Executive Summary

This book details the research, design, and implementation processes for the thesis project titled Icebergs.

Icebergs is an aquatic toy system for older children that provides them with an enriched play experience when compared to basic pool toys. The Icebergs toy system encourages social interaction and creativity in free play, and also helps to build confidence in the water by inspiring children to try new things.

Research has shown interest in the product from the target users and other stakeholders. A market analysis has also revealed an opportunity in the market for more engaging pool toys that go beyond stylized inflatables. Studies on the importance of play and swimming lessons being effective in the prevention of drowning accidents also inspired one of the design goals: use play as a motivator to get children swimming to build comfort and confidence in the water.

From initial ideations to focused design refinement, the ideas were shown to stakeholders for feedback. The responses helped guide the progress and decision making in design. Four rounds of testing in a swimming pool were also invaluable. Discoveries made at these sessions pushed the design closer to completion.

The final design is a modular toy system containing panels and identical connectors. The polyethylene connectors are adjustable to specific angles and are self-aligning. The panels, made of extruded polyethylene foam, are the building blocks of the system. The variety of shapes allows users to let their imaginations guide them on their aquatic adventures with their friends.
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The problem statement introduces the premise of the thesis project. Aquatic toys widely available for the consumer market are limiting the play experience of their users.

If a new aquatic toy can be designed and created that provides a more engaging and creative experience for users, than users will be encouraged to swim and play with the product more often.

The key goals of the project focus on becoming more comfortable playing in the water, being more social when playing in the pool, and developing the creative muscles of the users.
Problem Statement

Current pool toys are limited in the play experience they offer the users; most toys focus on supporting the weight of the user in the water. Inner tubes, pool noodles, and ride on top floats fall into this category. Aquatic play habitats also exist but are not reconfigurable, providing few opportunities for creative use. Other toys, such as dive toys and water blasters, have single prescribed uses.

A more engaging and creative aquatic toy or system could inspire kids to swim and play in the water more frequently.

Social activities encourage kids to play and learn together. Having the support of their peers motivates children to try new things and explore their own potential.

Therefore, there is also an opportunity to create a social experience for youth in the water that will encourage them to be creative and play while building confidence in the water.
If growing children have the opportunity to play with an open-ended social toy in the water

Then they will be compelled to play in the water more often, while building their confidence in the water with the encouragement of their friends, and exercising their creativity.
Create an aquatic toy that is engaging and therefore encourages youth to swim more often.

Create a play experience that users will want to share with their friends.

Provide an outlet for the user’s creativity when playing with the aquatic toy.

**Thesis Goals**
User research was done to discover opportunities for the overall project. Through interviews and observational research, a target market was chosen and user needs were found.

Market research and competition analysis informed the strength of the design direction for an aquatic toy. A healthy market size contributes to the product's viability. Knowledge of existing products and industry trends will help to ensure innovation in the project.

Academic studies were consulted to gain additional support for the project. The importance of play and early exposure to the water was investigated. Play has many developmental benefits while early swimming lessons helps to prevent drowning incidents. Therefore, using play to encourage more swimming is an opportunity to be explored through design.
User Research

- Early Interviews
- Observational Research
- Stakeholder Interviews
- Motivations
- Factors in Purchasing Decisions
- Target Users
- Stakeholder Analysis

Making connections with people who were potential target users was an important step in the process. They would help guide my project and the information I gleaned from them would drive my design decisions.

Early interviews were done with people who have had enduring relationships with water recreation. This was the seed from which the youth focus of my design was found.

Observational research was done with a group of school-aged children. They were given geometric shapes to build and play with, while imagining an aquatic environment. Their creations revealed attitudes that motivate their play patterns with friends.

Need finding interviews were done with parents and with help from other stakeholders. This helped to clarify the objectives of the design.

From the primary research sources, I was able to find my target market and create an influence map of the stakeholders.
Early exploratory interviews were done with a broad range of people who take part in water activities. Common experiences became a point of inspiration and a launching point for the redirected project.

With the broad topic of social water recreation, ideas were explored that catered to a range of experiences and comfort level in the water.

Barbara H. 26, civil engineer
Barbara has had a lifelong love of the water. Her first experiences with the water came as a young age thanks to the influence of her parents. Water provides her with a sense of calm, even with the adrenaline rush that she gets from the activities. She continues her involvement with water through competitive rowing in the summers as well as white water kayaking.

CJ Sewell, 42, property manager
Growing up in southern California, CJ began swimming at the age of 3. She went to the beach frequently with her parents and started surfing around 11. Today, she still feels the need to connect with the water regularly. The energy of the ocean recharges her from the duldrums of daily life. The beach is also a place she likes to go with friends where they can relax and enjoy each other’s company in nature.

John W. 64, retired veteran
John began sailing as a child in Detroit in his family boat. He is drawn to the water because it is something he has always done. Now, legally blind, he races competitively in Paralympic class boats. The sailing community has become his social network. His involvement with the Bay Area Association of Disabled Sailors (BAADS) has allowed him to meet many new friends.

Stephen P. 55, real estate
Stephen grew up in New York City but spent summers as a child at his grandparents’ on Martha’s Vineyard Island. There, he did many different water sports but when he moved West for school, he stopped. Years later, he was able to rediscover his passion for the water in the Bay Area.
Jim T. 58, physical therapist

Jim’s father was a boat builder so he was always around boats and the water as a child. He has always been attracted to the water because it offers him a sense of serenity and calmness that is not found in normal life. He likes sailing for the competition and team element as well as leisure.

Dave R. 26, primary school teacher

Dave spent his summers at a lakefront camp as a child and into adulthood as a camp counsellor. He is drawn to water because he sees it as a means of travel and exploration. He feels it allows him to experience Canada differently than most; he can relive the journeys of the traditional voyageurs who mapped the country. He loves sharing his passion for the outdoors and Ontario’s waterways with others. In the summers, he leads canoe trips for groups that last anywhere from 4 to 40 days.

David F. 25, software developer

At his family cottage, David started playing in the water from a very young age with his siblings. They would spend summers playing with rafts, noodles, and various paddle boats. They would pretend they were pirates and put on plays for their parents. As a family, they would take canoe trips to explore the surrounding islands. Swimming lessons continued in the city during the school year. He still loves being around the water in the summer, relaxing on the dock with a good book.

Adam C. 25, grad student psychology

Adam started his relationship with the water in Junior Guards as a child. As he grew up, he kept returning to the summer program, encountering the same friends. Together, they became Junior Guards instructors as teenagers and young adults. In addition to surfing and swimming regularly, he paddles the San Lorenzo River each spring with his friends in Santa Cruz.
Melissa M. 27, account manager

Melissa grew up in Washington state and does not remember a time when she didn’t swim. She swam competitively through high school and continues to swim for fitness. She finds that swimming relaxes her mentally and also relieves the symptoms of her chronic joint problems.

Anne C. 53, childhood educator

Anne grew up by the ocean. Although her first experiences with swimming lessons were negative, she grew to love the water. With her siblings, she grew up playing unsupervised at the beach and in the ocean. The mornings before high school were spent with friends body surfing and treading water. As she got older, she still maintained a love for the beach but went into the water less because she became scared of getting hurt.

Sean K. 25, lab technician

Sean grew up on the East Coast and began swimming at an early age and playing in the water at his grandparent’s cottage. In college he was part of the outdoors club and would go on rafting and paddling trips. His interest in the water has shifted to a social maker mindset; he is working on building a community of boat hackers. His current project is a coroplast boat that people can make from easily acquired materials. He sees it as a way to return to having practical skills that seem to have diminished in modern life.

Summary of Early Interviews

Based on the experiences of the interviewees, there were common findings that pointed to a design opportunity:

- Being introduced to the water from a young age fostered enjoyment later in life and increased the comfort with which other water activities were explored.
- Memories of playing with family and friends in the water were fondly recalled. This social aspect of water recreation is still enjoyed with their current aquatic interests.
Observational Research

I provided the kids with an assortment of foam shapes cut to 1/10 scale as well as images of kids at scale. They were asked to imagine the pieces in full size and create whatever they could come up with, knowing that the pieces would be for the pool environment. Parents were intrigued by the activity and once they realized that in full size, kids would be able to build their own contraptions for the pool, they were enthusiastic about the concept.

- Jeorge, 10
- Phoenix, 10
- Jack, 6
- Connor, 10
- Benjamin, 10
- Milla, 10
- Milla’s friend, 8
- Gillian, 10
- SunWoo, 10
- Antonio, 10
- Anne - Jeorge’s mom
- Mary - SunWoo’s mom
- Edie - Connor, Jack’s mom
- Kate - Gillian’s mom
- Alexandrea, Ben’s mom
- Tina - Antonio’s mom

There were several **key observations** throughout the afternoon.

When the boys were constructing in a group environment, they were looking for approval in what they were creating, evidenced by calls for validation from their peers.

Their conversation was a continuation of their online personae from social computer games such as Minecraft, Wizard 101, and Elsword.

Booby traps and sabotage opportunities were built into their creations and discovered when they were asked to explain their creations.

The girls that came to play were more calmly focused on their projects and created a story for their ideas.

Parents felt the build concept was great for the creativity but worried about the practicality of having many pieces.

Parents also prefer open-ended toys for their kids because they tend to be relevant for longer.
The group of children created many different models with the same assortment of foam core pieces. As they described their creations to me, it became apparent that they were mostly variations of the same themes. The most common were furniture, fantasy vehicles, platforms with booby traps, and fortresses. For a full catalogue of their creations, see Appendix A.

The observational research session with the group of school children was useful to understand the inner workings of their minds.

Their fascination with forts and booby traps revealed their desire to ‘win’ against their friends. Winning gains them respect and power which they will also try to maintain.

The variety in creations shows their imaginations at work, especially when coupled with the running narrative that they provided.
**Stakeholder Interviews**

After receiving validation for the social water recreation for kids concept at the play date, an early survey was sent out (see Appendix B for results) and interviews were performed with some of the parents and kids to further explore potential needs.

**Lanae B. mom to Kylie, 8**

Kylie was not enrolled in group swim lessons. Lanae and her partner decided that they could sufficiently teach her to swim on their own in the apartment complex pool. Kylie is comfortable playing in the water at the pool with friends and at the beach with limited supervision.

**Clinton L. dad to Chloe, 9**

Chloe is adventurous and likes the outdoors. He put her in swim lessons to learn water skills and safety so we could go boating in the summer. She is also starting to learn to SCUBA dive which we do on vacations.

**Annie C. mom to Jeorge, 10**

Jeorge has always has a fear of water. It has only been in the past couple years that he has become happier about swimming. He started lessons later than other kids but as his friends have been hosting pool parties, he has been gaining confidence and building his skills to keep up with his friends.

**Edie B. mom to Connor, 10 and Jack, 6**

Connor and Jack were both put in swimming lessons from an early age. They participated in Pool Guards programs in the summer. Connor has started going to summer camp on a lake in Washington state where he gets to play outside and in the water in kayaks and canoes. Connor likes to join groups and participate and Jack is a young dare devil that likes to push limits.

**Summary**

While motivations for putting their children in swim lessons differ, the common observation is that earlier exposure to water builds confidence and enjoyment in water activities for the kids as they grow up.

They are more likely to enjoy playing at the ocean, attending pool parties, and trying new things with friends if they have a basic level of comfort in the water. The influence of their peers also has the effect of allowing children to push themselves, independently of parental guidance.
Stakeholder Interviews

Colby Wiley, YMCA Embarcadero
Courtney Wheelock, YMCA Chinatown
Aquatics Directors

Both directors saw the advantage of having something that motivated kids to swim more often and at a younger age. However, given the limited budget of community centres and public pool regulations, the concept is better targeted for private home use.

Jim Wiltons
Deer Crossing Camp

Deer Crossing Camp is summer camp that specializes in teaching youth water sports. The programming at this camp is not necessarily suited to having a new recreational water activity, given that they have a lot of different water sports available. The lake environment is also not always cooperative with loose pieces. Pieces could easily end up down river and no one would know until it was too late.
Summary of Motivations

From the observational research play date and the stakeholder interviews, some key needs and wants for an aquatic play experience are abstracted.

Children

- Hacker/DIY attitude
- Fantasy worlds
- Power over friends
- “Risky” play through pushing limits
- Owning a creation
- No explicit Rules

- Fun
- Creativity encouraged
- Flexible play options: active or relaxed
- Gaining experience with playing in and around water
- Playing outside
- Social Playing

Parents

- Physical play
- No screens
- Children can grow with toys
- Younger siblings can grow into them
- Safety
- Controlled environment
Factors in Purchasing Decisions

A survey of parents was done to determine important factors in their toy purchasing decisions.

When buying toys, in general, the following factors were rated on a scale of 1 to 6 with 6 being extremely important:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Not at all Important</th>
<th>Not Very Important</th>
<th>Somewhat Important</th>
<th>Extremely Important</th>
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<td>Age Appropriate</td>
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<td>Creativity</td>
<td>5.11</td>
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<tr>
<td>Gender Neutrality</td>
<td>3.33</td>
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<tr>
<td>Storage</td>
<td>5.22</td>
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<tr>
<td>Practicality</td>
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<tr>
<td>Peer Pressure</td>
<td>2.44</td>
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<td></td>
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<tr>
<td>Physical Activity</td>
<td>4.67</td>
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<tr>
<td>Problem Solving</td>
<td>4.11</td>
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<tr>
<td>Social Play</td>
<td>4.67</td>
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<tr>
<td>Individual Play</td>
<td>4.33</td>
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</table>

When buying toys specifically for outdoor use, the following factors were rated on a scale of 1 to 6 with 6 being extremely important:

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<thead>
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<th>Factor</th>
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<th>Not Very Important</th>
<th>Somewhat Important</th>
<th>Extremely Important</th>
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<td>4.56</td>
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<td>Creativity</td>
<td>4.56</td>
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<td>Gender Neutrality</td>
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<td>Practicality</td>
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<tr>
<td>Individual Play</td>
<td>4.33</td>
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Target User

Primary

Children age 8 and up

Given that this is a product meant for water recreation, the users should also be comfortable in the water with appropriate supervision.

By creating a product that fits within the appropriate play patterns in this age group, children will be attracted to the product and influence those making the purchase decisions.

Secondary User

Parents and organizations are typically the ones making the purchasing decisions concerning children’s products. As a result, the product must also appeal to their requirements and sensibilities.

Families with backyard pools would be the most likely to purchase this for private use.

Stakeholder Analysis

Children directly influence over $187 billion of parents’ purchases annually, and indirectly influence at least $300 billion more.

To have a viable product, the market has to exist to support it. Swimming is one of the most popular forms of fitness and recreation in the United States. There are 16 million swimmers between the ages of 11 and 17. In addition to a population of swimmers, there are also approximately 79 million backyard pools in the continental United States.

The toy industry is a saturated market with lots of products vying for the attention of consumers. Aquatic toys are no exception; there are many options that are often variations of each other. Standing apart from the pack is important and being aware of the trends within the toy industry will enrich the product experience.
In the United States, there are:

**50 Million** people participate in swimming

**8.3 Million** swimmers are ages 7-11

**8.1 Million** swimmers are aged 12-17

"There are significant opportunities to engage inactive populations in swimming. Swimming ranks as a popular 'aspirational sport' for inactives ages six to twelve and ages 45 and up"


There are 7.9 Million home pools in the continental United States.

**1.24 million** of them are in California.

Average American Pool Owner

Age: middle aged (35-54)

Kids: 2-3

Income: 35% make $100,000-150,000, 36% make $150,000+

Education: College Graduate

Ethnicity: Caucasian (86%)
Coleman Company Inc. was founded in 1905 with a gas lamp. Since then, they have become one of the largest companies specializing in outdoor gear.

It acquired Sevylor in 2007. Sevylor is their watersports brand. They specialize in inflatables, including towables and floats.

$454.7 Million in annual sales

Wibit was started in 1997 by two German friends who wanted to bring fun and excitement to pools and resorts around the world.

The Wibit product line is unique due to its modularity. The design feature allows resort and pool managers to quickly inflate and easily assemble any size Wibit play area to maximize fun and safety.

$1.68 Million in annual sales

Poolmaster, Inc. was founded in 1959. They manufacture and market pool and spa products.

The company’s products include pool games and toys, pool and spa signs, inflatables, mattresses, pool chairs and lounges, water guns and squirts, snorkels and fins, balls and accessories, swim boards, maintenance products, and tubes.

$20 Million in annual sales

Founded in 1997, RAVE Sports is the premier supplier of inflatable water recreation products. RAVE Sports manufactures high quality water trampolines and bounce platforms.

They aim to make water fun with a complete line of boat towables, water playground items, slides, life jackets, water skis, wakeboards, kneeboards, stand up paddle boards and pool/lake products.

$5.5 Million in annual sales

Annual Sales Figures for Selected Companies, from www.hoovers.com
Product Survey

- Noodle $0.99
- Inflatable lounger with water gun $54.99
- Blaster board $33.49
- Dive rings $12.75
- Inflatable serpent $28.99
- Inflatable rocker $79.99
- Cube habitat $89.99
- Inflatable boat house $99.99
- Rave Sports Water Trampoline $799-1299 depending on size
- Wibit Obstacle Course $1500 - $5500 per module $60,000 for pictured set up
- Inflatable boat house $99.99
Toy Industry Trends

Each year, at the American International Toy Fair, the Toy Industry Association (TIA) releases a statement of what they are seeing as emerging trends for the year in new toys. The trend predictions for the past four years highlights fads as well as continuing strengths in the market.

2013

Retro:
• Nostalgia, Vintage, and Classic toys are popular due to the maturing of a generation who is passing on the joys of toys from their own youth.

Pop Culture
• Artistic pursuits like craft kits, performance-based musical toys, and baking sets, are encouraged by emulating reality shows that celebrate creativity, talent, and skills of contestants.

Construction Craze
• Building sets category grew 20% in 2012. Many companies are diversifying their existing lines, especially in an attempt to reach the girls market (ex: Lego Friends, MegaBlocks Barbie)

2012

Little Learners
• With rising birth rates, parents are looking for any future developmental advantage. Toys that appeal to young children and build cognitive and developmental skills are sneakily creating life-long learners.

Many Ways to Play
• Toys that engage kids on multiple levels are highly desirable. Parents can buy one very dynamic toy that will entertain and educate for an extended period of time, granting the feeling of great value for money spent.
• Toys with multiple play patterns allow a child to interact with the toy in new ways as they grow.
• Toys with the ability to customize allow kids to express their individuality.

Save N Splurge
• There is a trade-off that shows consumers are willing to buy the higher-priced toys instead of the mid- to lower-priced offerings. Consumers are willing to spend more to get high play value and the :wow: factor.

2011

Simply Social
• Increased connectivity to the internet through apps has spread to toys. Many apps for kids are based on classic games but there is an emerging trend of pro social games that teach kids about the world around them and societal expectations through play.

Performance Play
• Training your brain has become a new trend in toys. They encourage logical thinking, strategy, and mind puzzles.
• This trend also includes games that encourage children to get up and move around with a sensor as input for video games.

Design, Discover, Learn
• Learning through doing with hand’s on experiences. Trial and Error are a key part of the play experience. Constructible toys and crafts also follow this trend as they challenge kids to think spatially and express their creativity.

2010

Active
• Toys that encourage kids to use their minds and their bodies were growing in popularity. Physical play is tied with active intelligence and imagination.

Aspirational
• Products that empower children to make their own choices. Critical thinking on the part of the kids to determine their own fate. Eco-friendly products also fall into this category because they help to make the world a better place which benefits the child in the future.

The continued popularity of construction systems as well as items that promote exploration and creativity are apparent as they are characteristics in the trends listed. Physical activity has also been a recent trend due to public awareness of obesity issues facing today’s youth. Social integration and multilevel engagement are digital toy trends that could also be applied in an analog sense. Knowing these trends can enrich the design so that it remains relevant to kids and parents for years to come.
Academic resources were consulted for additional supporting information.

As the project became youth-orientated, it was important to determine age-appropriate traits that would help the product appeal to the target users. Developmental milestones outline the physical and mental capacities of youth at different stages.

Play research and swimming statistics uncovered the opportunity to link two important activities into a thesis project. Play has positive effects on childhood development and comes naturally. Early exposure to water through swimming has been proven to save lives. By using play to encourage swimming, more children will gain confidence in the water.

Child ergonomics and anthropometric measurements were researched to guide the design in being physically appropriate for the age group. Safety and standards were also researched so that the design would comply with them from the early stages of development.
Piaget Stages of Cognitive Development

**Sensory Motor Stage**
Birth to 2 years

Infants know the world through their movements and sensations
- Infants learn that things continue to exist even though they cannot be seen.
- They are separate beings from the people and objects around them. They realize that their actions can cause things to happen in the world around them.
- Learning occurs through assimilation and accommodation.

**Preoperational Stage**
2 to 7 years

Children begin to think symbolically and learn to use words and pictures to represent objects. They also tend to be very egocentric, and see things only from their point of view.
- Children at this stage tend to be egocentric and struggle to see things from the perspective of others.
- While they are getting better with language and thinking, they still tend to think about things in very concrete terms.

**Concrete Operational Stage**
7 to 11 years

During this stage, children begin to think logically about concrete events.
- They begin to understand the concept of conservations; the amount of liquid in a short, wide cup is equal to that in a tall, skinny glass.
- Thinking becomes more logical and organized, but still very concrete.
- Begin using inductive logic, or reasoning from specific information to a general principle.

**Formal Operational Stage**
12 and up

At this stage, the adolescent or young adult begins to think abstractly and reason about hypothetical problems.
- Abstract thought emerges.
- Teens begin to think more about moral, philosophical, ethical, social, and political issues that require theoretical and abstract reasoning.
- Begin to use deductive logic, or reasoning from a general principle to specific information.

The U.S. Consumer Product Safety Commission (CPSC) issued a report on appropriate toys and characteristics for developing children. The following pages summarize the information relevant for the potential target age groups: 6 through 8 years of age and 9 through 12 years.

### Age Determining Guidelines

<table>
<thead>
<tr>
<th>6 through 8 years</th>
<th>9 through 12 years</th>
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<tbody>
<tr>
<td><strong>Basic Abilities</strong></td>
<td><strong>9 through 12 years</strong></td>
</tr>
<tr>
<td>• With more strength and endurance, they are ready for more physical challenges</td>
<td>• Looking for activities to challenge advanced motor skills and thinking</td>
</tr>
<tr>
<td>• More risk tasking behaviors</td>
<td>• Prefer raw materials for making their own unique creations</td>
</tr>
<tr>
<td>• Spontaneous games with set rules</td>
<td>• More complex level of work in wide variety of activities.</td>
</tr>
<tr>
<td>• Increased dexterity</td>
<td></td>
</tr>
<tr>
<td><strong>Construction Play</strong></td>
<td><strong>6 through 8 years</strong></td>
</tr>
<tr>
<td>Construction play contributes to learning and development. It allows children to demonstrate their symbolic understanding of the world from a young age. As they get older, complexity of their structures increase as well as a shift from basic blocks to interlocking pieces.</td>
<td><strong>9 through 12 years</strong></td>
</tr>
<tr>
<td>• More engaging than simple blocks</td>
<td>• Highly complex puzzles</td>
</tr>
<tr>
<td>• Cognitive abilities to follow directions and to understand step sequences in model kits</td>
<td>• High number of smaller pieces for greater challenge</td>
</tr>
<tr>
<td>• Well developed fine-motor skills</td>
<td>• Can handle small, abstract, or interlocking pieces.</td>
</tr>
</tbody>
</table>

### Blocks

<table>
<thead>
<tr>
<th>6 through 8 years</th>
<th>9 through 12 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>• More intricate structures being built</td>
<td>• Most children have the ability to ride a two-wheeled bicycle</td>
</tr>
<tr>
<td>• More appeal in sets with many parts (100+)</td>
<td>• Coordination to use hand brakes</td>
</tr>
<tr>
<td>• Shift in interest towards sets with interlocking pieces</td>
<td>• Also interested in scooters and skateboards.</td>
</tr>
</tbody>
</table>

### Interlocking Building Materials

<table>
<thead>
<tr>
<th>6 through 8 years</th>
<th>9 through 12 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>• More engaging than simple blocks</td>
<td>• Most are very capable on bicycles and scooters.</td>
</tr>
<tr>
<td>• Cognitive abilities to follow directions and to understand step sequences in model kits</td>
<td>• Frequent use of hand brakes and hand gear shifters.</td>
</tr>
<tr>
<td>• Well developed fine-motor skills</td>
<td>• Likely to engage in risky behaviors like stunt riding and riding in traffic.</td>
</tr>
</tbody>
</table>

### Puzzles

<table>
<thead>
<tr>
<th>6 through 8 years</th>
<th>9 through 12 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Jig-saw type puzzles appropriate</td>
<td>• Highly complex puzzles</td>
</tr>
<tr>
<td>• Developing systematic methods of testing and sorting pieces</td>
<td>• High number of smaller pieces for greater challenge</td>
</tr>
<tr>
<td>• Pieces should be about 1” across until better fine motor skills present.</td>
<td>• Can handle small, abstract, or interlocking pieces.</td>
</tr>
</tbody>
</table>

### Computer Games

<table>
<thead>
<tr>
<th>6 through 8 years</th>
<th>9 through 12 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Console and handheld games are popular</td>
<td>• Creative and educational games are popular</td>
</tr>
<tr>
<td>• Both hands can be used performing different functions.</td>
<td>• Stronger social element</td>
</tr>
<tr>
<td>• Creative games like drawing and painting are appropriate.</td>
<td>• Popular themes: sports, fantasy games</td>
</tr>
</tbody>
</table>

### Ride on Toys

<table>
<thead>
<tr>
<th>6 through 8 years</th>
<th>9 through 12 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Most children have the ability to ride a two-wheeled bicycle</td>
<td>• Most are very capable on bicycles and scooters.</td>
</tr>
<tr>
<td>• Coordination to use hand brakes</td>
<td>• Frequent use of hand brakes and hand gear shifters.</td>
</tr>
<tr>
<td>• Also interested in scooters and skateboards.</td>
<td>• Likely to engage in risky behaviors like stunt riding and riding in traffic.</td>
</tr>
</tbody>
</table>

### Recreational Equipment

<table>
<thead>
<tr>
<th>6 through 8 years</th>
<th>9 through 12 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Enjoy climbing, swinging, balancing and chasing on playgrounds.</td>
<td>• Often use playground equipment in unintended ways.</td>
</tr>
<tr>
<td>• Developing swimming independence.</td>
<td>• Move to organized sport</td>
</tr>
<tr>
<td>• Enjoy diving for objects.</td>
<td>• Usually strong swimmers, depending on experience.</td>
</tr>
<tr>
<td></td>
<td>• Can use snorkels and flippers.</td>
</tr>
</tbody>
</table>
Early Swimming

In a 2012 report issued by Griffiths Institute for Educational Research, it was shown, according to Prof. Robyn Jorgensen, that "young children who participate in early-years swimming achieve a wide range of skills earlier than the normal population."

"Many of these skills are those that help young children into the transition into formal learning contexts such as pre-school or school."

"The research also found significant differences between the swimming cohort and non-swimmers regardless of socio-economic background."

The researchers also found there were no gender differences between the research cohort and the normal population.

Children were achieving physical milestones faster and scoring better in visual-motor skills and many mathematically related tasks. Their oral expression was also better as well as in the general areas of literacy and numeracy.

Researchers from the Griffith Institute for Educational Research surveyed the parents of 7000 children under five. An additional 180 children aged 3, 4, and 5 were involved in intensive comprehensive testing.
About one in five people who die from drowning are children 14 and younger. For every child who dies from drowning, another five receive emergency department care for nonfatal submersion injuries.

Children ages 1 to 4 have the highest drowning rates. In 2009, among children 1 to 4 years old who died from an unintentional injury, more than 30% died from drowning. Among children ages 1 to 4, most drownings occur in home swimming pools. Drowning is responsible for more deaths among children 1-4 than any other cause except congenital anomalies (birth defects). Among those 1-14, fatal drowning remains the second-leading cause of unintentional injury-related death behind motor vehicle crashes.

Formal swimming lessons and water-safety skills training can start at a young age. In fact, the American Academy of Pediatrics supports swimming lessons as young as age one. The decision to begin swimming lessons should be based on the individual child’s exposure to water, emotional maturity, physical limitations, and health concerns. Participation in formal swimming lessons can reduce the risk of drowning by as much as 88% among young children aged 1 to 4 years, who are at greatest risk of drowning.

Taking part in formal swimming lessons reduces the risk of drowning among children aged 1 to 4 years. However, many people don’t have basic swimming skills. A CDC study about self-reported swimming ability found that:

- Younger adults reported greater swimming ability than older adults.
- Self-reported ability increased with level of education.
- Among racial groups, African Americans reported the most limited swimming ability.
- Men of all ages, races, and educational levels consistently reported greater swimming ability than women.

Water play is categorised as “elemental play” because it enriches our experiences with the natural elements.

Water play is open-ended, offering opportunities for social interactions, physical skills, and concept development, including:

- Scientific investigation.
- Soothing sensory exploration.
- Connection with natural materials.
- Full body engagement.
- Hand-eye coordination and the manipulative skills of lifting, pouring, controlling.
- Mathematical and scientific concepts of weight, buoyancy, volume, and shape.
- Concentration and problem solving skills.

Water play offers an outlet for playful aggression. In play, children are able to act in roles without “real” consequences, take risks without danger of repercussions. Water is a good medium for this type of play because of its forgiving nature: children can shoot and be shot, fall without fear of a hard landing, and escape the normal constraints of playing on land.

Children have a desire to make sense of the world. Water play provides opportunities to problem solve and think critically. Multiple Intelligences are also benefitted through play with water.

**Mathematics and Logic**
Measuring volume, comparing quantities, counting pieces, and weighing things that float are examples of concepts that can be explored through water play.

**Science and Naturalistic Intelligence**
Play fosters curiosity which leads to experimentation. Children engage in both inductive and deductive thinking as they explore the properties of water. Concepts such as force, gravity, fluid properties, and energy can be discovered through water play.

**Physical Intelligence**
Water play develops both gross and fine motor skills as well as hand eye coordination. Large movements are required to lift and move objects. Small motor skills are used in making fine adjustments to objects.

**Social Intelligence**
Water play can be a solo pursuit or done in groups. Play sharpens the talent for empathy, cooperation, and also competition.

**Verbal Intelligence**
Play with water allows for the use of an expanded vocabulary. Words describing the properties of objects and fluids can be learned in a natural environment.


Value of Play

From “Active Faming - The future of play,” the importance of physical play is highlighted in an era when there are digital distractions.

Physical play in children helps to develop the physical, social, emotional, and cognitive domains as well as fostering imaginations and creativity. Discouraging children from active play harms their health.

Six factors make up the “disposition of play”

• Play does not need to be directed. When children play, they learn and enjoy the experience without external rewards. Let children pick the level of skill and challenge with which they feel comfortable

• Play is relatively free of externally imposed rules. When adults inappropriately interfere, children lose interest and stop playing. Being in control of their own play experiences positively affects self-esteem and sense of competence in children. Children with a strong sense of self-worth are much more likely to become well-rounded, mature individuals.

• Play is carried out as if the activity were real. Play must be meaningful to children, adding to their understanding of the world and the ability to adapt.

• Play focuses on the process rather than any product

• Play is dominated by the players

• Play requires the active involvement of the player

Play is Serious Fun.

It reinforces cognitive development with respect to representational competence, operational thought, and problem solving. It also serves as a context and vehicle for the expression and consolidation of development, providing opportunities for new learning. Play is an active form of learning that unites the mind, body, and spirit.

Free and unstructured play is essential for helping children reach important social, emotional, and cognitive milestones as well as helping them manage stress and become more resilient. Play keeps children’s minds engaged with the environment, ensuring optimal brain development.

Nature and Play

A child’s relationship with nature is important. Playing in the natural world increases physical competency. The decline in children’s independent playtime parallels the human disconnection with nature. Many children do not know how to play anymore. Children who play in natural settings appear to be more cooperative and more likely to create their own games than those who play on flat turf or asphalt playgrounds. Creativity and confidence in their imagination can be restored with independent play in nature, alone or with other children.

Children who are in charge of their own explorations tend to nourish their creativity, self-confidence, problem solving, and other important attributes. Playing in nature provides kids opportunities to take appropriate risks, expand the play territory, and earn critical skills. Kids who play in natural play areas are far more likely to invent their own games and far more likely to play cooperatively. They also test much higher in science.


Childhood ergonomics and anthropometric data is important in this design because the size, weight, behaviour of the product needs to be appropriate relative to the size, weight, and abilities of the youth interacting with it.

Their strength will limit how much force it will take to attach and detach pieces.

Their height and arm span will help to determine how big the pieces can become.

Their weight will help determine how much buoyancy and material will be needed for a fun water experience.

For measurement data for children age 8, 10, and 12, refer to Appendix C. These ages were chosen as a sample of the children in the target age range.
Although not necessarily a public playground, especially one on land with different fall hazards, there are still relevant aspects of playground structure safety to be considered.

- **Entrapment** - any condition that impedes withdrawal of a body or body part that has penetrated an opening.
- **Entanglement** - a condition in which the user’s clothes or something around the user’s neck becomes caught or entwined on a component of the playground equipment.
- **Supervisor** - any person tasked with watching children on a playground.
- **Use Zone** - the surface under and around a piece of equipment onto which a child falling from or exiting from the equipment would be expected to land.

- Bounded openings should have a minimum 9 in diameter, based on the large head template.
- Dangling clothing items present a hazard on projecting bolts.
- As with any pool toy, use with appropriate adult supervision at all times.
- Appropriate disclaimers for water use.
- Not a life saving device.
- Appropriate disclaimers for water use.

The toy system needs to comply with the following standards:

- ASTM F 963-08 - for all toys designed for use by children 14 years of age and younger
- ASTM F1549 - Pool Safety Standards
- ASTM F963-07 - Warning Label Standards for children’s toys, specifically for Aquatic Toys: “This is not a lifesaving device. Do not leave child unattended while in use”
Through research, the aquatic toy system became the strongest direction to pursue through design.

At first, ideation was focused on specific mechanisms and singular functions. This was ineffective because there was no coherent theme to develop. Once a thematic approach was adopted, the concepts began to appear and gain their own characteristics, becoming more diverse.

By showing the concepts to stakeholders early and often, the concepts continually evolved: weaker ideas were left behind but their strengths were adopted into other design concepts.

Space2O and Logs merged to form Space Logs and Icebergs maintained interest throughout the process. After testing mock ups and seeing the children merge the concepts, the final direction became Icebergs with the successful aspects of Space Logs.
*Early visual brainstorming efforts*
With the idea that the product would encourage creativity and allow kids to explore the properties of water, as well as encouraging comfort and confidence in water, a construction kit mentality was adopted.

Early ideation focussed on different mechanisms for connection myriad pieces. This became very broad and the lack of focus made progress more difficult.

Instead of looking at possible mechanisms, more ideation was done by looking at full system opportunities as opposed to a part-by-part view.
Early Concepts

- Buoys
- Hoops 'n Loops
- Labyrinth
- Arcs
- Icebergs
- One Offs

Ideation through thematic concepts was helpful in focusing my thoughts and making progress.

With the project goal to encourage creativity, social interaction, and building confidence in the water, several broad concepts were created, as well as various one-off ideas that could be incorporated as features in a core concept.

Feedback on these early concepts was given at an observational research session which led to further concept ideation and development.
Buoys

This is an interchangeable system of parts that capitalizes on the kids’ desires to create their own floating jungle gym.

The vertical posts formed by the buoys support stacking pieces that provide a variety of physical challenges, from balancing planks to climbing ropes.

The scale of this concept was meant for larger pools and outdoor areas.
This concept was based on the idea of children practicing their underwater skills. Toys that sink are popular at pools because it presents an obvious challenge for the kids to dive after them.

Hoops and Loops offers a twist on the diving toy concept. It presents a target opening for swimmers to swim through. If they touch the loop, it disengages from its base, floating to the surface.

Using the fluid motion and instability of water, this concept is a balance game where players shift the platform to maneuver a ball to a target.

The maze could be reconfigured with modular pieces for different variations and modes of play.
Arcs

Made of bent panels, this was a system for building small platforms and lounge spaces.

The pieces could connect along edges and corners. It is an exploration of geometry.

The panels could be stylized to fit different themes and functions: science fiction, booby traps, and faux wood were just a few thoughts on the possibilities.

Icebergs

Inspired by floating icebergs, the core of this concept was creating unstable multi-faceted mass with various pieces.

Solid angular polygons can be attached arbitrarily to create the larger mass. Panels could also be used to expand the geometries. Different configurations could create different play water-scapes.
While developing thematic concepts, there were several one-off ideas that were imagined. By themselves, these ideas were not rich enough to be their own concepts but some of them had the potential to be incorporated into thematic concepts as features of the set.

From observational research, it was discovered that children in the target age group like play games against their friends. This competitive attitude leads to creativity in finding new ways to win.

Some of the one-off ideas included target games where kids aimed a stream of water at their friends or a floating objective. Another option was a target at which projectiles could be launched or thrown.

Common games played by kids in the pool are variations of tag. The flag tag belt is a belt that has a pull tab that released a flag or parachute when pulled. This serves as a visual indicator to being tagged and also slows down the swimmer.

Zoom ball was a popular outdoor toy in the 1990s. Using the same method of propulsion on a larger scale, the concept is a friend-propelled knee board.
Additional one-off concepts were inspired by the youthful enthusiasm for booby traps and the popularity of game shows such as “Wipe Out.”

Atlantis as a platform that could be sunk on demand by adjusting buoyancy. A giant syringe would suck out air and flood the air bladder with water to sink the platform.

Rollers was an obstacle with large rollers that players could run or slide over. Safety would have been a major concern here.

Over/Under is a game of avoiding traps. Players scramble over or under the rotating arm and avoid holes in the platform that would cause them to fall into the water.

Bubble Wrap was another concept that allowed players to adjust buoyancy. This time it would have capsules of air that could be “popped.” As capsules are removed, the platform becomes unstable and less buoyant.

Floe was inspired by polar bears hunting seals in the arctic. Swimmers would take turns popping up through the holes and another friend would be on top, waiting to pounce on them (with a padded paw).
Expanded Concepts

• Icebergs
• Buoys
• Turrets
• Peg Leg
• Logs
• Space2O
• Arcs
• Hulls
• Semi-Submerged

More thematic concepts were explored after the positive feedback gained from the early concepts. Additional research also helped to expand the variety in the concepts.

Construction concepts with different shapes and methods of expanding were considered. Different possible uses of the floating pieces also led to new ideas. By playing with the location of the planes, relative to one another, the play experience can become more immersive in the water.

These concepts were shown to kids and a group of parents for feedback at a concept test session with scale pieces.
Icebergs

The scale of the pieces for icebergs was explored more. With a focus on maintaining the ability to attach pieces arbitrarily requires some thought for smooth execution. The angular look of the concept was found to be intriguing and unique by the parents and kids.

Buoys

The DIY obstacle system was distilled down to balance planks and social platforms. The stability of the structure depends on how the kids have arranged the pieces. Opportunities for “parkour” are apparent, according to kids giving feedback.

Turrets

This concept was inspired by the aggression that children often exhibit to each other in their online gaming. A water blaster concept incorporates a behaviour that kids already display. The turret has an underwater platform to stand on and protection from oncoming fire.
**Peg Leg**

This concept was based on peg boards and basic geometry. The concept was straightforward with pegs inserting into larger pieces. The modularity of the pieces would allow for easy expansion. Users could be enticed to buy more pieces to build bigger things.

**Logs**

Logs is a similar concept to Peg Leg but the scale of the pieces was larger. Kids can challenge themselves and balance on the logs as well as build larger formations by combining and attaching pieces at different angles. The parents thought this was a strong concept.

**Space2O**

Inspired by space stations, Space2O is a more linear obstacle and construction concept. With a combination of pontoons and platforms, kids can race from end to end moving around, over, and under different obstacles. One of the unique features of this concept is that some of the panels are submerged from the pontoon, forcing swimmers to manoeuvre around them as well.
Arcs

The bent panels were meant to cradle people as they relaxed in the water. When connected along their sides, they could form a running surface that could incorporate different obstacles. Multiple linked arcs would also be the perfect place for friends to gossip on the water.

Hulls

Many pool toys take the form of boats; however, these are typically just inflatables. Hulls allows swimmers to build their own boat with modular pieces; they can make stubby boats or long tankers according to the whims of the builder.

Semi-Submerged

Taking advantage of the aquatic environment, semi-submerged creates different levels for people to play on. They can be up high, above the water, floating directly on the water, or in shallow water, supported by a submerged platform.
After receiving feedback from the kids and a panel of parents at the second playdate, the concepts were narrowed down.

Space 2 O and Logs were perceived as similar concepts and had positive responses. The moms could see kids in different age groups playing with the pieces together and as they grew up.

Turrets had an immediate response that was positive from both the kids and parents. It had an obvious function that appealed to the kids. Parents could see it becoming part of the pool decor if styled appropriately.

Icebergs was a strong favorite because of its uniqueness compared to existing products. The ambiguity of the potential forms had the ‘wow’ factor that parents look for and was also fun for the kids.
Through feedback from kids and parents, the Space2O and Logs concept merged. The cylinders of Logs indicated the balance games that could be played while the flat surfaces in Space2O are potential places to stand, sit, or lay down.

Methods of connecting pieces were explored through slot systems, peg holes, and friction fitted openings.

The layouts were also explored for potential feature parts such as balance boards and archways. The designs that came off strong were ones that broke from the single surface plane: having vertical or angled surfaces added to visual interest as well as functional variety.

The space logs hybrid concept was tested in the pool with a group of three children. They played with the pieces and made a few different platform configurations. Problems arose with the stiffness of the cylinder pieces that held the inserted platforms.
Various possible developments for turrets were explored. The key feature was the submerged platform that would give swimmers a place to stand in deeper water. It was eventually decided that turrets would become an integrated feature of the eventual core concept.

The deliberate angularity of the icebergs was a key feature. The angles and size of the pieces play a part in how the assembled mass will look. This concept was further explored through models that were tested with kids.
Concept Refinement

- Inspiration Boards
- Form exploration
- Functional Exploration
- Possible Configurations

Through testing the final concept directions with kids, the decision was made that the aesthetic influence of the design would stem from the Iceberg concept but successful aspects of turrets and Space Logs would be incorporated into the design for the richest play experience.

There were functional aspects to the design that needed to be resolved: how do pieces attach to each other on face to face contact and how would panels connect to each other along their sides. A morph chart was used to find a broad range of solutions before deciding a final methods of attachment.

An exploration of possible construction options was also performed to show the creative range with a given set of parts.
By combing the strengths of the developed concepts into Icebergs provides a play experience that is creative, social, and builds confidence in the water.

The system consists of a set of parts:

- Panels
- Iceberg solids
- Connectors
- Blaster (optional)
Functional Exploration

One feature of the design is the ability to connect the pieces face to face, ideally in a way that is not dependent on aligning parts.

A morph chart was used to explore options to connect the pieces. After weighing the benefits and disadvantages of the various methods, 3M's Dual Lock was seen as the ideal choice.

Similar to Velcro's hook and loop fasteners, Dual Lock supported the iceberg feature of arbitrary attachment of the pieces on contact. This would allow players to throw a piece at another and have the surfaces connect on contact. Its advantage over Velcro is that both surfaces are the same connector so there is no polarity issue with hooks only attaching with loops.

Alternative attachments were considered as well as possible graphic treatments of fastener-covered surfaces through the use of color and texture.
Another function of the design is that the panels can attach to each other along their sides. This allows larger platform areas to be created.

Initial sketches involved a molded cap for the corner. Because the panel triangles were scalene, thus had different angles in each corner, the connector would have had to be flexible but still have enough hold on the part to be secure, which is a potential technical problem. Possible configurations for this method of connection were explored in CAD and can be seen in Appendix D.

A morph chart was also used to come up with a more simple way of attaching panels at the corners.

Flexible connectors were explored for use with the triangles. Fixed connectors were tested in the pool due to greater perceived strength.
The design and feedback loop was vital in the development of the project. Ideas that looked interesting on paper did not necessarily translate to physically engaging concepts. The reverse is also true, where a drawing was received better than expected by the stakeholders and developed further.

Frequent consultation with stakeholders led to discoveries about what they imagined themselves doing instead of just speculation from the designer.

When testing the full sized mock-ups, the kids made their own discoveries on how to play with the pieces. The variety they exhibited was not something that could have been known without testing.
Early Feedback

Buoy
The response from the kids was enthusiastic. The parents were intrigued but concerned about the complexity and practicality of so many different pieces.

“Great idea, but seems a bit expensive for people” -Phoenix

“Ancs
Feedback for this concept was warm.

Parents like that this is an open ended system with no direct cues. It was pointed out that kids who are not used to open ended play might have a harder time with this concept.

“Big sets would be good for birthday gifts! everyone would want it” -Phoenix

“You could build a fort with this...make a 3d tunnel” -Jeorge

Labyrinth
Feedback for this concept was mediocre.

The kids understood it but were not interested when compared to the other concepts presented.

Parents said that their kids would probably just end up on top of it and treat it as a platform instead of just a game.

Icebergs
Feedback for this concept was enthusiastic.

The kids imagined trying to climb on top of the large cluster and playing King of the Hill.

Parents liked that this was a pretty ambiguous concept, stimulating the imaginations of their kids. They also liked that the pieces could remain attached for easy storage.

Hoops n Loops
Feedback for this concept was mixed.

The girls thought it would be fun to play with and compete with friends.

Parents were concerned about safety of a full loop, but happy with the idea of swim-through targets if there was an escape opening.

Suggestions to make this more appealing was to gamify it and add a scoring element.

“Plastic covering to protect from squirrels” -Phoenix

“You could build a fort with this...make a 3d tunnel” -Jeorge
Testing Expanded Concepts

Similar to the first playdate, I provided the kids with an assortment of pieces. I was trying to simulate some of the concepts I had drawn. This time, I also provided a couple tubs of water so the pieces could float.

Although pieces of different concepts were created, the boys decided to cross-thematically use the pieces and ignore the separation of parts that was set up.

Although productive, there were some shortcomings to this playdate:

- Nicer weather made the kids more energetic and they wanted to play on their bikes and playground more.
- Limited space around the tubs of water for full involvement from the group.
- More pieces would have helped to have more kids involved at any given time.

The strongest takeaway from this playdate was the feedback from the parents of the kids at the park. They provided me with feedback on each concept as a panel.

Key points from the panel responses:

- Storage is a big concern. Size and number of parts that could potentially get lost are factors to consider.
- The less directed concepts have more potential for more creative play over a longer period of time.
- While interacting with friends while playing is great, having the ability to play separately is also valuable.
Feedback for Expanded Concepts

Icebergs
"I like all the angles and it looks like you get lots of different options and how they can stack" - Karith
"Storage is a concern but if they click together, that’d be great and easy." - Mary
"I can see Jack, age 6, playing by himself and then Connor (10) might join him" - Edie

Buoys
"Look super fun, worried about storage because they’re all different and big" - Mary
"Kids would look at that and immediately think FUN! but less likely to play by themselves" - Edie
"I don’t really see someone buying this then continually rearranging it regularly" - Edie

Peg Leg
"Looks really fun because it’s so connected to toys that kids already understand" - Edie
"I worry that it’s not as versatile or engaging as icebergs. They might just sit on it for awhile" - Mary
"Younger kids can play on it and understand it more easily. It would work well out of water as well" - Karith

Space2O
“This is one of my favorites. The kids would have so much fun chasing each other" - Mary
“It would be great if more toys were see through so I can see into the water” - Tina
“Aligning things is an older kid skill so finding a way to have young kids involved would be better.” - Edie

Turrets
“It could be a part of the pool environment if attractive. Has the cool factor and might just stay on display, but should be a subtle color because you get tired of seeing the bright colors if it stays out” - Mary
“I like the shield from water blasts. But I’d like to be able to see through it so I know which kids is there.” - Edie

Logs
“Just looks super fun to rearrange and do crazy balance games and knock each other off” - Mary
“If there were ridges to secure pieces in, I would feel better with the kids climbing over it” - Edie
“Would be great out of the pool, in a yard with a sprinkler” - Tina

Semi-Submerged
“The variety is nice for hanging out. The kids could be separate if they wanted to or together” - Mary
“The storage is easy. Could spend less money and still have a good set” - Edie
“It’s simple but more unique than peg leg” - Tina

Hulls
“Seems like it might be dangerous if it filled with water or flipped” - Karith
“Less unique. Basically a make your own boat but then what else would you do?” - Edie
“It would be hard to store and doesn’t seem as unique as other concepts.” - Mary

Arcs
“The lounging aspect is very clear here” - Tina
“I like that the pieces could stack or just stay connected together for storage” - Mary
“Seems more limited in what you can do compared to the other ideas” - Edie
“Less fun looking than the other ideas” - Karith
Mock Up Construction of Developed Concepts

After several rounds of ideation and feedback from kids and parents off of drawings, it became necessary to test the concepts in its intended environment - the pool. Icebergs was mocked up using insulation board and urethane foam. Space Logs was created using bundled noodles and cut boogies boards.

Some of the icecubes were filled with a marine urethane pour foam to give extra support to the hollow form. It was also an experiment to see if the pour foam would work in a mold; this result was mixed and in the end deemed unnecessary.
Concept Testing

Three kids (Jeorge, Sun Woo, and Gillian) helped to test out the Iceberg concept and Space Logs.

They played well with the pieces for Space Logs after some experimentation. Vehicles for personal flotation and transport were the main creations. Attempts at creating rafts to stand on were met with mixed success. The noodles were not rigid enough to prevent bowing when supporting someone.

The scale and number of pieces might have limited options but the ability for the interchangeable pieces was enjoyed by the kids.

They also attached pool blasters (belonging to the host) into the pool noodle logs, effectively creating the turrets concept on their own. There seemed to be a preference for a square space as opposed to a linear expansion.

The iceberg pieces were briefly played with by Sun Woo and Jeorge. They tried to sit on the smaller blocks and used them to float on their backs. The small icebergs also became cargo for their transportation rafts as they played.
Refined Concept Testing

A second pool testing day was held with improvements to the mock ups.

The kids were still intrigued by the concept and the form but the pieces were not portraying the same potential as the drawing. This time, I brought more pieces with varying properties: some pieces were foam-filled, some were hollow with holes (this let the pieces fill with water and sink a bit then drain water when picked up), and one of the big icebergs was also weighted (to change the tumbling behavior). They all had velcro on the planes so that pieces could be arbitrarily attached. I hoped that the different icebergs would make for a better play experience.

The new pieces and development proved to be successful.

First, the boys explored the behavior of the pieces in the water by chasing, tossing, catching, tumbling the icebergs. They each had their own preference for specific properties; the one with the drain hole was particularly amusing because it would be partially submerged then sprayed them when they pulled it out.

After the preliminary exploration with the pieces, they tried building things and then tried to climb on top of them, with varying degrees of success. Along the way, they also decided to challenge each other to a balancing competition of sitting on and keeping the small icebergs submerged.
Another game they came up with was to herd the icebergs around using water blasters. The goal was to blast the iceberg to the other team’s side of the pool. This was played several times using different blocks.

Overall this test session with modified icebergs proved to be successful.

The same pieces were able to be used by the boys in a variety of ways that they came up with themselves, demonstrating the use of creativity in free play.

Although the space/logs concept was a creative activity, the overall play was more prescribed and the games less varied.

The iceberg concept was more successful in being social because it is easier to attach pieces with someone else holding the other piece; one of the issues previous test was that it was easy for a single child to monopolize the parts.
Additional Summer Concept Testing

After the interim design was determined, another testing session was held to gauge the response to the addition of panels and removal of some of the bigger solids.

The panels were based on the plane size of the large solids and made of the same material. Holes were created along the edges and rope was provided as a method of attachment.

The new method of connecting the panels provided a new way to interact with the parts. The desire to be on top of the panels (treated like a raft) was apparent.

The parents liked that the panels were less abstract and easier for the kids to relate to in building. The planes provided an obvious starting point for some of their explorations with the parts. Broken pieces were also repurposed into hand paddles and decorations for their assemblies.

SunWoo was also able to create a lounger with a sun shade. Jordan created a structure that he declared was a submarine. Jeorge used the smaller panels as paddles for his hands. The boys also created “tanks” and charged at one another.
Final Concept Testing

Based on the feedback and play observations from the panel and solid combination testing, changes were made to the parts.

The moms were impressed at the progress and how much the parts had developed. They really appreciated the ease of storage and transport of the new set of parts.

Connectors were mocked up with a variety of plumbing fittings to achieve different angles. The ends fit the grid of holes in the panels provided.

The panels were thickened for strength and additional floatation. This was tested by the children as they tried to sink the pieces as well as stand and balance on them.

The connectors intrigued the boys but they wanted a different distribution of the angles provided. Straight connectors (180 degrees) were in higher demand than the 60 and 120 degrees connectors. The fixed angles were inconvenient even if they offer better strength.

The connector also needed to be refined to fit more snugly in the holes.
"The kids do different things when they first start playing it. They want to float on it and surf on it and then as time goes on they start thinking of other things to do with the parts, what to build with it. It changes as the kids get to know it."

"The multiuse is great. It gets people in the water to play with it...it's something to draw them in [to the pool]."

"It’s great that they found different ways to use the parts. Ways that we didn’t even know were possible, but they did. Like the paddle boarding."

"It’s a great design. It’s lightweight and kids can move it easily on their own. Not a lot of adult supervision needed to work the parts."

Quotes taken from a conversation between Mary, mother of SunWoo, and Liz, mother of Jordin.
Final Design Development

Design is a non-linear and iterative process. Throughout the semester, ideas were developed with the help of supporting research and talking to stakeholders. Each time ideas were created and developed further, potential users provided feedback. The final design was determined after testing the concepts in a swimming pool.

Based on user behaviors with the mock ups in the water, the final design incorporates the flat panels from Space Logs and maintained the angular feel of Icebergs.

Icebergs has evolved from the vague description of “unstable multifaceted mass” to a modular system that allows children to have a creative and social experience in the water.
Connector Development
The connector is the key to the modularity of Icebergs.

Designed for easy, on-the-go adjusting, a polyurethane elastic compresses the parts together when the teeth of the hub interlock. The hubs allow the parts to self-align at specific angles as well as provide support at those angles.

Made from rotationally molded polyethylene, the two halves of the connector are identical. Therefore, they can be manufactured from the same mold which saves on tooling costs for the part.

Polyethylene plastic was chosen for its relatively low cost, UV stability, and good strength to weight ratio. It also comes in a variety of colors.

Rotational molding is the ideal method of manufacturing the connector. The tooling costs are kept low because high pressure resistance is not required of the mold. The cavity created by the molding process will also provide buoyancy for the connector.
Basic Panels

Auxillary Panels
Manufacturing of Panels

Polyethylene foam was chosen as the material for the panels because it has many favourable properties for the pool environment:

- Excellent buoyancy
- Closed cell foam
- Very lightweight
- Easy to fabricate
- Impervious to mildew, mold, rot, and bacteria
- Water resistant as well as resistant to solvents and grease, including chlorine.
- High resistance to tearing based on strength
- UV stability is appropriate for extended outdoor use
- Wide range of colors available
- Environmentally friendly by being CFC free

Fabrication of the panels was inspired by that of entry level boogie boards.

1. Notches will be cut out of the central layers of PE foam.
2. The layers are fused together with heat, along with a reinforcing mesh to provide additional strength and rigidity to the panels.
3. Details such as the chamfer will be cut away.
4. The outer skin, also PE foam, will wrap the layered block in a denser foam to protect and provide a different external finish to the panel.
5. Through holes are cut into the block with the curved hole profile.
6. Branding elements can be molded in with heated dies to finish the panel.
Accessories

By using the same peg profile used in the connectors, a series of decorative accessories can be created to fit snugly into the holes of the panels.

These accent pieces have high imaginative potential; from being handles and steering wheels to facial features that can transform the panels into sea creatures.

These parts would be rotationally molded, similar to the connector.

This also provides a cost effective way to expand the product line in the future.

Branding

The Icebergs logo is inspired by the 30 degree angles of the connector and shapes of Icebergs.

Alternative color schemes for the logo based on the Pantone colors of the parts.

Due to the simplicity of the design, branding of the product is a way to differentiate the original product from copy cats. The logo line work can be debossed on the surface of the panels as part of the fabrication process.
Costing Estimates

Basic Kit of Parts:
- 2 squares
- 2 triangles
- 2 half triangles
- 1 square with bump
- 1 square with hole
- 1 arc
- 15 connectors

Total Cost Estimate: $191.20

Therefore, a retail price under $300 could still be profitable while being inexpensive enough to be attractive to parents and pool owners.

Material Costs for Panels:
- 48” x 108” sheet of 0.5” thick PE foam: $13.75
- 36 sq ft @ $13.75
- Square Panel:
  - area = 7.2 sq ft
  - cost per 0.5” layer = $2.74
  - full panel (2.5” thick) = $13.70
- Triangle:
  - area = 3.89 sq ft
  - cost per 0.5” layer = $1.48
  - full panel (2.5” thick) = $7.41
- Half Triangle:
  - full panel (2.5” thick) = $3.70

Tooling costs for the part: $1700
Cost per molded half: $3.50
Cost per assembled connector: $7.00

Numbers based on quotes acquired from talking to people at New England Foam and John Hammond at RotoLite. Both sources are US-based companies, which are more costly than sourcing in Asia.
Guide to Assembly

There are three ways to connect panels:

1. Face to Face
2. Face to Edge
3. Edge to Edge

As seen from the cross sections, the interior profile of the holes match the curve of the peg to snugly hold the connectors in place laterally while allowing for rotation around the axis of the peg.
Sample Assemblies

While there are infinite possibilities with Icebergs, sample constructions could be provided as a source of inspiration for the aquatic builders.

From basic boxes to a floating house.
Swimmers can unleash their inner explorer with rocketships and boats.
They can challenge their friends with custom obstacle courses or just hang out on an island.
Icebergs is an aquatic toy system that addresses the opportunity of providing children with a more engaging play experience than current products in the category. The play experience is enhanced through social play and opportunities for creativity. These characteristics will encourage users to spend more time playing in the water, building their comfort and confidence in the pool environment.

Icebergs helps develop social skills in children by encouraging group play and cooperation. As discovered through testing, competitions can be spontaneous with the parts. Teamwork was also exhibited when the kids built structures together.

Icebergs provides an outlet for creativity by having endless possible configurations to build as well as unprescribed use of parts. Play with the iceberg pieces is not limited to construction; the pieces were thrown, submerged, sprayed, tumbled, kicked around during the play session.

The final design of Icebergs achieves the project goals of encouraging more time playing in the water by allowing for social interaction and creative explorations to enhance the play experience for the users.
Technical Drawings

Base Square 162
Equilateral Triangle 164
Accent Triangle 166
Square with Hole 168
Square with Bump 170
Arc 172
Connector 174
Accessories 176
Base Square

SECTION A-A

SECTION B-B

DETAIL C
SCALE 1 : 4

SCALE: 1:12
**Accent Triangle**

Scale: 1:8

SECTION A-A
Square with Hole

SCALE: 1:12
Connector

SCALE: 3:4

R.25

5.48

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1.50

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R.05

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Appendix A
Observational Research Activity Results

Gigi, 10
Platform inspired by Space Invaders.
Umbrella or seat attachment

SunWoo, 10
Platform with tunnel
Decoration on top - possible goal post

Antonio, 10
Inspired by ‘Wipe Out’
Round platform spins with dual diving boards
Diving boards pass over different pools and player needs to time jump to land in correct space.

Jack, 6
“Water Seat”
Built in sun shade
Has steering

Jack, 6
“Luxury Water Hotel”
Semi enclosed room
Deck opens out onto water

Jack, 6
Alternate view of “luxury water hotel”
Diving board on top of room
Could also be seat

Antonio, 10
Alternate view of Left
Round platform can be raised according to comfort level.
Platform can also be spun at different speeds
Built independently from other boys because he arrived late.

Unknown Participant

SunWoo, 10
People Carrier/Tank

SunWoo, 10
More heavily armored tank/carrier

Phoenix, 10
“nuclear rod carrier”
Has door that can open and shut
Jack, 6
extension to “Water Seat”
double as storage and toilet
controlled by other “Water Seat”

Jack, 6
Sail Platform
Can move around in circles

Phoenix, 10
people mover with “aerodynamic shape”

Phoenix, 10
people mover turned diving board

Phoenix, 10
tip of “speedo trap” flips tips up and
down with hinge joint.

Phoenix, 10
“Speedo Trap”
Fortress mode
Also high speed escape vehicle

Milla’s friend, 8
hang out space with built in shade so
you don’t have to get out of the pool

Phoenix, 10
deep sea floater

Ben, 10
Long platform
Run from end to end

Ben, Age
Platform with secret trap door

Phoenix, 10
Alternate orientation of “speedo trap”
Arrowhead inspired
Phoenix, 10
Floating furniture

Ben, 10
undeclared

George, 10
frame

Connor, 10
Floating platform

Connor, 10
Platform based on frog

Ben, 10
Hurdle to climb over
Skateboard ramp

Phoenix, 10
Cargo boat

SunWoo, 10
Platform

Milla's friend, 8
Similar to previous creation with shade.
She came to build more after boys had left and we were cleaning up

Milla, 10
Houseboat with flag or possibly a mailbox
Can sit on the roof

Jeorge, 10
Trampoline surface
Fake floor falls through if you jump too many times or too much weight.
Booby trap for friends
Goal post when tipped
These were the results of the preliminary survey put out to parents looking at the water recreation habits of their children.

How old is your child(ren)?

- 12+ years
- 10-11 years
- 8-9 years
- 6-7 years
- 0-5 years

How comfortable are you with your child(ren) playing in or near the water?

- Extremely Comfortable
- Very Comfortable
- Comfortable
- Uncomfortable
- Very Uncomfortable
- Extremely Uncomfortable

What type of exposure to water recreation does your child(ren) have in the summer?

- free play, beach time, Raging Waters
- They used to have lessons and one was in Junior guards in 2011
- Scuba
- They have weekly swim lessons, and we go to the beach once or twice a week for an hour at a time.
- Junior guards, beach and pool with friend time
- beach time, organized swimming at summer school, public pools
- Swim lessons (gradually increasing levels), free swim at friends house, beach time.
- Has had a few lessons. We have a pool so he gets free play in the pool
- Swim lessons, free play in pools and ocean
- did lessons for 4 years, now free play at friends pools and beach time.
- lessons and beach time and friends pools
- lots of beach time, pool at our home
- every saturday year round and some extra water play in the summer
- We go to the beach, pool in the apartment complex and hot tub at familiy home.
- Free play at the beach and at home in the kiddie pool
- free play at beach camping at creeks swimming in pools at friends house

Where are the top three places where your child(ren) plays in the water?

- ponds
- rivers
- vacation resorts
- lakes
- backyard pool
- community pool
- ocean
What are your child(ren)'s favorite things to do in and around the water?

- What are your child(ren)'s favorite things to do in and around the water?
- play games dive for objects on the bottom of the pool Jump or dive into the pool
- Swim, snorkel
- Scuba
- swim, splash, dig in the sand/dirt, throw rocks
- Swim, body surf, lay out in the sun
- ride the waves, dive for objects, swim underwater and time self for holding breath
- Swim & play
- Pretend a minecraft type game. Water slide. Practice diving. Talk in the hot tub
- My child has just begun to learn to swim. He enjoys using a raft or inflatable ring to float around. He also likes to
  use cups and sandcastle building toys to play in shallow water at the river or lake.
- boggie board, body surf, water toys and cannonballs in the pool
- float on things, explore ocean, go down slides, squirt each other, stand on hands
- surf, boggie board
- swim, basketball, water slides
- probably play in the small waves at the beach, in a pool wrestle around and splash at each other.
- Splash, pretend to surf and run through shallow water
- boogie boarding surfing diving in digging in sand, sandcastles

When playing in the water, on average, how many other children are playing with your child(ren)?

- [ ] 1-3 children
- [ ] 4-6 children
- [ ] 7-8 children
- [ ] more than 8

What pool toys, water toys, or equipment does your child(ren) like to play with in the water?

- little rockets than sink Inner tube water squirters
- goggles, snorkel mask and fins, balls that float, slide if available
- Rubber ducks
- floating ring (that goes around the body under the arms), squirty things, toys to pour water with, buckets
- Body board, soaker guns
- Blow up sharks/dolphins (ride on). Water blasters; Water balloons [not to throw at each other/ only to play with]
- Raft, inflatable tube, buckets and cups
- rafts, boggie boards, water noodles, super soakers
- things that squirt but we wont buy items that resemble guns. they like the super shooters but most pools can’t
  accomodate them, they like intertube float things
- not much in pool, but in ocean, wetsuit, boogie board, surf board, bootsies, sand toys, shovels
- balls, slides
- probably rubber balls and those water rocket gun things that spray a long stream of water.
- Buckets, pumps, cups, kick boards, hoses
- boogie board surf board water guns inner tube goggles pool noodle

What do you think is a reasonable price for larger water toys?

- [ ] under $100
- [ ] up to $150
- [ ] up to $200
- [ ] up to $250
- [ ] up to $300
What is your approximate household income?

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Table 1: Weight, Stature, Standing, and Sitting Measurements

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Table 2: Shoulder, Arm, and Hand Measurements

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Appendix D
Possible Configurations of Early Icebergs Concept

Due to the modular nature of the pieces and to highlight the creative possibilities, rough renders of the pieces in many different configurations were created to illustrate the concept.
Camber: A Rocking Stool
Directed Study with Derek Chen
Academy of Art University
Fall 2012
**Project Brief**

The Directed Study with Derek Chen of Council Design was focused on an exploration of ‘American Design’ from our own perspective. From there, we designed and built a furniture piece that reflected our thoughts.

My associations with this country influenced my thoughts on ‘American Design.’ As a traveller, American cities like New York, San Francisco, and Chicago are my first thoughts. They are bustling places with moments to savor.

Influenced by the energy of the city, I decided to translate that to a rocking stool made from urban materials: concrete and steel, with comfort being brought in by a padded seat.

**Development**

Various curvatures for the base were tested for rocking ability as well as stability. The proportions were also explored in scale models. The curvature of a 15 degree ellipse was determined to be the optimal shape for the base of the stool.
Since I had never worked with either sheet metal or concrete, the manufacturing of my stool was a learning experience.

First, I created a part file for the concrete base in SolidWorks. The reusable mold for the concrete base was then CNC’d out of foam which was then fiberglassed to protect it during the concrete pour.

The concrete base has an interior curvature that helped to reduce the weight of the stool. The concrete was a mix of Sakrete and additional stabilisers for strength and a smooth surface finish.

The body of the stool is made from 20 gauge sheet steel. I designed the flat pattern so that when cut, the steel could be cold-rolled to its conical shape and the two halves could be bolted together.

The halves were painted different colors to highlight the construction of the piece.

**Bill of Materials**

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Camber

a rocking stool that fits in without blending in
Google Inspired Furniture
Furniture Design 1
Academy of Art University
Spring 2012
Project Brief

The hypothetical premise for this class project was that Google is opening a showcase lounge as part of the mid Market Street gentrification efforts in downtown San Francisco in the near future.

Our goal was to design furniture pieces for the Google brand that are iconic and true to the nature of the company as well as fitting for the space.

Concept Ideation

Google cites the human touch as one of their user experience guidelines. The chair echoes this aspect of Google with the gesture of a hug. A hug represents a feeling of welcome and warmth that is universally understood.

Inspired by the location icon from Google Maps, the “you are here” chair is a cafe style chair. The icon reminds the user to enjoy the moment and take in the surroundings.
Painted Seat Rim
Aluminum Mesh Seat
Aluminum Tube Frame
Aluminum Mesh Back

18.000
Ø 17.500
R6.912
6.500
3.0°
Ø 16.000
34.000
4.500
15.229

Sturdy Upholstery
Wood Back Support
Foam Padding for Backrest
Wood Interior Support
Variable Density Foam

Here

Left: Volume Study
Right: Ergonomic Buck
Buzzzz Exhibit Benches
Design Internship
Palo Alto Junior Museum and Zoo
Project Brief

During a summer internship at the Palo Alto Junior Museum and Zoo, I was given the opportunity to design a series of children's activity benches to match the existing activity stations of the new Bug Exhibit.

Within the limited budget, I was able to design a set benches that echoed the look and feel of the activity tables.

Although each bench had varying dimensions, a graphic motif was used to unify the benches as well as illustrate the story of a caterpillar becoming a butterfly.

Right: sample drawing submitted to manufacturer.

The motifs were laser cut from plywood. The cut out butterflies were also painted and repurposed in another part of the exhibit as upright supports for toddlers.