Daniel Schwab

interdisciplinary design

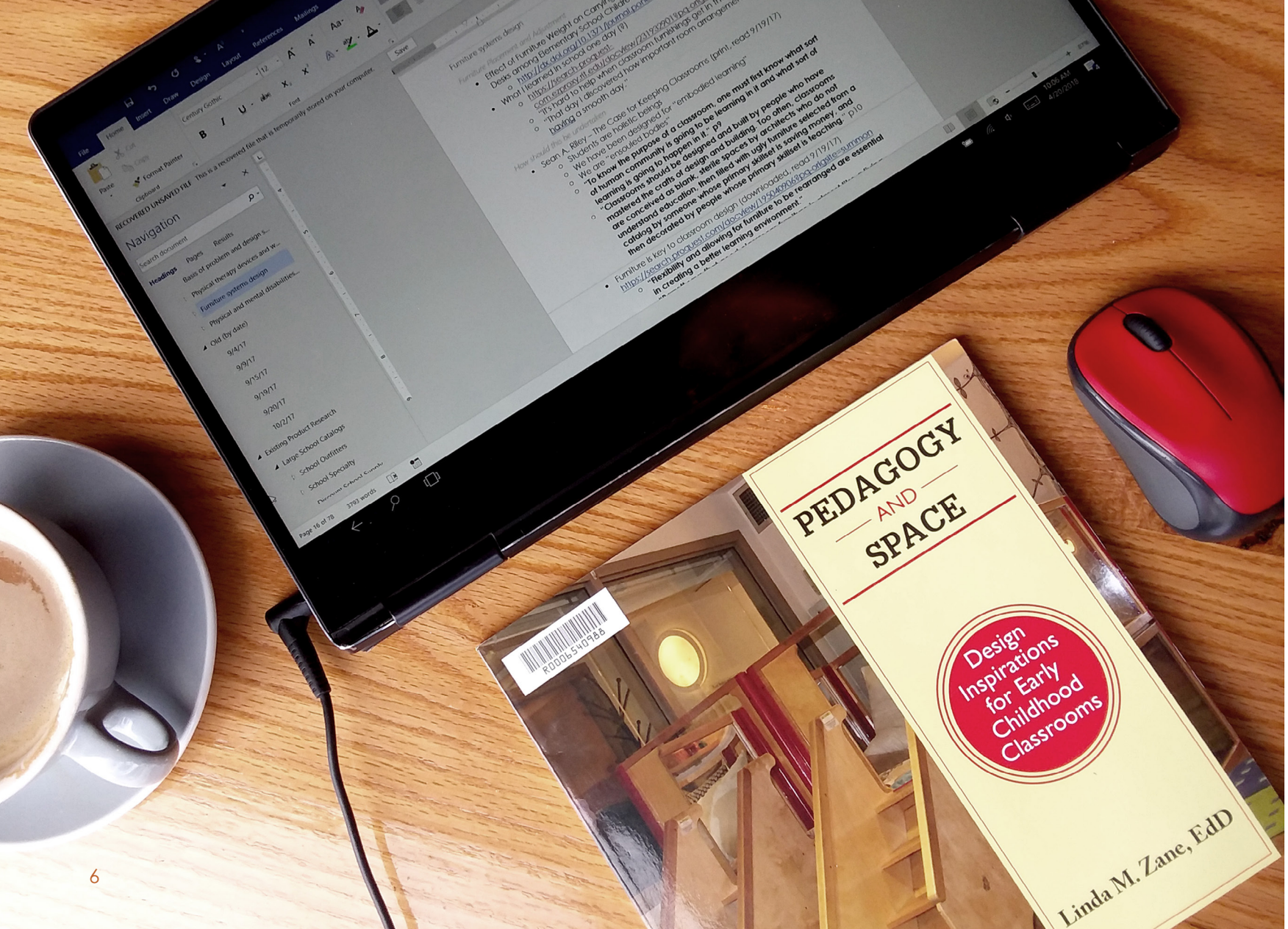
contents

Classroom Furniture System

chapter one

problem and research

This project was born out of my desire to design furniture for childhood education. Primary research revealed a design opportunity for special education furniture, which further directed my research.



secondary research

In order to find a problem to solve, I began the design process by researching educational furniture in books and articles and scouring catalogues for inspiration.

inspiration

Initially, I focused on adaptive and active classroom furniture.

Vidget 3-in-1 Active Seat

This chair was designed to encourage movement in the classroom for children who need sensory input. It can also be used as a desk, a stool, or a rocking chair. This helped me to break away from usual chair forms.

Ruckus Chair

This chair was designed to allow active learning. Students can sit in the seat facing any direction and can even sit on top of the back. This influenced me to think broadly about the way furniture should be used.

beauty in the classroom

Classroom furniture design is just like all other types of user experience design, yet many early education classrooms and furniture designs are treated as if children require a much more jarring and exciting experience.

Abigail Clevenger

"We must hold a higher standard of beauty than what is fun or colorful."

"Simplicity and elegance within reason is often better than complexity and color everywhere."

Sean A. Riley

"Classrooms should be designed and built by people who have mastered the crafts of design and building. Too often, classrooms are conceived as blank, sterile spaces by architects who do not understand education, then filled with ugly furniture selected from a catalog by someone whose primary skillset is saving money, and then decorated by people whose primary skillset is teaching."

searching for a problem

It would have been simple to redesign common classroom furniture. Instead, I searched for common classroom problems to solve in new ways.

Rita Oates

"Flexibility and allowing for furniture to be rearranged are essential in creating a better learning environment."

"Good classroom furniture is almost like a living thing that adapts and changes over time."

Helena Hemmingsson et al.

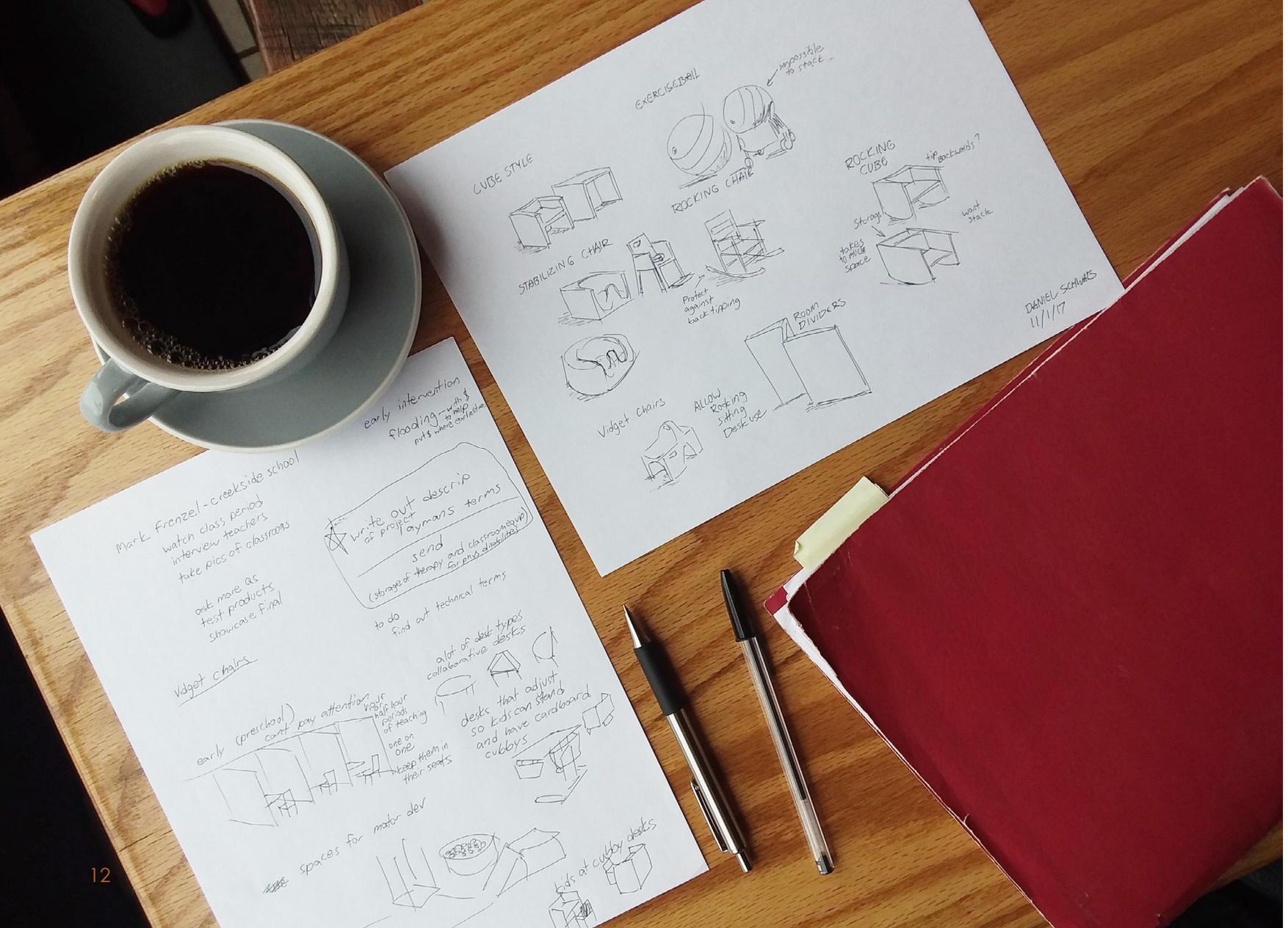
"The students' major concern about the classrooms was the furniture."

Monica Hay-Cook

"I discovered how important room arrangement is to having a smooth day."

Pamela B. Tanguay

"The success or failure of most [non–learning disability] children is based on the environment in which they are required to function."



primary research

While I researched academic furniture, I was visiting classrooms and talking to educators.

Sean A. Riley

"To know the purpose of a classroom, one must first know what sort of human community is going to be learning in it and what sort of learning is going to happen in it."

teacher interviews

The first few educators I interviewed connected me with a specific special education classroom.

Kacy Cope

Interview Results

The furniture storage in the Harding Elementary School's level 2 classroom is unacceptable. Many different kinds of furniture are used and necessary in the room and they are stored in the hallway, but the hallway is not large enough to safely traverse when it is used for storage. The students' backpacks lining the opposite side of the hall make it even more crowded. In addition to this, purchasing better furniture is too expensive.

Suggested Improvements

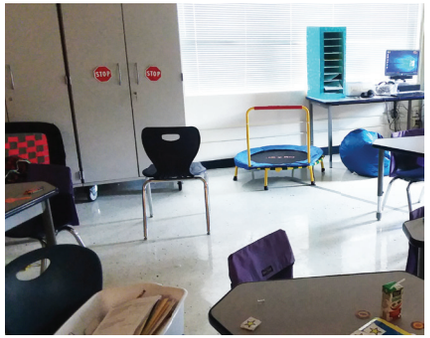
- Storable teacher chair
- Corralling exercise balls
- Storable wheelchair desk
- Better storage solution
- Affordable furniture

classroom visits

These statements are not direct quotations, but they capture the priorities of the schools that I visited.

Harding Elementary School

"We use every chair stored in the classroom. We just try different chairs until something works."



Creekside School

"Our kids need furniture that accommodates their sensory needs. It is important that the furniture aids focus."

Leary Elementary School

"Some kids need the added support of a chair with arms. They love to squirm and are often visually distracted."

existing furniture

I found these and similar products in the classrooms that I visited.

Cube Chair
several height and arm rest configurations

Childrite Therapy Seat
helps children with no core stability sit on the floor

Vidget Chair
several height configurations; allows rocking for sensory input

Woodcrest Chair
gives students structure with freedom of movement

Rifton Toddler Chair
adjustable straps and footrests help kids sit at a table

Rocking Chair
rocking provides needed sensory input

Bag Chair
provides fun relief from the structured classroom

Bumpy Seat
enhances sensory input of other chairs

Exercise Ball
allows sensory input and complete freedom of movement

personas

These people were invented to be steriotypical examples of my user base.

Katherine Moore

32 years old

5 feet 6 inches tall

Teaches a class of students with exceptional physical, mental, or sensory needs.

Often makes quick decisions about classroom arrangement and student accommodation.

"These kids deserve to have their needs met, but we never have enough funding to create the best environment."

Bella Anderson

5 years old

3 feet 7 inches tall

Has an aide assigned to her at all times because of her motor skills and attention span.

She is unable to sit up without a special chair with belts and pads. She is frequently transferred from chair to chair.

"I love the trampoline and the rocking chair. I love to sit with my friends or play with them like other kids."

Harding Elementary School

research conclusions

Insights

There is a need for storable special education furniture. This problem requires a furniture system, not a single product.

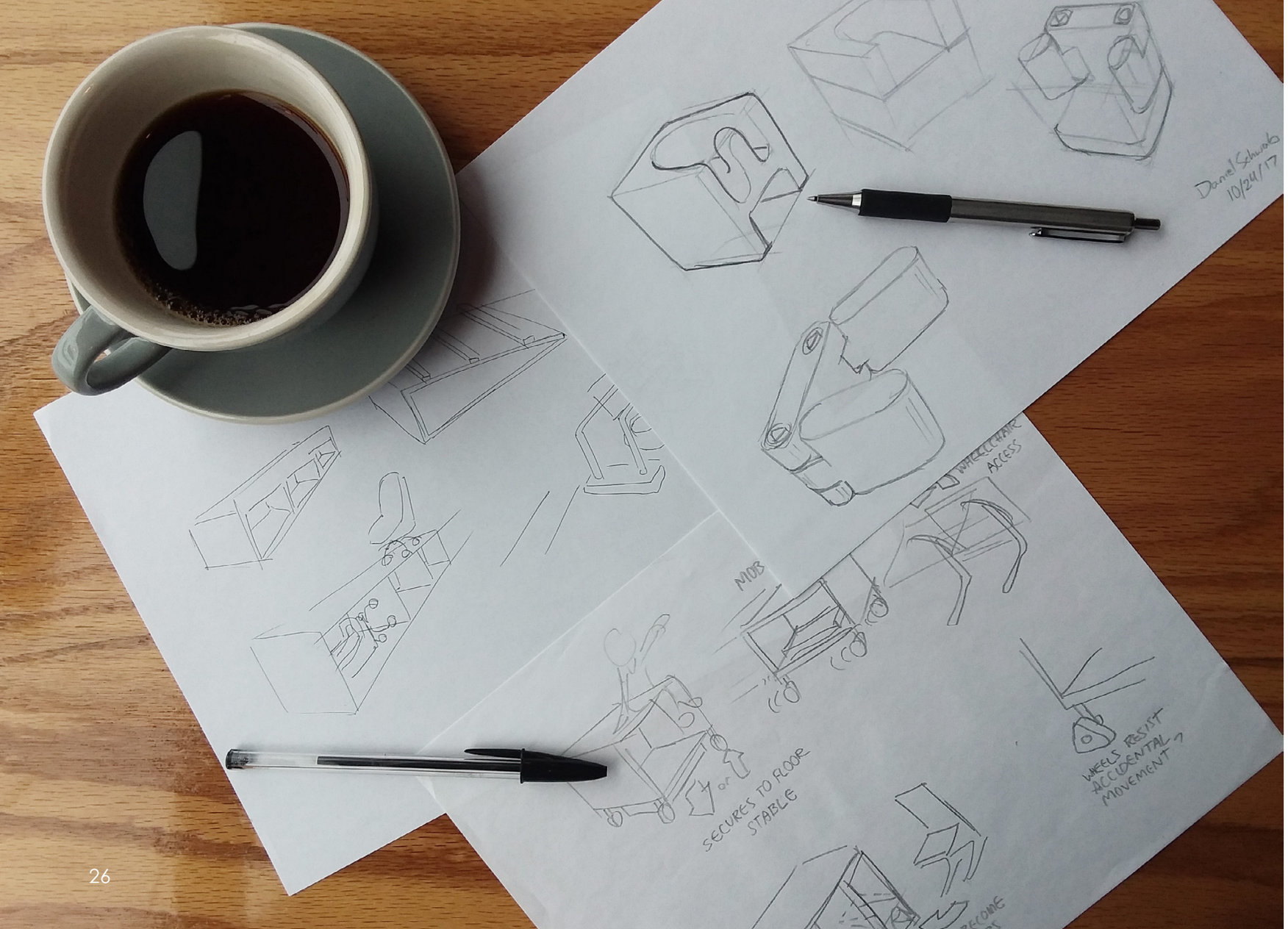
Problem Statement

Special education classrooms are often cluttered with large furniture and activity devices which obstruct pathways and limit space.

chapter two

design process

After a first phase of concept sketching, I settled on designing modular classroom seating. After a second design phase of sketching and CAD, I settled on the current chair concept. Finally, I designed and refined fasteners using iterative 3d printing.

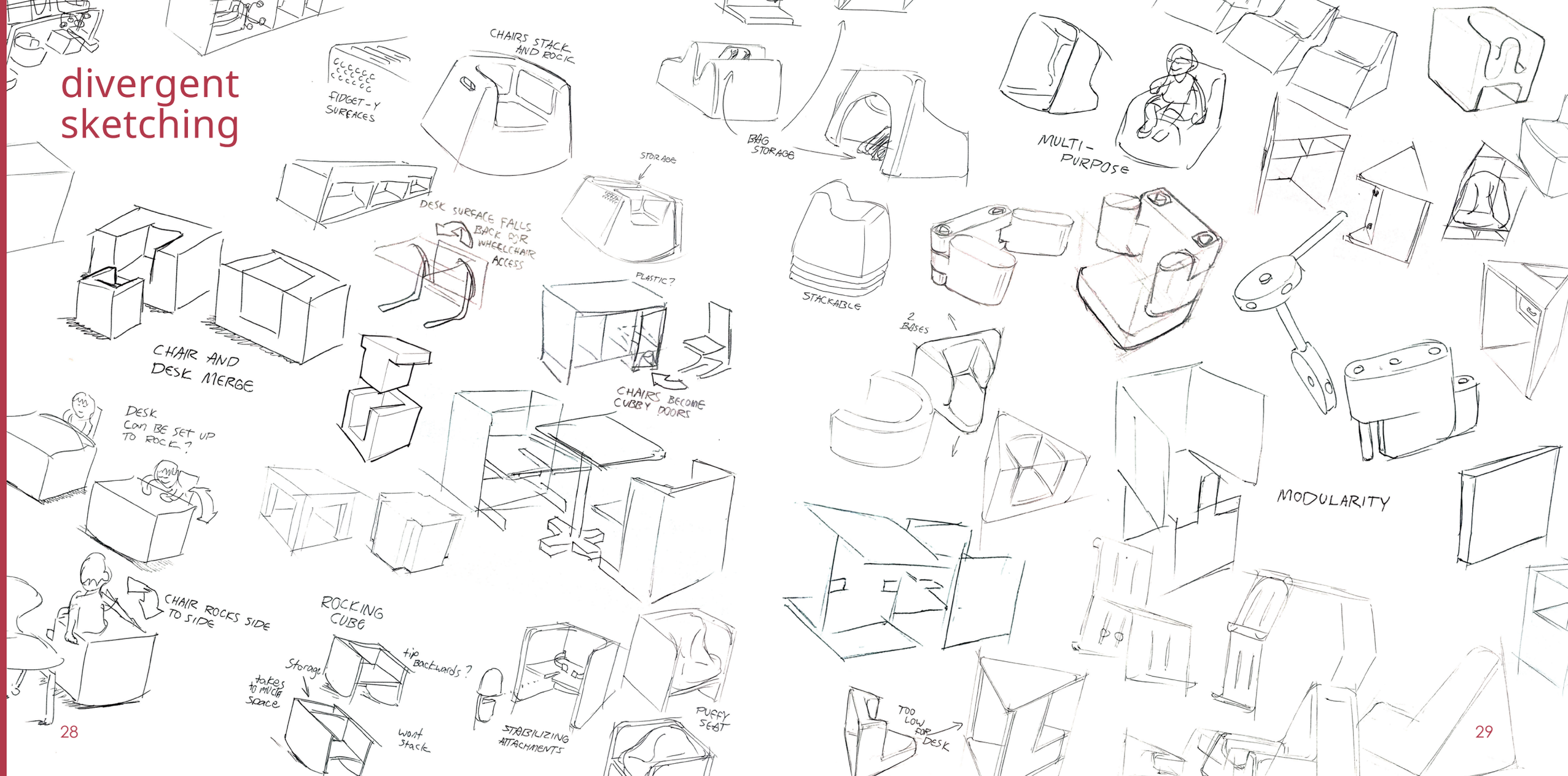


approaching the problem

I began my design effort by sketching every solution that came to mind. As I developed concepts I refined a list of design mandates:

- Increases usable classroom space
- Is cost-effective
- Follows high standards of safety
- Accommodates without complexity
- Is aesthetic, calming, and fun

divergent sketching



possible solutions

In order to direct my design, I diagrammed the systems that could address the problem and chose a direction.

Multipurpose Objects

design a single object

used in many ways

Modular System of Objects

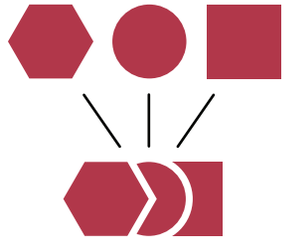
design many objects

join together for storage

Object Storage System

design for storage

of many objects



design direction

Modular System

- Increases storability
- Is easily cost-effective
- Can be designed for safety
- Can make many forms
- Is a functional design choice

Design Statement

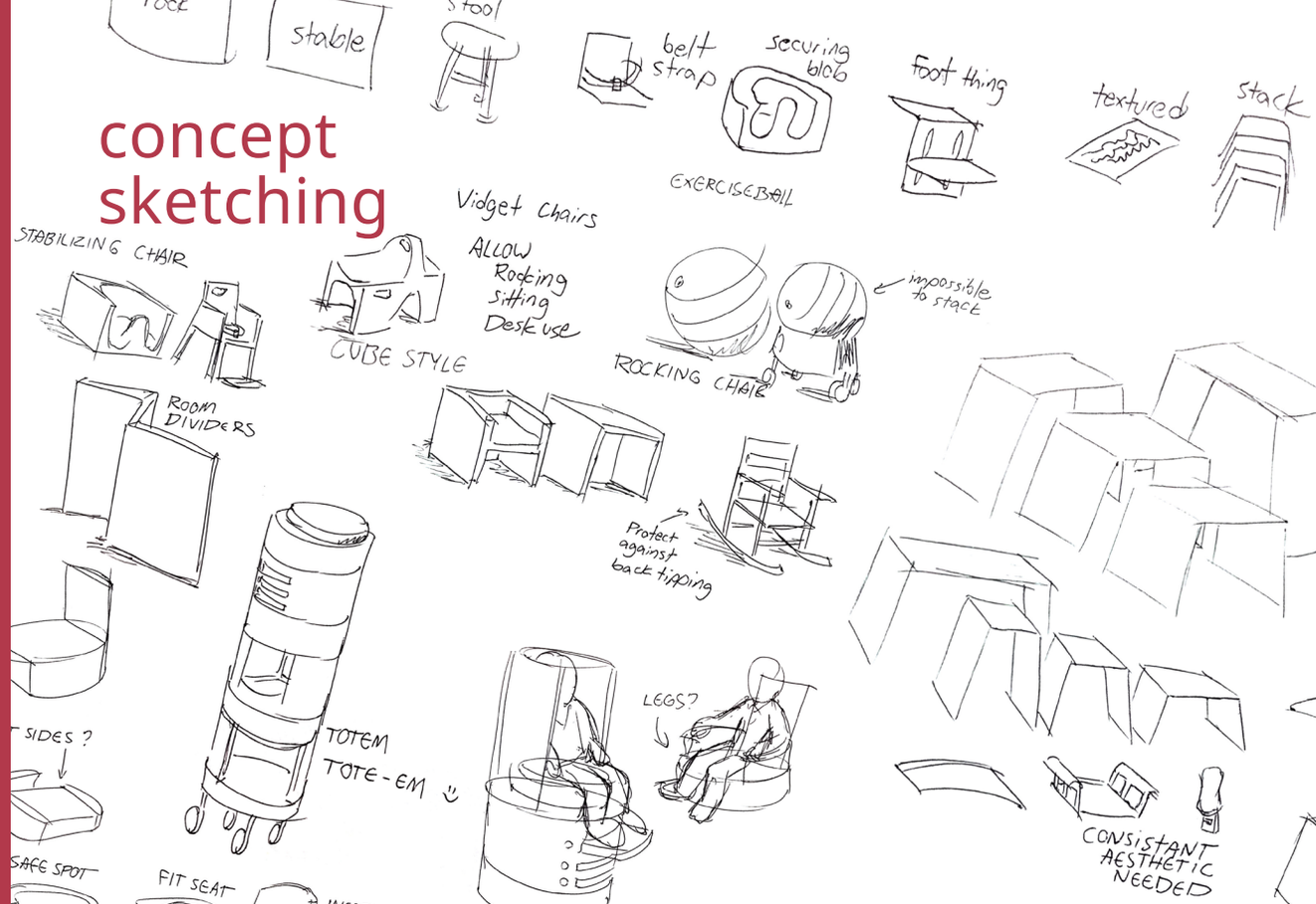
I sought to design a single, modular space-saving classroom furniture system which accommodates children of all abilities and enhances the storability of necessary seating and activity devices.

modular furniture

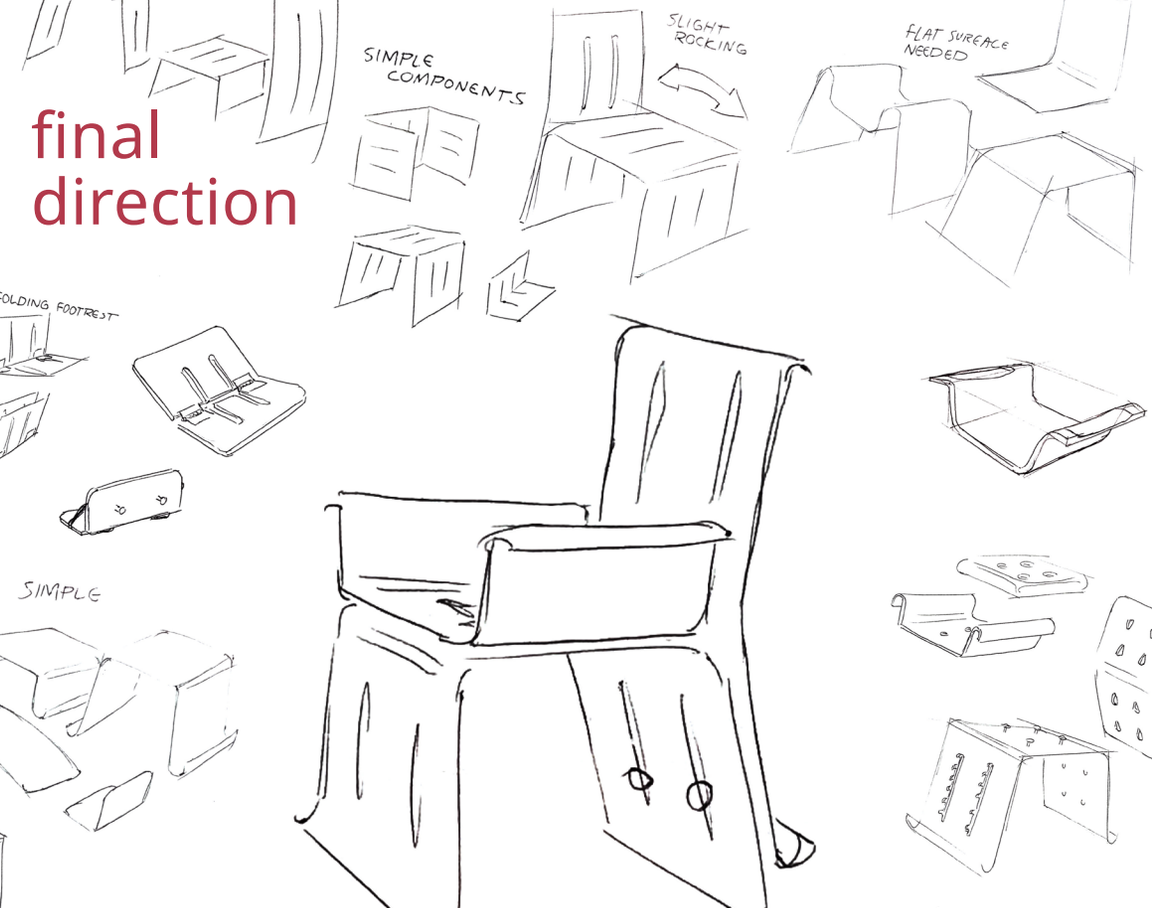
With my initial direction decided, I began to sketch more focused solutions. Throughout the process I developed a broader set of design directives:

- Easy variable chair and desk height
- Body-stabilizing options
- Padding options
- Sensory options
- Storage options
- No visual or tactile distractions
- Rapid assembly and disassembly
- Durability

concept sketching

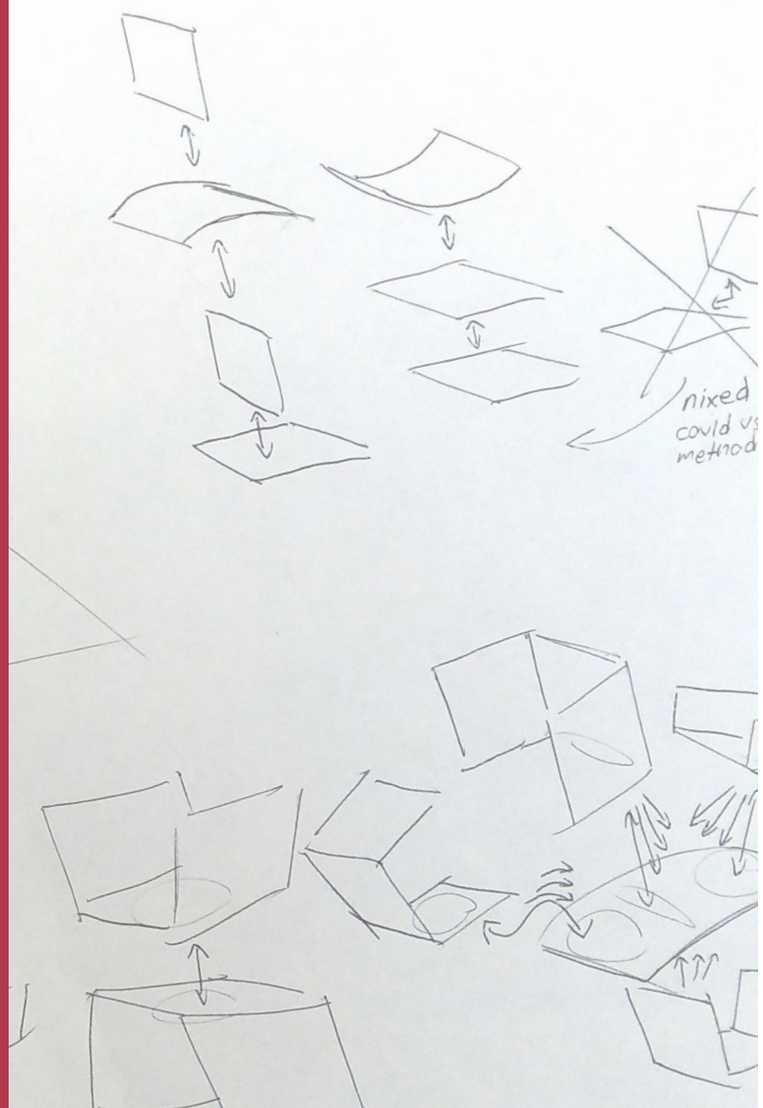


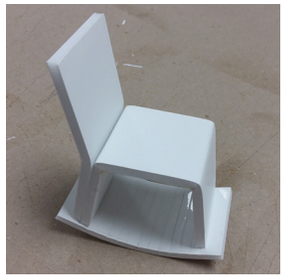
final direction

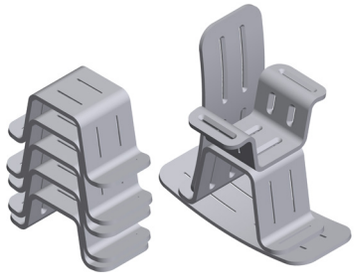


final design refinement

CAD software allowed me to adjust and test small aspects of the design without needing to build a new model.







Foam Core Models

The first step was making sure the concept worked. I needed to feel and touch the design to know that it would fall into place.

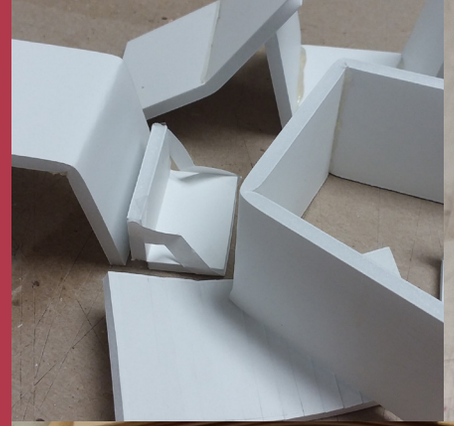
Accommodating Fasteners

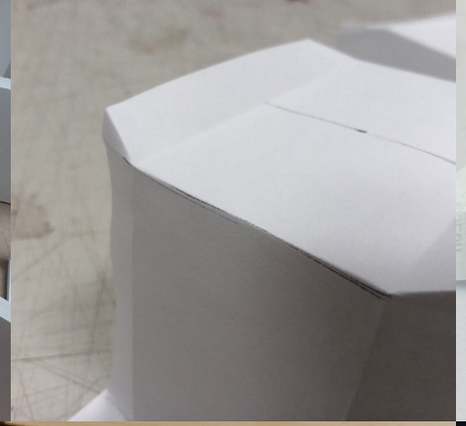
I designed fasteners that required chamfered slots. The shape of the form was driven by the need to fasten in specific ways, largely to accommodate the rocker section.

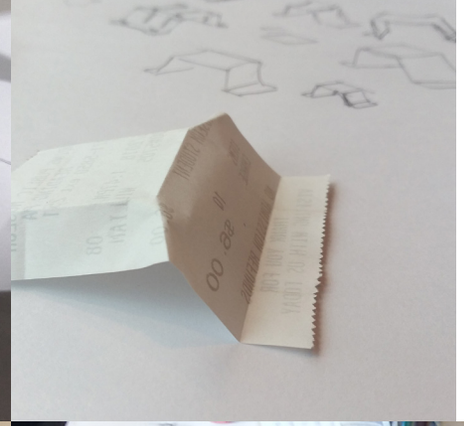
Designed for Plywood Lamination

The final adjustments to the form included widening the base for support and adjusting angles and radii slightly to allow the forms to be manufactured out of bent plywood laminate.

process work







Modeling

I cut grooves in foam core and hot-glued to the angle that the part required. Later form exploration models were simply folded paper.

Final Production

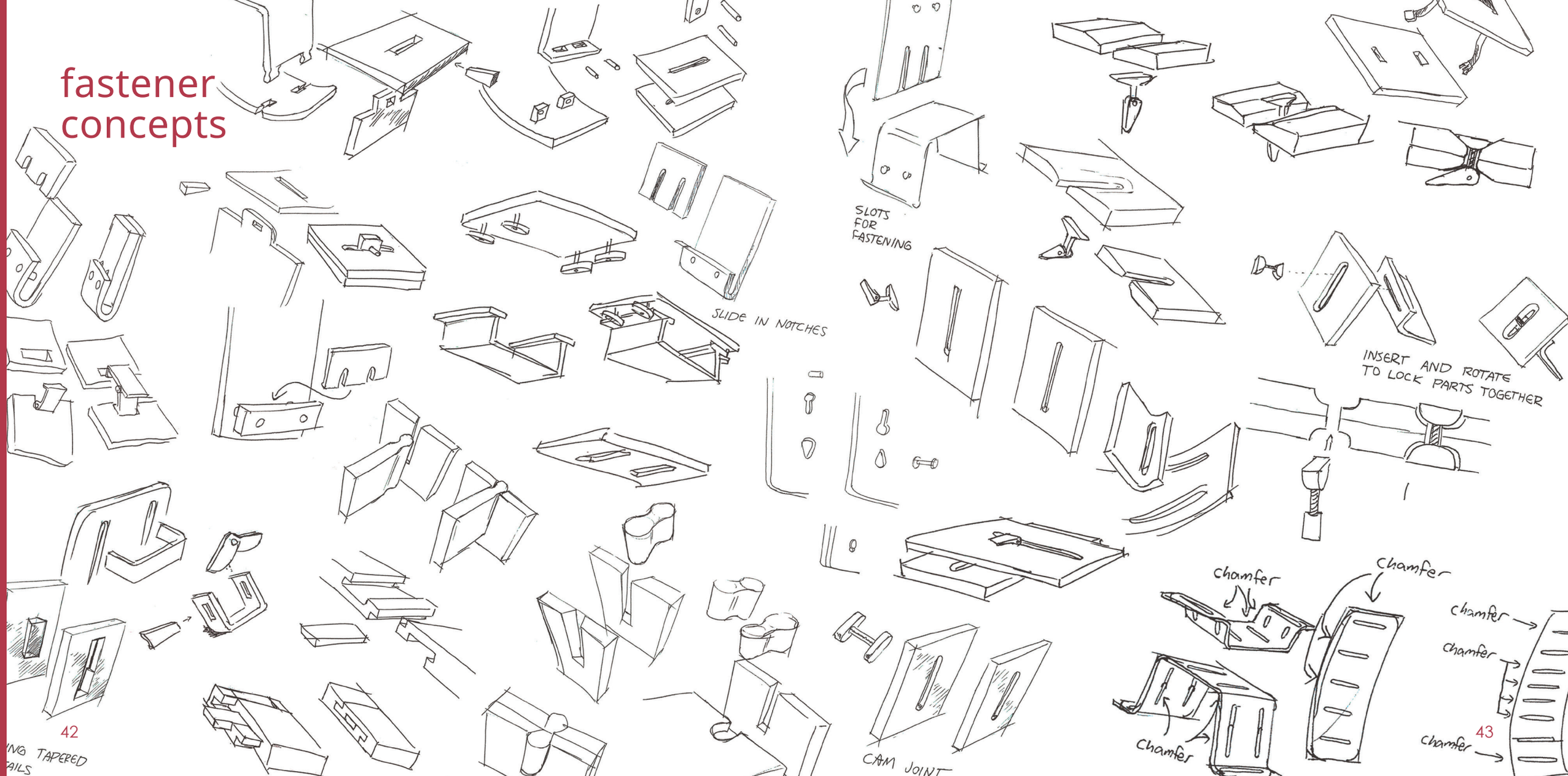
I was able to research and test bending plywood laminate on a small scale, but ran out of time to build a functional prototype.

rapid fastening

The chair parts required a fastener system to hold them together. I began the fastener design process with sketching, but quickly moved into iterative models to test functionality. These were my design mandates:

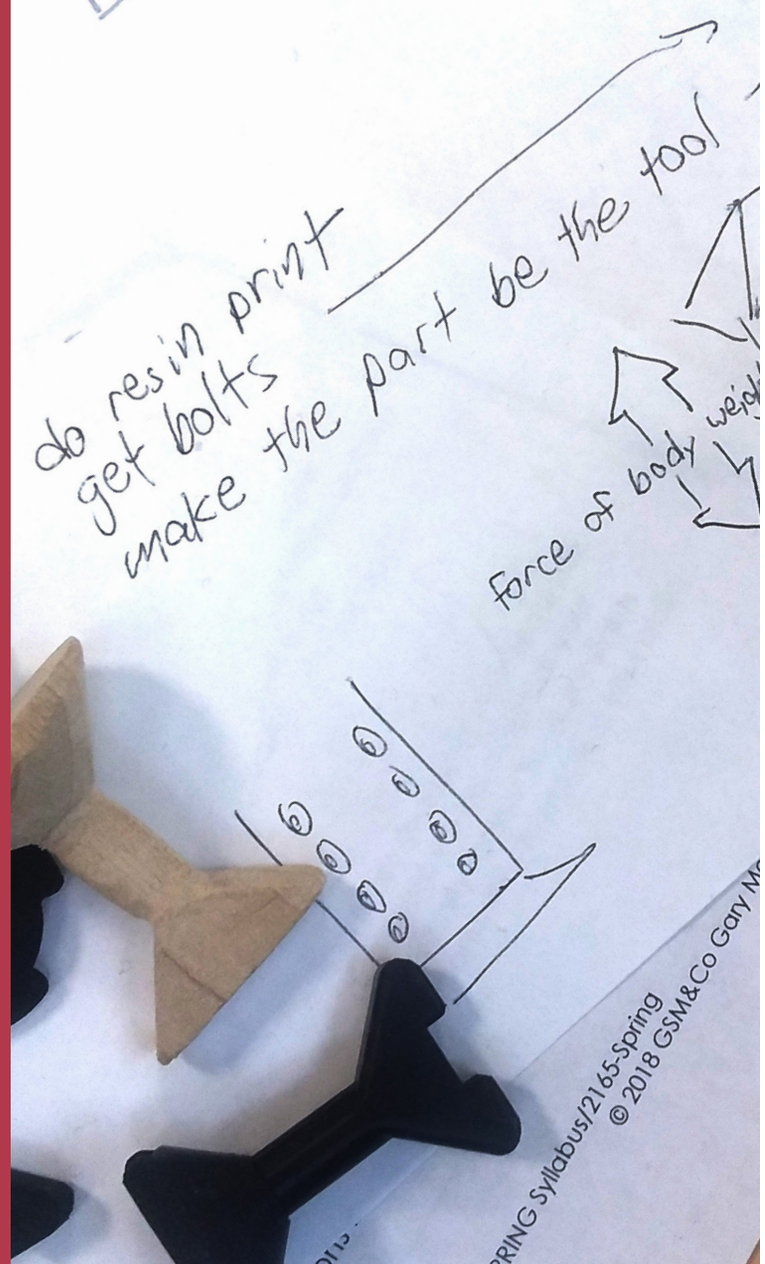
- Allows rapid assembly and disassembly
- Does not require a tool
- Is not tamperable by small children
- Avoids choking hazards
- Is indestructible

fastener concepts



rapid prototyping

3D printing enabled me to alter and test the functionality of my design multiple times a day.



Initial Flat Fastener

My first design was based off of my initial sketches. This simple fastener rotates into place with a single quarter turn, and when fastened is flush to the surface.

Cone Added

The fastener only needed one end to insert into a slot. The larger head mimics existing fasteners while making this design more stabile when locked into place.

Flat-head Tool

The simplest way to childproof the design was to require a tool to rotate. This fastener was designed to serve as its own tool. A central bolt was added for strength.

Assembly with Bolt

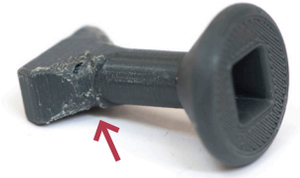
The bolt allowed the fastener to be manufactured in two simple pieces, and initially appeared to allow for adjustability.

Square Key Tool

The initial flat-head design was complex and did not provide leverage. This was resolved with a square hole. The corners of the insertable end served as square keys.

Bolt Removed

Having the fastener divided caused problems with rotating into place, and the bolt provided no added strength. The final fastener would now be made of metal.



Rounding Fastener End

The fastener was having difficulty rotating into the slot during testing. I rounded the end with a file until it rotated smoothly into place.

Variable Fillet

The fillet was increased close to the shaft to allow the fastener to rotate into place. This provided the necessary freedom of rotation.

Designed for Machining

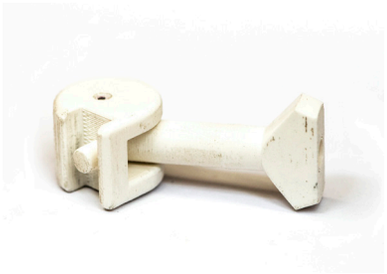
The design was adjusted to be turned and then milled. The fillets were removed in favor of radial symmetry.

Cam Tightening Fastener

It was necessary to have a secondary, more secure fastener. I designed a simple cam tightening option.

Square Key Hole

The cam needed to be tamper proof. The lever was replaced with a square hole to be operated with the fastener's tail.

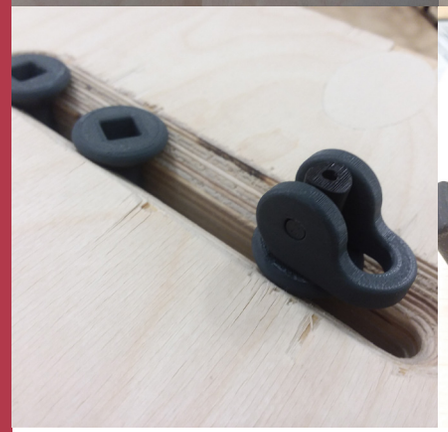


Slot with Projection

It proved difficult to use the fastener end to loosen the cam. The square hole was replaced with a slot designed to fit the fastener end directly.

process work



Wooden Pieces

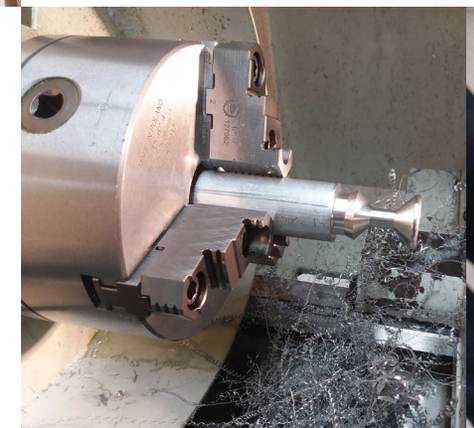
The wooden prototypes were cut approximately with a band saw and then filed down to size.

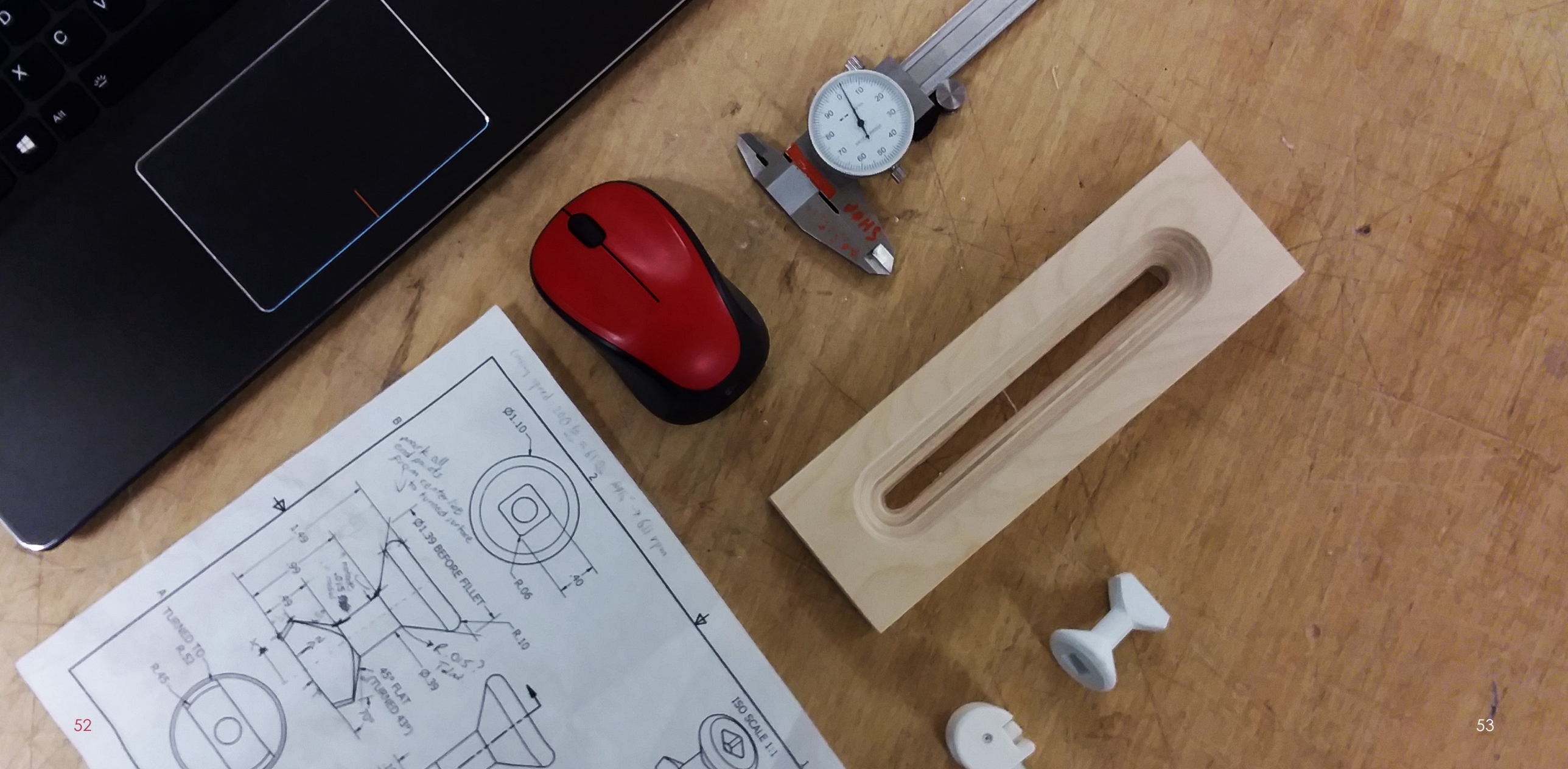
Plastic Pieces

The early plastic parts were 3D printed on a FDM printer. Later pieces used for stress testing were printed in resin using SLA.

Final Production

The final part was turned on a lathe and then machined. The slots used for testing were cut with a CNC router.




Ø1.10
R.06
40
Ø1.39 BEFORE FILLET
R.10
Ø.39
45° FLAT
TURNED 43?
TURNED TO
R.53
R.45
ISO SCALE 1:1

chapter three

final design and direction

chair system

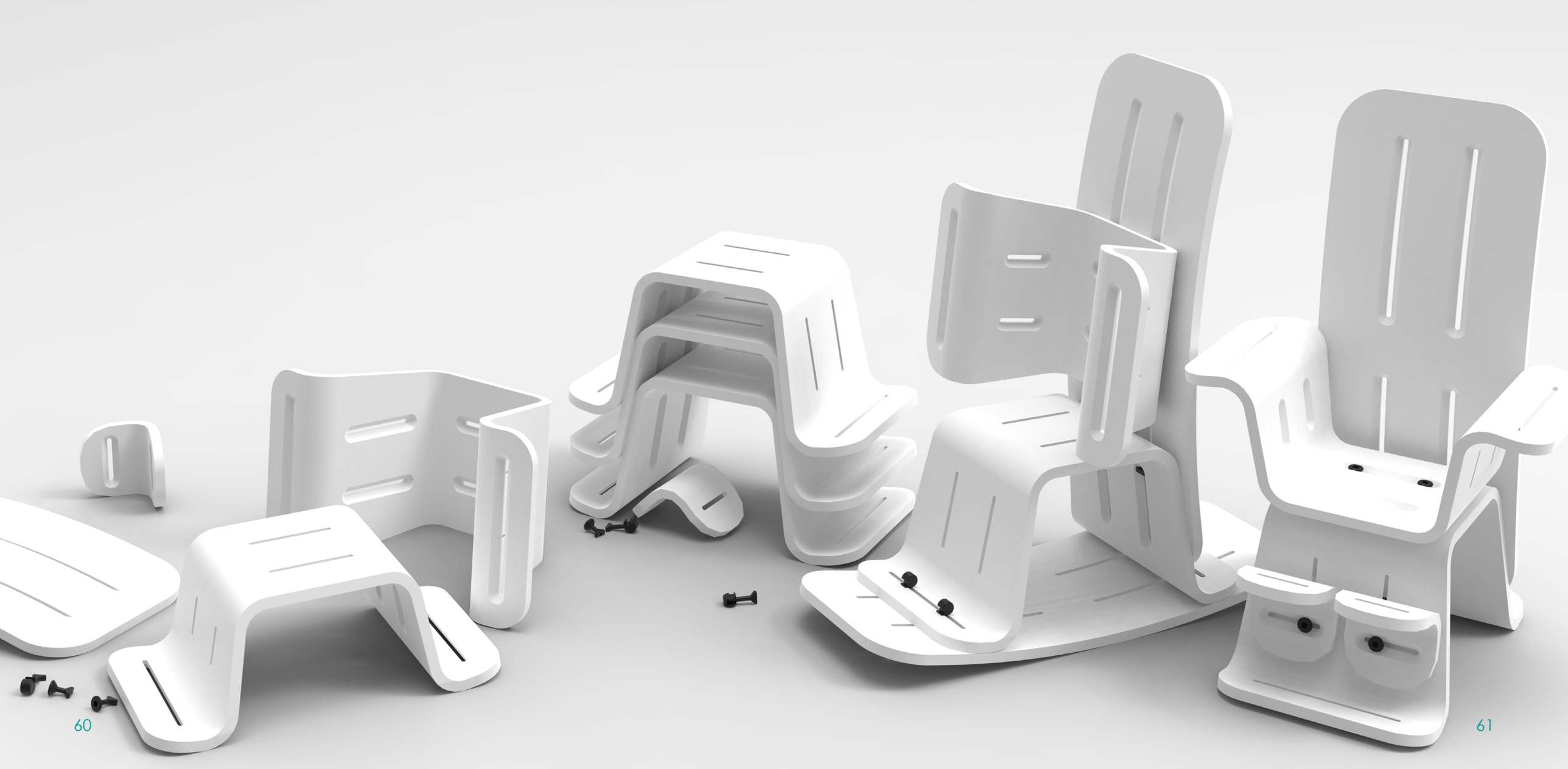
Completely reconfigurable foot, arm, and back support, on bases of different heights.

- Efficient storage of pieces
- Rocker for sensory input
- Allows for strap-on cushions
- Supports straps & buckles
- Bent plywood or plastic

rapid fastener

Simple fastener slots into grooves and rotates 90° to hold parts in place.

- Single turn to fasten
- Part serves as tool
- Not easily tamperable
- Choke preventing hole
- Durable aluminum 6061




STOP

chapter four

future considerations

It would be foolish to spend a year refining a design without learning a few things. These are the unanswered questions and unsolved design problems.

unanswered questions

Is the Fastener System Sturdy?
The fasteners are strong and make a sturdy connection, but do they work well on a larger-scale model?

How Quick is Reconfiguration?
The fasteners are quick one at a time, but would this change in full-scale testing?

Are the Chairs Comfortable?
The slots are on the seat of the chair. Does this affect comfort? Should the slots be adjusted?

design problems

Fasteners Damage the Slots
Constant assembly and disassembly slowly wears down the slots, weakening the connection.

Slots Only Fasten One Way
The slot chamfers are one-sided, which only allows parts to be fastened one way.

Reconfigurable Not Adjustable
This system allows for infinite reconfiguration, but the arm rests and chair height can only be adjusted by replacement.

further design opportunities

Further Chair Refinement
The chair forms were minimally refined, and could be tested and improved many times over.

Strap and Buckle System
The slots accommodate straps and buckles, but this system would need to be designed.

Cushion System
There are many ways that cushions could be modularly added to the design. This is another system which could be designed.

Cam Fastener Refinement
The cam fastener was only refined twice and was never fully tested. This fastener has as much potential as the rotational fastener.

Expansion of System
I only had the time to design basic chair elements. This system has the potential to expand into desk, room divider, storage, and therapy device design.

references

Clevenger, A. (2017). Beauty in Classroom Spaces. The Journal, 10, 12-14.

Doctoroff, S. (2001). Adapting the Physical Environment to Meet the Needs of All Young Children for Play. Early Childhood Education Journal, 29(2), 105-109.

Hay-Cook, M. (1996). What I Learned in School One Day. Teaching Pre K–8, 26(7), 60.

Hemmington, H., Borell, L. (2000). Accommodation Needs and Student-Environment Fit in Upper Secondary Schools for Students with Severe Physical Disabilities. Canadian Journal of Occupational Therapy, 67(3), 162-172.

Moore, G. T. (1979). Designing Environments For Handicapped Children: A Design Guide and Case Study. New York, NY: Educational Facilities Laboratories.

Oates, R. (2000). Furniture Is Key to Classroom Design. School Planning & Management, 39(5), 54-57.

Riley, S. A. (2017). The Case for Keeping Classrooms. The Journal, 10, 7-10.

Tanguay, P. B. (2001). Nonverbal Learning Disabilities at School: Educating Students with NLD, Asperger Syndrome and Related Conditions. Retrieved from https://ebookcentral.proquest.com

Zane, L. M. (2015). Pedagogy and Space. St. Paul, MN: Redleaf Press.

thank you

Friends & Family	for feedback at critical points in this process
Faculty at 3 Schools	for answering crazy questions
Anne Stoolsfus	for allowing me to visit her classroom during class
Mark Frensel	for being my first connection to a NY school
Design Professors	for their helpful advice every step of the way
Byron Conn	for forcing me to think practically about wood
Kacy Cope	for connecting me to my problem statement
Eli Heisey	for manufacturing my final fastener
Tim Wood	for being a great capstone advisor
Stephanie Schwab	for early research advice
	for being my first teacher
	and for being my mom

Daniel Schwab
Industrial Design

Hi, I'm Daniel Schwab. I love designing pretty much anything, but my formal education is in Industrial Design with minors in Web Design and Development and Music Performance. During my enrollment at RIT, I focused on developing an interdisciplinary design sense, and exploring the realms of graphic design, interface design, and user experience design, as well as maintaining my interest in music, history, and theology. If you haven't already, take a look at some more of my work at **dschwabdesign.com**.