



United States
Consumer Product Safety Commission

Potential Hazards Associated with Emerging and
Future Technologies

September 2022

*This report was prepared by the CPSC staff.
It has not been reviewed or approved by,
and may not necessarily reflect the views of,
the Commission.*

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EXECUTIVE SUMMARY

Keeping abreast of new consumer product technology entering the marketplace, and the associated potential hazards, continues to be a focus for the Consumer Product Safety Commission (CPSC), although it is a growing challenge, given the pace of change and resource limitations. The Risk Management Group (RMG), within the Office of Hazard Identification and Reduction (EXHR), strives to identify emerging consumer products, technologies, and societal trends that may impact the CPSC's mission to protect Americans from unsafe consumer products under our jurisdiction. The RMG staff first reviewed emerging hazards in FY 2017, as documented in *Report on Emerging and Future Technologies*, published on January 17, 2017.¹

Now, staff provides a brief review of some of the potential consumer products and technologies that have emerged since 2017, as well as societal trends that may influence consumer demand and acceptance of advancements in new consumer products. CPSC staff provides this report in two parts: Part One provides an overview of new potential consumer products and technologies, as well as societal trends, that have emerged since the previous report and may gain wider adoption in the next three to five years. Several of these technologies are advancements of previously identified new technologies, such as virtual reality and 3D printing. Part Two of this report reviews staff efforts to proactively address potential hazards presented by the products and technologies identified in the 2017 report.

Staff identified several emerging hazards associated with a range of products, consumer use scenarios and behaviors: expanded use and intensity of virtual reality and augmented reality devices; a likely increase in more time spent indoors; consumers increased reliance on social media rather than experts for information and advice; a proliferation of data targeted to consumers; potentially unsafe products marketed for infant sleep as well as consumer use of unsafe sleep surfaces; and environmental concerns influencing manufacturing and consumer choices. Staff also identified technologies that have potential to improve product safety, including blockchain technology. Finally, the COVID-19 pandemic has impacted the daily lives of most Americans and has impacted the consumer product world in ways that may be long-lasting.

¹ Potential Hazards Associated with Emerging and Future Technologies, CPSC, January 17, 2017: https://www.cpsc.gov/s3fs-public/Report%20on%20Emerging%20Consumer%20Products%20and%20Technologies_FINAL_0.pdf

These new and emerging consumer products and technologies may mitigate some product hazards, but they also may simultaneously introduce new sources of existing hazards. Among the potential hazards are:

Loss of a safety function: Safety devices, or products connected (either physically, or digitally) to safety devices, may fail to operate or may cause another device to fail to operate under hazard conditions.

Fires and burns: If a product or technology contains, or is connected to, an energy source (e.g., battery, liquid fuel, power cord), the rapid, uncontrolled release of that energy could ignite the product, ignite nearby combustibles, or make an accessible surface hot enough to pose a potential burn hazard. New technologies that employ low-power devices, or new materials that are resistant to burning, can reduce the risk of fire or burn.

Electrical shock: If a product or technology uses voltages in excess of 30 Vac or 60 Vdc, a potential shock hazard may arise.

Chemical Exposure: New materials, included novel textiles, may expose users to irritating or toxic compounds. The effects of exposure could be chronic or acute.

Laceration/contusion/trauma/crush/impact/amputation: Mechanical hazards may exist with new products. A device with increased kinetic or potential energy, or one that transports a user faster, may pose an increased risk of impact or falls.

Choking/strangulation/asphyxiation: Wearable and other small devices must be designed to avoid creating a risk of choking.

Significant progress was made in addressing identified safety concerns presented in the 2017 report through agency actions, voluntary standards, and stakeholder engagement. Example activities include:

- Briefings to the Commission (Micromobility, Internet of Things (IoT), Three-dimensional (3D) printing, Wearables)
- Publication of focused staff reports (Micromobility, IoT, 3D printing, Wearables, Nanotechnology)
- Stakeholder engagement meetings (Micromobility, Artificial Intelligence (AI)/Machine Learning (ML), Advanced materials, Nanotechnology)
- Webinars seeking input on hazard mitigation strategies (AI/ML)
- Letters to and meetings with voluntary standards organizations to develop new safety standards (Wearables, 3D printing, AI/ML, IoT, Virtual Reality, Nanotechnology)
- Participation in new voluntary standards activities (Internet connected products, AI/ML, Virtual Reality and Augmented Reality, Robotics, Nanotechnology)
- CPSC-sponsored interagency research (3D printing, Advanced materials, Lithium-Ion batteries)
- Intramural laboratory research (Internet of Things, 3D printing)

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- NFPA/CPSC – Multi-generational safety campaign

Staff acknowledges that this report is not exhaustive. We endeavored to capture trends in technologies and potential hazards through subject matter expert knowledge, risk assessment, and a search of the literature, but we cannot foresee every potential product and hazard. We note that as products become increasingly complex in their technology and capabilities, the agency’s current budget will not be sufficient to work on what we need to accomplish to reduce the unreasonable risk of injury to American consumers.

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1 EMERGING AND FUTURE TECHNOLOGIES AND SOCIETAL TRENDS

1.1 INTRODUCTION

The Risk Management Group (RMG), within the Office of Hazard Identification and Reduction (EXHR), works to identify and understand the hazards and risks associated with emerging technologies and trends as they may affect consumer product design and/or consumer behavior.

As we look out over the next 3 to 5 years, we anticipate further expansion of consumer products using technologies we identified in 2017, that have advanced since then, and our focus continues to be on these new technologies as they are introduced and used in consumer products. Some of the consumer product trends and technologies identified in this report are an outgrowth of these technologies. Although we cannot be sure of the future, staff can take steps to discern potential trends and products that may enter the marketplace, or become more widely used, and identify possible consumer product hazards associated with those products. Alternatively, we are looking for trends and technologies that may improve consumer product safety by reducing risk of injury.

Staff also identified the following changes in consumer behaviors, overarching technologies, and societal trends for further exploration in this report, including:

- Virtual worlds: An expansion of virtual reality gaming and devices, which support extended reality products worn by consumers;
- Indoor time: A growth in time spent indoors (including increased use of telework and online learning), which is likely to rise with an expansion of virtual spaces and more time engaged with computers and other household electronics or “screen time”;
- Unsafe infant sleep. Although the hazards of inappropriate infant sleep practices are generally well known, we continue to see new, innovative products enter the marketplace that, while they may appeal to some caregivers who believe they help some infants sleep better, may not adhere to best practices for safe sleep. Only after these products are in the marketplace for some time do the hazards become apparent;
- Consumer robotics. Increased use of consumer robotics, personal electronic assistants, and their interaction with consumers and other connected products;
- Social Media. Potential consumer reliance on misinformation/disinformation on social media and other platforms, with consumer product safety messaging of particular concern;
- Consumer driven data. An increasing amount of data and its interpretation targeted to consumers without the support of a knowledgeable expert; and
- Environmental Issues. Consumer concern with the environment, leading some consumers to seek out new products that are deemed more environmentally friendly. For example, staff expects increased use of alternative energy sources, such as solar power and new battery technologies, which may lead to other safety considerations.

Staff identified new technologies that have potential to improve product safety, including:

- Sensor technologies. Advances in sensor technologies will allow consumers greater ability to monitor the area around them and detect potential hazards. It will be important for consumers to understand how to maintain the accuracy of these products; and
- Blockchain technology. Blockchain is an emerging application providing greater ability to track the sale and distribution of products, which may be beneficial for identifying products involved in recalls. This technology may also provide greater security for connected devices.

The Covid-19 pandemic brought about some changes in consumer behavior that may be long-lasting, while others may be short-lived. The pandemic resulted in expedited research and applications of diagnostic tools, such as wearables, and rapid, consumer-level manufacturing technologies, such as 3D printing, to respond to global demands for personal protective equipment. The pandemic spurred new product innovation, including consumer products claiming to protect consumers from Covid-19. It also impacted consumer behavior in other ways, including a shift in shopping habits (moving further from traditional brick and mortar outlets towards online sources) and in activity patterns.

1.2 NEW TECHNOLOGIES

1.2.1 Extended Reality

The category of “extended reality” includes both fully immersive virtual reality (VR) and augmented reality (AR). VR takes the user to another place; AR is anchored in the real world where computer imagery is superimposed onto the users’ view of the world around them. AR technology, in the form of AR glasses, is not commercially available yet, but the major technologies companies, including Apple and Snap, are developing these products for wider consumer adoption.²

Given the potential growth of the use of VR equipment, there are questions regarding how consumer product safety will be impacted.³ For example, intense use of screen-based products or VR equipment may cause cybersickness, which results in extended dizziness and disorientation.⁴ There are questions whether vulnerable populations, such as the elderly and young children, will develop cybersickness or other adverse effects resulting from VR use. Gaming applications using VR equipment may cause a wide range of potential injuries. Since users are encompassed in the virtual world, and the real world is not visible, there may be the potential for running into objects resulting in injuries. Wearing VR equipment may result in the

² Seeing and Believing. The Economist. April 9, 2022. Pp. 49-50.

³ <https://medical-dictionary.thefreedictionary.com/cybersickness>

⁴ <https://www.healthline.com/health/cybersickness#What-is-cybersickness?>

release of chemicals that may cause irritation to the skin.⁵ Finally, this technology raises important legal questions, as it is not clear whether these applications are consumer products, nor whether data or other content, such as media, are consumer products.

1.2.2 Increased Indoor Time

Over the past 50 years, time-activity patterns have changed, and the average person, including young children, spends considerably more time indoors. In 2001, the Environmental Protection Agency (EPA) released the results of an important and oft-cited study of human activity patterns that suggested that the average person within the United States spends as much as 87 percent of their time indoors, both at home and at work, with an additional 6 percent in a vehicle.⁶ There is a continuing shift of more time spent indoors at home, rather than engaging in outdoor activities. Researchers suggest that the growth in electronics in the home, such as televisions, computers, and cellular phones, have contributed to this trend.^{7,8} With more time spent indoors, occupants are exposed longer to an array of consumer products that are typically used in the home. Indoor, rather than outdoor play, may lead to physical encounters with products, such as unstable furniture, increasing the likelihood of injury.

During the Covid-19 pandemic, many organizations allowed employees to telework to maintain continuity of operations, and most schools instituted virtual learning until localities deemed it safe to return to in-person learning. The teleworking trend has continued, with large organizations allowing employees to work a full or part-time teleworking schedule. The time indoors for “occupational” purposes will likely increase or be redefined as the home environment is now a workplace. Young children also greatly increased their screen time indoors.⁹ This increased time spent indoors places more emphasis on the safety of the home environment and the need to ensure that potential consumer product hazards are minimized, particularly for homes with vulnerable persons, such as seniors or young children. Combined with very limited data on chemical exposures from products, and the toxicity of such chemicals, CPSC will be challenged in obtaining needed data to assess the risk for a growing list of chemicals and products.

1.2.3 Unsafe Infant Sleep Practices

Parents and care givers, in many cases, are desperate for their infants to sleep, so that they, too, can get enough sleep to function the following day. This need for sleep has led to many

⁵ <https://www.cpsc.gov/Recalls/2021/Facebook-Technologies-Recalls-Removable-Foam-Facial-Interfaces-for-Oculus-Quest-2-Virtual-Reality-Headsets-Due-to-Skin-Irritation-Hazard-Recall-Alert>

⁶ <https://www.buildinggreen.com/blog/we-spend-90-our-time-indoors-says-who> and <https://pubmed.ncbi.nlm.nih.gov/11477521/>

⁷ [Children’s Screen Time Has Soared in the Pandemic, Alarming Parents and Researchers - The New York Times \(nytimes.com\)](https://www.nytimes.com/2020/04/02/health/children-screen-time-pandemic.html)

⁸ Trinh M, Sundaram R, Robinson SL, et al., Association of Trajectory and Covariates of Children’s Screen Media Time. JAMA Pediatric. 2020;174(1):71–78. doi:10.1001/jamapediatrics.2019.4488.

⁹ <https://www.nytimes.com/2021/01/16/health/covid-kids-tech-use.html>

innovations in products purported to help infants sleep better. Some of these innovations have arguably improved infant and caregiver sleep, while also posing a hidden hazard to infants.

Many of the new product innovations are not designed with best practices for safe infant sleep. Inclined sleepers are an example from the recent past, where an innovative product that promised, and in many cases delivered, hours of uninterrupted sleep to newborns (and therefore, parents). However, after several years on the market, it became clear that allowing infants to sleep on a non-flat surface posed risks. These products were recalled in 2019 and early 2020,¹⁰ and led to the promulgation of a new regulation on Infant Sleep Products.¹¹

The recall of inclined sleepers has not appeared to slow down product innovation in this market, and now there is general acceptance that the sleep surface must be flat. However, additional products marketed as soft, safe spaces to briefly rest an infant, are now becoming widespread in the market. Newborns sleep 14 to 19 hours a day, which means that they will often sleep wherever they are placed for more than a few moments. If the infant is placed on a soft, pillowy object, sleep is, by nature, imminent. Unfortunately, the incident data support that infants fall asleep in these products, leading to fatalities and recalls.¹²

Staff has identified safe sleep as a priority area and is continuing to work on identifying factors that are contributing to infant fatalities and ways to develop safe infant sleep messaging that reaches caregivers. In addition, staff continues to work on voluntary standards for sleep products, including monitoring and/or participating in the development and maintenance of infant sleep-product-related voluntary standards.

1.2.4 Artificial Intelligence (AI)/Machine Learning (ML)

The 2017 report identified robotic machines, such as products for cleaning gutters, sweeping swimming pools, and mowing lawns as an emerging technology. Since that report, personal robotic assistants are now commercially available. Robotics may include software with sophisticated algorithms that are controlling machines that interact with people that may cause

¹⁰ <https://www.cpsc.gov/Recalls/2020/Summer-Infant-Recalls-SwaddleMe-By-Your-Bed-Inclined-Sleepers-to-Prevent-Risk-of-Suffocation>; <https://www.cpsc.gov/Recalls/2020/Evenflo-Recalls-Pillo-Portable-Napper-Inclined-Sleepers-to-Prevent-Risk-of-Suffocation>

¹¹ <https://www.cpsc.gov/Newsroom/News-Releases/2021/CPSC-Approves-Major-New-Federal-Safety-Standard-for-Infant-Sleep-Products>

¹² CPSC is aware of a total of 254 incidents, including 21 fatalities, related to infant sleep products (inclined and flat), occurring between January 2019 and December 2020, reported since the SNPR. The hazard patterns associated with the infant inclined sleep products include design-related issues that resulted in infants rolling over and asphyxiating, children developing respiratory problems, or developing physical deformations due to extended periods of use. Hazard patterns for the flat infant sleep products included infants falling out of the product, or suffocating on soft structure sides.

physical harm. The software algorithms often include artificial intelligence (AI) and/or machine learning (ML).

“AI” can be defined as any method for programming computers or products to enable them to carry out tasks or behaviors that would require intelligence if performed by humans. “ML” is typically understood to be an iterative process of applying models or algorithms to data sets to learn and detect patterns and/or perform tasks, such as prediction or decision making that can approximate some aspects of intelligence. Artificial intelligence systems use machine- and human-based inputs to—

- (A) perceive real and virtual environments;
- (B) incorporate such perceptions into models through analysis in an automated manner; and
- (C) use model inference to formulate options for information or action.

Although AI/ML has been around since the 1950s, with technological improvements in battery energy density, electronics, the Internet, and software, many consumer products are including AI and ML (AI/ML) to improve product efficacy and consumer experience. AI/ML may be found in an increasing number of products, including personal robots, children’s toys, home appliances, virtual reality devices, and pool monitoring systems. Although opportunities exist for manufacturers to improve safety using new AI/ML technologies, the inclusion of these technologies may also create hazards inadvertently.

1.2.5 Social Media and Diminishing Consumer Reliance on Expert Advice

Providing accurate safety messaging to the appropriate audience was a challenge for the CPSC before the advent of social media. The internet has provided agencies with new tools to share critical information quickly with a wide range of stakeholders. Getting accurate and timely information to consumers regarding defective products, recalls, and educational campaigns on best practices for product use has likely prevented deaths and injuries. However, the speed at which information—or misinformation (sharing of false or misleading information without an intent to deceive)—spreads on social media platforms, is of concern, in addition to the spread of such misinformation on many online outlets. This is a serious challenge for CPSC’s safety messaging.

For example, in 2018, a “challenge” spread through social media, encouraging teenagers to eat laundry pods, leading to a spike in calls to poison control.¹³ The dangers of ingesting laundry pods were already known in 2018, but that didn’t stop this social media challenge from going viral. CPSC staff worked with ASTM and manufacturers to develop a voluntary standard to reduce the risk of ingestion to young children and the elderly. However, the notion that teenagers would take up the challenge, and that it would spread on social media, is not something that can

¹³ <https://www.womenshealthmag.com/health/a19994474/tide-pod-challenge/>. January 22, 2018.

be addressed by a standard. On January 12, 2018, the CPSC tweeted out the message “please don’t eat laundry pods.”

Generation Z (Gen Z) gets most of its news and information from social media.¹⁴ Nearly 40 percent of Gen Z, born between the late 1990s and the early 2000s, prefer using TikTok and Instagram as their search engines.¹⁵ These platforms can be very effective in spreading misinformation and conspiracy theories; and although Gen Z grew up with social media, they do not necessarily know how to evaluate the accuracy of what they are seeing on sites like TikTok or Instagram. The information users are seeing on social media is mostly dictated by whom they follow on the platform; users select whom to follow, and algorithms tend to suggest similar sites to follow, so social media tends to confirm our already-held opinions and beliefs.

The need to develop sound approaches for communicating health risks to the public is a global challenge, and international organizations like the Organization for Economic Co-operation and Development (OECD) have begun to provide guidance on using social media as a tool to communicate risks, in addition to guidance on challenges using this approach for stakeholder engagement.¹⁶

The Covid-19 pandemic provided a case-study on the benefits of the Center for Disease Control (CDC) communicating critical public health information over social media. Social media sites also provided a platform for those who disagreed with CDC guidance, resulting in confusion for some consumers on what are the best actions to take to protect their health and safety.¹⁷

In addition to misinformation, consumer product safety and CPSC are vulnerable to disinformation (sharing of purposely false or misleading information) as above, as well as potentially impacting incident data reporting integrity.

Consumers who receive false or misleading information may be more likely to experience adverse effects from hazardous products. They may not heed warnings or may continue to use recalled products, potentially not trusting established entities, such as the federal government or medical professionals.

1.2.6 Proliferation of Consumer-Driven Data

Innovations in consumer products include Internet-connected products that allow the collection of considerable amounts of information about a consumer. These data can be used to develop a feedback loop that allows the manufacturer or other data user to provide customized communications that are transmitted back to the consumer. Feedback can be a powerful motivator for improving behaviors, making decisions, and providing peace of mind.

¹⁴ Generation Z (or Gen Z for short), colloquially known as “zoomers,” is the [demographic cohort](#) succeeding [Millennials](#) and preceding [Generation Alpha](#). Researchers and popular media use the mid- to late 1990s, as starting birth years, and use the early 2010s, as ending birth years.

¹⁵ <https://www.businessinsider.com/nearly-half-genz-use-tiktok-instagram-over-google-search-2022-7>

¹⁶ <https://www.oecd.org/gov/risk/social-media-in-risk-and-crisis-communication.htm>

¹⁷ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8403670/>

Fitness trackers and other devices that collect biometric data have been available to consumers for many years. Feedback from these products, in the form of data, could be inaccurate. For example, the device may have been developed without consideration of skin tone differences,¹⁸ and could provide misleading or easily misunderstood guidance, resulting in negative outcomes.

Another example of products that provide non-validated data to consumers are baby monitors. Some baby monitors provide medical data, such as oxygen levels and heart rate, to the user. The safety, reliability, and lifespan of these products is unknown. CPSC staff reviewed the marketed features of the newer baby monitors for sleeping infants and toddlers. The baby monitor products can live-stream video and audio, and some products incorporate the capability to detect small movements in the sleeping child. Baby monitors have applications for remote compatibility with cell phones or other monitoring devices that allow the caregiver to see, hear, and review the child's activities outside of the sleeping area.

Some baby monitors have high-sensitivity pressure sensors incorporated into a flat pad that is installed under the crib mattress to sense movement. The manufacturers claim these sensors track the micro-movements of the children as they sleep, and the system alerts the caregiver if there is decreased movement activity in the child. Other baby monitors have sensors mounted above the crib to record respiratory rates through breathing movement of the child; these products promote health monitoring without a wearable device. There are also wearable devices, such as socks or wraps, that contain multiple pressure sensors that also use an overmounted camera and microprocessor that analyze the sensor data on the child. Many of the baby monitors also record room environment temperature and humidity and allow for the caregiver's voice or music to transmit through the monitor and near the child.

Challenges with these advances in baby monitors are cloud data collection and signal transmission of the sensors that can lose connectivity with the device. Connected product devices, such as baby monitors, can have security hacking, disturbances in cloud or Internet transmissions of the data or the caregiver's monitor. More concerning for CPSC is that the baby monitors with vital sign sensor capability have not been approved by the U.S. Food and Drug Administration (FDA) as medical devices. Whether the devices can detect potential health issues in infants is unknown. In addition, a contributing author from the recent AAP Infant Safe Sleep guideline, Dr. Racheal Moon, was interviewed and expressed concerns about these devices. Moon said, "We're worried people will become complacent" adding, "If they have a monitor, they might feel they can put their baby on its belly to sleep, or sleep with their baby."¹⁹

1.2.7 Impact of Consumer Response to Environmental Concerns

In some cases, consumers have altered their product purchasing and use patterns in response directly or indirectly to societal issues, including consumer perceptions of the effects of their actions on the environment. Furthermore, government action across federal, state, and local

¹⁸<https://www.independent.co.uk/news/health/nhs-blood-oxygen-oximeter-black-asian-b1894424.html>

¹⁹ Pediatricians say no to wearable smartphone baby monitors, Dennis Thompson, HealthDay News, January 24, 2017.

levels, in some cases, has incentivized such changes through government programs and/or taxes. Consumer responses to these environmental issues and government incentives vary, and may involve a range of consumer products.

Extreme weather events are increasingly common and often result in power outages. During power outages, consumers frequently resort to the use of fuel-powered generators to provide electricity to their homes and businesses. These generators produce dangerous amounts of carbon monoxide, which can cause chemical asphyxiation, and sometimes death, to exposed individuals.

Recent legislation, such as the Inflation Reduction Act, includes incentives for use of alternative energy sources, like solar panels with battery storage units. These systems may present shock or fire hazards and may include an array of batteries to store the energy collected by solar panels. The use of large battery systems, which typically use flammable electrolytes, brings an associated change in fire risk, as well as electrical hazard. The use of battery storage approaches, like lithium-ion batteries, may involve hazards, such as fire and shock, and this may be true for other alternate energy storage technologies.

Alternatively, some consumers may choose to switch from gas-fueled products, such as gas-fueled outdoor equipment, to battery-powered outdoor equipment, which may reduce fatalities from exposure to carbon monoxide and other products of combustion.

1.2.7.1 Energy Efficiency and Unintended Consequences

Global warming has been a concern for many regulators, consumers, and manufacturers for years. Recently, federal and state laws have forced industries that use substances with high global warming potential to find alternatives. The heating, ventilation, air conditioning, and refrigeration (HVAC&R) industry has begun to use refrigerants with much lower global warming potential. The traditional refrigerants used in residential appliances, such as refrigerators, heat pumps, air conditioners, and dehumidifiers, have not been flammable. However, the alternative refrigerants that will be used in residential appliances are flammable. The industry has developed new safety requirements for these appliances, based on many international standards, but consumers will face new hazards. The alternative refrigerants are odorless, colorless, and difficult to detect. Many of the new safety requirements focus on leak detection within the appliance to alert the homeowner to a potentially unsafe fire or explosion scenario. State regulations for alternative refrigerants will begin to go into effect in 2023. Because many of the appliances that use refrigerants have long lifespans, it will take years for these alternative, flammable refrigerants to become common in homes. It is possible that the potential for residential fires and explosions from these types of appliances may be affected in the future.

Recent Department of Energy (DOE) mandates have also driven improvements in energy efficiency equipment that have resulted in the use of variable speed drives in HVAC equipment and other motor-driven products where energy efficiency is a concern. The variable speed drives for higher efficiency motors use power conversion techniques that may introduce high-frequency electrical noise onto the power line. To combat this converter noise, manufacturers have added filtering that has increased the amount of current to ground for some of these motor products.

Leakage current in grounded appliances is often limited for safety reasons. If the ground connection is lost due to a loose connection or other fault, the appliance could become energized, and a person in contact with a grounded surface and the appliance could be shocked or electrocuted.

To improve electrical system safety and reduce the number of shock and electrocutions, the *National Electrical Code* (*NEC*- National Fire Protection Association (NFPA 70)) has expanded the number of residential branch circuits requiring ground-fault circuit interrupters (GFCIs) protection. The use of GFCIs has played a significant part in reducing the number of electrocutions since their introduction in the 1970s, and the *NEC* is the installation code adopted in many jurisdictions in the United States. The 2020 *NEC* added a requirement for GFCI protection for circuits supplying outdoor HVAC equipment. After the enforcement of this requirement began, reports of unwanted or nuisance tripping (the GFCI opening the circuit even though no ground fault condition existed) and potentially the loss of heating and air conditioning started to occur.

The loss of heating or air conditioning equipment can be deadly in extreme heat conditions, especially for vulnerable consumers. Exposure to excessive leakage current on improperly grounded appliances can also be deadly.²⁰ To address these hazards, staff has been participating on an *NEC* task group and an Underwriters Laboratories (UL) Standards Technical Panel (STP) for Ground-Fault Circuit Interrupters (GFCIs) to ensure that these hazards are addressed. Staff will also engage with other industry stakeholders to ensure that the safety of these new technologies is addressed and does not affect consumer use.

Another safety concern from energy mandates is the functioning of safety vacuum release systems (SVRS) devices with pumps that are now required to meet the Department of Energy (DOE) rule, Energy Conservation Program: Energy Conservation Standards for Dedicated-Purpose Pool Pumps, which became effective on July 19, 2021. The DOE rule applies to the range of pool pump sizes typically found in residential and some commercial installations. Variable speed pumps (VSP) are more likely to comply with the new requirements because they can be operated at higher energy efficiencies than the single-speed pumps typically installed in pool and spa circulation systems. However, in normal operation, a VSP can lower suction pressure such that current SVRS technologies may not differentiate between the pressure change due to pump operation and pressure change from entrapment of a bather on a drain. The lack of a requirement that an SVRS device operate with a VSP installed may put consumers at risk.

²⁰ As the frequency increases, the thresholds for the current levels that produce harmful shock response, (*e.g.*, let-go, respiratory arrest, ventricular fibrillation) increase, but current GFCIs are not designed to account for this. Consequently, a high frequency ground current could cause a GFCI to trip even though the situation is not hazardous.

1.2.8 Advances in Sensor Technologies

Today's consumers have a vast amount of data at their fingertips. However, greater access to data has both positive and negative safety implications. On the one hand, there is an opportunity to improve safety, such as a “nudge” or encouragement for healthier behaviors or get timely information out to consumers on potentially unsafe products. Rapid advances in sensor technology have made sensors cheaper and more available in a wide range of products to provide consumers access to data they have never had before and, potentially, guidance to consumers that may impact their behavior. Consumer-level sensors are available to monitor a variety of conditions, including home indoor air quality, fitness levels, and even the status of their children.

These next generation sensors can collect a significant amount of data on the consumer. For example, biometric data, including heart rate and blood pressure, in addition to location, are collected by wearable sensors like fitness trackers. These devices are connected to the Internet, and data may be shared with health care providers. There are concerns regarding the security of the data and the potential for sensitive personal information to be accessed by those with malicious intent. If the accuracy of the data cannot be relied upon, there may be negative safety implications. For example, a consumer may rely upon the biometric data provided by the sensor to determine whether attention to their health is needed and may not act if the sensor frequently provides false positive readings.²¹ Some of the devices providing this type of information have been identified as being in CPSC's jurisdiction.

Sensors include those that simply provide consumers access to a data point or sensors that have pre-defined data points, which trigger an alarm. For example, smoke alarms are a widely used and familiar type of sensor-based alarm. However, in some areas where sensors are emerging, trigger values may not be well established, which could lead to both false alarms and a false sense of security. Dependence on Wi-Fi connectivity may also affect false alarms and false positives. Additionally, software may create other problems, such as reliability, hacking, and remote software updating issues.

1.2.9 Blockchain

Blockchain is a new technology that has potential to impact positively applications in the consumer product industry, by improving the tracking and monitoring of products, information flow, and support services that could benefit both manufacturers and consumers.²²

Blockchain is a structure that stores transactional records, also known as the “block,” of the public in several databases, known as the “chain,” in a network connected through computers and servers.²³ Typically, this storage is referred to as a “digital ledger.” Every transaction in this ledger is authorized by the digital signature of the owner, which authenticates the transaction and

²¹ <https://www.health.harvard.edu/heart-health/how-accurate-are-wearable-heart-rate-monitors>

²² <https://www2.deloitte.com/us/en/insights/industry/retail-distribution/disruptive-technologies-consumer-products/disruptive-digital-technologies-blockchain-potential.html>

²³ <https://www.docryptocurrency.com/what-is-blockchain-technology/>

safeguards it from tampering. The data the digital ledger contains is highly secure. In simpler words, the digital ledger is like a spreadsheet shared among numerous computers in a network, in which, the transactional records are stored based on actual data. No participant can change or tamper with a transaction after it's been recorded to the shared ledger. If a transaction record includes an error, a new transaction must be added to reverse the error, and both transactions are then visible. One possible application of blockchain technology for consumer product companies and authorities are improvements to product safety by tracking genuine products and identifying and separating counterfeits. In addition, products that are determined to be unsafe or have defective components can be removed from use more effectively by targeted product recalls. Consumer satisfaction may also be improved with blockchain technology. Consumers can have product information (*e.g.*, product manuals, user guides) at any time and have access to contracts or warranties for maintenance services. Consumer protection can also be improved as the digital records of consumer data stored on a blockchain platform are more secure than those stored on local platforms.

There are concerns associated with blockchain technology. One concern with blockchain is security. Although blockchains may appear to be secure, if there are vulnerabilities in one node of the chain, the entire data chain can be compromised. For example, if a computer is hacked in the network, all the data can be made available to unauthorized users. If there is a safety nexus to that chain (and staff has not been able to identify any yet), this could result in a degradation of safety.

1.3 THE COVID-19 PANDEMIC

It is too early to predict which aspects of our collective “pandemic life” will remain once we exit the pandemic. However, anecdotal reports suggest that some pandemic habits may linger. For example, many people rediscovered outdoor activities, such as hiking and biking; the joy of cooking at home; and do-it-yourself home improvements. However, there may be more time spent indoors as home-based activities become more integrated into daily life routines. The use of products to mitigate microbial exposures may continue, such as the use of hand sanitizers, disinfectant cleaners, and air cleaning devices. The use of sensors in health and fitness trackers to determine body temperature, blood pressure, and other physiological parameters for adults and children will likely continue. It is unclear to what extent these changes will impact overall safety. Staff will report out separately on trends in planned epidemiological reports for specified products and for overall trends.

2 PROGRESS SINCE 2017

2.1 INTRODUCTION

In January 2017, the Commission published a report, *Potential Hazards Associated with Emerging and Future Technologies*.²⁴ This report discussed the commercialization of new products and advances in existing products that provide an array of new features and capabilities. The 2017 report identified the following trends in consumer products:

- Connected products, such as appliances, which communicate through the Internet and operate remotely;
- Micromobility products, such as e-scooters and e-bikes, which incorporate batteries and are connected to the Internet via a web application (app);
- Wearable technology products, including apparel and accessories, allowing consumers to self-monitor many aspects of health and fitness; and
- 3D printers that allow consumers to “manufacture” products in their homes.

The 2017 report also identified several technological and societal trends that staff thought would be likely to influence the marketplace for consumer products:

- Increased integration of Smart Technology and the Internet of Things (IoT);
- An aging population, aging-in-place, and multigenerational homes;
- Large data set analysis, or “Big Data”; and
- E-commerce and direct-to-consumer transactions.

In the 5 years since the 2017 report, product designers continue to innovate and incorporate new technology and advanced materials into consumer products. Safety concerns raised by consumers and other stakeholders and staff-initiated investigations on certain new product designs led to recalls, reducing consumer exposure to such hazards. The CPSC made significant progress in addressing identified safety concerns through agency actions, voluntary standards, and consumer advocacy. Example activities include:

- Briefings to the Commission (Micromobility, IoT, 3D printing, Wearables)
- Release of focused staff reports (Micromobility, IoT, 3D printing, Wearables, Artificial Intelligence (AI)/Machine Learning (ML) in consumer products, Nanotechnology)
- Stakeholder engagement meetings (AI/ ML, Advanced materials, Micromobility)
- Webinars seeking input on hazard mitigation strategies (AI/ML)
- Letters to and meetings with voluntary standards organizations to develop new safety standards (Wearables, 3D printing, Virtual Reality)

²⁴ https://cpsc-d8-media-prod.s3.amazonaws.com/s3fs-public/Report%20on%20Emerging%20Consumer%20Products%20and%20Technologies_FINAL.pdf

- CPSC-sponsored interagency research (3D printing, Advanced materials, Lithium-Ion batteries)
- Intramural laboratory research (IoT, 3D printing)

Part two of this report updates our activities on the hazards identified in the 2017 report, *Potential Hazards Associated with Emerging and Future Technologies*. This information is not exhaustive, and will provide examples of key reports, meetings, and voluntary standards activities occurring in the past 5 years.

Of note, two of the previous 5 years have been occupied by the Covid-19 pandemic. The pandemic certainly wasn't predicted in our previous report, and some of the changes in consumer behavior during the pandemic may be felt for some time, while others may be short-lived changes. The near-term impacts of the Covid-19 pandemic on injury rates was the subject of two staff analytic reports.²⁵ Other impacts of the Covid-19 pandemic appear to include the expedited research and application of diagnostic tools, such as wearables, and rapid consumer-level manufacturing technologies, such as 3D printing, to respond to global demands for personal protective equipment. The pandemic has also created supply-chain problems, which may further drive 3D printing and e-commerce trends.

2.2 TECHNOLOGIES DISCUSSED IN 2017, AND CPSC STAFF ACTIVITIES

2.2.1 Smart Technology, the Internet of Things (IoT), and Internet Home-Based Smart Technologies

The market of Internet-connected devices continues to expand with about 64 billion IoT-connected devices expected to be available globally by 2025, a 6.4-fold increase from 2018.²⁶ IoT allows consumers to affect physical change remotely in consumer products, offering unique opportunities to enhance various aspects of life and consumer product safety, while simultaneously presenting new risks and challenges. In the broad and large-scale, this term applies to a system of connected products that transfer data at local, national, or global levels. Within the broad IoT terminology, connected consumer products are consumer devices capable of connecting to the IoT and have a unique and assigned Internet identifier, through Bluetooth, or other communication protocol addresses.

²⁵ <https://www.cpsc.gov/content/Effect-of-Novel-Coronavirus-Pandemic-on-2020-NEISS-Estimates-March%20%80%93December-2020>; <https://www.cpsc.gov/content/Effect-of-the-Novel-Coronavirus-Pandemic-on-Preliminary-NEISS-Estimates>

²⁶ <https://www.cpsc.gov/content/Status-Report-to-the-Commission-on-the-Internet-of-Things-and-Consumer-Product-Safety>

There are a few potential safety advantages that exist with smart and connected products that include increased recall effectiveness through automatic product registration and notification and quicker implementation of safety corrective actions or safety improvements through remote software updates. On the other hand, the potential disadvantages of these smart connected products include unauthorized access, malware, and failed software updates that could lead to safety risks. For example, hackers may establish control of a product with heating elements or moving components, alter the function of the product, and intentionally cause physical harm.

2.2.1.1 Activities 2017-2021

In May 2018, the Commission held a public hearing on the Internet of Things and Consumer Product Hazards. The hearing identified potential safety issues and benefits with consumer products, as well as provided recommendations from industry experts to address connected product safety risks. Since the public hearing, staff has focused work in three areas:

- Develop staff expertise and in-house capabilities for Internet-connected products;
- Engage in the development of domestic and international voluntary consensus standards; and
- Collaborate with other federal agencies, foreign governments, and with a wide range of stakeholders.

In FY 2019, staff organized and led an Interagency Working Group on Consumer Product Safety of Internet-Connected Products. Participating agencies included the National Institute of Standards and Technology (NIST) National Cybersecurity Center of Excellence (NCCoE), the Food and Drug Administration (FDA), the Federal Trade Commission (FTC), the Federal Communications Commission (FCC), the Department of Energy (DOE), and the Department of Homeland Security (DHS). The Interagency Working Group serves to share information, research, standards, best practices, and enforcement activities specific to Internet-connected consumer products (connected products). The purpose of the working group is to articulate and understand each agency's roles and responsibilities on connected products; identify potential regulatory gaps in agency jurisdictions; learn collaboratively; create opportunities for interagency cooperation; and promote the development of voluntary consensus standards. Collaboration with working group members helps CPSC to develop recommendations to voluntary standards organizations to ensure that connected products are designed and produced to be safe and secure.

Beginning in 2019, staff worked with ASTM International and industry stakeholders to develop a new voluntary standard guide for connected products (ASTM F3463 *Standard Guide for Ensuring the Safety of Connected Products* – current revision *ASTM F3463-21*). Additionally, staff participates on the standards technical panels (STPs) UL 2900 series *Voluntary Standards for Software Cybersecurity for Network-Connectable Products* and UL 5500 for *Remote Software Updates*. Both UL standards apply to Internet-connected products and are component standards intended to be referenced in end-product voluntary standards. Staff will continue to participate on these STPs and on related voluntary standards committees, including emerging areas, such as wearable technologies, connected cooking systems, and artificial intelligence.

In 2021, staff joined the Internet of Things Federal Working Group (IoTFWG).²⁷ The IoTFWG is led by the Department of Commerce through the National Institute of Standards and Technology (NIST) and is tasked to provide recommendations and a report to Congress relating to several aspects of the Internet of Things, including:

- Identifying any Federal regulations, statutes, grant practices, budgetary or jurisdictional challenges, and other sector-specific policies that are inhibiting, or could inhibit, the development or deployment of the Internet of Things;
- Considering policies or programs that encourage and improve coordination among Federal agencies;
- Considering any findings or recommendations made by the IoT Advisory Board steering committee and, where appropriate, act to implement those recommendations; and
- Examining how Federal agencies are using the Internet of Things, addressing challenges related to IoT or enabling the use of Internet of Things technology.

Staff continues to identify and evaluate the safety of connected products and how being connected to the Internet has contributed to safety hazards. Examples of IoT technologies and potential hazards under review include:

- cooking appliances activated through cellular phone apps, initiating and causing fire hazards;
- remote-controlled thermostats, allowing furnaces to heat higher than temperatures selected in an app;
- smoke alarms not activating and providing false alarm notification;
- scooters with random electronic braking applied, causing riders to be thrown off;
- child safe sleep monitors failing to communicate or properly monitor the child, causing caregivers to be unaware of the child's status.

During the most recent update to CPSC's *Age Determination Guidelines*, "smart toys" were identified as an emerging category of Internet-connected, technology-based toys that were previously unaddressed. CPSC issued a contract to research these new toys, including the expansion of toys into smart-connected technologies. The contractor conducted social media and marketing research²⁸ to develop new and expand existing categories of toys, including which types of smart toys are available to children and the potential hazards, injuries, and concerns associated with smart toys. Smart toys and the associated hazards identified in the report include:

- Robotic toys, including animals with movements and sounds designed for children, are associated with choking hazards from small parts, pinch and laceration hazards, and hair entanglement hazards.

²⁷ [H.R.6395 - 116th Congress \(2019-2020\): William M. \(Mac\) Thornberry National Defense Authorization Act for Fiscal Year 2021 | Congress.gov | Library of Congress](#)

²⁸ <https://cpsc-d8-media-prod.s3.amazonaws.com/s3fs-public/Westat-Online-Review-of-Nine-Toy-Categories-Social-Media-and-Marketing-Research-and-Hazard-Analysis-of-Smart-Toys-Final-Report-January-2022.pdf?VersionId=3knvFvDHJLmFjgGbVFKX4.0R7pWPFmt6>

- Virtual reality gaming is associated with children experiencing nausea, falls, and running into objects.
- 3-D printing devices that use a pen-type extrusion printer for creating objects are associated with potential burn hazards from the hot pen.

2.2.2 Aging Populations, Aging in Place, and Multigenerational Homes

From 1960 to 2020, the number of elderly people rose from 17 million to 47 million, and estimates suggest that number could reach 65 million by 2040.²⁹ The elderly are considered a vulnerable population that may be more susceptible to injury if they encounter a hazard. Because of the increased risk of an adverse health outcome, it is important to understand areas where seniors may be at greater risk and work to address these potential outcomes. Housing is an area that can be improved to meet the needs of senior occupants. Homes may need kitchens and other parts of the house to be wheelchair accessible, have handrails in bathrooms, and entry ways that offer step-free access.³⁰ Nearly two-thirds of the estimated consumer product-related injuries to older adults are due to falls, by far the most common hazard to seniors.³¹

2.2.2.1 Activities 2017-2021

CPSC staff has developed warnings and activities to address senior safety and to educate seniors and their families on hazards and the ways to reduce hazards. A page on the CPSC website titled, “Older Adult Safety,” provides useful recommendations to help reduce falls and the risk of injury to seniors from fires.³² Additionally, staff is active in senior safety-related, mandatory and voluntary standards activities, such as adult portable bedrails, walkway safety, and poisoning prevention, as detailed below:

- Developed the Adult Portable Bedrail Notice of Proposed Rulemaking (NPR) briefing package for the Commission in FY 2022 as well as worked on ASTM F3186-17, *Standard Specification for Adult Portable Bed Rails and Related Products*;
- Participated in the development of ASTM F2508-16e1, *Standard Practice for Validation, Calibration, and Certification of Walkway Tribometers Using Reference Surfaces*;
- Participated in ASTM WK60578 potential new voluntary standard test method for walkway friction testing;
- Participated in the development of ASTM F3159-15, *Standard Safety Specification for Liquid Laundry Packets*; and

²⁹ <https://www.urban.org/policy-centers/cross-center-initiatives/program-retirement-policy/projects/data-warehouse/what-future-holds/us-population-aging>

³⁰ <https://www.census.gov/library/publications/2020/demo/p23-217.html>

³¹ [Consumer Product-Related Injuries and Deaths Among Adults 65 Years of Age and Older - December 2021 | CPSC.gov](https://www.cpsc.gov/Safety-Education/Safety-Education-Centers/Older-Adult-Safety)

³² <https://www.cpsc.gov/Safety-Education/Safety-Education-Centers/Older-Adult-Safety>

- Published, in March 2022, an epidemiological report: [Consumer Product-Related Injuries and Deaths Among Adults 65 Years of Age and Older - December 2021 | CPSC.gov](#)

2.2.3 Large Data Set Analysis and Big Data

In the 2017 staff report, staff discussed advances in online technology and businesses using artificial intelligence and analytical techniques, to draw insights into consumer behavior. Data Science is the use of predictive analytics, user behavior analytics, or certain other advanced data analytics methods that extract value from big data. As expected, advances in this area have grown substantially and are used increasingly by small and large business to develop new business models, strategies, and data-driven services to generate growth and revenue.

In our 2017 report, staff identified that CPSC could potentially use large data set analysis to target safety messaging to consumers. That report also discussed how large data set analysis could potentially be used as an early warning system to look for correlations between a product and safety-related complaints, before they appear in traditional data systems.

2.2.3.1 Activities 2017-2021

To this end, the agency hired a Chief Data Analytics Officer in 2020, to assist the agency in identifying how to leverage existing data resources for better hazard identification. Staff has been active investing in infrastructure and in developing pilot programs and tools for data management (*e.g.*, imputation and quality control) and analysis in this area, including:

- Expanding the CPSC data lake to include majority of analytical data sets;
- Implementing a cloud analytics environment (SAS Viya) for a FY2023 launch;
- Continuing to develop machine learning models on retail data, particularly examining injuries and their severities;
- Continuing to develop predicting product codes using machine-learning algorithms;
- Increasing imputation work on missing racial and ethnic data elements; and,
- Building out training regiments for textual data analysis and machine learning.

2.2.4 E-Commerce and Direct-to-Consumer Transactions

The eCommerce industry continues to grow worldwide at dramatic rates.³³ In turn, there are increased product safety concerns surrounding the marketing and sale of consumer products domestically and how products enter the distribution chain from foreign markets. Social media platforms, including Instagram, Facebook, and Twitter, among others, are a driving force in both online traffic and sales.

³³ <https://www.oberlo.com/statistics/global-ecommerce-sales-growth>

2.2.5 Activities 2017-2021

The CPSC is actively addressing these eCommerce issues through the agency's eCommerce Surveillance, Analysis, and Field Enforcement (eSAFE) team within the Office of Compliance and Field Operations and through the Office of Import Surveillance (EXIS) and the newly formed eCommerce team.

The eSAFE team is positioned to provide services in this area. The team is in the first phase of a multifaceted IT project to develop a system for eCommerce surveillance and data analytics. The eSAFE team currently monitors eCommerce for product-related safety issues, conducts surveillance, requests takedowns of recalled or banned products, and refers matters for compliance action. eSAFE completed nearly 700,000 screenings in FY 2021, and the team is projected to complete more than 2,000,000 screenings in FY 2022.

The EXIS eCommerce team monitors cross-border, direct-to-consumer transactions to identify products that are arriving outside of the traditional consumer product distribution chain. When consumer products are made in foreign factories, purchased by, and then shipped directly to, consumers, compliance and enforcement issues could arise, with no domestic entity available with whom to address these issues. Direct-to-consumer shipments of this type are not always examined or subject to any other oversight, potentially leading to hazardous or untested products reaching consumers.

2.2.6 Three-Dimensional (3D) Printing – Additive Manufacturing (AM)

Since the 2017 report, 3D printers have improved in speed and printing capabilities, such as the ability to 3D print a full-sized home. Smaller units have become more affordable for consumer use. CPSC staff developed an internal research program to address the hazards outlined in the staff report: [Safety Concerns Associated with 3D Printing and 3D Printed Consumer Products](#).³⁴ The results of the internal study can be found in a report that summarizes the results of testing raw materials used in 3D printers and printed products.³⁴ Specific types of testing included the flammability of the raw material, the release of small parts from the impaction of the product, and the determination of the concentrations of potentially toxic organic and inorganic chemicals in raw material.³⁵ There are additional safety hazards that were not addressed in this study that will be investigated in future research efforts.

2.2.7 Activities 2017-2021

Since the 2017 report, CPSC staff has participated in a UL Printer Safety Committee, as a member of their advisory board, which has been evaluating UL 2904 *Methods for Detecting VOCs and Particulate Emissions from 3D Printing*. Staff is also a member of STPs for UL

³⁴ <https://www.cpsc.gov/content/Safety-Concerns-Associated-with-3D-Printing-and-3D-Printed-Consumer-Products>

³⁵ <https://www.cpsc.gov/content/Lifecycle-Evaluation-of-3D-Printers>

60950 *Safety Standard for Information Technology Equipment* and UL/CSA/IEC62368-1 *Audio/Video Information and Communication Technology Equipment*, which is a new hazard-based safety standard. Additional voluntary standards efforts include an ISO JG68/ASTM F42 Joint Committee, looking at development of mechanical and emissions testing methods; an ASTM/ISO Additive Manufacturing Center of Excellence, intended to coordinate research and standards development; and an ANSI group identifying existing standards work and areas of need for additive manufacturing. Staff also published a report, *Safety Concerns Associated with 3D Printing and 3D Printed Products*³⁶ and completed a more detailed research report in fiscal year 2022.³⁷

2.2.8 Software as a Component Part (Softwarization)

In the 2017 report, software as a component part was identified as a potential emerging hazard. More products are using software to provide product enhancements. Just about all products that have displays, sensors, and actuators are manufactured with software used to control the products. Software gives the manufacturer of the product the ability to enhance and easily change functionality of the product once it is assembled and purchased. Smartphones, tablets, personal computers, and the Internet allow for remote software updates of products. This allows manufacturers to update products, essentially creating a new product with enhanced functionality, correct software bugs, and correct safety issues.

Because many of these products are updated through the Internet, they need to be designed and tested to connect securely and make updates without errors. Improper software updates could cause safety implications for many consumer products, including those with heating elements, battery charging, or mechanical controls that could cause physical injury.

Support for a product with software is also a concern. The product support needs to address not only error-free updating, but also cybersecurity vulnerabilities that could potentially cause product safety issues. Consumers should be aware when the product is no longer supported by the manufacturer for product updates, including cybersecurity and safety issues.

2.2.8.1 Activities 2017-2021

Staff is participating in the UL 2900 series of *Standards for Software Cybersecurity for Network-Connectable Products* and UL 5500 *Standard for Safety Remote Software Updates*. End products that connect to the Internet and are remotely updated will need to have some minimum requirements to ensure a product is safely connected to a network and is not vulnerable to cybersecurity risks that could lead to safety issues when software is updated remotely.

Given AI/ML's continual evolution and growing applications, no single standard exists. CPSC staff is working to address the safety concerns of potential hazards associated with these technologies, by participating in the establishment and enhancement of voluntary consensus

³⁶ <https://www.cpsc.gov/s3fs-public/Safety-Concerns-Associated-with-3D-Printing-and-3D-Printed-Consumer-Products.pdf>

³⁷ [Lifecycle Evaluation of 3D Printers | CPSC.gov](#). September 23, 2022.

standards leveraging existing foundational standards. Staff participates or monitors the following UL product and horizontal standards development and revisions:

- UL 3300 *Outline of Investigation for Service, Communication, Information, Education and Entertainment Robots*
- UL 4600 *Standard for Safety for the Evaluation of Autonomous Products*

In developing these standards, emphasis is placed on operational challenges because specific requirements and prescribed controls are not practical for autonomous products. Standards development includes compiling safety cases for anticipated operational design domains, detection, environmental concerns, use and misuse of products, and methodologies. On March 31, 2022, staff held an AI/ML Forum to garner stakeholder input on concerns and approaches to addressing this new technology. Staff subsequently published a report outlining insights on test and evaluation of products using AI/ML. Staff will continue to participate in voluntary standards development with consumer products using AI and ML technologies.

2.2.9 Wearable Consumer Products and Technologies

Wearable consumer products comprise a wide range of technology-based products that are worn directly on the body. Products in this category include smart clothing and fitness trackers. These devices are continuing to grow in popularity, and the recent pandemic has increased the use of wearable products with biomonitors capabilities. Many wearables monitor body temperature, heart rate, and blood pressure, with some of these metrics used to indicate disease status. Staff is aware of products that are intended to be used by caregivers of vulnerable populations, such as infants, that allow parents to track infant sleep patterns, heart rates, and other factors. These products may provide essential information regarding the health status of an individual and may provide physicians, caregivers, and others additional tools that can improve biomonitors and allow expedited detection of an adverse outcome, and faster response. However, there are also concerns regarding the accuracy of these products and whether consumers without medical and scientific training can properly use and maintain these devices. Improper critical updates may impact the accuracy of these devices and result in an adverse outcome for the consumer.

Because wearable products are worn directly on the body, the issue of biocompatibility is also an important factor in many use scenarios. Staff has received complaints from consumers who have experienced severe dermal irritation resulting from the use of wearable products. Previous product recalls indicate that users can develop allergic or irritant reactions to the stainless-steel casing, materials used in the strap, or adhesives used to assemble the product, resulting in redness, rashes or blistering where the skin has been in contact with the wearable product. Nickel and latex allergic reactions are quite common for some people. Additionally, there have been recalls with products that allow moisture (*e.g.*, perspiration, water, or pool water) to get across the battery terminals or allow moisture across the charging terminals. Both scenarios can cause hydrolysis, which can lead to electrochemical burns and severe skin irritation.

More severe incidents have also been reported where a device exploded causing severe burns to the skin. Given these devices contain a power source (battery), hazards involving high heat conditions, or even fire, must be considered and addressed.

2.2.9.1 Activities 2017-2021

In November 2019, staff presented a briefing to the Commission on the commercialization of wearable products and the potential health risks that may result from the use of these products. In April 2020, CPSC staff released a report on wearables titled *Safety Concerns Associated with Wearable Technology Products*.³⁸ The report included a discussion of the challenges with determining jurisdiction for some products and whether they are consumer products or medical devices. A primary focus of the wearables report was to categorize the vast array of wearable products into categories, including accessories, articles, patches, imbeds and inserts. Through this categorization, the potential safety implication and hazards can be identified more easily, and potential mitigation strategies and voluntary standards needs can be pinpointed. In addition, CPSC staff routinely engages with staff from the FDA to discuss issues regarding the regulation of these products. The FDA regulates products that are considered medical devices, and this determination is made for each product.

Staff is aware of several voluntary standards activities that seek to address the potential safety hazards that may result from the use of wearable products, and they are recommending testing procedures to identify potential hazards and develop mitigation strategies. Staff's voluntary standards participation or monitoring includes:

- In December 2019, staff sent letters to UL and ASTM International requesting that they consider developing standards, certification programs, and best practices guidance associated with the safety of wearables products.
- On February 27, 2020, staff met with ASTM International leadership to discuss approaches to standards development for wearables.
- Staff is participating in the UL STP 8400 Virtual Reality, Augmented Reality and Mixed Reality Technology Equipment. This UL STP is developing a new standard for those products.
- ASTM subcommittee D13.50 for Smart Textiles, developed a standard for terminology of smart textiles and is considering requirements regarding durability of smart garment electrodes under certain conditions.
- ASTM subcommittee F08.53 on Headgear Sensors is developing a new standard for the use of force sensors in helmets and other headgear.
- ASTM subcommittee F15.75, for Connected Products, developed the new ASTM F3463-21, *Standard Guide for Ensuring the Safety of Connected Consumer Products*.

³⁸ <https://www.cpsc.gov/content/Safety-Concerns-Associated-with-Wearable-Technology-Products>

2.2.10 Virtual Reality/Augmented Reality/Cross Reality Update

Virtual reality is an exciting technology that allows users to engage in a computer-generated, three-dimensional world. The number of VR headsets sold in the United States and globally continues to grow, and sales estimates suggest a doubling of these devices sold over the next 5 years. In the United States, the VR market is estimated to increase from \$5B in 2021, to \$12B in 2024.³⁹ There are other projections that estimate sales to increase 18 percent annually from 2021 to 2028.⁴⁰ These sales and use data may be impacted by the use scenarios. Currently, VR devices are used largely by the gaming community; however, other applications for VR technology are expected to expand the uses for these devices. The pandemic has focused on the utility of virtual education, and users suggest that VR may enhance learning and the overall teaching process. Other applications include virtual meetings, where attendees develop an avatar to represent them in the virtual meeting space. The VR headsets can also be used to participate in events such as concerts or sporting activities. Given the wide range of consumer applications, the demographics of the VR users are expected to expand as well.

Since 2017, staff has begun to investigate the uses and potential hazards of VR devices and participate in voluntary standards activities that address these potential hazards. The initial concern with VR is that the user is completely absorbed into the simulated environment and cannot see the “real world.” Colliding into objects in the home environment, such as walls and furniture, is an obvious hazard that becomes more likely during some gaming activities involving rapid movements, where a gamer would collide into items with increased velocity. Another issue is the biocompatibility of the materials used in the VR, device which is worn directly on the skin. CPSC staff has received more than 100 complaints from users regarding severe skin irritation and sensitization, primarily from gaming devices. The users often engage in gaming where there is considerable physical movement, which may lead to sweating and the greater likelihood of chemicals migrating from the product matrix and that can result in dermal contact and subsequent irritation. In 2021, a popular gaming device was subject to a recall due to the potential irritation hazards.⁴¹

2.2.10.1 Activities 2017-2021

CPSC staff has actively participated in the UL 8400 voluntary standard for VR and AR devices. The draft standard addresses a wide range of hazards, including head trauma, eye injury, and irritation.

2.2.11 Personal Transportation Products/Micromobility

After the lessons learned with self-balancing scooters (also referred to as hoverboards), personal transportation was identified in the 2017 report as an emerging hazard. Specifically, the following categories were identified:

³⁹ <https://www.statista.com/topics/2532/virtual-reality-vr/>

⁴⁰ <https://www.grandviewresearch.com/industry-analysis/virtual-reality-vr-market>

- Pedal Electric Cycle (Pedelec)/Conversion Kits
- Electric Kick Scooters/Personal Scooters
- Electric Skateboard
- Electric Shoes/Skates

This area has become known as “micromobility,” and includes consumer and commercial-grade products, such as those used for on-demand rentals of battery-operated scooters and e-bikes.

Micromobility use has grown in popularity over the past several years. New developments, such as higher energy density lithium-ion batteries, have made micromobility products more affordable, more powerful, easier to charge, and lighter weight. With the advent of the “sharing economy,” commercial ride-sharing programs have expanded in cities, towns, and universities.

This trend has led to more micromobility products and their riders co-existing with motor vehicles on streets and with pedestrians on sidewalks. Although this access has improved transportation options available to many people, injuries have also occurred, due to impacts, falls, and other hazards. Given the demand for affordable products and local transportation needs, staff believes that new innovations in micromobility products will continue to grow.

2.2.11.1 Activities 2017-2021

Staff began a project to delve into micromobility personal transportation devices, specifically including electric scooters, electric hoverboards, and electric bicycles. These products were selected based on prior issues with hoverboards and the rapid expansion of ridesharing/rental platforms for e-bikes and e-scooters.⁴² The CPSC held a stakeholder forum on micromobility products in September 2020. The forum provided staff with information on the micromobility product market, hazards, risks, and risk reduction efforts that is assisting staff in making recommendations for improving consumer safety of these products.

The hazards associated with micromobility products primarily fall into three broad areas: (1) mechanical, (2) electrical, and (3) user/environmental factors. The mechanical hazards consist of falls, including rider ejections due to frame or structural failures, and braking problems and collisions with motor vehicles, objects, and pedestrians. The electrical hazards include fires and explosions due to battery failures, mechanical battery-mounting issues, and falls and rider ejections due to electronic control (hardware and firmware) problems. Hazards related to user/environmental factors include, but are not limited to, the abovementioned risks associated with user expectations and reasonably foreseeable use cases, such as those pertaining to user positioning (*e.g.*, probable forward body positioning due to handle placement and width of foot area) and the location and operation of emergency controls (*e.g.*, brakes), which affect the user’s ability to respond safely in a dangerous situation. These product hazards, in conjunction with

⁴² Lee, Douglas, Safety Concerns Associated with Micromobility Products, U.S. Consumer Product Safety Commission, March 2020. Online at https://www.cpsc.gov/s3fs-public/Report-on-Micromobility-Products_FINAL-to-Commission.pdf?THHlorYXAZ.KiZnobh1o7.7.IN9nNCLo.

rider unfamiliarity with the products, riders not using helmets, and local laws that vary, all contribute to consumer injuries.

Staff has conducted multiple studies of death and injury data for micromobility transportation devices,^{43,44} finding a statistically significant increase (p-value < 0.01)⁴⁵). It is too soon to understand if this represents a plateauing of incidents as the use becomes widespread or an artifact of the pandemic changing personal transportation needs.

To address the mechanical hazards associated with micromobility products, staff has been participating in the following ASTM standards activities to update existing and develop new voluntary standards:

- ASTM F2641-08 (reapproved 2015) *Standard consumer safety specification for recreational powered scooter and pocket bikes*
- ASTM F2642-08 (reapproved 2015) *Standard consumer safety specification for safety instructions and labeling for recreational powered scooters and pocket bikes;*
- ASTM F15.58 *Draft Standard consumer safety specification for self-balancing scooters (hoverboards); and*
- *ASTM F15.58 Draft Standard commercial electric-powered scooters for adults (commercial ride-sharing).*

Staff provided incident data and requested that the ASTM F15.58 subcommittee consider addressing brake failures, electrical and thermal-related events, software issues, durability (fatigue testing), dynamic and static load testing, environmental conditions, and warning labels and instructions.

Staff also actively participates in and monitors the following and related Underwriters Laboratories (UL) standards:

- UL 2272 *Standard for electrical systems for personal e-mobility devices.* (Staff notes this standard needs to be revised to include commercial ride-sharing products), and
- UL 2849 *Standard for electrical systems for e-bikes* (Staff notes this standard needs to be revised to include commercial ride-sharing products).

Prior to 2017, most of the battery-related fire and fall incidents from hoverboard products were associated with products manufactured before development of battery voluntary standards for electric-micromobility products. In 2016, the electrical voluntary standard, UL 2272, addressed the battery management system (BMS) requirements needed for lithium-ion battery safety. The

⁴³ Tark, James, "Micromobility Products-Related Deaths, Injuries, and Hazard Patterns: 2017–2021." U.S. Consumer Product Safety Commission, August 2022.

⁴⁴ Tark, James, "Micromobility Products-Related Deaths, Injuries, and Hazard Patterns 2017-2020." U.S. Consumer Product Safety Commission, September 2020. Online at: <https://cpsc-d8-media-prod.s3.amazonaws.com/s3fs-public/Micromobility-Products-Related-Deaths-Injuries-and-Hazard-Patterns-2017-2020.pdf?VersionId=s8MfDNAVvHasSbqotb7UC.OCWYDcqena>

⁴⁵ Tark, James, "Micromobility Products-Related Deaths, Injuries, and Hazard Patterns: 2017–2021." U.S. Consumer Product Safety Commission, August 2022.

standard, along with CPSC’s letter urging manufacturers, importers, distributors, and retailers of self-balancing scooters to certify their product to the voluntary standard, appears to be effective, based on no known substantial fires associated with products certified to the voluntary standard that did not involve modifications to the product.

2.2.12 New Materials (Advanced and Emerging Materials) and Nanotechnology

A fundamental aspect of technological innovations is the incorporation of new functions into a product, and material science has been identified as a critical driver in the development of these new technologies.⁴⁶ Material science involves the understanding of the properties of matter and its applications to various areas of science and engineering. Over the past 20 years since the release of the National Nanotechnology Initiative (NNI), significant media attention has been focused on the potential impacts of nanoscience and nanotechnology, in addition to placing greater emphasis on the role materials science plays in the development of new technology.⁴⁷ Emerging products and applications in electronics, robotics, 3D printing, and mobility products all rely on materials that possess a wide range of properties, such as strength, flexibility, and electrical conductance as essential features that promote improved performance. The materials used to provide these needed properties are developed through exhaustive research into the intrinsic properties of the materials and how they may be used in these new applications. In recent years, there has been a shift to describe these materials as “advanced” materials.

Regardless of the terminology, advanced and nanoscale materials are experiencing increased use in a wide range of technologies, and ongoing research is finding new ways to utilize the unique properties of these materials. The electronics and semiconductor industries are significant users of nanoscale transistors and other components leading to smaller and more powerful handheld devices and sensors. Additive manufacturing/3D printing is an emerging technology that has also been a significant user of these materials. Traditional materials like concrete and thermoplastics have been engineered or “advanced” to provide the properties needed for their use in the printing process.

Given their unique properties and functions, concerns regarding their potential effects on consumers who use products made with these materials have been raised. Nanomaterials have been the subject of concern regarding their responsible incorporation into consumer products. The NNI agencies have worked together to develop testing protocols, and several interagency agreements between the CPSC and the Environmental Protection Agency, National Institute for Occupational Safety and Health (NIOSH), and National Institute of Standards and Technology (NIST) have been developed. These interagency agreements provide a mechanism to develop collaborative research efforts to quantify the release of advanced nanomaterials from consumer products.⁴⁸ International efforts have included collaborations with European scientists through

⁴⁶ <https://www.americanelements.com/materials-science> Materials Science | AMERICAN ELEMENTS ®

⁴⁷ https://www.nano.gov/sites/default/files/pub_resource/NNI-2021-Strategic-Plan.pdf

⁴⁸ <https://www.tandfonline.com/doi/abs/10.1080/17435390.2022.2028919>

contracts with U.S. academics. CPSC staff supported scientists from the University of Florida, who worked with researchers in Germany, Portugal, France, and other European nations to develop testing protocols for silver nanoparticles used in touch screens.⁴⁹

2.2.12.1 Activities 2017-2021

There has been great interest in understanding advanced materials, including a consensus on the definition of “advanced materials,” and the similarities and differences with nanomaterials. In August 2020, the ANSI Nanotechnology Standards Panel (NSP) convened a workshop on “Advanced Materials.” The purpose of the workshop was to examine efforts beyond nanotechnology and the potential inclusion of materials that may be considered “advanced materials” into nanotechnology activities.⁵⁰ The workshop included several stakeholders from government agencies, industry and non-governmental organizations who discussed their perspectives on current and proposed activities to define “advanced materials” and develop safety standards for these materials. A follow-up webinar on advanced materials was held in May 2022.

There are several organizations and voluntary standard activities that have developed protocols for testing nanomaterials and addressing the data needs to build robust risk assessments of nanomaterials incorporated into products. Specially, staff is aware of:

- International Standards Organization (ISO) TC 229, which has a significant number of toxicity testing guidelines available for stakeholders to use to test nanomaterials in a range of media. In 2020, CPSC staff began leading an effort to develop a standard ISO protocol to quantify the release of nanomaterials from treated wood products.
- ISO TC 229 has also sponsored meetings to discuss the safety of advanced materials and has sought to develop a consensus definition of the materials and determine how they differ from nanomaterials.
- Other standards organizations, such as the ASTM E56, have released guidance documents on nanomaterial safety.
- Research collaborations between CPSC, EPA and NIOSH have been conducted in several areas, including 3D printing and additive manufacturing. These partnerships have also resulted in technical reports that provide guidance on the use of nanosilver in textiles.⁵¹

2.2.13 Brain Machine Interface/Implantable Technology

The ability to improve brain function is a need of many consumers, such as the elderly, who may suffer from dementia, or students seeking to improve their academic performance.

Neurocognitive stimulation is just one of the outcomes that may result from the use of brain stimulation devices that have been commercialized in the past few years. Devices that provide

⁴⁹ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3912856/>

⁵⁰ <https://share.ansi.org/Shared Documents/Standards Activities/ANSI-NSP/ANSI-NSP 125-2020 Adv Materials Presentation Sharma.pdf>

⁵¹ <https://sn.astm.org/?q=update/silver-nanomaterials-textiles-so16.html>

this improvement may be placed directly on the scalp or directly implanted or attached to the brain or nervous system. Many of these devices use Transcranial Direct current stimulation that involves placing electrodes directly on the head or Transcranial Magnetic Stimulation (TMS) that is based on the induction of a magnetic field in a coil that is also placed on the head.⁵² These devices are used to aid in relaxation and meditation in addition to improvement in cognitive function.⁵³ Some of this technology is incorporated into games for young children that involves placing the device on the child's head and allowing the child's brainwaves to interact directly with the game. Academic researchers have shown these devices to be effective in altering mood, as well as short-term memory tasks.⁵⁴

Some scientists have expressed concern about the potential hazards of external neurostimulation devices.^{55,56} There is particular concern regarding kits that allow consumers to make their own devices. With this technology incorporated into games, chronic impacts on the developing brain and neurological systems of young children is unknown. Implantable technology is a rapidly evolving product area, with trends moving very quickly. As these technologies require surgeons or other medical professionals to implant the devices, RMG staff is maintaining contact with the FDA and interfaces, when necessary. However, the role of CPSC's jurisdiction over these technologies is case dependent, and requires evaluation of each product hazard, to determine whether it is a consumer product and not a medical device.

2.2.13.1 Activities 2017-2021

Staff engaged in monthly meetings with the Food and Drug Administration (FDA) to discuss the commercialization of devices that may impact the neurological system.

2.2.14 Energy Storage/Generation

In the 2017 report, staff identified several potential hazards with energy storage systems, including lithium-ion battery hazards. The use of batteries in consumer products continues to grow exponentially. Portable power stations/battery generators have become increasingly popular, offering up to several kilowatt hours for residential power outages and use in remote locations. Solar energy has also increased with either a need to safely store energy locally or a means to transfer energy to the power grid. Recently, a climate energy bill passed that further promotes the use of alternative energy sources that will likely involve technology advances in wind, batteries, heat pumps, solar energy, and hydrogen fuel cells. Although energy efficiency is

⁵² <https://www.health.harvard.edu/mind-and-mood/can-brain-stimulation-aid-memory-and-brain-health>

⁵³ <https://forum-network.org/lectures/wearable-brain-stimulation-device/>

⁵⁴ Ohn, S.H., Park, C.I., Yoo, W.K., Ko, M.H., Choi, K.P., Kim, G.M., Lee, Y.T. and Kim, Y.H., 2008. Time-dependent effect of transcranial direct current stimulation on the enhancement of working memory. *Neuroreport*, 19(1), pp.43-47.

⁵⁵ McKendrick, R., Parasuraman, R. and Ayaz, H., 2015. Wearable functional near infrared spectroscopy (fNIRS) and transcranial direct current stimulation (tDCS): expanding vistas for neurocognitive augmentation. *Frontiers in systems neuroscience*, 9, p.27.

⁵⁶ McCall, I.C., Lau, C., Minielly, N. and Illes, J., 2019. Owning ethical innovation: claims about commercial wearable brain technologies. *Neuron*, 102(4), pp.728-731.

expected from these changes, safety issues and advances are unknown at this time. Some concerns include the use of more lithium batteries in the home for energy storage products could lead to more fire and shock hazards in the home. However, advances in solid-state lithium batteries are also expected to drastically improve thermal issues with lithium batteries.

2.2.14.1 Activities 2017-2021

As part of the fiscal year 2017 and 2018 Operating Plans, the Commission directed staff to perform additional work to address the emerging and ongoing hazards associated with high-energy density batteries. The project is intended to review enforcement, voluntary and mandatory standards, import surveillance and compliance, and industry, interagency, and intergovernmental activities to mitigate the hazards. More information and status reports of the battery project are archived at: <https://www.cpsc.gov/Regulations-Laws--Standards/Voluntary-Standards/Topics/Batteries>.

New trends in battery technology include high-energy-density cells, safer cells, and early- (fault) detection battery management systems. CPSC funded [research](#) to learn about emerging high-energy-density battery technologies and to identify strategies to mitigate the fire hazards related to battery failures. The research focused on technologies with viability for consumer applications. CPSC staff is using the results to guide future efforts to promote development of safer high-energy-density batteries for consumer applications and possibly to develop recommendations for improvements to standards for batteries and battery-powered products.

Some experts believe that batteries with solid-state electrolytes will dominate the market in 3 to 5 years. These batteries will have greater than two times the energy density, more cycle life, and charge four times faster. However, they will not have flammable electrolytes that present lithium-ion batteries use. Flexible solid-state batteries use a gel polymer electrolyte and have similar benefits, but are stable, even with bending fatigue. These batteries are optimal for wearable products or anywhere where a flexible battery is needed.

Presently, manufacturers are optimizing the materials to use for solid-state electrolytes and developing methodologies for mass manufacturing of larger capacity cells. Solid-state electrolyte batteries are expected to eliminate thermal runaway and explosive cell issues that are common with manufacturing defects or battery-shorting issues in lithium-ion batteries. These types of batteries are expected to require less complex battery management systems and thermal management to ensure safety. Nonetheless, voluntary standard updates for new technologies will continue to address battery management, flexing tests, battery washing, and operational safety, as needed.

Staff sponsored a contract to develop mitigation of single-cell faults in consumer products. The report of this research can be found at: <https://www.cpsc.gov/content/Consumer-Product-Safety-Commission-CPSC-Staff%E2%80%99s-Statement-on-Naval-Surface-Warfare-Center-Carderock-Division%E2%80%99s-NSWCCD-Report-on-%E2%80%9CEvaluation-of-Cell-to-Cell-Propagation-in-Lithium-Ion-Batteries-Containing-18650-Sized-Cells%E2%80%9D>. The objective was to learn more about the catastrophic failures of multicell lithium-ion battery packs, such as those used in hoverboards, from a single cell that enters a thermal runaway condition,

and to evaluate several methods to isolate the failure to the one cell. This information will support improvements for the voluntary safety standards for electric scooters, e-mobility devices, and other consumer products, to reduce the severity of fire incidents.

Staff worked on the development of and/or revision of several standards relating to battery management and operational safety:

- *IEEE 1725 Standard for Rechargeable Batteries for Mobile Telephones*
- *IEEE 1625 Standard for Rechargeable Batteries for Multi-Cell Computing*
- *UL2054 Standard for Household and Commercial Batteries*
- *UL2056 Outline of Investigation for Safety of Power Banks*
- *UL1642 6th Edition Standard for Safety for Lithium Batteries*
- *UL2743 2nd Edition Standard for Portable Power Packs*
- *UL1310 7th Edition Standard for Safety for Class 2 Power Units*
- *UL 62133 2nd Edition Standard for Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, for Batteries Made from Them, for use in Portable Applications*
- *ANSI C18.2M Part 2-2021 American National Standard for Portable Rechargeable Cells and Batteries-Safety Standard*
- *ANSI C18.4-2017 American National Standard for Portable Cells and Batteries – Environmental*

2.2.15 Robotics

Given AI/ML's continual evolution and myriad applications, no single standard exists for robotics. CPSC staff is working to address the safety concerns of potential hazards associated with these technologies by participating in the establishment and enhancement of voluntary consensus standards leveraging existing foundational standards.

2.2.15.1 Activities 2018-2021

Staff participate in the following UL product and horizontal standards development and revisions:

- *UL 2900 Standard for Software Cybersecurity for Network-Connectable Products*
- *UL 3300 Outline of Investigation Helps Advance Safety of Consumer, Service, and Education Robots*
- *UL 4600 Standard for Safety for the Evaluation of Autonomous Products*
- *UL 5500 Standard for Safety Remote Software Updates*

Emphasis is placed on operational challenges, because specific requirements and prescribed controls are not practical for autonomous products. Standards development includes compiling safety cases for anticipated operational design domains, detection, environmental concerns, use and misuse of products, and methodologies. In March 2022, staff held an AI/ML Testing and Evaluation Forum to assist in the development of AI/ML testing in product voluntary standards.

2.3 SUMMARY

The continued evolution of consumer products provides significant opportunities for improved product performance and consumer satisfaction, but it also provides the potential for new hazards that must be understood and mitigated. Since the publication of this preceding report in 2017, the staff has not only become aware of these new product trends, but we have also been engaged in several activities, including the development of focused reports on micromobility; IoT; 3D printing and wearable technology; and we've provided briefings to the Commission regarding these product categories. Staff has engaged with other federal agencies through the development of new interagency working groups, such as those formed for IoT, Battery Safety, and existing efforts in advanced materials. Staff has also monitored and participated in a range of voluntary standards activities, and when needed, we have communicated with voluntary standards organizations to encourage them to develop standards in specific areas of need. Other countries around the world, such as those in the EU, have also been engaged in understanding emerging hazards, and staff has engaged globally to leverage resources, information, and risk management approaches.

In the 5 years since the development of the report, new trends and product applications have been identified, as described in Part 1 of this report. In addition, the Covid-19 pandemic has caused changes in behavioral patterns and resulted in more pronounced engagement in others. Along with the growth of this technology, proper attention must be paid to understanding and addressing the associated health and safety risks that may arise. Additional resources will be required to enable CPSC to keep up with these changes and ensure that the public is protected from unreasonable risk.

The 21st century promises to be a time of significant technological changes and integration of these technologies into society. Consumer products will continue to be a major focus for technology and provide a gateway for enhanced human interactions. Through interagency collaboration, engagement with stakeholders, voluntary standards activities, and global engagement, staff will be able to understand and address the potential hazards that may arise from these rapidly evolving product innovations.

