APPENDIX A: PROJECT DEFINITION

Project Name: Nesting Number Blocks

Client: Nicole Humphrey, Misericordia

Team Members: Gautham Anne, Jonas Goldberg, Lucas Holliday, Burke Stanton

Date: December 2, 2023

Version: 3.0

Mission Statement

To design a durable product that effectively educates and engages residents with intellectual or developmental disabilities through oral, visual, or tactile feedback that meets their sensory profiles while maintaining their dignity and safety.

Project Deliverables

- A set of nestable number blocks corresponding with integers 1 through 5
- Final report
- Poster and presentation for the Design Expo

Constraints

The only major constraints are the project due dates at the end of fall quarter.

- Final prototype due December 2, 2023
- Final report due December 4, 2023
- $150 budget allotted towards development of project

Users/Stakeholders

- Primary user: _____, a resident of Misericordia who has a basic understanding of identifying numbers, who will use the product for cognitive stimulation to learn number sense and basic arithmetic.
- Secondary users: Other adults with IDDs at Misericordia
- Project partner: Nicole Humphrey, _____'s teacher at Misericordia, who will use the product in her classroom.
- Other stakeholders: Misericordia staff members who will be influenced by the residents' responses to the product.

User Profile

_____ is an energetic, affectionate, and curious adult resident of Misericordia who recognizes numbers. However, he has trouble distinguishing them from other numbers and associating quantities with them. He often places items in his mouth, enjoying the stimulation from chewing. _____ tends not to interact with other residents, but prefers to focus on the object that has his attention at that moment or with his teacher or caretaker. Because _____ is autistic, nonverbal, and has limited motor control, it is difficult to engage him in educational lessons without the use of manipulatives.

Illustrative User Scenario

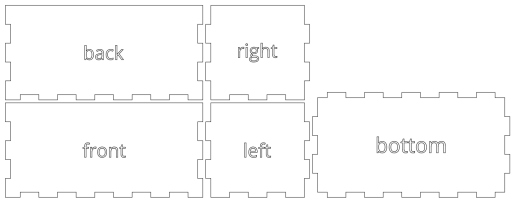
The user in the illustrative scenario below is based on observations at Misericordia conducted on Monday, October 9, 2023.

_____ wakes up and is ready for a day of fun educational activities. Upon entering the Misericordia classroom, he notices blocks of various sizes: numerous hollow blocks that each correspond to a number and can be stacked inside of each other. Intrigued, _____ decides to experiment. He picks up the 1-unit block corresponding with the number 1 and places it inside the 3-unit block corresponding with the number 3. _____ notices that there is still room left in the 3-unit block, and attempts to place a 4-unit block in the remaining space. However, since the 4-unit block is larger than the remaining space, he learns through trial-and-error that only the 2-unit block or two 1-unit blocks fit. Mathew learns that $3 = 1 + 1 + 1$ or that $3 = 1 + 2$. He also learns that $3 > 2 > 1$. He further experiments with the numbers 1 to 5 visually and through physical manipulation, without the need for verbal communication.

Project Requirements - Requirements Identification and Specifications

#	Requirements	Specifications
1	The product shall physically represent numbers one to five. Rationale: Research shows that subitizing quantities 1 to 5 is the first thing that learners need (Expert Interview, Michele Ricamato).	Each block corresponds to a number.  Figure 1. Blocks correspond to a number
2	The product shall represent each number quantity relatively using relative size. Rationale: Preserving relative size of things to compare has been shown to aid developing brains' ability to perceive numerosity (see *How Children Learn Math* book).	The width of each block increases by 0.456 inches. The length of the nth block is [n/(n-1)]*(length of block n-1) + 0.456 inches, where n is the nth block being calculated (n = 2, 3, 4, 5).  Figure 2. Demonstration of relative size
3	The product shall demonstrate in a visual and physical manner the concept of addition and equality. Rationale: The nesting will allow mathematical concepts to be visually expressed without any verbal mediums.	Each subsequent block exponentially increases in size to allow for the nesting of smaller blocks.  Figure 3. 2 + 1 = 3

		 Figure 4. 1 + 1+ 2 = 4 The two smaller 1-unit blocks fit perfectly inside the larger 2-unit block. Each block has the number it corresponds to engraved on all sides.  Figure 5. Unit blocks
4	The product shall represent each number quantity identically. Rationale: Preserving size of equal quantities has been shown to aid developing brains in perceiving equal numerosity (see *How Children Learn Math* book).	 Figure 6. 1-unit blocks are identical in shape and size
5	The product shall remain intact under the force of a human bite. Rationale: Many residents at Misericordia have PICA and tend to chew on non-food items (see Appendix C for Project Partner Interview Summary).	The five sides of each block are constructed of durable wood, connected via an interlocking finger system, and glued together.
6	The product shall have no parts small enough to present a choking hard. Rationale: Many residents at Misericordia have PICA and tend to chew on non-food items or throw products which could break or chip, presenting a choking hazard.	Each block meets the guidelines from the Consumer Product Safety Commission on Small Parts for Toys specifying that a toy must have a minimum width of 2.25 inches and a minimum length of 1.25 inches.
7	The nesting blocks must be durable and	Each side of a block is made of fingers

	difficult to break apart or chip. Rationale: Residents at Misericordia may throw or drop objects.	that tightly interlock with each other and create a friction fit. They are then glued and coated with mineral oil to strengthen durability.  Figure 7: Interlocking fingers
8	The product shall be chronological age-appropriate for residents. Rationale: Requirement of the Project Partner (see Appendix C for Project Partner Interview Summary).	The natural wood from which the Nesting Number Blocks are made does not draw unwanted attention or threaten the users' sense of dignity because it is not designed for children, toddlers or babies.
9	The product shall not contain features that distract from math concepts in order to maintain the association with math quantity. Rationale: Varied color blocks may cause the user to associate the number value with the color. Using one color makes the connection between the relative block sizes and their associated number value more clear (Expert Interview, Michele Ricamato).	All blocks are left "as is" after sanding and not painted. A food-grade mineral oil is applied as a finish.
10	The product shall only contain features that help illustrate math concepts. Rationale: Using only elements necessary to the illustration allows for a clear association of the properties of a number and its relative size (Expert Interview, Michele Ricamato).	Each block is designed to have only a specific size and a specific associated number engraved into it.
11	The product shall be cleanable in the same amount of time as other learning manipulatives in the classroom. Rationale: The product requires existing	The application of mineral oil makes the blocks easy to clean with soap and water. Since frequent cleaning with water will dry out the wood, the mineral oil should occasionally be reapplied with a soft

	cleaning materials procedures at Misericordia.	cloth. Another sanitizing alternative to reduce time involved in wiping down the blocks is to add equal parts water and vinegar to a spray bottle. Spray the blocks with this vinegar-water solution and allow them dry completely, ideally overnight ("Butcher Block Care").

References

"Butcher Block Care: How to Sanitize Your Block" *YouTube,* April 14, 2022, https://www.youtube.com/watch?v=R1MOEMxwohU

Krasa, N., K. Tzanetopoulos, and C. Maas, *How Children Learn Math*. Routledge.

"Small Parts for Toys and Children's Products Business Guidance." *United States Consumer Product Safety Commission.* https://www.cpsc.gov/Business--Manufacturing/Business-Education/Business-Guidance/Small-Parts-for-Toys-and-Childrens-Products

"Standard Consumer Safety Specification for Toy Safety," *United States Consumer Product Safety Commission.* Available: https://law.resource.org/pub/us/cfr/ibr/003/astm.f963.2011.html