

Design, Fabrication, and Testing of a Pedagogically Sound Toy

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More than 20 years have passed since a truly novel toy design was last introduced into the market for the 2 to 3 year old age group. Although appearances have changed over time, the underlying concepts of today's toys remain the same. The purpose of this project was to apply the engineering design process, including project planning, concept development, detail design, testing, and analysis to the development of an innovative, pedagogically sound toy for children aged 2-3.

Concept development began with an extensive collection of customer needs. A variety of methods were used, including surveys, observation, and research to obtain a comprehensive sample. Concrete needs such as child safety standards were paired with more subjective ideas such as child preferences and motor and sensory capacity to provide a good understanding of the target market. These needs were communicated to two focus groups of undergraduates from a variety of majors. These groups participated in a fast-paced idea-trigger brainstorming session to generate a total of 93 concepts, of which 33 were revised and finalized for further study. In collaboration with the Virginia Tech Child Development Lab School, and after applying Failure Mode and Effects Analysis (FMEA), the concept of a "shape molding mat" was selected for prototype development and testing. The aim of this toy is to provide children with a unique sensory experience that promotes creative interaction and social play.

The prototype toy consisted of a sealed, moldable cushion placed inside a tapered rectangular frame fit over a flat base plate. The cushion was filled with a polymer substance similar in consistency to Play-Doh®, made from simple household components; and covered by a 0.006" thin natural latex rubber sheeting, chosen for its high tensile strength, elasticity, and pliability. The toy was assembled by force-fitting the frame over the latex covered cushion and screwing the base plate into place. Figure 1 shows a CAD model of the fully assembled toy.

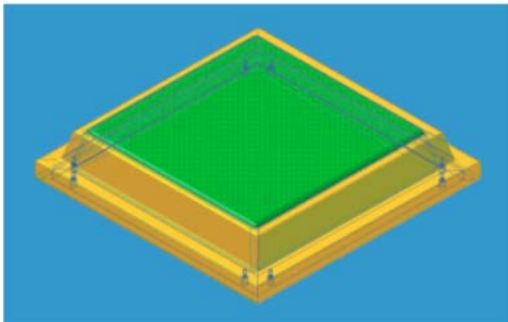


Figure 1: CAD model of the molding mat.



Figure 2: Children interacting with the toy.

A validation experiment was conducted at the Virginia Tech Child Development Lab School. The purpose was to measure the children's interest retention and creative and sensory development, and to investigate certain design issues, such as the thickness and consistency of the cushion. The toy scored above average in both subjective assessments: The interest retention increased as children warmed up to the toy; those hesitant at first to touch the surface were encouraged by watching other children having fun. The creative and sensory development was demonstrated by the children coming up with new modes of interaction with the toy, including walking on it, drawing on it, and incorporating it with other toys. Figure 2 shows the children interacting with the toy.

From a design point of view, the validation experiment identified a number of issues that will have to be addressed. At 7.2 kg, the prototype was too heavy for cost-effective product shipment and for small children to easily move the toy. The main source of this weight was the cushion. A future design should therefore look to reduce the mass of this cushion, for instance by replacing part of it by a soft-foam base. This should also significantly reduce the cost of the device as the cushion contains relatively expensive ingredients. Likewise, alternative ingredients should also be investigated to further reduce the cost of the cushion. Finally, a different material is needed to seal the cushion. The natural latex sheet was too thin to withstand the children's stretching and puncturing, and it degraded beyond usability after a few months of contact with the cushion fill material. As these issues are addressed, it would also be interesting to investigate larger mats to facilitate increased walking and physical interaction. The concept of a shape-molding mat has shown significant pedagogical promise, and with targeted design refinement, it could demonstrate significant market potential as well.