The Naughty List

The Science and Mechanics Behind the Toys That Are Likely to Cause Claims

By Timothy Tresierras

The holiday season is upon us, and for many children it is the season of toys. That means it is also the season of revenue for toy manufacturers. Worldwide, the toy market will rake in an annual revenue of around $80 million, with around a quarter of that generated in the United States.

With all of the potential monetary resources in the toy market, it is no wonder that there is a marketing shroud over the public's awareness of unsafe toys. According to the Consumer Product Safety Commission (CPSC), there were an estimated 240,000 toy-related injuries in 2016. Between 2010 and 2016, CPSC says 79 children died in toy-related incidents in the U.S.

Government agencies like the CPSC, and watchdog groups such as World Against Toys Causing Harm Inc. (WATCH), do their share of monitoring hazards, alerting the public, and performing proactive toy testing. Yet year after year, toys with inadequate age recommendations, poor manufacturing, inconsistent cautions, and other well-known hazards find their way to consumers. In recent years, unsafe toy regulation has been made worse by the rise of online shopping. Standards, such as the removal of recalled merchandise, are not as well enforced for many online vendors. Meanwhile, a winter holiday survey by Deloitte LLP in 2017 found that consumers were expected to spend half of their winter holiday budget online.

In this article, we will discuss popular toys that have had an extensive run in the toy market—even while having been recognized as unsafe, though not necessarily recalled—with an emphasis on the science and mechanics that demonstrate why these toys are hazardous.

TRAMPOLINES

In the context of this discussion, the term "mechanics" specifically refers to the fundamental principles of mass, motion, and energy. The trampoline is a prime example of these three mechanical principles working in unison, and it is a mainstay on the list of unsafe products tracked by the CPSC.

For 45 years, the CPSC has developed reliable safety standards to promote consumer product safety. For injury-specific cases, the CPSC uses the National Electronic Injury Surveillance System (NEISS), a group of designated hospitals across the country that collects and reports product-related injuries from the hospitals' emergency departments.

A 2017 NEISS report ranks the top 20 products with reported injury by age. At the one-to-four age bracket, there are many generic product titles, such as "playground equipment" (ranked sixth) and "miscellaneous toys" (ranked fourth). It is significantly alarming that the category "trampolines" has its own ranking (ranked 13th). Trampolines jump up to number five for ages five-to-nine, but drop to eighth for ages 10-14.

Two generalized trampoline hazards can be broken down by the relevant mechanics of a trampoline in action. An occupant can transfer the energy of his motion (known as kinetic energy) through the trampoline jump surface to the springs along the trampoline perimeter, where the springs elongate and briefly store the energy (known as potential energy). For a single occupant, the energy needed to jump higher than normal is not initially available, and only with a properly timed repetitive jumping motion will energy be "pumped" into the system. This is the same process of building up energy in a playground swing by pumping your legs in a repetitive and properly timed motion to go higher and higher. The added energy in a jump keeps the occupant in the air for a longer period of time. During that time, the body can rotate or pitch farther than expected, or it can stray off course away from the trampoline, both of which can result in an unanticipated landing—a mechanism for injury.

This hazard may not seem unlike the experience of riding a bicycle, where at first it is foreign but quickly feels more natural and controllable. However, controllability is the key difference between a bicycle and the second general hazard of a trampoline, which emerges when there are two or more occupants. While the bouncing energy may appear to be spread evenly among the occupants for a reasonable period of time, it is possible for a sudden majority of the total energy to be imposed on one occupant, sending him higher or laterally farther from the trampoline than the occupant could achieve on his own. Occupant weight also becomes a factor. If a parent and a child (weighing half as much as the parent) are both bouncing around, then the child could end up bouncing up to three times the height normally achievable. Multiple occupants also add the danger of bodies colliding.

BOUNCE HOUSES

The chaotic bounce energy phenomenon in a bounce house is typically mitigated by the inherent design of the structure, which an occupant may simplistically describe as less bounce compared to the trampoline. Yet it is the inherent design of the structure that brings a new mechanical hazard to the discussion.

Inflatable amusements, such as the bounce house and inflatable slides, can be described as lightweight structures with a lot of surface area, which is the same description an aeronautical engineer might use to describe a wing. There have been numerous incidents of outdoor inflatable slides and bounce houses being swept over, or, in extreme cases, swept into the air, with occupants carried for over 20 seconds. There is typically a tie-down or mooring system to keep the structure grounded, but it is often either not used or insufficient in extreme circumstances. Warning labels typically state that the bounce house should not be used if winds are in excess of 15 mph. Unfortunately, weather can change faster than a bounce house can be deflated, and a short gust of wind is enough to cause a severe incident.

SLIP AND SLIDES

Transitioning from gliding on air to sliding on a thin film of water, the generic slip and slide class of toys utilizes a hydrodynamic effect, commonly known as hydroplaning. The toy becomes hazardous when the slip and slide turns into an uncontrolled slip and fall, frequently onto one's head. The hydroplane effect occurs when two rigid surfaces come together faster than a liquid between them can get out of the way. This prevents the surfaces from contacting each other and they instead slide past (or move parallel to) each other.

For the general slip and fall of a person, the two rigid surfaces are often the heel of the foot and the flooring. The smoother the flooring and heel surfaces are, the thinner the liquid film needs to be to prevent the surfaces from contacting, which results in a loss of traction. Thus, slip and falls can occur with only a few drops of water on the right surface.

The slip and slide uses the smooth surface of a plastic sheet to increase the ability of generating the hydroplane effect. Users run up to the sheet and dive forward to slide on the trunks

Photo credit: ChameleonsEye / Shutterstock.com of their bodies. Unfortunately, excited children often end up running or walking onto or across the slippery surface, and because these slides are designed for children under 4'6" tall and under 60 lbs., older children (and adults) have experienced neck or spinal cord injuries when they dive or abruptly stop at the slide's end.

The toy often has warning labels that address height or weight restrictions, but, considering that bicycle helmets are required for children to prevent head injuries from similar fall heights and travel speeds, most restrictions the toy imposes are inadequate to protect children from the hazard of a critical head injury.

LAWN DARTS

As mentioned in the opening, the rise in internet merchants has increased the difficulty of regulating unsafe toys. Pointed lawn darts have been banned in the U.S. since 1988. According to the CPSC website, a reissued reminder of the ban occurred in 1997 after a seven-year-old child suffered a brain injury when a dart pierced his skull. As of this writing, vintage pointed lawn darts are still available for purchase online.

Lawn darts are played by performing an underhand swing of the weighted dart and having it land on a designated horizontal target or ring on the ground. As an object moves through the air, it experiences air resistance—a push on the object's surface in the opposite direction of travel. The fins on the end of the dart use the push by air to ensure that the tip of the dart remains at the front of its path through the air and strikes the ground first, where the dart tip typically imbeds into the ground (lawn). Total dart weight is also an important design aspect for wind. Wind can impose an unpredictable push on the dart, which can make its path erratic from throw to throw. As the total weight of the dart increases, the path-altering effect of wind lessens. Increased weight is necessary to drive the pointed tip into the ground, but conservative estimates have shown that even a short toss can result in the dart striking at 23,000 pounds per square inch, easily enough to pierce a human skull.

SQUISHY TOYS

According to SafeKids Worldwide, the Danish Environmental Protection Agency (DEPA) recently banned the sale of popular "squishy" foam toys after an investigation determined that they emit high levels of multiple chemicals linked to health hazards for children. DEPA found that all the toys they tested emit chemicals at concentrations high enough to put children at risk simply by being in the child's bedroom. Some of the chemicals uncovered are carcinogens, while others pose a risk of liver damage or impaired fertility. These inexpensive toys are popular in the U.S. as well, and are readily available on Amazon.

BICYCLE HELMETS

SafeKids also warns against purchasing cheap bicycle helmets that do not have a sticker certifying that they meet CPSC standards. In three tests with crash dummies, the bicycle helmets in question failed each time, one of them cracking in half. There are reports that the counterfeit helmets were sold on eBay.

Readers are encouraged to visit WATCH online at toysafety.org, The Good Housekeeping Institute at goodhousekeeping.com, and SafeKids Worldwide at safekids.org for expanded resources and information on specific unsafe toys and toy hazards outside the scope of this article. ■

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