Journal of Electronic Research and Application, 2022, Volume 6, Issue 2
http://ojs.bbwpublisher.com/index.php/JERA
ISSN Online: 2208-3510
ISSN Print: 2208-3502

# The Human-Machine Safety Design of Mechanical Toys for Children

**Dan Lv***

Hangzhou ZT Model Co., Ltd., Hangzhou 310053, Zhejiang Province, China

***Corresponding author:** Dan Lv, 576779625@qq.com



**Abstract:** In order to ensure the safety of children while using machineries and avoid harm caused by mechanical toys, this paper analyzes the types and detection standards of children's toys, discusses the reasons for the harm caused by these toys, and proposes human-machine safety design strategies for children's toys as reference.

**Keywords:** Mechanical toys; Human-machine safety; Optimal design

***Online publication:*** April 15, 2022

## 1. Introduction

Toys are essential tools in the process of a child's growth. Toys on the market today are more complex, and the use types and product-based endeavors are diverse. Toys play an important role in children's growth. They help children learn about their surroundings and integrate into the society as they grow, which has a significant enlightening effect. With the continuous development and progress of science and technology, children's toys are becoming more and more intelligent, but there are still various types of hidden dangers in these toys that can affect children's physical and mental health [1-6]. For example, if toxic substances are used in the selection of production materials and are used by children over time, there will be an effect on their bodies. The implementation of the "Made in China 2025" plan clearly stipulated the improvement of manufacturing to a high-quality level and the achievement of a high market demand and high supply goal. At the same time, as the pillar of the future, it is the common responsibility of the state and all people to protect children's physical and mental health. Therefore, when manufacturing children's toys, green and high-quality production materials should be used. On the basis of ensuring the safety and quality level of children's toys, it is important to further improve the innovative design ability of children's toys and strengthen the craftsman spirit of the manufacturing industry. This puts forward higher requirements for manufacturers and designers [2-8]. Children's toys have certain hidden dangers. Strengthening the design and safety performance of children's toys as well as realizing human-machine safety interaction will not only engender a happy childhood and give full play to the educational role of toys in their growth stage, but also prevent injuries caused by toys. Taking the human-machine safety design of children's toys as the starting point, this study focuses on changing the product performance and design method, so as to provide children with high-quality and safe toys.

## 2. Types of toys and safety testing standards

### 2.1. Types of toys

Children's toys are not only articles that bring happiness to children. At present, toys are also widely used

in education to guide children to learn. From the perspective of education, toys can be divided into six categories: cognitive toys, language toys, science toys, action toys, operation toys, and social toys [8-13]. **Table 1** describes the types of toys in detail.

**Table 1.** Types of toys for children

| Category | Effect | Type |
|---|---|---|
| Cognitive toys | Toys that can help children learn and establish various basic concepts, such as paired toys with shape, color, and relationship as clues, toys with game rules, and so on. | Jigsaw puzzle, stacking cups, etc. |
| Language toys | Toys that help develop children's hearing and promote language expression, organizational ability, as well as practice before writing. | Story tapes, story cards, drawing boards for painting, etc. |
| Science toys | Toys that can attract children to observe, compare, collect, and analyze. In addition to arousing their enthusiastic curiosity, children may form the habit of observing, analyzing, collecting data, doing things, and seeking truth from facts through these toys. | Microscope, kaleidoscope, various specimens, etc. |
| Action toys | Toys that can be used to train the coordination of muscles and various parts of the body. | Baby-crawling toys, all kinds of carts, bicycle-riding, dart-throwing, etc. |
| Action toys | Toys that can promote flexibility of finger muscles and coordination between eyes and hands. | Clay, threading, beading, stacking blocks, etc. |
| Social toys | Toys that enable children to express their emotions and experience people as well as the world outside. Children have more opportunities to understand their surroundings and absorb relevant life experience through these toys. | Dolls, stuffed toys, etc.; toys designed for life situations, such as supermarkets and airports. |

In addition to considering the educational nature of toys, parents will naturally consider the safety of toys, and whether the toys will cause harm to their children. For example, a child's live can be threatened by accidentally swallowing parts that have fallen off from a toy. Aside from that, a damaged toy may be sharp, causing harm to the child. In order to avoid these situations, it is necessary to strengthen the safety detection of toys.

### 2.2. Safety testing standards for mechanical toys

The safety testing of toys is generally to test the physical properties of toys. Physical properties are the contents and factors that mainly affect the safety of toys for children. In order to reduce the risk of toys causing harm to children, it is necessary to test the physical properties of toys before they are sold. Toys that fail to pass the performance test need to be returned to the factory for reconstruction or destruction. The performance test of toys mainly includes tension test, torque test, bite force test, and so on.

(1) The bite force test is used to test the condition of a toy under the action of a normal bite force in consideration that the toy will be bitten by children, resulting in swallowing. When testing the bite force, a pulling force in pounds is mainly used for testing. At present, the test is carried out in accordance to the United States' test standard, as shown in **Table 2**.

**Table 2.** Bite force test standard

| Age | Pounds |
|---|---|
| 0-18 months | 25 lbs |
| 18-36 months | 50 lbs |
| 36-96 months | 100 lbs |

(2) The tension test is also measured by weight. The tension test is different from country to country. The specific standards are shown in **Table 3**.

**Table 3.** Tension test of toys in various countries

| Age (month) | U.S.A | Europe | Thailand | China | Japan | Canada | Australia |
|---|---|---|---|---|---|---|---|
| 0-18 | 46.7 N | If accessible size ≤ | 50 N | If accessible size | | 4.5 kg | 5.2 kg |
| 18-36 | 69.0 N | 6 mm = 50 N | 75 N | ≤ 6 mm = 5.1 kg | | 4.5 kg | 7.7 kg |
| 36-96 | 69.0 N | If accessible size > | 90 N | If accessible size | | 4.5 kg | 9.3 kg |
| | | 6 mm = 90 N | | > 6mm = 9.2kg | | | |

## 3. Analyzing the causes of injury from toys

### 3.1. Hazards caused by artificial intelligence

There are many kinds of artificial intelligence products. With the integration of artificial intelligence into children's toys, the product form and use mode are more intelligent. Manufacturers and designers place a high value on the profitability [14,15] and intelligence of toys when designing and producing them, but the negative impact of artificial intelligence in these toys, as well as the safety issues brought about by artificial intelligence itself, are ignored, increasing the risk of harm to children's growth.

### 3.2. Hazards caused by cost and inferior materials

With the continuous expansion of international trade frictions and the sharp increase of resource consumption, the price of producing materials for children's toys is rising, resulting in an increase in the manufacturing cost. Under the condition of limiting the pricing of children's toys, the space for profit is gradually reducing. In order to enhance the interests of enterprises, manufacturers are suspected of cutting corners and using inferior products in the production of toys. As a result, the harmfulness of children's toys due to the use of inferior materials is increasing, and the toys produced do not meet the requirements of international export standards, resulting in safety issues.

### 3.3. Hazards caused by inappropriate mechanical structure

Due to the deficiencies of some production enterprises in production capacity and equipment, there are deficiencies in the details of the mechanical structure of toys, along with unreasonable structural design and flawed production technology, thus affecting the quality of toys and the safety of children. At the same time, in regard to the selection of toys, parents should consider their children's individual needs and select appropriate toys for them. For example, for children under the age of three, parents should select smaller and lighter toys to avoid accidents. Children of this age are too frail to hold heavy and bulky toys, and as a result, they may end up hitting themselves, thus causing physical injuries. Therefore, this is one of the most important aspects that parents should look into.

### 3.4. Hazards caused by flawed testing standards

At present, the current testing standards for children's toys in China are flawed. Only the mandatory safety

risks are specified in the standards for testing the safety of children's toys; there are no clear provisions on the subject other than the mandatory safety standards, resulting in the lack of judgement when testing unexpected safety issues and potentially leading to them.

## 4. Human-machine safety design optimization strategy for children's mechanical toys

### 4.1. Environmental-friendly design

Children's awareness of society is still insufficient as is their ability to avoid harm. Therefore, considering these characteristics, it is important to consider the harm to children when designing children's toys. When selecting design materials, those that are environmental-friendly and do not cause physical harm to children should be selected. In addition to ensuring that the toys are resistant to wear and wrestling, we it is also important to ensure that they are environmental-friendly. Materials that are less polluting, non-toxic, and recyclable should be prioritized in material selection [16-19], so as to achieve the goal of human-machine safety design and eliminate the risk of harm to children caused by these materials.

### 4.2. Structural optimization

In addition to children's interest, the safety of toys must also be considered. When designing toys, it is necessary to ensure the safety performance and firmness of toys. For instance, in the case of plastic toys, we should not only simplify the structure of toys, but also avoid certain designs, such as holes and eyes, on these toys. Children's toys must meet stringent structural requirements. These toys should also be ensured that they are fall resistant. It is crucial to ensure that the plastic shell does not disintegrate, and the toy parts do not break off after sustaining a fall, leading to accidental consumption by children. When optimizing the structural design of toys, designers and manufacturers should avoid shaping the external structure of toys with sharp corners to ensure the stability of parts. At the same time, the toy parts should be specially reinforced to avoid life-threatening hazards as a result of the fallen parts being consumed by children.

### 4.3. Shape optimization

Each child has different needs at different stages and different attraction for different toys. Toys of different shapes may harm children in various ways. For example, non-bulbous toys are nearly 30% more harmful to children than bulbous toys, but there are many non-bulbous toys on the market. When designing toys based on age groups, designers and manufacturers must design different types of toys for different age groups. In the selection of toys, parents should choose toys that conform to their children's age group with high safety features for their children to play with. The shape and structure of toys are very appealing to children. Therefore, it is very important to optimize the shape of toys.

### 4.4. Emotional interaction

"Made in China 2025" has put forward new requirements for the manufacturing industry, clearly stipulating that it is necessary to improve the quality of products while meeting the social needs of products, which implies that toy manufacturers and designers should innovate the design concept and discard the traditional one. While pursuing their own interests, manufacturers and designers also need to consider the design form and pay more attention to the physical and mental health of children to design better toys from the perspective of children's growth [20, 21].

For example, in designing the shape, it is best to focus on creating a rounded overall impression. On the whole, the structure is simple and has strong integrity, which reduces the use of parts, prevents parts from falling off and being consumed by children by accident, as well as reflects the characteristics of a sun in its overall form to attract their attention. Functional changes should be based on meeting the physical and mental health needs of children, giving full play to the role of toys in their growth as well as the function

of toys to inspire their intelligence and improve their hands-on skills. In the design, it is necessary to avoid designing toys that seem like food or having food smell, so as to prevent children from mistaking toys as real food and eating them by mistake. The improvement of the emotional interaction function of toys is primarily intended to enrich children's childhood, create a good living and learning environment for children, as well as teach children through play.

## 5. Conclusion

In a nutshell, the hazards of mechanical toys affecting children's safety include those caused by artificial intelligence, cost, inferior materials, inappropriate mechanical structure, and flawed testing standards. In order to avoid these hazards and strengthen the human-machine safety design of children's toys, it is necessary to optimize the design material and mechanism from the perspective of environmental protection, structure, and human-machine interaction, so as to ensure the safe use of toys among children.

## Disclosure statement

The author declares no conflict of interest.

## References


[1] Zhang T, 2022, Guide to the Annual Update of EU Toy Standards. Chinese and Foreign Toy Manufacturing, 2022(02): 68-70.

[2] Wu E, Wang Q, Dai S, et al., 2022, Quality and Safety Risk Analysis and Standard Status of Baby Dental Gel Products. China Standardization, 2022(01): 176-181.

[3] Fu D, Huang K, Tan Y, et al., 2021, Study on the Quality and Safety Risk of Inflatable Toys. Standard Science, 2021(11): 95-99.

[4] Lin P, Zhang H, Wang C, et al., 2021, Research on the Difference between toy Impact Test Method and Domestic and Foreign Testing Standards. Light Industry Standards and Quality, 2021(05): 47-49, 58.

[5] Xie J, Ye M, Wang R, et al., 2021, Quality and Safety Risk Analysis of Recalled Chinese Toys in Europe and America in 2019-2020. China Standardization, 2021(15): 208-213.

[6] Liao H, 2021, Ensure the Implementation of Quality and Safety Standards for Children's Products in Place, China Market Regulatory Journal, 007.

[7] Chen W, Liu B, 2021, Common Sense of Safety of Toys and Buggies. Fujian Quality and Technical Supervision, 2021(06): 43-44.

[8] Lin L, 2021, Quality and Safety Analysis of Magnet Toys. Toy Industry, 2021(06): 66-67.

[9] 2021, Promulgation of the Implementation Rules of Toy Quality Spot Check. Toy Industry, 2021(06): 67.

[10] Li Y, 2021, "Toylike stationery" May be a Safety Hazard. China Quality Promotion, 2021(06): 7-8.

[11] Zhou X, 2021, Pay Attention to the Quality of Strollers to Build a "Safety Fortress". Fujian Quality and Technical Supervision, 2021(04): 49.

[12] Wen F, 2021, Research on the Present Situation and Future Development Trend of Eu Toy Product Technical Legislation. Standard Science, 2021(02): 41-48.

[13] Wang P, 2021, Implementation of Quality Control in Toy Laboratory. Science, Technology and Innovation, 2021(01): 116-117.

[14] Qiao F, 2020, Quality and Safety Risk Analysis of Children's Toys. Standard Science, 2020(12): 167-170, 179.

[15] Huang G, Li S, 2020, Analysis of Safety Standard of Toy Gun. Chinese and Foreign Toy Manufacturing, 2020(12): 18-19.

[16] 2020, Update Industry Guide on Toy Safety Requirements. Toy Industry, 2020(12): 79.

[17] Xie L, Xu W, 2020, Research on Material Selection in Children's Toy Design. Yihai, 2020(08): 120-121.

[18] Zhang D, Zhang X, Yang X, et al., 2018, Design of Remote Control Toy Car for Children's Traffic Safety Awareness Training. Machinery Manufacturing and Automation, 47(04): 176-178, 211.

[19] Li X, 2017, Discussion on Toy Testing and Design Safety. Light Industry Standards and Quality, 2017(03): 58-59.

[20] Shi K, Liu M, 2013, Thoughts on Safety in Children's Toy Design. Popular Literature and Art, 2013(13): 69.

[21] Hu X, Li H, 2012, Man-Machine Safety Design of Children's Toys. Ergonomics, 18(04): 92-95.