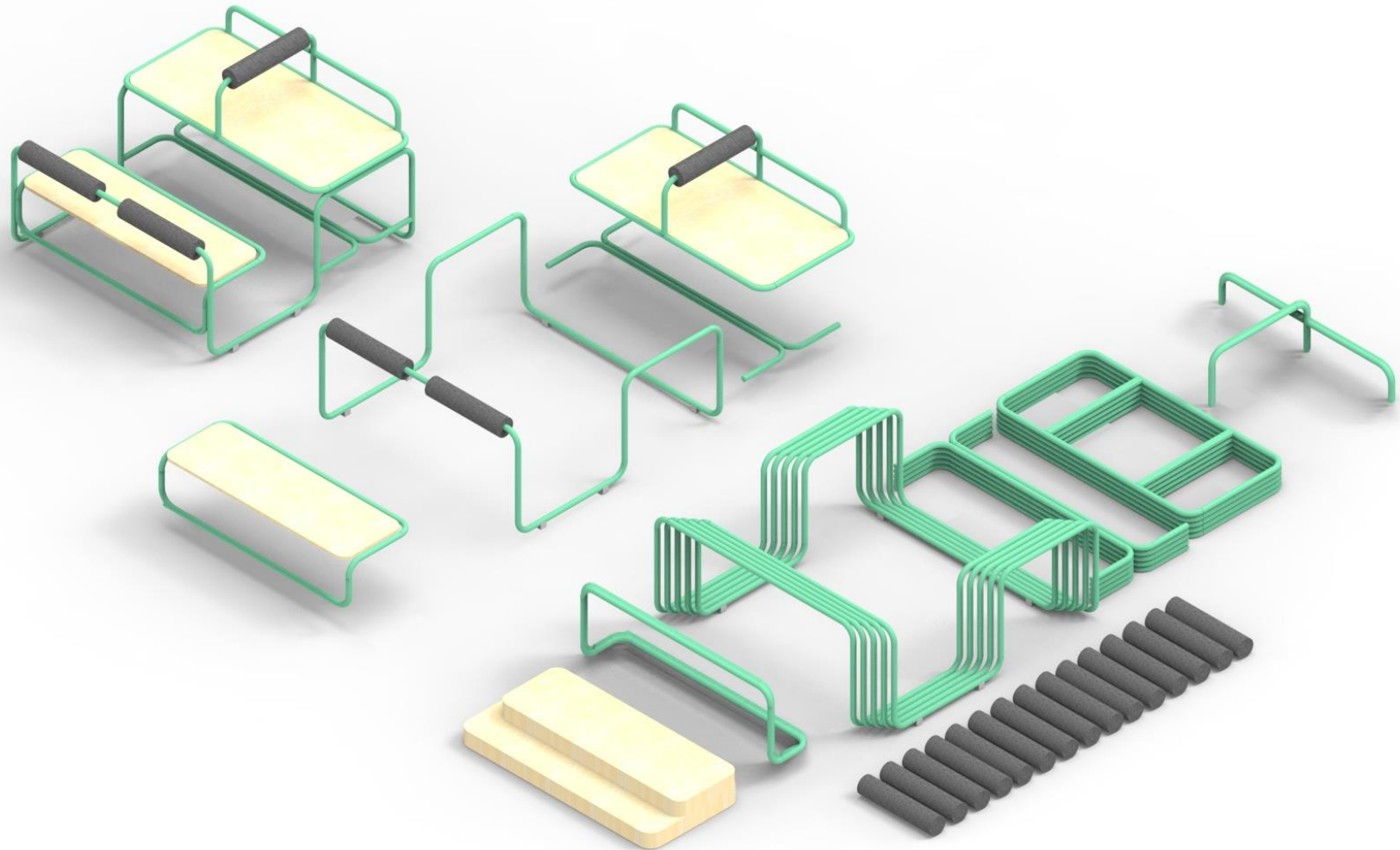


Also the sliding in aspect help the elders to sit closer and stack them when open space is necessary in the classroom.





Variant 03 is a flat-pack option where the parts can be made separately and can be assembled in classrooms.



This will reduce the packaging volumes and transporting costs drastically.



- The project was an experience in learning how furniture can **bridge** the needs of two different user groups
- The role of furniture as an entity that can bring **behavioral changes** in a larger group of people
- Understanding the **commonalities and differences** between user groups
- The **design brief** went through different iterations and the lack of specific client gave lot of freedom at the same time had to learn how to restrain when necessary
- Prototyping from **external vendors** help understand the reality of how industries work, manufacturing, costing and negotiations
- Though the furniture solves the requirements at a physical level, it needs to be seen how this works at a **socio- cultural** level when executed in classrooms.

- Taifa, I. W., & Desai, D. A. (2016). *Anthropometric measurements for ergonomic design of students' furniture in India*. Engineering Science and Technology, an International Journal.
- Harvey, E. J., & Kenyon, (2013). *Classroom Seating Considerations for 21st Century Students and Faculty*. Journal of Learning Spaces, 2(1).
- Wang, L., Lyu, J., & Chen, M. (2018). Study and practice on seat products design for elderly people. *IOP Conference Series: Materials Science and Engineering*, 394, 032130.
- Brooker, Stephanie Lee. "Primary Objects: Developing a New Type of Furniture for the Early Elementary Classroom." Master's thesis, [Name of the Institution], 2011.
- Rahman, Md., Hasan, Md., & Datt, Ms. B. "Ergonomic Furniture Design for Secondary Girls School in Bangladesh." International Journal of Research in Industrial Engineering, Vol. 8, No. 2 (2019), pp. 187–202.
- Openshaw, Scott, and Taylor, Erin. "Ergonomics and Design: A Reference Guide." Allsteel Inc, 2006.
- Almandrawy, Mohammad Abdullah Taha. "Ergonomic Design of Metal Chair for the Elderly." *International Journal of Engineering Research & Technology (IJERT)*, Vol. 4, Issue 01, January 2015
- Dhara, Prakash Chandra, Khaspuri, Gurucharan, & Soudeep Kumar. "Complaints arising from a mismatch between school furniture and anthropometric measurements of rural secondary school children during classwork." Environmental Health and Preventive Medicine, 2009.
- Savanur, C. S., Altekar, C. R., & De, A. (2007). *Lack of conformity between Indian classroom furniture and student dimensions: proposed future seat/table dimensions*. Ergonomics, 50(10), 1612-1625. DOI: 10.1080/00140130701587350
- Gudur, Raghavendra Reddy. (2019). *A Framework to Understanding Factors that Influence Designing for Older People*. In International Association of Societies of Design Research Conference 2019
- Fallah, H., Nazari, J., Choobineh, A., Morowatisharifabad, M. A., & Jafarabadi, M. A. (2021). *Inclusive design: An approach to adapt homes for the elderly*. Journal of Aging Research and Healthcare, 1(1), 25-36.
- Obeidat, I. M., & Obeidat, S. M. (2015). *Designing for the Elderly: Comfort, Health, and Well-Being*. Journal of Design Research, 10(2)

Bureau of Indian Standards. (1990). *Indian Standard Specification for School Furniture* (IS 4837:1990). Retrieved from [https://law.resource.org/pub/in/bis/S03/is.4837.1990.pdf]

Journal of Indian Education, Volume XLIV, Number 4, February 2019. Retrieved from [https://ncert.nic.in/pdf/publication/journalsandperiodicals/journalofindianeducation/JIE-FEB2019.pdf]

UNESCO. (1975) *National Curriculum Framework for School Education*. Retrieved from [https://unesdoc.unesco.org/ark:/48223/pf0000015000]

Herman, F., Van Gorp, A., Simon, F., & Depaepe, M. (2013). *The school desk: from concept to object. History of Education: Journal of the History of Education Society*. Retrieved from [https://www.tandfonline.com/doi/abs/10.1080/0046760X.2014.894935]

Kass, D. (2022). *School furniture: desks, tables and chairs: New South Wales, late 19th century - 2000. Dictionary of Educational History in Australia and New Zealand (DEHANZ)* . https://dehanz.net.au/entries/school-furniture-desks-tables-and-chairs/

Cornell University. (n.d.). *Sitting and Chair Design*. Retrieved from [https://ergo.human.cornell.edu/DEA3250Flipbook/DEA3250notes/sitting.html]

United Nations Population Fund (UNFPA) India. (2011). *Report on the Status of Elderly in Select States of India 2011*. Retrieved from [https://india.unfpa.org/en/publications/report-status-elderly-select-states-india-2011#:~:text=The%20report%20covers%20a%20primary,compared%20to%20the%20national%20average.]

Ministry of Social Justice and Empowerment, Government of India. (n.d.). *National Policy for Senior Citizens*. Retrieved from [https://socialjustice.gov.in/writereaddata/UploadFile/dnpsc.pdf]

Kwok, C. Y. T., Cheng, T. C. E., & Wong, K. Y. H. (2018). *Furniture design guidelines for the elderly and people with visual impairment: A case study in Hong Kong. Indoor and Built Environment*

D'Source. (2016). *Furniture for Government Primary Schools*. Retrieved from [https://www.dsource.in/sites/default/files/case-study/furniture-govt-primary-schools/introduction/file/Furniture-for-govt-primary-schools.pdf]

Praja. (2023). *Report on State of Municipal Education in Mumbai*. Retrieved from [https://www.praja.org/praja_docs/praja_downloads/Report%20on%20State%20of%20Municipal%20Education%20in%20Mumbai.pdf]

Salvendy, G., & Karwowski, W. (Eds.). (2021). *Handbook of Human Factors and Ergonomics*. John Wiley & Sons.