Easter Egg Counter

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ENP64 Methods for Human Factors Engineering

Product Overview

Purpose: the Easter Egg Counter is a seasonal children's toy that facilitates in the process of counting Easter eggs. It is meant as an educational toy that can help children in learning how to count and identify numbers through visual and auditory cues.

Functionality: Easter eggs can be inserted into the circular opening of the container, to which a weight sensor at the base can weigh and display the current count of eggs.

- Optional auditory component that announces egg count
- Buttons (on/off, reset count, turn speaker on/off)
- Handles to facilitate in lifting the container
- Lid that can be easily removed

Target Users

Target Users:

- Children ages 3 and up
  - The product requires fine motor skills, is interactive and encourages critical thinking
  - Teaches children the concept of numerosity and how to count
- Families who celebrate Easter (product could possibly be more generalized to count balls rather than easter eggs in order to reach a wider audience)

Design Methodology

Needs Analysis: What concepts do we need to know about for this product?

Primary objective: understand when children learn how to count and what types are methods are most effective for learning how to count

- When counting is learned:
  - Children start to learn to count at the ages of 2-3 (sequences of numbers)
  - Identification of numbers and basic counting skills can occur as early as 12 months
- How counting is developed:
  - Concept of more/less (larger physical appearance might indicate greater value)
  - Order between numbers (combination of appearance and judgement to distinguish order between different objects
- Effective Counting Methods
  - Rote memory (involves understanding proper order; not skipping or repeating numbers)
  - Enumeration: using counting words to determine the number of objects
    - Involves side-by-side comparisons of word and number (visual input)
    - Auditory component to help children learn how to pronounce words

Design Methodology cont.

Observations: How to children interact with box shaped objects?

- https://youtu.be/MhGUkWAA9WM
- Children tend to grasp the top ends of the box
- They grip it through pushing inwards on the box and through friction
- Bend down and reach forwards

Design Considerations:

- Since the design intends on being box shaped, adding handles onto the sides would help with lifting the box
- It would also help signify orientation
- Handles offer the **affordances** of grabbing. They indicate what can be done with the box and where to pick it up from

Market Research

Product Names	Product Images	Pros	Cons
Counting Ball		- Simple (no electronics) - Numbers clearly printed on sides - Interactive features	- Balls cannot be removed - Counting may be difficult without parents help
Count and Roll Buggie		- Audio component (sings counting songs when balls inserted) - Highly interactive - Numbers on wings	- More expensive - Harder setup - Cannot function without power
Fill, Slide & Count Ball Learning Toy		- Audio component (counts balls) - Side handles with games - Different modes	- Difficult to clean - Balls not contained easily - More expensive
Wooden Ball Game		- Simple (no electronics) - Balls easily contained - Easy setup	- No counting feature - Many small parts - Fragile/easy to pull apart

Anthropometric Analysis

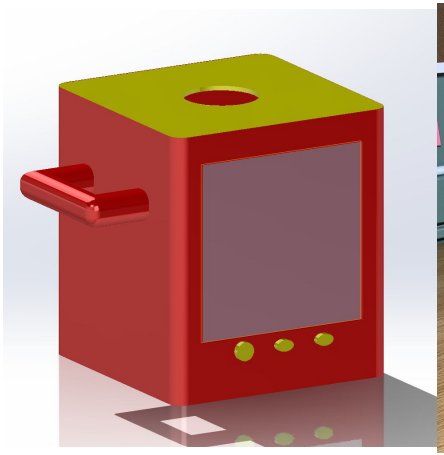
Key Physical Dimensions:

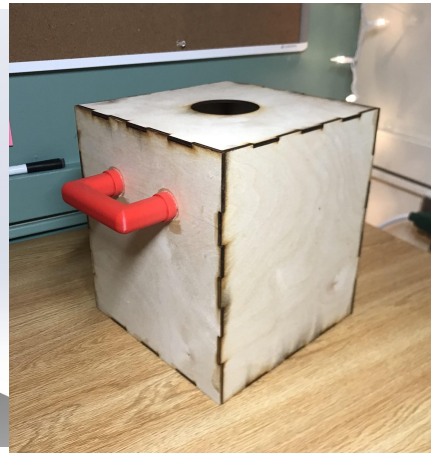
1. Height, width and length respectively (approximate dimensions for box)
    a. Upper leg (5th percentile female aged 3): 18.5 cm
    b. Biiliac breadth (5th percentile female aged 3): 14.2 cm
    c. Upper arm length (5th percentile female aged 3): 17.1 cm
2. Length of circular opening:
    a. Hand width (female aged 5): 5.85 cm (2.76 inches)
    b. Easter egg width (standard size): 2-⅓ in = 5.93 cm (2.5 inches)
3. Handle width and opening:
    a. Hand width (female aged 5): 5.85 cm
    b. Grip breadth (children): 2.2 cm

Prototype Dimensions

Based on the anthropometric data sets:

1. Dimensions of outer frame:
   - Length: 8 in
   - Width: 8 in
   - Height: 9 in
2. Product cover dimensions:
   - Circular opening: 2.5 in (taking into account approximate hand size and average easter egg size)
3. Handle dimensions:
   - Handle opening size: 7 in
   - Handle grip breadth: 2.5 cm





Biomechanics Analysis

Target user: A 3 year old child, weighing 32 lbs

Max load of the product: 5 lbs

Analysis: Determine compressive load on spine at the L1-S5 joint if the user has to hold the product close to him/her and with their arms extended. Use the compressive strength formula to analyze whether the task is safe for the user to be doing.

Biomechanics - Spinal Load

Spinal load (arms extended)

- *Mass distribution of arms (10.2% of body weight)*
- Load of object: (2.27 kg *9.81) * 0.569 = 12.7 Nm
- Load of arms = (1.48 kg * 9.81) * .315 = 4.57 Nm
- Total load on back muscles = 17.3 Nm
- Force exerted by back muscles = 17.3 / 0.07m = **246.8 N**

Spinal load (load overhead)

- *Mass distribution of upper body is 68.6%*
- Spinal load = (32lbs(0.686) + 5 lbs) * 9.81 = 12.7 kg * 9.81 = **124.6 N**

Biomechanics – Compressive strength

Compressive Strength formula:

CS = -13331.2 - (73.7 * Age) - (962.6 * Gender) + (403 * LMS) + (79.8 * BW)

CS = -13331.2 - (73.7 * 3) - (962.6 * 2) + (403 * 48) + (79.8 * 14.5 kg) = **5023.6 N**

The product will likely be lifted up more than one time in a given day, therefore, the margin of safety would be 30% (repeated tasks)

Biomechanical tolerance = 0.3 * 5023.6 N = 1507.1 N

Ratio of job demand for biomechanical tolerance:

- Arms fully extended 246.8 N / 1507.1 N = **0.164**
- Load directly above: 124.6 N / 1507.1 N = **0.083**

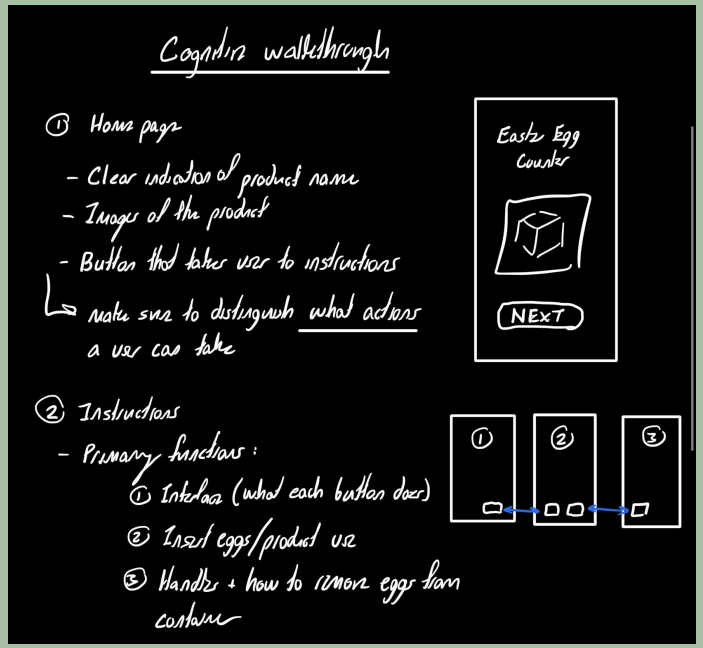
Biomechanics - Summary

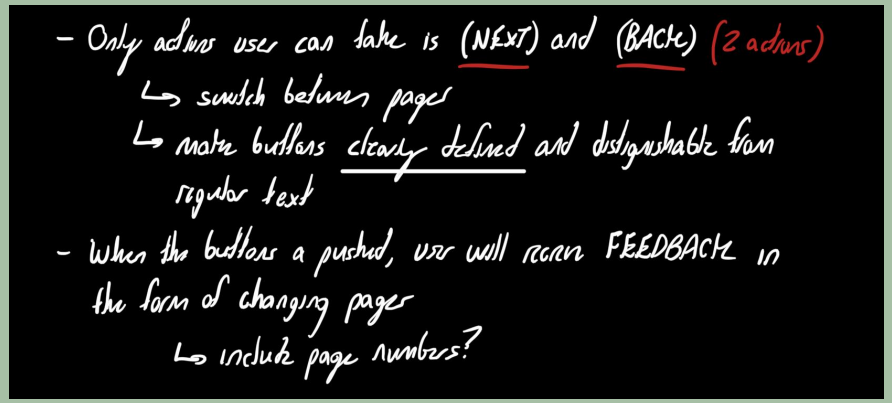
Given that the ratio of job demand to biomechanical tolerance is significantly less than one for the extended arm and overhead weight condition, we can conclude that the task is safe for children to be doing.

- Low musculoskeletal injury concerns

App Interface Design Considerations

Cognitive walkthrough conducted to provide a representation of the app interface, action sequences, and identify potential problems.





Usability Considerations

1. Effectiveness:
    a. Were users able to successfully navigate through the app?
    b. Error rate: were there any observable errors made when navigating through the app
2. Efficiency:
    a. How quickly were users able to identify features within the app (next and back buttons)
    b. Overall time to get through the instructions
3. Satisfaction:
    a. Have users rate overall satisfaction with the app using the System Usability Scale (SUS)

User Testing Outcomes

1. Effectiveness:
    a. User was successfully able to navigate through app
    b. A noticeable error was that the user would often click on features that looked like buttons
2. Efficiency:
    a. Consistency within app made “next” and “back” buttons easy to locate and identify
    b. User took approx 23 seconds to get through the app.
3. Satisfaction:
    a. SUS scale displayed in next slide

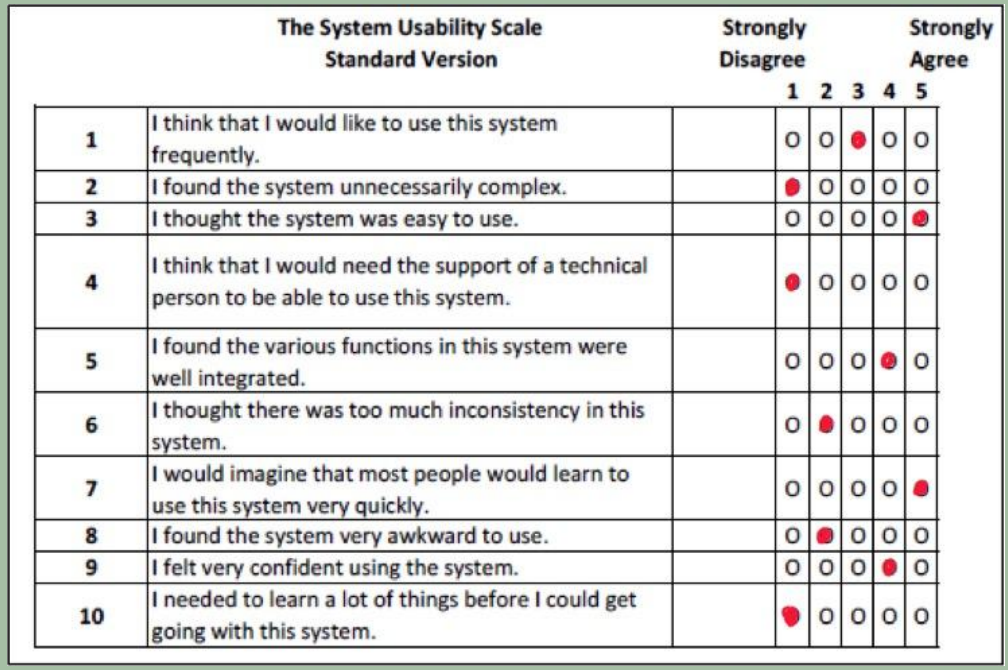
System Usability Scale

Scoring:

- For odd numbered questions, subtract 1 from score
- For even numbered questions, subtract value from 5
- Sum all score and multiply by 2.5

Score: 85

The average SUS score is 68, indicating that any score higher than this value indicates that the system is very satisfactory to use. Since our score is greater, we conclude that the app is satisfactory

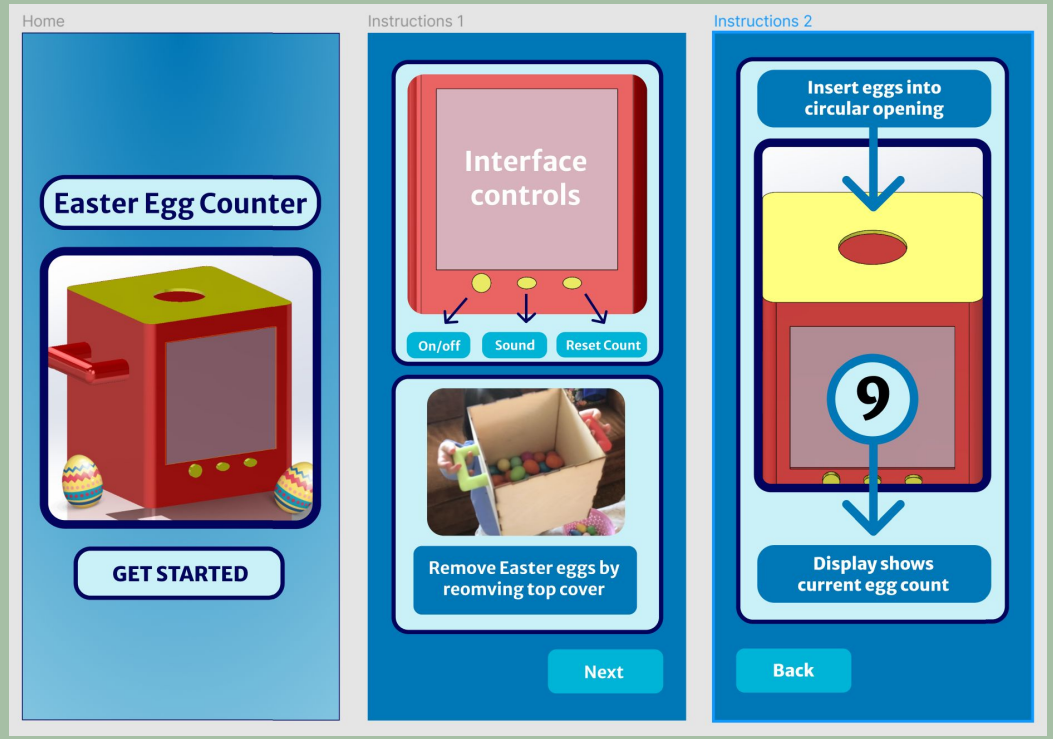


	The System Usability Scale Standard Version		Strongly Disagree 1	2	3	4	Strongly Agree 5
1	I think that I would like to use this system frequently.		o	o	●	o	o
2	I found the system unnecessarily complex.		●	o	o	o	o
3	I thought the system was easy to use.		o	o	o	o	●
4	I think that I would need the support of a technical person to be able to use this system.		●	o	o	o	o
5	I found the various functions in this system were well integrated.		o	o	o	●	o
6	I thought there was too much inconsistency in this system.		o	●	o	o	o
7	I would imagine that most people would learn to use this system very quickly.		o	o	o	o	●
8	I found the system very awkward to use.		o	●	o	o	o
9	I felt very confident using the system.		o	o	o	●	o
10	I needed to learn a lot of things before I could get going with this system.		●	o	o	o	o

Usability Testing Feedback

Feedback:

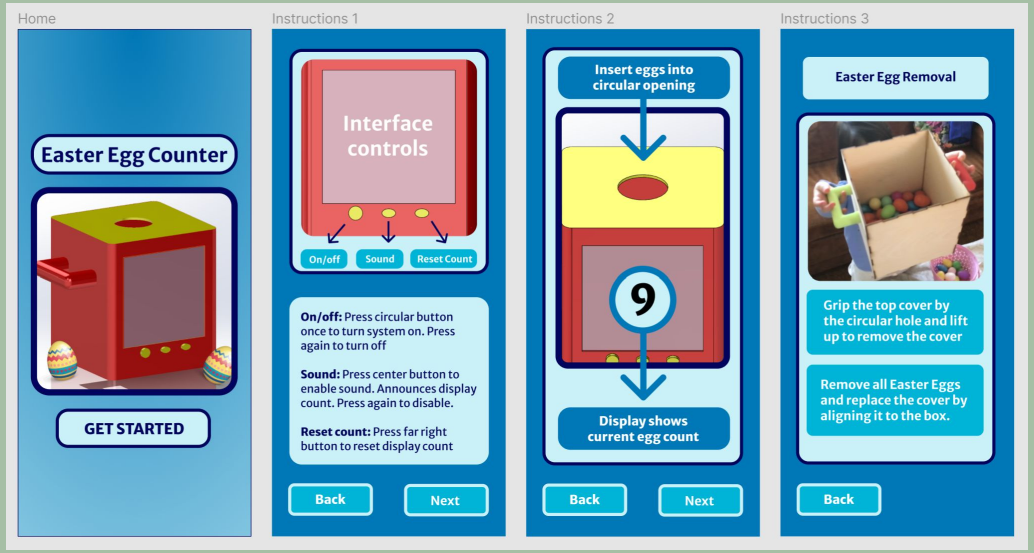
- Change overall flow of material and instructions (interface controls should be explained in a single page)
- Change aesthetics to reduce confusion about what features the user can interact with
- Add more description about how interface controls work



Usability Testing Redesign

Redesign:

- Better defined pages (home, interface controls, functionality; Easter egg removal)
- Added description to each interface control
- Better defined buttons by adding a light blue highlight around “next” and “back” buttons
- Created consistency between buttons and instruction text



Reflection

Physical project: Creating a physical project was one of the most challenging but rewarding experiences for any project this semester. While most of the process was self guided, I learned a lot more about the prototyping resources on campuses and widely improved my confidence in being able to use these resources independently. Some highlights include:

- Accessing Bray Labs and learning how to request different materials, laser cut materials, and use their workshops. I was unable to create by final product here because their laser cutter broke midway through the process, therefore I resorted to using NOLOP's laser cutter
- Using the laser cutter at NOLOP; changing the dimensions of the prototypes to fit on their laser cutter bed size; creating Solidworks models and learning how to use the 3D printer to create the handles on the box

App Development Experience: The overall app development experience was beneficial because it gave be a better understanding on how to use Figma, which is an industry standard in the field of Human Factors and UX Design. Being able to create the app and conduct user testing gave me a better understanding on how to implement Human Factors methods in order to better improve interface design.

Reflection cont.

Human Factors methods were utilized throughout the entirety of this project, from conducting a needs analysis and using anthropometric data in the initial ideation phase to using a cognitive walkthrough and user testing in the design and redesign phase of the instructions app.

- Being able to actively use these methods we learned from class in an independent project allowed me to gain a better understanding on the purpose of each of them and how they can be applied to real life situations to produce and improve upon systems

Course takeaways: the most significant takeaways from this course would be being able to effectively implement and identify when to use different human factors methods in various situations. This class exposed me to a variety of different human factors methods and additionally provided opportunities to implement them through exam problems, in-class activities and this final projects.

- Moving forward in my career as a Human Factors engineer, I intend on using the methods I learned from this course to elevate my understanding on how to effectively approach design problems, ideate and address concerns using HFE methods, and in designing and iterating on problem solutions
- What has left a lasting impression on me is that the user is never at fault for not being able to use a system. It is up to us to make sure that we effectively test a product to make sure the user experience is as seamless as it could be

References

Target user research:

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Market research:

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SUS Scoring:

https://usabilitygeek.com/how-to-use-the-system-usability-scale-sus-to-evaluate-the-usability-of-your-website/