A Qualitative Study of the Correlation Between Human Factors and Design Hazards in Consumer Products

Submitted to the Faculty of

Worcester Polytechnic Institute

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Sponsoring Agency: Consumer Product Safety Commission (CPSC)

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Abstract

This project examined the underlying trends in consumer product defects—specifically, trends pertaining to human factors—for the U.S. Consumer Product Safety Commission (CPSC). The team conducted archival research of Product Safety Assessments (PSAs), internal interviews of CPSC staff, and discussions with industry representatives. As a result of the research, the team recommends that the CPSC generate a handbook for both internal and external use. The handbook will inform external users about the importance of integrating human factors into product design. Internally, the handbook will encourage increased awareness of the importance of human factors in product design. The team made additional recommendations to improve the utility of CPSC's internal databases.

Authorship

Throughout this report, the team members provided equal contributions in research and writing. Thus, all team members deserve equal credit as authors. Details regarding the specific contributions of each student during this Interactive Qualifying Project (IQP) follow.

Kendall Cotton focused on the background of the CPSC and current design methods. Furthermore, he examined the Mechanical Engineering Product Safety Assessments and identified trends. Cotton also formatted the Excel document and generated the figures within the report.

Taylor Landry concentrated on the selection of PSAs and the background of human factors. Additionally, Landry reported the trends gleaned from the interviews and summarized the group's findings in the report's conclusion. In addition, he assumed primary responsibility for developing the final presentation.

Lastly, Adam Morehouse examined the potential product hazards based on a review of human factors and health sciences PSAs. In addition, Morehouse formulated the recommendations ultimately provided to the Commission resulting from the team's investigation.

Although sections of the report have primary authors, each section received multiple team edits. Our team worked together in an equitable and cooperative atmosphere to produce the final product.

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List of Acronyms

Acronym	Definition
ANSI	American National Standards Institute
ASTM	American Standards for Testing and Materials
CAP	Corrective Action Plan
CO	Compliance Officer
CPSC	Consumer Product Safety Commission
ES	Engineering Science
EU	European Union
EXHR	Office of Hazard Identification and Reduction
FDA	Food and Drug Administration
FY	Fiscal Year
GDP	Gross Domestic Product
HF	Human Factors
HS	Health Sciences
ICPHSO	International Consumer Product Health and Safety Organization
IDI	In-Depth Investigation
IRAD	Innovative Risk Assessment Design Model
IQP	Interactive Qualifying Project
ME	Mechanical Engineering
NEISS	National Injury Surveillance System
NIST	National Institute of Standards and Technology
OCFO	Office of Compliance and Field Operations
PSA	Product Safety Assessment
RAPEX	Rapid Alert System for Non-Food Consumer Products
REM	Risk Elimination Model
UL	Underwriters Laboratories
WPI	Worcester Polytechnic Institute

Executive Summary

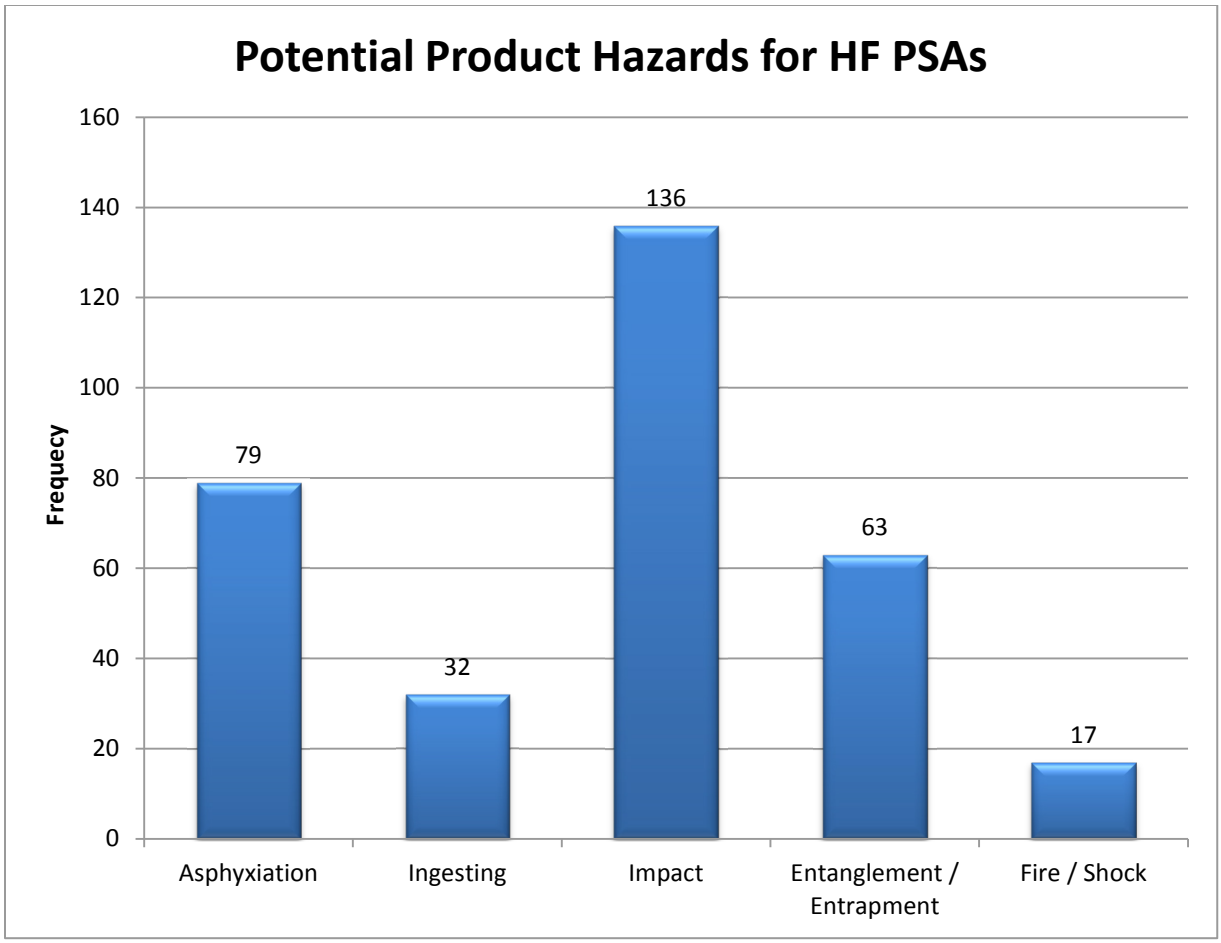
As technologies develop and grow, people's interactions with consumer products become more complex and extensive. People around the world use consumer products every day, but people are often unaware of the hazards consumer products can pose. Although products frequently come with warning labels and instructions stating the product's intended use, consumers often ignore the warning labels and instructions, increasing the likelihood of injury. Product misuse beyond manufacturers' guidelines is inevitable and can result in a serious injury or death. Identifying how a consumer might misuse a product and designing the hazard out prior to manufacture is a true challenge for product designers. The CPSC's Division of Human Factors has a team of psychologists and engineers who evaluate product designs not only for potential misuse of the product, but also to account for the human-product-environment system. Integrating sound human factors analysis and testing into the design process are two of the most difficult steps in attempting to ensure that a product is safe. The CPSC is interested in encouraging widespread awareness and application of human factors design among product manufacturers. Manufacturers and designers often fail to evaluate the risks associated with a product until an injury related to the product has been reported. The CPSC hopes to improve the safety of products entering the marketplace by providing strategies for manufacturers to follow regarding integrating human factors analysis early in the design process.

Currently, the CPSC is primarily a reactive agency, meaning that the agency may not take corrective action until a hazardous product-related incident occurs that demonstrate a potential product defect. Ideally, products enter the market hazard free; however, this is an unrealistic expectation, largely because of the human element. While the CPSC's current reactive stance helps to protect the public, there is room for improvement to prevent incidents from happening in

the first place. Manufacturers could accomplish this by incorporating pre-production human factors analysis into product design. Product-related incidents recur cyclically: manufacturers create products and introduce the products to the public; an injury or an incident occurs; manufacturers reevaluate the product; and the problem is mitigated or fixed. The Division of Human Factors (HF) is interested in supporting industry by informing manufacturers about common design risks that occur with products similar in category and function. By educating manufacturers and product designers about some of the foreseeable misuses of products, the CPSC hopes to reduce greatly the number of unsafe products made available to the public.

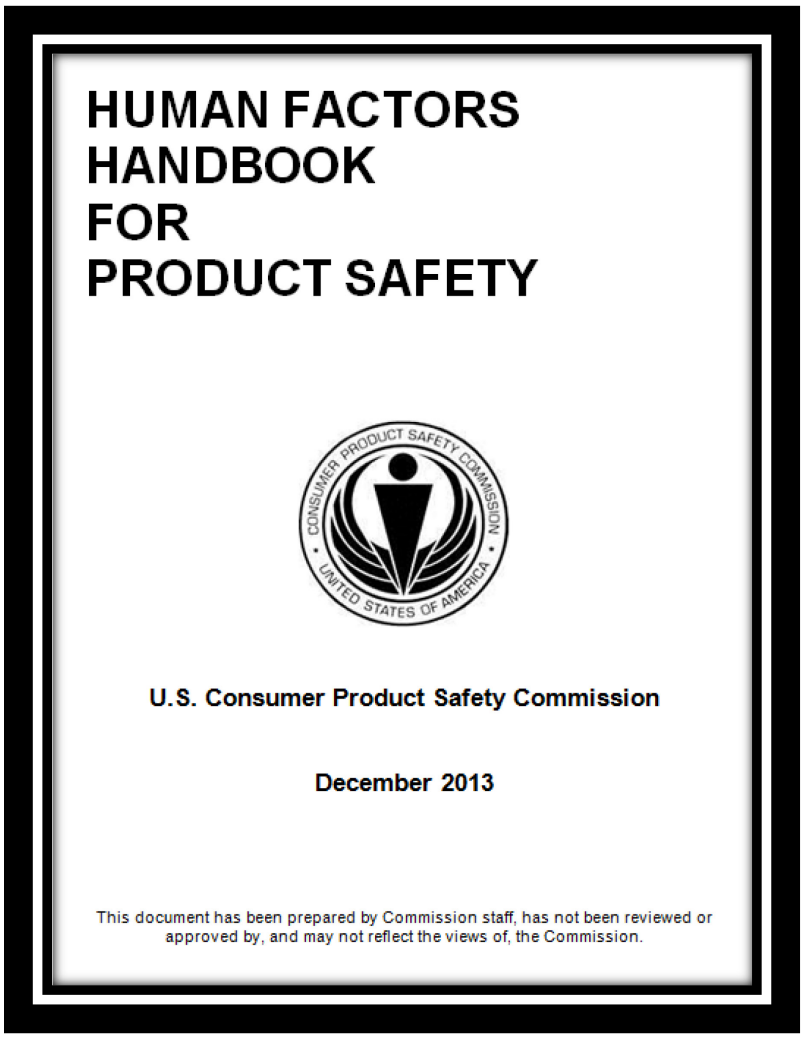
The goal of this project was to formulate a method of communicating information proactively to manufacturers regarding best practice design guidelines with the intent of reducing the risk of injury that products might pose, whether the risk is due to technical factors or human misuse. To achieve this goal, we conducted an archival study of PSAs; reviewed internal documents analyzing product incidents; identified common human factors' design and performance trends; and explored the root causes of product incidents. Interviews of CPSC personnel and discussions with representatives of manufacturers and trade associations connected with consumer products demonstrated the steps CPSC takes to help mitigate issues with hazardous consumer products. The interviews were helpful in identifying potential gaps in manufacturers' product design systems that may need to be addressed. Interviews with company and trade association representatives showed how the companies and organizations work to incorporate human factors analysis into their design process.

A significant number of hazards are associated with home goods, infant products, and children's toys. From the Human Factors PSAs for FY 2011 to FY 2013 we found the most frequent hazard was an Impact hazard, as shown in Figure below.



Many of these hazards arise from manufacturers' inattention to the applicable voluntary and/or mandatory standards for their products. Our analysis of PSAs and the interviews we conducted suggest that standards for products exist, but manufacturers lack accountability when it comes to abiding by the relevant standards. Communication between firms and the CPSC is lacking; communication within various divisions in the CPSC needs improvement; and communication between firms and the consumers who use their products is poor. We concluded that manufacturers must be educated about the importance of incorporating human factors into their design processes.

We suggest that the CPSC consider drafting a human factors best practices handbook for manufacturers. Our team has provided a template to the Human Factors Division; shown below is our suggested title and cover page (see Appendix J for a complete template).



Currently, awareness of human factors and its impact on product safety is not widely understood. We also recommend that the CPSC work to improve the utility of the agency's internal database communication and data storage. Further, The CPSC's internal and external communications could also be improved. Overall, this project provided insight into current industry practices and identified measures that can be undertaken to improve them.

Chapter 1: INTRODUCTION

Consumer products are increasing in complexity and diversity, leading to an increase in product-related injuries (Gartaganis, 2010; Ford, 2011). Since products are becoming more sophisticated, there are more complex user interactions with a wide variety of consumer products, thus opening the door for an increase in possible misuse (Wickens, 1999). Product design should focus on the physical operation of the product and the full range of possible user interaction with a product in order to ensure the safety of the operator or other end users. Government agencies have responded to this dilemma by initiating efforts to develop human factors design guidelines (Campbell, 1996). The increasing complexity of products has emphasized the importance of providing product developers with human factors guidelines early in the design process.

In the United States, some products are released to the public that are potentially hazardous to consumers. When a consumer product incident occurs, the Consumer Product Safety Commission (CPSC, 2010) is notified and the agency analyzes the incident to determine its cause. The CPSC is an independent federal health and safety regulatory agency that is responsible for protecting the public from risk of injury or death related to consumer products. Ideally, the CPSC would not have to deal with any incidents if all products entering the market posed no danger to the consumer. However, this is not the case, often because of potential human factors issues and design flaws, products enter the marketplace that cause harm to consumers. Human factors is a systems engineering discipline that takes into account human capabilities and limitations in designing products. Product developers also use different design procedures, which form the basis for various product development standards, which ultimately can lead to varying

levels of safety standards (Wickens, 1999). Currently, there is no consistent set of design guidelines across manufacturers to minimize flaws and misuse of products by consumers.

The CPSC (2013c) is a reactive agency by nature, examining products that have resulted in severe consumer injury. The CPSC's Division of Human Factors currently provides analysis focusing on consumer product incidents and how a user interacts with a product. When examining an incident, the CPSC creates a Product Safety Assessment (PSA), a document that provides a technical analysis of a product-related hazard (Bonnie Novak, personal communication, Sept. 11, 2013). PSAs are initiated by the CPSC primarily in response to contact from a company self-reporting that complaints have been filed or incidents have occurred due to a particular product. Research into the manufacturing design process and the steps needed to avoid harmful products includes task analysis methods and strategic plans to prevent product failure and to achieve higher safety standards (Ainsworth & Kirwan, 1992). Liu (2003) analyzed why product designers will often make design decisions based on intuitive judgments as opposed to using systematic and scientific methods. These studies identified a lack of systematic approaches and provided suggestions about how to avoid this failure to implement an essential element of engineering fundamentals.

Despite current research into design guidelines, an increasing information gap exists between the advancement of product systems and the consistency and availability of human factors design criteria (Campbell, 1996). At the CPSC, staff evaluates product failures. However, there has been little or no research conducted on identifying poor human factors design and performance trends that emerge from a critical analysis of the PSAs (Bonnie Novak, personal communication, Sept. 11, 2013). It is important to identify these performance trends and uncover common design flaws that lead to product failures so that manufacturers can reduce the

occurrence of these flaws. Furthermore, the CPSC wants to research what standardized human factors design criteria companies are using and determine whether companies are incorporating operational scenarios into their design and product development, such as intended use and foreseeable misuse of products.

The goal of this project was to formulate a method of communicating information proactively to manufacturers regarding best practice design guidelines with the intent of reducing the risk of injury that their products might pose, whether the risk is due to technical factors or human misuse. In turn, this will greatly reduce the number of unsafe products released in the marketplace. We achieved our project goal by reviewing Product Safety Assessments (PSAs) completed by the Division of Human Factors, Division of Mechanical Engineering, and Division of Health Sciences by identifying human factors design and usability hazards. Furthermore, we interviewed CPSC and industry officials to determine the processes and methods used to address product incidents. Upon completion of our research, we recommended a communication plan to the CPSC, outlining how the agency can educate and inform manufacturers about design steps that can help prevent products that pose risks to consumers from entering the marketplace. This research will help increase the consumers' safety from potentially hazardous products.

Chapter 2: BACKGROUND

People around the world use consumer products every day, but often people are unaware of the hazards consumer products can pose. This chapter will provide an overview of consumer products and the potential safety risks that arise from these products. We will also discuss the resources at the CPSC's disposal used to mitigate health and safety risks from these products. Moreover, we will examine the discipline of human factors and its ability to uncover design flaws in the product pre-production stage. Finally, we will review companies' protocols to prevent product-related design flaws.

2.1 Consumer Products

The Consumer Products Safety Act of 1972 (U.S. Congress, 1972) defines a "consumer product" as:

> any article, or component part thereof, produced or distributed (i) for sale to a consumer for use in or around a permanent or temporary household or residence, a school, in recreation, or otherwise, or (ii) for the personal use, consumption or enjoyment of a consumer in or around a permanent or temporary household or residence, a school, in recreation, or otherwise; but such term does not include— (A) any article which is not customarily produced or distributed for sale to, or use or consumption by, or enjoyment of, a consumer (Section 3a).

The CPSC (2013c) regulates a variety of different consumer products; these products range from dishwashers to toys, all-terrain vehicles to art supplies, children's sleepwear to portable gas generators, and cigarette lighters to household chemicals. Consumer products are essential to the global economy (C.I.A., 2013); in the United States, consumer products account for nearly 71 percent of the nation's Gross Domestic Product (GDP). As the number of consumer products on the market have increased, so have the number of defects and failures (Gartaganis, 2010; Ford, 2011).

2.2 Product-Related Injuries

Consumer products are commonly designed for a specific type of user, frequently categorized by factors such as age or gender. An adult is not likely to use a car seat, nor is a child likely to use a lawnmower (Healthy Children, 2001). One of the biggest challenges presented to engineers when developing a new product is how do you ensure that the intended user is handling the product? The CPSC and manufacturers have to consider factors such as safety features, usability, choking hazards, and other potential misuse of a consumer product (Bonnie Novak, personal communication, Sept. 11, 2013).

In 2010, approximately 38,573,000 people sought medical attention for an injury related to a consumer product but not necessarily caused by one (Schroeder, 2012). This is a 5.6 percent increase from the prior year. Out of all of those injuries, it is hard to identify one specific trend. However, one of the largest trends is with injuries related to landings, stairs, ramps, and floors. These accounted for 18 percent of the consumer product-related injuries in 2010 resulting in hospitalization.

Another established trend is the age range of consumers who are most likely to be injured. Figure 2.1 shows the data presented by Schroeder (2010) of medically treated injuries related to consumer products by age group from 1985 through 2010.

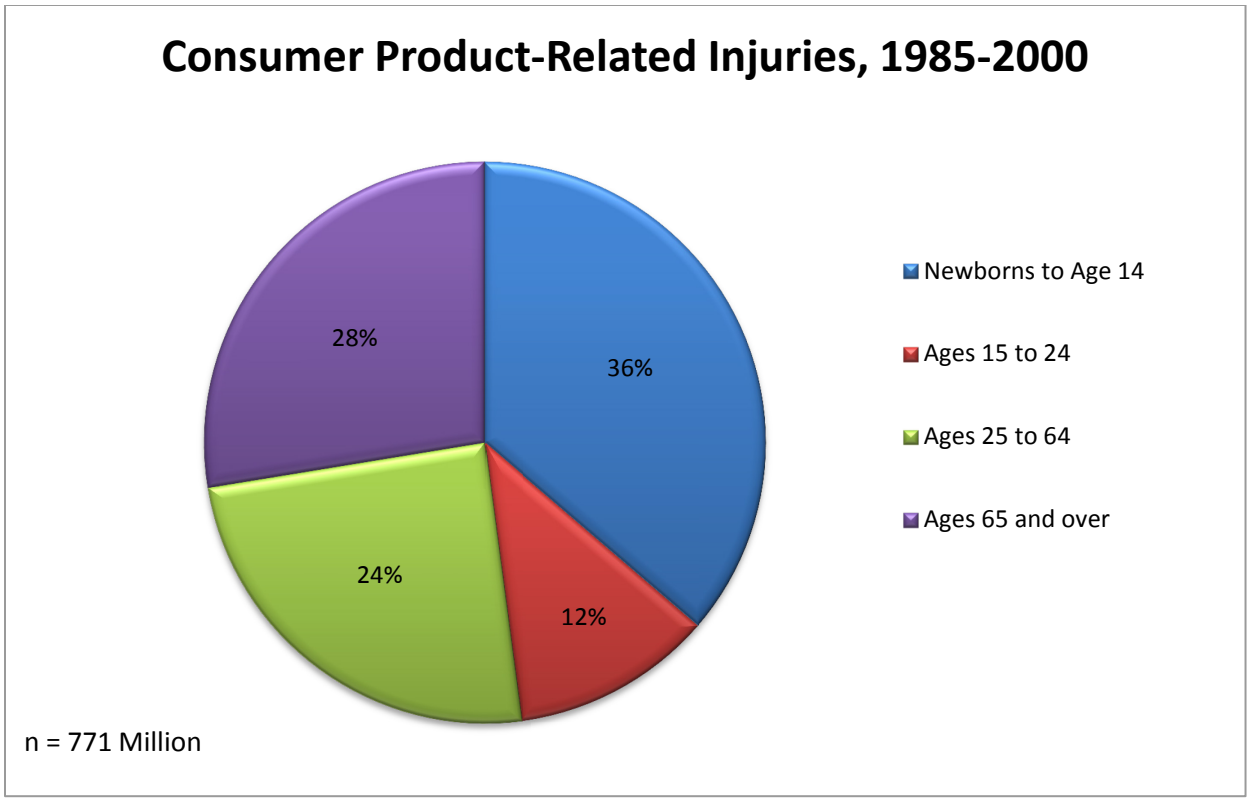


Figure 2.1: Consumer Product-Related Injuries by Age of Consumer per 100 residents (Schroeder, 2012, Table C)

The figure suggests that the majority of accidents with consumer products involved infants and the elderly. Schroeder (2012, Table C) further suggests that there is an increase in product-related injuries with consumers over the age of 85 in the past few years. In 2005, 19.4 per 100 subjects over 85 years old had product-related injuries. In 2010, the number increased to 27.2, which is a significant increase. This increased injury rate to the elderly suggests a need to consider product designs for an aging population.

2.2.1 Types of Safety Issues

With a diverse range of consumer products, there is also a wide variety of safety issues. Many of these issues are related to children but also involve all other age ranges. Mislabeled products are among the leading causes of injury because the user does not properly understand, or appreciate the hazards associated with, operation of the product and uses the product for

unintended functions (CPSC, 2013a). Some of the common accidents related to product misuse are electric shock, lacerations, and choking (CPSC, 2013d).

2.2.2 Human Factors vs. Product Defects

Consumer product-related incidents are not always related to mechanical flaws (CPSC, 2013d). Product designers not only have to ensure that their products are sound mechanically, but they also have to take into account any possible misuses. For example, engineers do not design most vehicles or other motorized equipment to be operated in enclosed spaces. However, despite manufacturer warnings, some operators may purposely or accidently operate their equipment indoors or within confined spaces, which results in the accumulation of carbon monoxide. This can lead to carbon monoxide poisoning or even death. This example illustrates that human factors are an essential part of the design process, and potential misuses need to be considered by the design team to protect the consumer.

2.3 Human Factors

Due to increasing technological developments, it is essential to consider the interactions of humans with machines (Wickens, 1999). The discipline of "human factors" can be defined as "the study of how humans accomplish work-related tasks in the context of human-machine system operation, and how behavioral and nonbehavioral variables affect that accomplishment" (p.2). This discipline was created after World War II when engineers examined why there were so many product failures, particularly with plane crashes, when there were no mechanical defects detected. The main goal of this discipline is to reduce design error, increase productivity, and enhance consumer safety. Being a human factors specialist requires a deep background in engineering and psychology. Having an understanding of how humans interact with products and how to incorporate that knowledge into a design process is crucial to designing a safe product.

This can be understood more easily from the product design and evaluation cycle presented graphically in Figure 2.2. The figure depicts the cyclical life of a product and how it starts with design, enters the market, evaluated and then a conclusion is drew about the product. Depending upon this cycle the product may have to go through the design phase again.

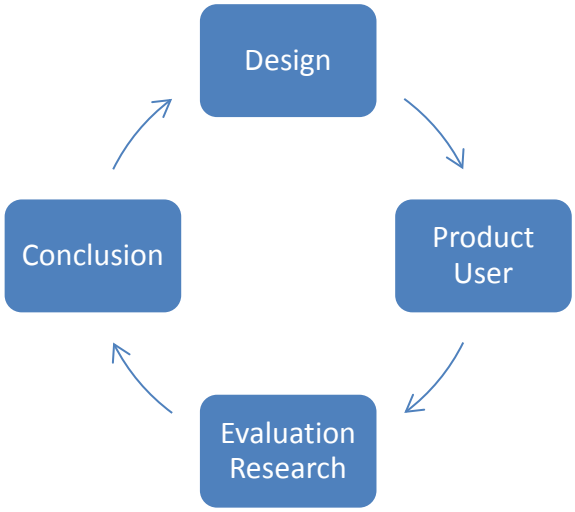


Figure 2.2: Product Design and Evolution Cycle (Wickens, 1999, Figure 1.1)

A study on human factors done with the Federal Aviation Administration, Gray (2012) agrees with Wickens (1999) regarding the process considering human factors. Gray explains that from a design standpoint, greater productivity and reduced overall costs can be achieved when human factors are considered early on in a design process. This relation of productivity and cost when human factors are applied early in the design process can be seen in Figure 2.3.

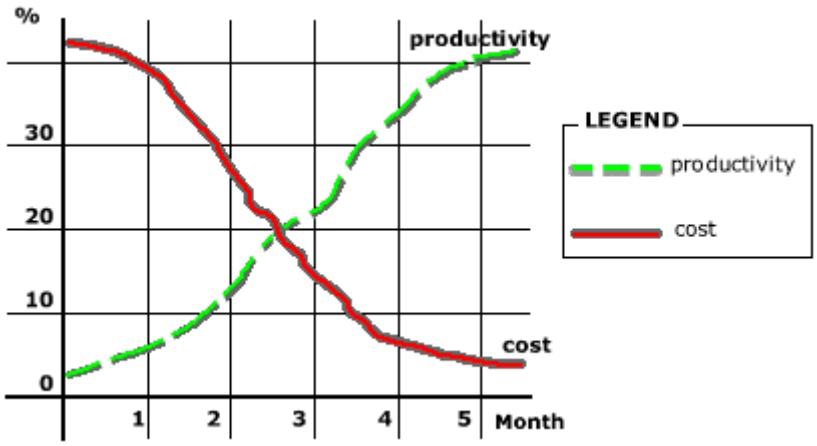


Figure 2.3: Improved System Design Results in Reduced Costs and Improved Productivity/Performance (Gray, 2012, Why Should We Care about Good "Human Factors")

Currently, there is no consistent guideline for balancing product development for physical design and human factors elements. To improve product safety, there needs to be a system that integrates both of these components.

The human factors profession prescribes a hierarchy of methods to address hazards that are ordered according to effectiveness (Fowler, 1980; Sanders & McCormick, 1993; cf. Tillman & Tillman, 1991). The primary goal is to design the dangerous features out of the product. If that is not feasible, protect against the hazards by guarding or shielding. If no other option is available, provide adequate warnings and instructions for proper use and foreseeable misuse. Instructions and warnings are a last resort because they rely on human variables, such as attention, perception, comprehension, memory, motivation, and a willingness to read and understand instructions and warnings provided. Although instructions are essential, people tend to read them only when they cannot proceed without them; and then consumers skim the instructions to find the information they need. Warnings may be skipped because they are

perceived as unlikely to contain important and relevant information. Even when instructions are used, people may fail to notice important details and may misread or misinterpret what they have read. If the instructions require later action, people may forget or fail to follow through.

2.4 The Consumer Product Safety Commission

The United States regulates consumer products through the CPSC. The CPSC is an independent federal health and safety regulatory agency responsible for protecting the public from risks of injury or death related to consumer products. Congress created the agency under the *Consumer Product Safety Act* in 1972 (United States Congress, 1972, 15 USC 2051-2084). Congress stated many reasons for creating the CPSC, including:

- An unacceptable number of consumer products that present unreasonable risks of injury are distributed in commerce;
- Complexities of consumer products and the diverse nature and abilities of consumers using them frequently result in an inability of users to anticipate risks and safeguard themselves adequately;
- The public should be protected against unreasonable risks of injury associated with consumer products;
- Regulation of consumer products the distribution or use of which affects interstate or foreign commerce is necessary to carry out this Act (Section 2a).

Congress was motivated to protect the public from hazardous consumer products, and there was no existing legislation that could accomplish this purpose on its own.

2.4.1 Internal Offices

The CPSC (2013b) is structured with different offices to focus on a specific task to achieve its mission, vision, goals, and purpose. Details about the structure of the CPSC can be found in Appendix A. In this section, we will discuss the Office of Hazard Identification, the Office of Compliance and Field Operations, and the Directorate for Engineering.

Office of Hazard Identification

CPSC's Office of Hazard Identification and Reduction (EXHR) is under the Office of the Executive Director, Safety Operations (United States Government, 2012, 16 CFR 1000). This office is responsible for collecting incident, injury, and death reports related to consumer products, and then data are analyzed to identify hazard trends. From this information, mandatory regulations and voluntary standards are formulated; regulations are requirements that companies must follow for a particular product. EXHR can gather information only after an incident has happened, which can help prevent future incidents.

Office of Compliance and Field Operations

The Office of Compliance and Field Operations (OCFO) investigates defects in products and enforces regulations, recalls, and penalties (United States Government, 2012, 16 CFR 1000). OCFO conducts thorough investigations of any product that poses a significant risk to the consumer. The OCFO also monitors (called surveillance) shipping ports, retail stores, and the Internet to locate products that do not adhere to the current standards (Schoem, 2012). The Office reviews all section 15 reports, which are reports produced by a company that believes its products could pose a severe risk to the consumer or that might have violated a regulation. Thereafter, OCFO determines what action is to be taken: recall, refund, replace, repair, or no action. If a replacement or repair is offered to customers, the CPSC tests the product to determine whether the product contains any defects and that the replacement product poses minimal risk to the consumer. The OCFO is also a reactive office, meaning the office reacts only when an incident occurs or a regulation is ignored.

Directorate for Engineering

The Directorate for Engineering Sciences develops the technical regulations that companies must follow when designing a specific product (United States Government, 2012, 16 CFR 1000). This Directorate connects the EXHR with the OCFO; the EXHR determines a potential hazardous product, and then the Directorate creates a Product Safety Assessment and reports the information to the OCFO. The Directorate for Engineering Sciences creates and assesses a variety of manufacturing protocols based on engineering and scientific methods, including:

- product safety standards;
- product safety tests and test methods;
- performance criteria;
- design specifications;
- quality control standards for consumer products (1000.29).

These protocols help manufacturers to create and improve longer lasting, safer products for the public (Ghemraoui-Lagord, 2011). The Directorate also conducts human factors studies and researches product-related injuries that could be related to a human component (United States Government, 2012), such as a consumer not reading a warning label.

2.5 CPSC's Resources

To determine whether a consumer product is safe, the CPSC must gather data on incidents that have occurred. The CPSC uses a wide variety of databases to identify current product safety concerns.

2.5.1 Communication

Despite laws stating that manufacturers are legally obligated to notify the CPSC within 24 hours of learning of a product defect (Felcher, 2003), more often than not, the CPSC learns about product hazards on its own. Some information that is important to the CPSC can be

withheld by hospitals. Therefore, the CPSC must rely on the external sources (Felcher, 2003), including:

- newspaper articles
- coroner reports
- reports on lawsuits
- insurance investigations
- manufacturers who call the CPSC to report unsafe products made by other companies (p. 175).

Having to find out about consumer product defects by essentially doing detective work slows down the process for the CPSC of identifying product defects. This puts the public at risk for a longer period of time.

2.5.2 Databases

To draw conclusions and validate their rulings on consumer products, the CPSC has databases that provide the tools necessary to judge whether a product can be considered safe. One of the most useful databases for the CPSC is the National Electronic Injury Surveillance System (NEISS) (Schroeder, 2012). NEISS provides a way for the CPSC to monitor and measure the consumer product-related injuries treated in hospitals. This information is available to regulators within 72 hours of an accident. This small sample size makes it difficult for the CPSC to generalize its findings to the entire population. The CPSC also uses surveys and censuses to derive information to help them understand some of the recurring issues with consumer products.

2.5.3 Product Safety Assessments

A Product Safety Assessment (PSA) is a document created by the CPSC that provides the technical and scientific analysis conducted by the CPSC technical staff on a specific product (Bonnie Novak, personal communication, Sept. 11, 2013). Depending on what is determined by the PSA, the PSA can lead to further action, such as a recall. PSAs are usually initiated by the

CPSC's Office of Compliance. This occurs when issues arise regarding recalls, liaisons with companies, and compliance of manufacturers with the CPSC regulations. Companies can initiate their own recalls by contacting the CPSC if they believe their product is not safe for the intended user. Consumers can also contact the CPSC directly, by using the CPSC consumer hotline to file a complaint regarding a product (Felcher, 2003).

For every fiscal year, there are roughly 1,000 assessments completed. The typical time frame for a PSA is 1to 6 weeks, depending on the level of priority assigned by the Office of Compliance. There are also "Fast-Track" PSAs that are completed in less than a week, and in some cases, there are PSAs that are completed the day they are assigned. Each PSA is assigned for review by a specific division, with the majority of PSAs over the past 3 fiscal years having been assigned to Epidemiology. This division completes the most PSAs to investigate and gather injury statistics. The Human Factors Division had 296 assessments from fiscal years 2011 to 2013. A radar chart showing the distribution of the assessments by division is shown in Figure 2.4.

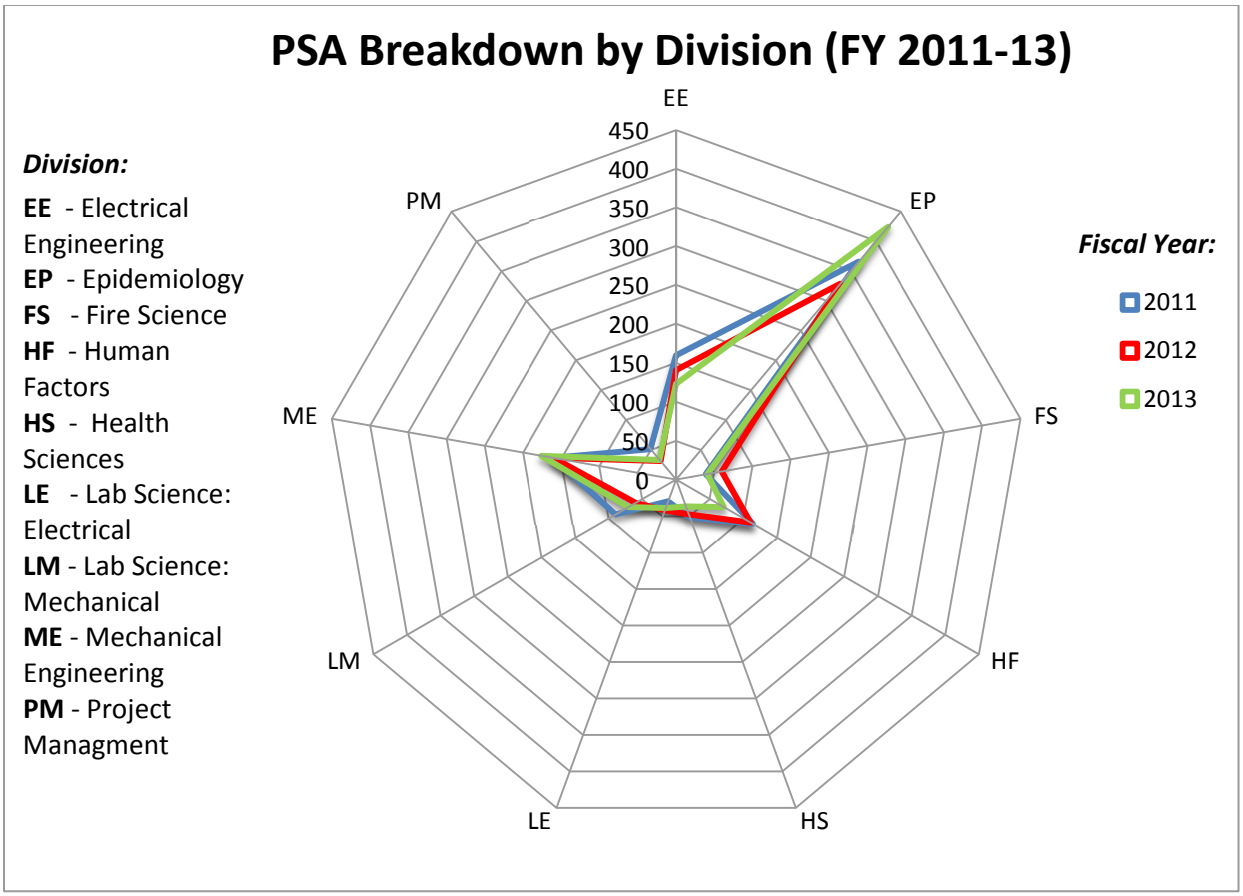


Figure 2.4: PSA Breakdown by Division

The majority of PSAs focus on one specific hazard, rather than on multiple hazards. By looking closely into the most dangerous hazard, the CPSC is able to determine more efficiently whether a product is safe than it would be possible for the agency to accomplish by looking into every detail of the product (Felcher, 2003). A typical PSA is written as a free-form essay and contains the following information (Bonnie Novak, Personal communication, September 17, 2013):

- a description of the product;
- references to incidents that have occurred with the product;
- a request from the Compliance Office to review a specific aspect of the product;
- discussion of the analysis; and
- conclusion.

Depending upon the product and its complexity, a PSA can range from 2 to 12 pages long. Once this assessment has been completed and reviewed, additional steps can be taken by CPSC officials to determine whether a recall is necessary.

Product Safety Assessments are initiated by Compliance and sent to the various divisions. PSAs are sent to Epidemiology to request a review and collection of incident data. The Divisions of Electrical, Mechanical, and Chemical Engineering are asked to determine the cause of an incident and described in either an incident report or in-depth investigation where an incident and/or exemplar sample is collected. The Division of Human Factors is requested to determine consumer use of a product based upon their understanding of how the product is used, or should be used; or, the lack of instructions, guidelines/warnings provided to consumers in order to have complete understanding of how a product is used and how to use is safely without incident. PSAs sent to Health Sciences are initiated to determine the risk to the consumer as a result of using a product that contains a defect which presents a risk of injury or how the unsafe use of a product can present a risk of injury and specifically what types of physical injuries/conditions can occur if the product is unsafe or used in an unsafe manner. PSAs can be canceled by Compliance officers for the following reasons:

- Not enough physical evidence in the form of either incident samples or exemplars are collected in order for an adequate technical assessment to move forward
- It has been determined based upon previously assigned PSAs from another directorate that an additional PSA from another directors is no longer needed, and may not support the other directorate's finding, or contribute to the enforcement investigation
- The firm given a timeframe to respond, files under fast track and decides to move forward with a recall program which requires no technical evaluation but may still require a review of incident data
- It is determined by Compliance staff that no additional technical review is needed and the matter is closed prior to the completion of a technical evaluation (rare occurrence).

2.6 Consumer Product Safety in Other Countries

Consumer product safety is a concern not only in the United States, but also throughout the world (Bekeny, 2012). Many nations see consumer product safety as an important issue and are constantly taking steps to help protect the public. Similar to the United States, countries such as Canada, Australia, and members of the European Union (EU) are enacting safety regulations. Canada passed the Canada Consumer Product Safety Act in June, 2011, which includes new mandatory incident report forms and also stricter penalties for violations of consumer product regulations. Australia has also been proactive and passed the Australian Consumer Law (ACL) in January 2011. Soon the EU will be taking big strides toward mitigating product defects, by promising a number of significant changes resulting from the European Commission Consumer Agenda adopted in May 2012.

The EU has already been active in protecting the public with RAPEX, Rapid Alert System for non-food consumer products (Product Safety for Manufacturers, 2013). This system is similar to NEISS because it monitors the entire EU for consumer product-related injuries. RAPEX, however, alerts authorities of a hazard, even if the hazard has not been reported in a hospital. The National Contact Point informs the European Commission, and then the European Commission adds these hazards to the RAPEX database. Once data are in RAPEX, RAPEX alerts all countries within the European Union. From there, countries can make the decision whether to pull the product from the market, send out warnings, or even replace the product.

One area in which the CPSC and product safety agencies in other countries differ concerns classification of products. Each country has its own interpretation of what is considered a consumer product or has separate agencies that deal with a specific product. For example, the CPSC does not deal with tobacco products; this is the responsibility of the Bureau of Alcohol,

Tobacco, Firearms and Explosives (ATF, 2013). In Australia, however, the Australian Competition & Consumer Commission (ACCC) has control over tobacco products and the agency's oversight has led to a ban on smokeless tobacco since 1991 (Product Safety Australia, 2013).

Globally, there is a consistent effort to mitigate product-related injuries. However, early in the design process, there is a common disconnect between product safety agencies and product developers. A lack of communication between these groups needs to be addressed to benefit the general public.

2.7 Company Protocol

Many companies have their own internal standards that they follow to prevent safety problems. According to Ghemraoui-Lagord (2011), most protocols are not sufficiently in-depth and do not have the ability to identify a design flaw at an early stage (p. 54). When a safety issue finally is found, it is often too far along in the design process for modifications to be cost effective The other problem with most prevention standards is their inability to account for the complexity of the next generation of products.

Current products under design are becoming complex to afford the consumer a more comfortable lifestyle. For example, a gas-powered push lawn mower in the 1980s had relatively few components (Nelson, 1999). It was a simple machine, and the safety issues could be foreseen during manufacturing (see Figure 2.5). Today, a gas lawn mower can be a complex system that includes an electric starter, clipping collector, forward and reverse gear with speed adjustment, and a mechanism to turn the blades on and off (see Figure 2.6). There are many more components to the modern lawn mower, and this makes it harder to plan for all of the potential

safety issues. Products are becoming complex systems rather than simple machines, as is evident in the figures below.

Figure 2.5: 1980's Lawnmower (Wikipedia, 2010)

Figure 2.6: 2000's Lawnmower (Wikipedia, 2006)

2.7.1 Risk Elimination

The Risk Elimination Model (REM) is aimed at reducing risk and increase safety (Hollnagel, 2008). This method has been around the longest, is one of the simplest, and still is in use today. This method creates a risk assessment for an already-designed product by:

- representing how events may develop;
- creating event and fault trees for characteristic examples;
- estimating and/or calculating the probability of a specific event or combination of events (Sec. 1.1).

After risks have been identified, the next step in this method is to limit these risks as much as possible (Hollnagel, 2008). The main problem with this model, and most models that typify risk removal, is that the primary function might pose the largest risk. For example, a chain saw's function is to cut through wood by use of a sharp chain moving at high speeds. To eliminate the risk of a user being cut, the manufacturer would have to change the primary function of the chain saw. In this case, the manufacturer can only reduce the risk to a limited extent, by adding safety

devices. With most products, it is not feasible to eliminate all risk; however, a good design will reduce or eliminate the risk while retaining the primary function of the product.

2.7.2 Innovative Risk Assessment Design Method

The Innovative Risk Assessment Design Method (IRAD) is based on designing safety factors in parallel with the product design process (Ghemraoui-Lagord, 2011). The product designer works on task clarification when developing the design parameters. The designer has to do this once for each of the design stages (See Table 2.1). The risk is always evolving as the product progresses through the design stages and as the human interaction changes. When risks are identified at each stage, safety requirements are made to reduce or eliminate the risk. Each design stage has its own specific risk focus. In the conceptual stage, the risks are based on the environment or principle of the design; this is called Human-Principle Interactions. The embodiment stage focuses on such Human-System Interactions. Finally, the detail stage is about the technical aspect called Human-Machine Interactions. IRAD was designed to consider human interaction with a product during all parts of the design process. Table 2.1, below, specifies the stages of design.

Table 2.1: Stages of Design (Ghemraoui–Lagord, 2011, p58)

Stages of Design	
Design Stage	**Description of Design Stage**
Conceptual	General working principals are developed
Embodiment	Systems to carry out the working principals developed in the conceptual stage are developed
Detail	Components of the device are specified

2.7.2 Reaction to Product-Related Incidents

Once a product is on the market, there are limited actions that companies can take in reaction to a product-related incident (Hollnagle, 2008). When a company receives an incident report, they will first look into whether this incident was a "freak" event or was related to the use of their product. From there, companies examine what they can do to prevent this sort of incident in the future or consider whether product redesign is required. Table 2.2 (see next page) shows the main strategies companies may consider after a product incident is determined to be non-isolated i.e., not the result of a freak accident. This table also lists the different types of main reactive strategies and gives an example of each type. After an incident has happened, the incident will be added to the company's database to try and prevent future occurrences of the same incident.

Table 2.2: Possible Reactive Strategies for Accident Prevention (Hollnagel, 2008, p. 224)

Possible Reactive Strategies for Accident Prevention		
Main strategy	Type	Example
Elimination	Cancelation	Withdrawing a product from the market
	Restructuring	Making a function unnecessary through redesign
Replacement (complete or partial)	Identical unit or component	Spare parts or components; backups
	Improved unit or component	New models; new software releases; automation
Monitoring	Early warnings	Performance indicators; alerts and alarms
Prevention	Functional barrier system	Alarms
		Interlocks
		Interface
	Physical barrier system	Buildings, fences
	Symbolic barrier system	Rules, tasks
		Procedures
	Incorporeal barrier system	Safety culture
Protection	Physical barrier system	Wall
	Functional barrier system	Airbag
	Recovery	System design
		Operational support
		Fault tolerance
	Mitigation	Feedback
		Detection
		Undoing
Facilitation	Task redesign; work design	Improved task 'logic'; collaborative work
	Interface design	Consistency; usability; functional grouping
	Support	Attention, memory

2.8 Chapter Summary

Although there are many regulations and guidelines for companies and manufacturers to follow when designing consumer products, there are still a significant number of recalls and injuries related to products on the market. There have been many methods developed to account for product safety, but there are no consistent guidelines for the development of a product related to human factors. Currently, the CPSC is a reactive agency that deals mainly with consumer products once a hazard has been identified. The CPSC attributes many of these identified hazards to human factors. By researching human factors and identifying some of the underlying trends in defects that arise, the CPSC seeks to formulate a plan to become a more proactive agency and educate companies and manufacturers about how to improve the safety of their products before they are released to consumers.

Chapter 3: METHODS

The goal of this project was to formulate a method of communicating proactively to manufacturers, product design guidelines and principles that will result in marketable products with the least possible risk, whether the risk is due to technical factors or human misuse. The purpose of the project was to help reduce the number of unsafe products released to the marketplace, by encouraging the use of basic principles of human factors design early in the product development phase. Our project involved looking at patterns of past product incidents to identify design problems. To achieve this goal, we developed methods, discussed in this chapter, for gathering information, including interviews and archival research. The following sections detail each method, its purpose, and the reason for implementation.

3.1 Product Safety

In the first phase of our project, we assessed the current level of product safety. This was completed through archival research of Product Safety Assessments (PSAs) to identify the underlying patterns among the factors that have caused accidents and incidents related to consumer products. We examined the injury reports found in the PSAs to identify common trends among assessments. We used analysis of this information on causes of consumer injuries as a basis for formulating our interview questions.

3.1.1 Selection of Product Safety Assessments

On a yearly basis, the CPSC generates a large number of PSAs, typically around 1,000 per year. Over the past decade, there were over 10,000 PSAs filed. Therefore, it would not be feasible or efficient for us to look at all of the assessments in their database. However, we decided to review all PSAs from the past three fiscal years filed under the Division of Human Factors (HF). This division was selected due to the project's focus on human factors' issues

related to product hazards. Additionally, our team also reviewed FY 2013 PSAs for the Division of Health Science (HS) and the Division of Mechanical Engineering (ME) to identify any potential variation among incidents between divisions. These divisions were selected because they were often referenced within the HF PSAs. In total, we reviewed and analyzed 509 PSAs: 296 HF, 176 ME, and 37 HS assessments. PSAs within this time period were more applicable to our overall project goal because the products we reviewed were more likely to be in the market, whereas older products may have resolved their problems or outlived their market life.

3.1.2 Analysis of Product Safety Assessments

In looking at each PSA, we focused on key variables, such as the victim's age, type of injury, injury severity, injury cause, and the type of product, as well as key words/phrases used within the report. We created a PSA Analysis Protocol to be used for each PSA (Appendix C). By filling out these forms, we gained a better understanding of the product, the issue, how the issue relates to human factors, and how the issue potentially could be resolved. To use the information from the completed forms, we used Microsoft Excel to quantify and graph the apparent hazards and frequency of product types. From this process, we established some common patterns among these incidents and categorized them. The first type of category we generated was product type, which included six major product types: Appliances, Children's Toys, Home Goods, Indoor Recreation, Infant Products, and Outdoor Recreation. These categories and associated products can be found in Table 3.1 below. Within the Excel document, we labeled each PSA accordingly and labeled those that were canceled as well. PSAs can be canceled by Compliance officers as explained in Section 2.5.3.

Table 3.1: Product Type Category Breakdown

Product Type Category	Includes
Appliance	Kitchen
	Ceiling Fan
	Gas grill
Children's Toy (Infant, Toddler, & Adolescents)	Dolls
	Growing Polymer
	Inflatable Ball Pit
	Play slide
	Pool Toy
	Riding Toy
	Small Magnets
	Sound Sword
	Toddler Activity Center
	Toy Building kit
	Toy Car
	Toy guitar
	Toy Stroller
Home Good	Furniture
	Blind/Shade
	Child lock
	Detergent Packets
	Food Slicer
	Glass Vase
	Landscaping equipment
	Powered Mop
	Step stool
	Lamp
Indoor Recreation	Exercise Equipment
	Massage Device
Infant Product	Baby Bather
	Baby Exerciser
	Baby Monitor
	Seat
	Blanket
	Child Carrier
	Cradle
	Crib

	High Chair
	Play Yard
	Positioner
	Stroller
Outdoor Recreation	Bicycle
	Fireworks
	Fuel
	Hand Truck
	Playground
	Sports Equipment
	Utility Vehicle

Next, we labeled the product with a direct identifier, such as "blinds." After we identified the product, we classified the severity of the injury resulting from the product. In addition, we identified the potential injury that could result from a particular product hazard. The categories we created for injury severity were:

- Death
- Laceration
- Internal Injury
- Head Injury
- Minor Injury
- Fracture
- Amputation.

We associated "Not Applicable" with PSAs that were completed without reference to an incident report.

Next, we identified the hazard(s) the product posed to the consumer. The categories of hazards established were: Impact; Asphyxiation; Entanglement and Entrapment; Fire and Shock; and Ingestion. We broke down Impact into sub-categories, including: *Contact*, *Crushing*, *Falling*, and *Tipping*. These subgroups are defined in Table 3.2.

Table 3.2: Impact Subcategory Definition

Subcategory	Definition	Example
Contact	Incident that resulted in a laceration or injuries related to projectiles	A toy sword impacting the head of the user, resulting in a laceration
Crushing	Incident that involved a product falling on the consumer	A dresser falling on top of a child, resulting in suffocation
Falling	Any scenario where the user free falls	A child falling through a high chair, resulting in a head injury
Tipping	Incident where the user falls with the product	A slide falls over with the user on top of it, resulting in a head injury

These product hazards relate to the injury that a product can inflict on the consumer. The injuries that fall under each heading can be found in Table 3.3.

Table 3.3: Product Hazard Categories - Number denotes NEISS Diagnosis Code

Product Hazard Category	Injury Related to Hazard
Asphyxiation	Anoxia (65)
	Submersion (69)
	Suffocation
	Choking
	Strangulation
	Entanglement
Ingestion	Aspirated foreign object (42)
	Ingested foreign object (41)
	Internal organ injury (62)
	Poisoning (68)
Impact ***Falling*** ***Crushing*** ***Contact*** ***Tipping***	Avulsion (72)
	Contusions, abrasions (53)
	Dental injury (60)
	Dislocation (55)
	Crushing (54)
	Hematomas (58)
	Concussions (52)
	Fractures (57)
	Hemorrhage (66)
	Nerve damage (61)
	Strain or sprain (64)
	Laceration (59)
	Amputation (50)
	Projectile
	Puncture (63)
Entanglement / Entrapment	Restricted Movement
Fire / Shock	Burns, Scald (48)
	Burns, Thermal (51)
	Burns, Chemical (49)
	Burns, Electrical (46)
	Burns, not specified (47)
	Electric shock (67)

We cross-referenced each injury including numbers to National Injury Surveillance System (NEISS) diagnosis codes. Once we recorded these key components for each PSA, we designated

a column for comments that included other injuries resulting from a product along with a quick description of the hazard for future reference.

Lastly, each division had a unique product-related element that needed to be analyzed in addition to evaluating the product incidents. These division-specific elements are explained in Table 3.4 below.

Table 3.4: Division-Specific Analysis Elements

Division	Element	Description
Human Factors	Instructions	Examine instruction manuals to address if they are adequate
	Warnings	Examine warning labels to see if they are adequate and meet standards
	Both	Examine instructions and warnings
	Neither	Unrelated to product instructions or warning labels
Mechanical Engineering	Corrective Action Plan (CAP) Adequacy	Established plan or physical fix for the current product issue
	Product Analysis	Analyze the product design
	Conformance to Standards	Check to see if the product meets the standards
	Review Bulletin	Review the adequacy of the notification to consumer that there may be a hazard present
Health Sciences	Health Effects	What the overall effect on the consumers health was in relation to the injury
	Safety Issue Identification	Examine potential product hazards
	Extent of Injury	Examine all possible injuries related to a particular product defect

For individual PSA analysis by division, we incorporated the appropriate element associated with the PSA into a column.

3.2 Identify Current Defect Prevention Methods

In the next phase of our project, we identified the current defect prevention methods used by companies. This information allowed us to determine which methods are effective at ensuring

product safety. By interviewing representatives from companies and trade associations, we were able to gain insight into how industry currently accounts for human factors while developing a product.

3.2.1 Interviews with Company/Trade Association Representatives

To catalog and rate current prevention methods, we interviewed company and trade association representatives, including those identified by the CPSC and those who represent additional constituencies that our group identified through our background research. The CPSC provided us with an initial set of five company representatives to interview. Our team conducted 6 interviews in total to get a variety of responses.

The interviews were structured around determining what design steps can be taken to account for user interaction and what experience the representative had with human factors. The interviews followed a set of structured questions so that responses could be compared to other representatives' answers (See Appendix D for interview protocol).

3.2.2 Interviews with CPSC Personnel

CPSC personnel have a wealth of knowledge regarding current design methods that are effective at ensuring product safety. CPSC personnel who deal with the Division of Human Factors were interviewed to tap into their expertise on product safety hazards. We interviewed four CPSC employees within the Division of Human Factors, two with an engineering background and two with a psychology background. To broaden our responses, we interviewed two members of the Division of Mechanical Engineering. These individuals work with product incidents, and thus, they have insight on emerging hazards and product safety. Based on this knowledge, we structured the interviews to determine the common root causes of product-related

injuries. The interviews followed a set of structured questions to facilitate comparing other employees' answers (See Appendix E for interview protocol).

3.3 Chapter Summary

We used interviews and archival studies to meet the overall goal of identifying common human factors patterns relating to product defects. At the end of this project, we submitted a report to the CPSC that includes the product trend, as well as gaps in company product safety protocol as determined from our research. We intend for the CPSC to use this information to communicate risks to manufacturers. We also believe the information illustrates the ways in which products can be made safer by incorporating human factors design early in the product development phase, before actual production is undertaken. Our team also identified potential areas calling for additional research to be undertaken by the Human Factors Division.

Chapter 4: RESULTS

This section discusses the results of our research on recurring product safety hazards and how companies incorporate human factors into their product development to reduce these hazards. From archival research of PSA for the Divisions of Human Factors, Mechanical Engineering, and Health Sciences, variables such as potential product hazard, injury severity, and human factors analysis were cataloged. The results of this research are presented and analyzed in this section, including a breakdown of PSAs by product type and hazards. As a supplement to the PSA analysis, we conducted interviews on industry-human factors integration, which provided insight into common industry practices.

4.1 Trends in Product Safety Assessments

This section reports on the hazards associated with consumer products after reviewing PSAs. More specifically, we discuss the trends identified among products with regard to product type and the associated hazards. This section will include trends from Human Factors PSAs, as well as Mechanical Engineering and Health Sciences PSAs.

4.1.1 Human Factors PSAs

There were 296 Human Factors (HF) PSAs for fiscal years 2011 to 2013. Of these, 33 PSAs were canceled by a Compliance officer for varying or unknown reasons. For the 263 completed HF PSAs, Figure 4.1 illustrates the breakdown by product type: Appliances, Children's Toys, Home Goods, Indoor Recreation, Infant Products, and Outdoor Recreation (defined in section 3.1.2).

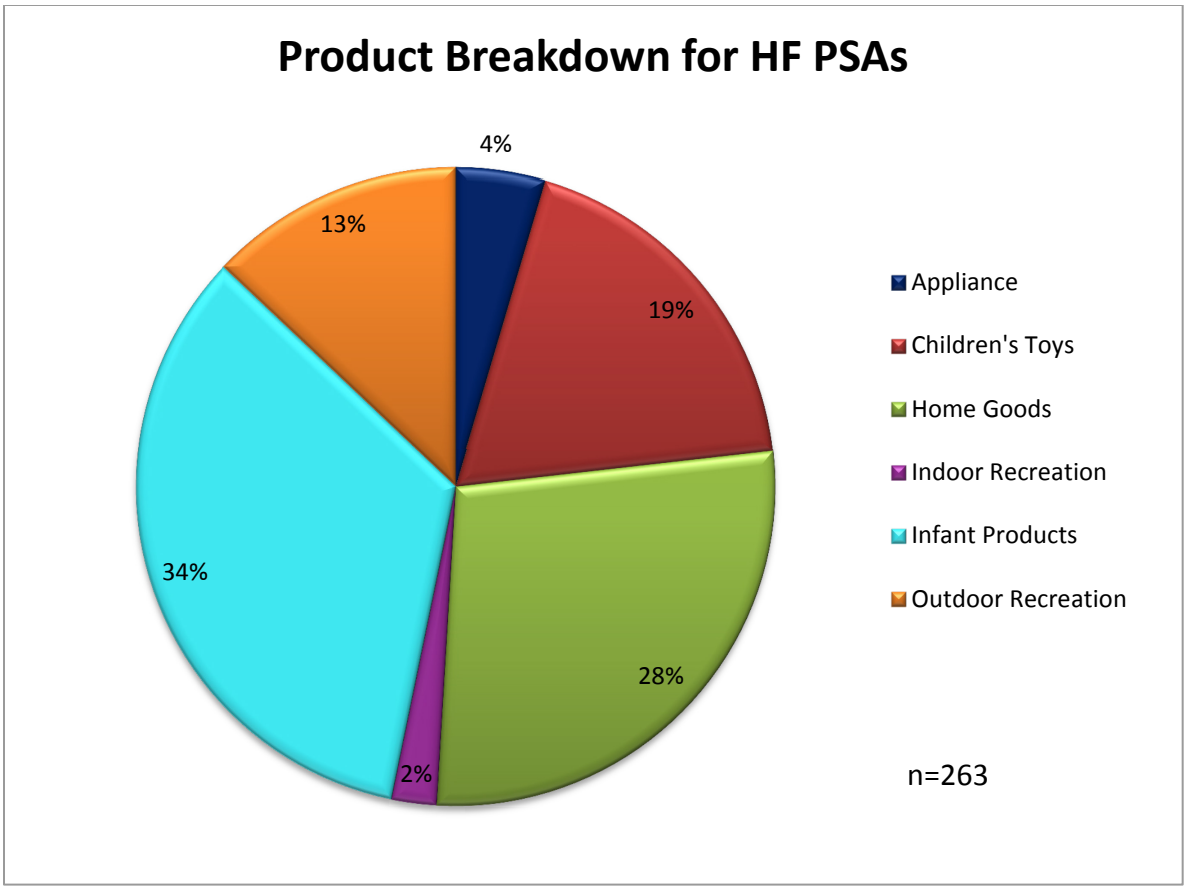


Figure 4.1: Product Breakdown for Human Factors PSAs (FY2011-FY2013)

The top three product types by percentages were Infant Product (34%), Home Goods (28%), and Children's Toys (19%). Outdoor Recreation products made up 13 percent of the HF PSAs. The remaining products were accounted for by Appliances (4%) and Indoor Recreation products (2%).

For the 263 HF PSAs, Figure 4.2 illustrates the breakdown by potential product hazard (defined in section 3.1.2). Products could pose multiple hazards; thus, the total number of hazards is larger than the total number of PSAs.

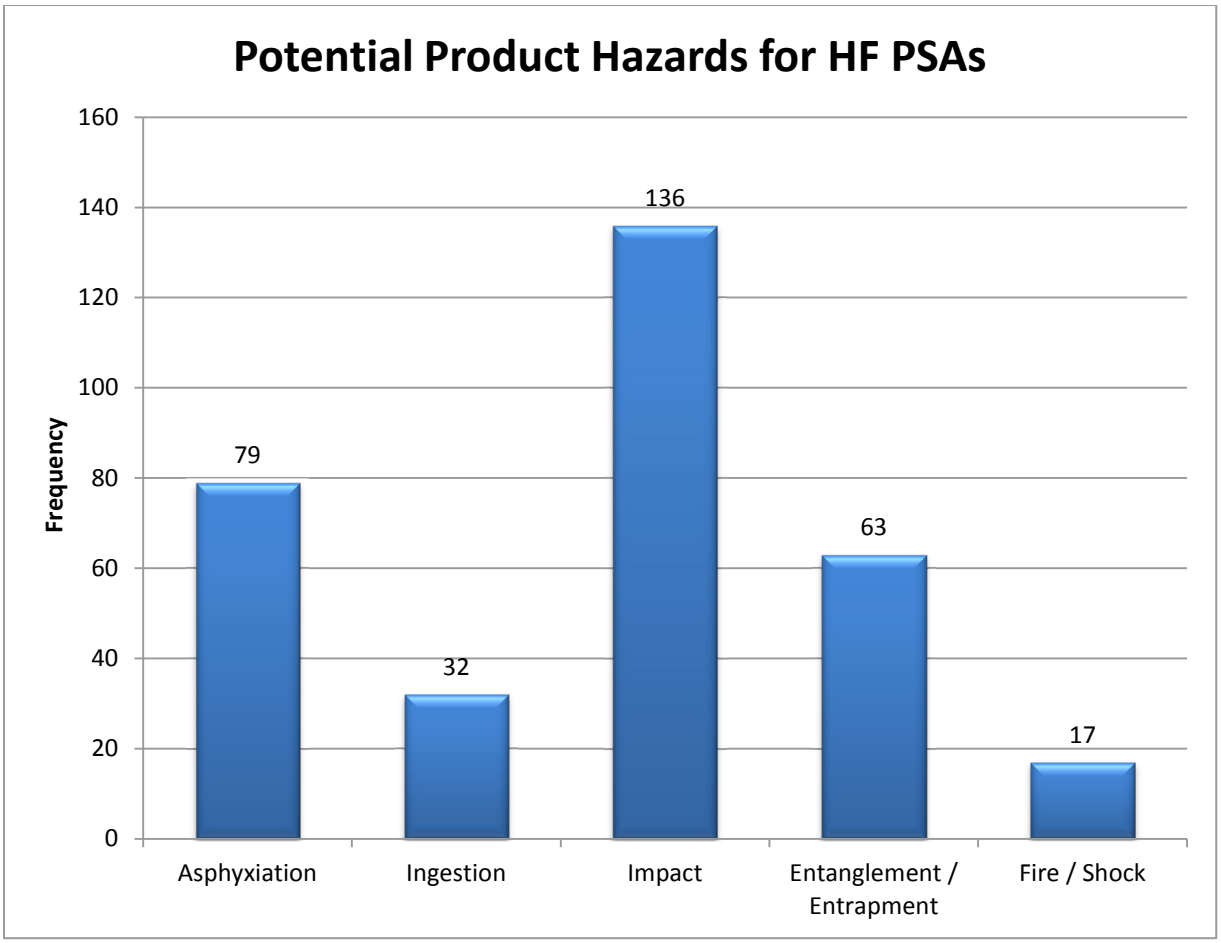


Figure 4.2: Potential Product Hazards for Human Factors PSAs (FY2011-FY2013)

The Impact hazard was the most recurrent among the HF PSAs, with 136 products posing this hazard. This hazard was 1.72 times larger than the second most recurrent hazard, which was Asphyxiation. The third most frequent hazard was Entanglement and Entrapment at 63 products.

Seeing that the Impact Hazard was so frequent, the following figure, Figure 4.3, breaks down the category by the four subgroups: *Crushing*, *Contact*, *Falling*, & *Tipping* (defined in section 3.1.2).

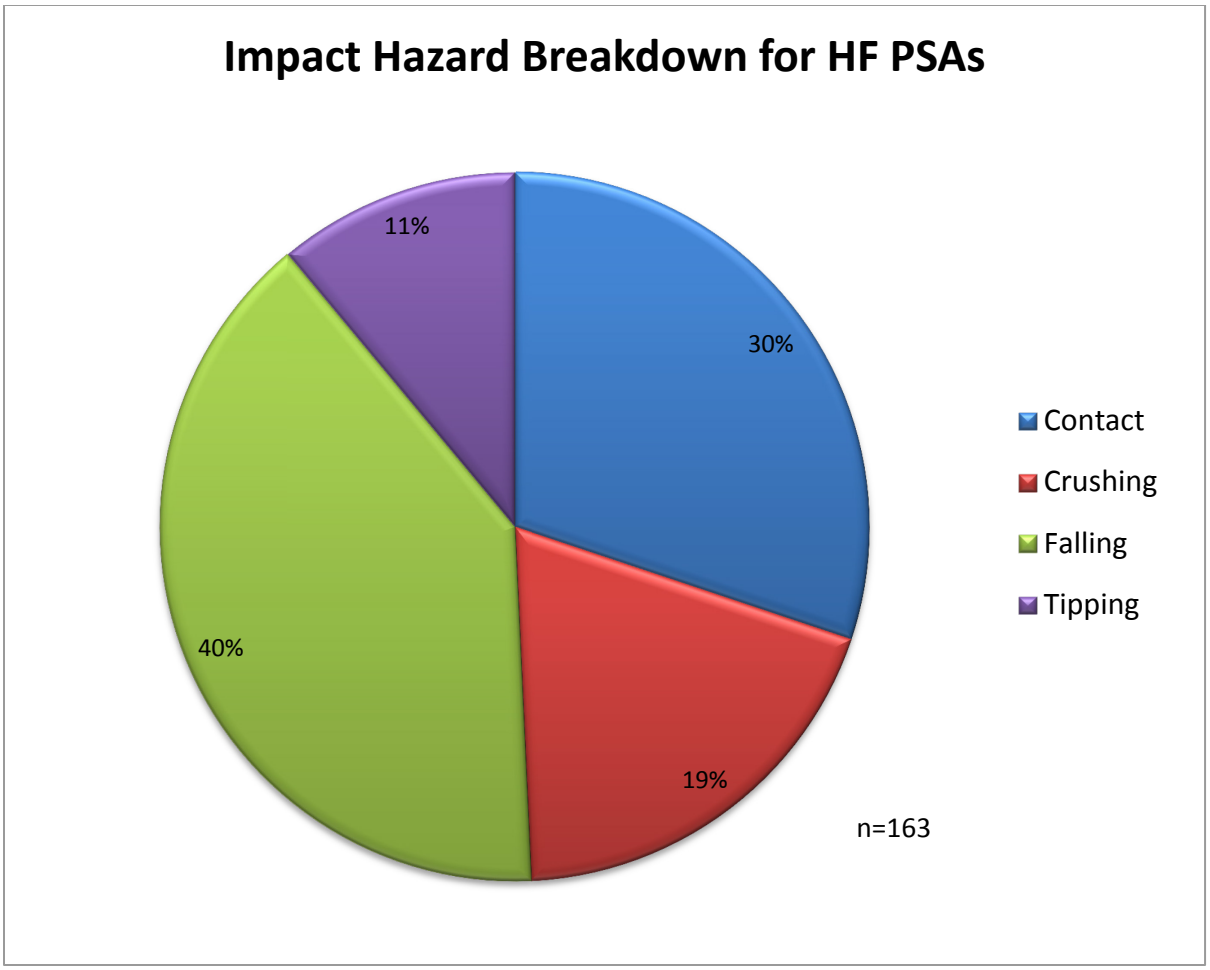


Figure 4.3: Breakdown of Impact Hazard for Human Factors PSAs by Subgroups (FY2011-FY2013)

Of the 163 Impact Hazards: 54 were associated with a *Falling* hazard, 41 with *Contact*, 26 with *Crushing*, and 15 were *Tipping*.

For the Human Factors PSAs, we also recorded the reported injuries from an incident associated with a product, as well as the potential injury that a product could inflict on the consumer. Figure 4.4 shows the comparison between reported injuries vs. potential injury.

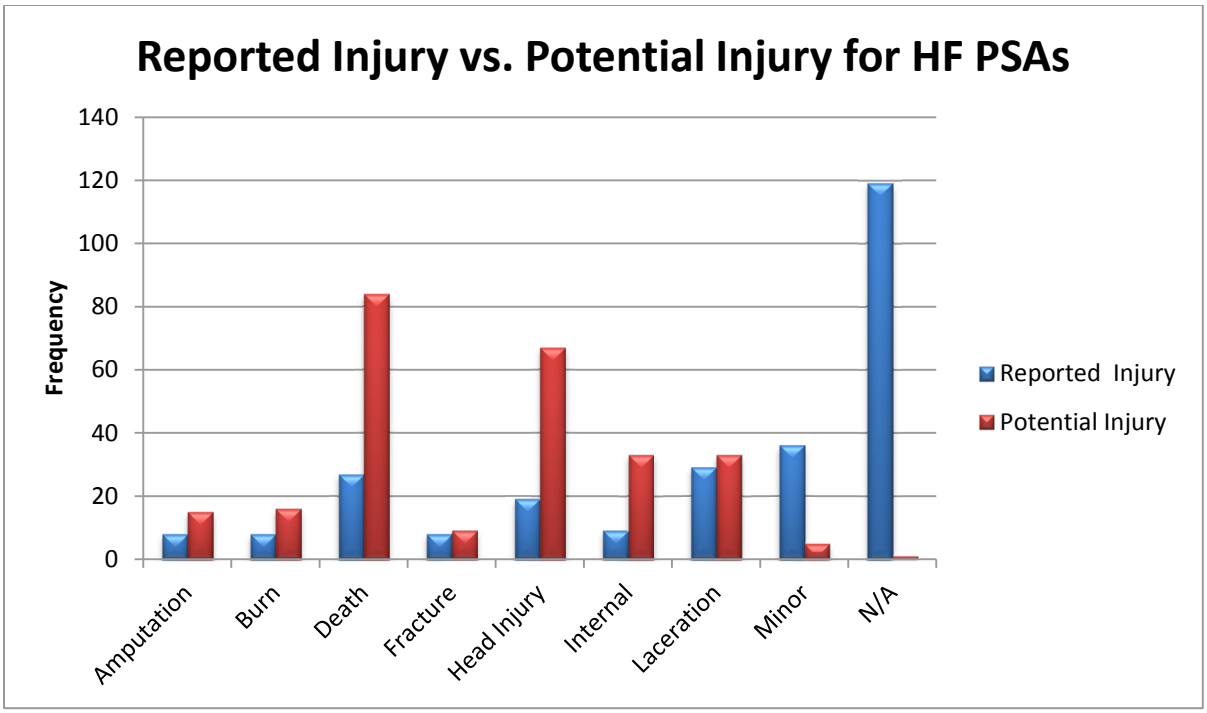


Figure 4.4: Reported Injury vs. Potential Injury for HF PSAs (FY2011-FY2013)

The most recurrent potential injury a product could inflict on the consumer was Death, followed by a Head Injury. The most frequent category for reported injury was N/A, meaning there was no associated injury with the given PSA. This suggests that the PSAs were completed for a product with no reported injuries. The most recurrent reported injury for products was Minor, followed by Laceration and Death.

Recurrent Product Types

Infant Products, Home Goods, and Children's Toys accounted for the most recurrent product types analyzed for PSAs. Therefore, these categories were broken down further by potential hazard.

Infant Products

For the 263 HF PSAs, 89 were associated with Infant products. The potential hazards for these products are shown below (see Figure 4.5).

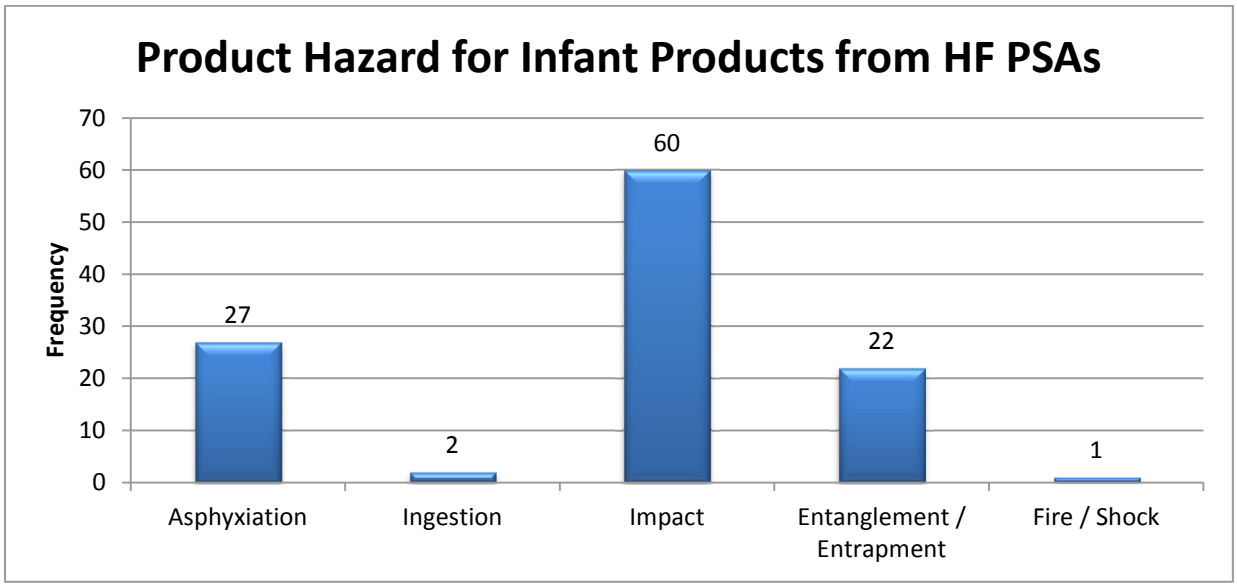


Figure 4.5: Potential Product Hazards for Infant Products (FY2011-FY2013

The most recurrent hazard for Infant Products was Impact, with 60 products posing this hazard. This was followed far behind with Asphyxiation (27) and Entanglement and Entrapment (22). To breakdown the Impact hazard further, Table 4.1 presents the distribution by subgroup.

Table 4.1: Breakdown of Impact Hazard by Subgroups for Infant Products from HF PSAs

Impact Hazard Subgroup	Frequency
Crushing	9
Falling	30
Contact	11
Tipping	10

The most recurrent subgroup of Impact was *Falling,* with 30 products posing this hazard.

Home Goods

For the 263 HF PSAs, 73 were associated with Home Good products. The potential hazards for these products are shown below (see Figure 4.6).

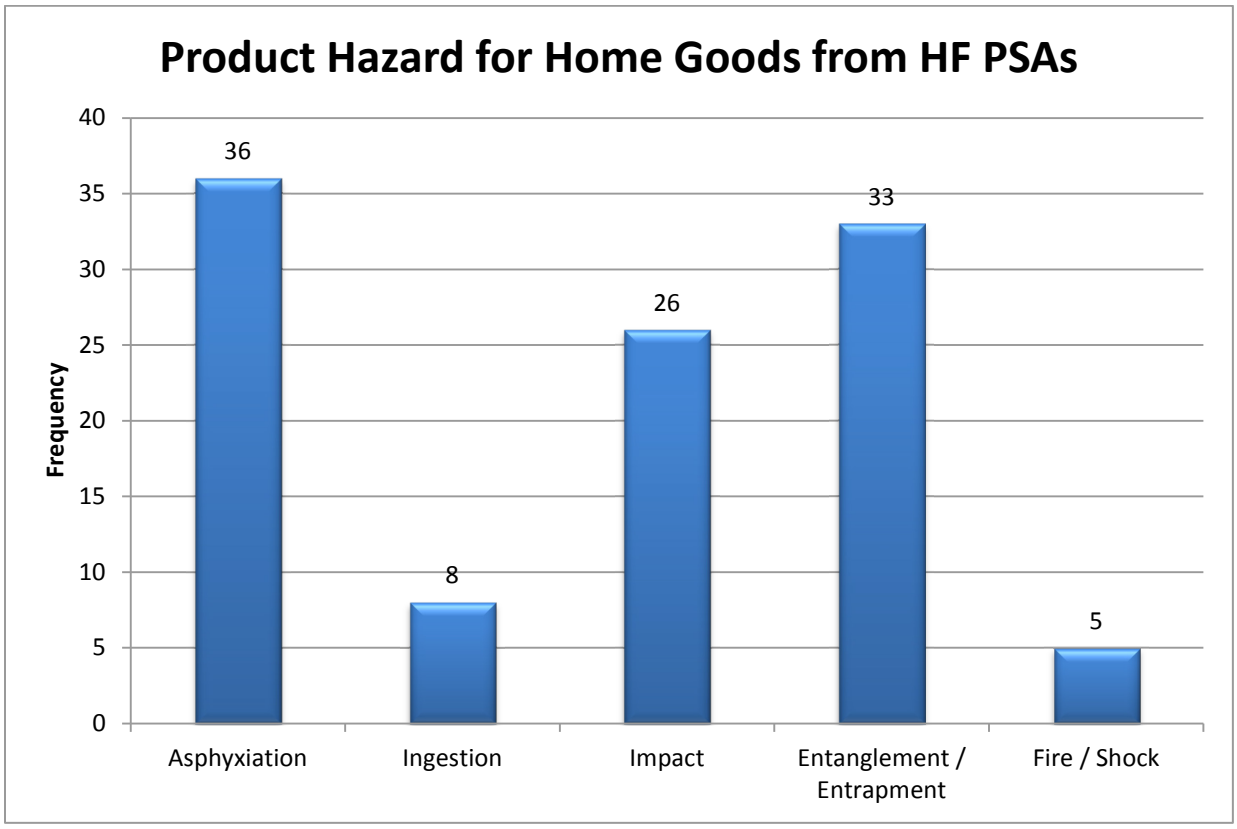


Figure 4.6: Potential Product Hazards by Home Goods for HF PSAs (FY2011-FY2013)

The most recurrent hazard for Home Goods was Asphyxiation, with 36 products posing this hazard. This was closely followed by Entanglement and Entrapment (33) and Impact (26). Of the 73 Home Good products, 23 of the products were blinds/shades.

Children's Toys

For the 263 HF PSAs, 49 were Children's Toys. The potential hazards for these products are shown below (see Figure 4.7).

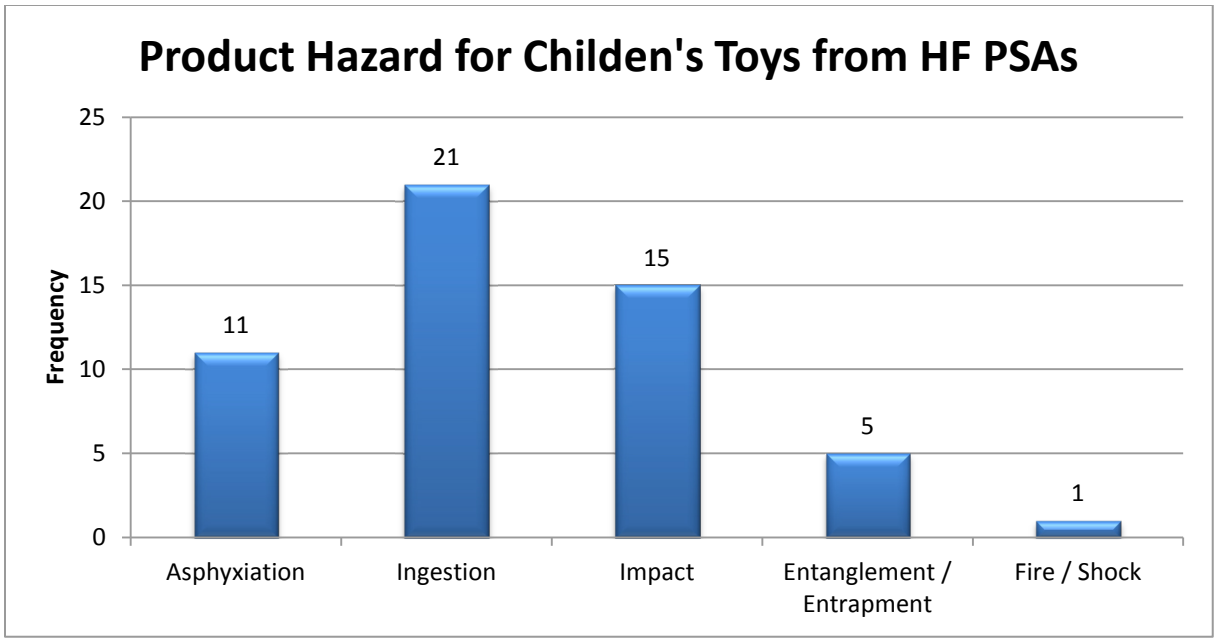


Figure 4.7: Potential Product Hazards for Children's Toys from HF PSAs (FY2011-FY2013)

The most recurrent hazard for Children's Toys was Ingestion, with 21 products posing this hazard. This was followed by Impact (15) and Asphyxiation (11).

4.1.2 Mechanical Engineering PSAs

We reviewed a total of 176 PSAs from the Division of Mechanical Engineering. Out of 176 PSAs issued in FY 2013, 10 were canceled by Compliance for varying reasons, leaving 166 completed PSAs. Figure 4.8 shows the breakdown of the ME PSAs by the six different product types: Appliances, Children's Toys, Home Goods, Indoor Recreation, Infant Products, and Outdoor Recreation (defined in section 3.1.2).

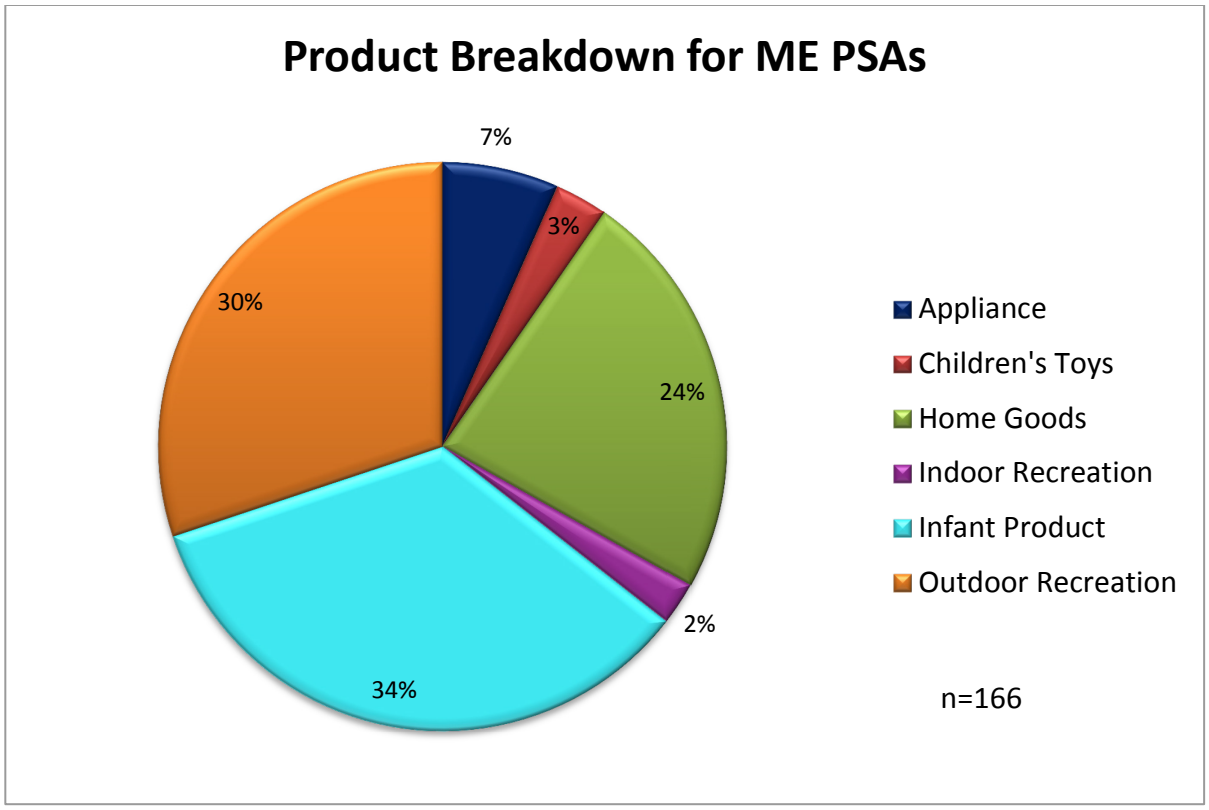


Figure 4.8: Product Breakdown for ME PSAs (FY 2013)

Infant Products were associated with the most PSAs (34%) followed by Outdoor Recreation (30%), and Home Goods (24%). The remaining assessments were related to Appliances (7%), Children's toys (3%), and Indoor Recreation (2%).

The ME PSAs also reviewed for the potential product hazard. A single product can pose multiple hazards, and therefore, the number of hazards is different from the number of PSAs. Figure 4.9 shows the distribution of potential product hazards: Asphyxiation; Ingestion; Impact; Entanglement and Entrapment; and Fire and Shock.

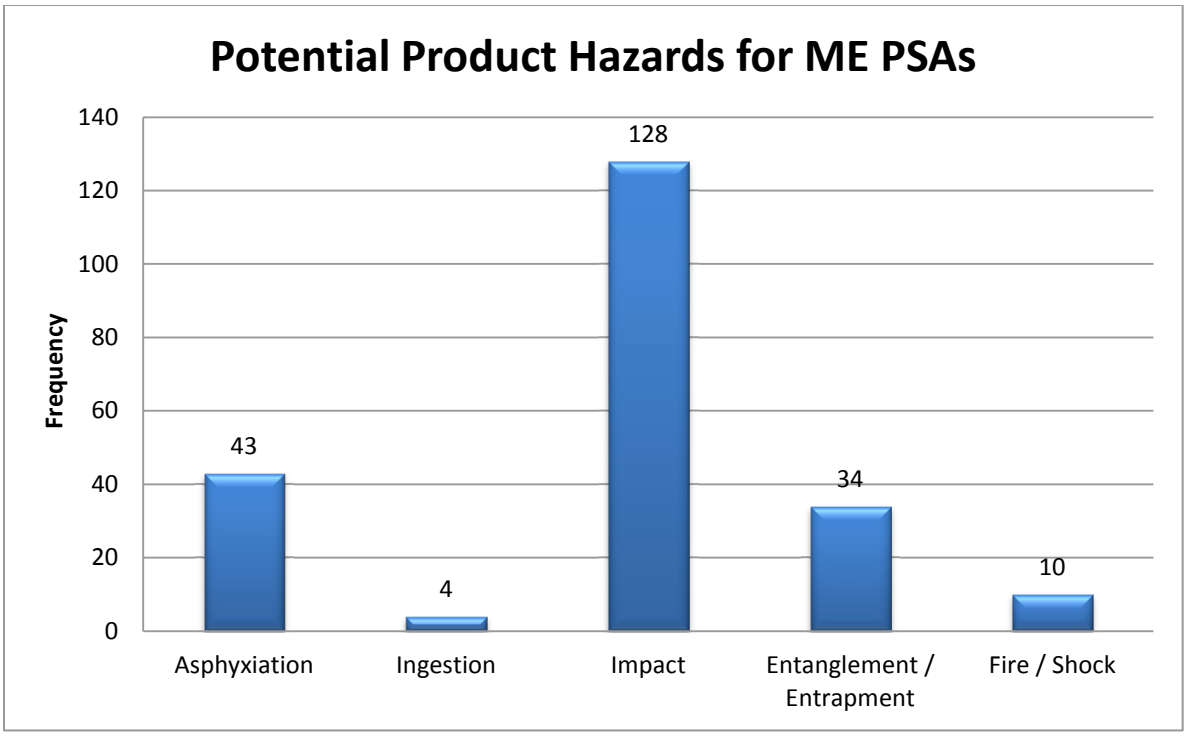


Figure 4.9: Potential Product Hazards for ME PSAs (FY 2013)

The Impact hazard is the most frequent category with 128 different products. Asphyxiation follows at 43, approximately three times less frequently than Impact. The third most recurrent hazard was Entanglement and Entrapment (34).

Because the Impact Hazard was so frequent (128), the following figure, Figure 4.10, breaks down Impact Hazard by four subgroups: *Crushing*, *Contact*, *Falling*, & *Tipping* (defined in section 3.1.2).

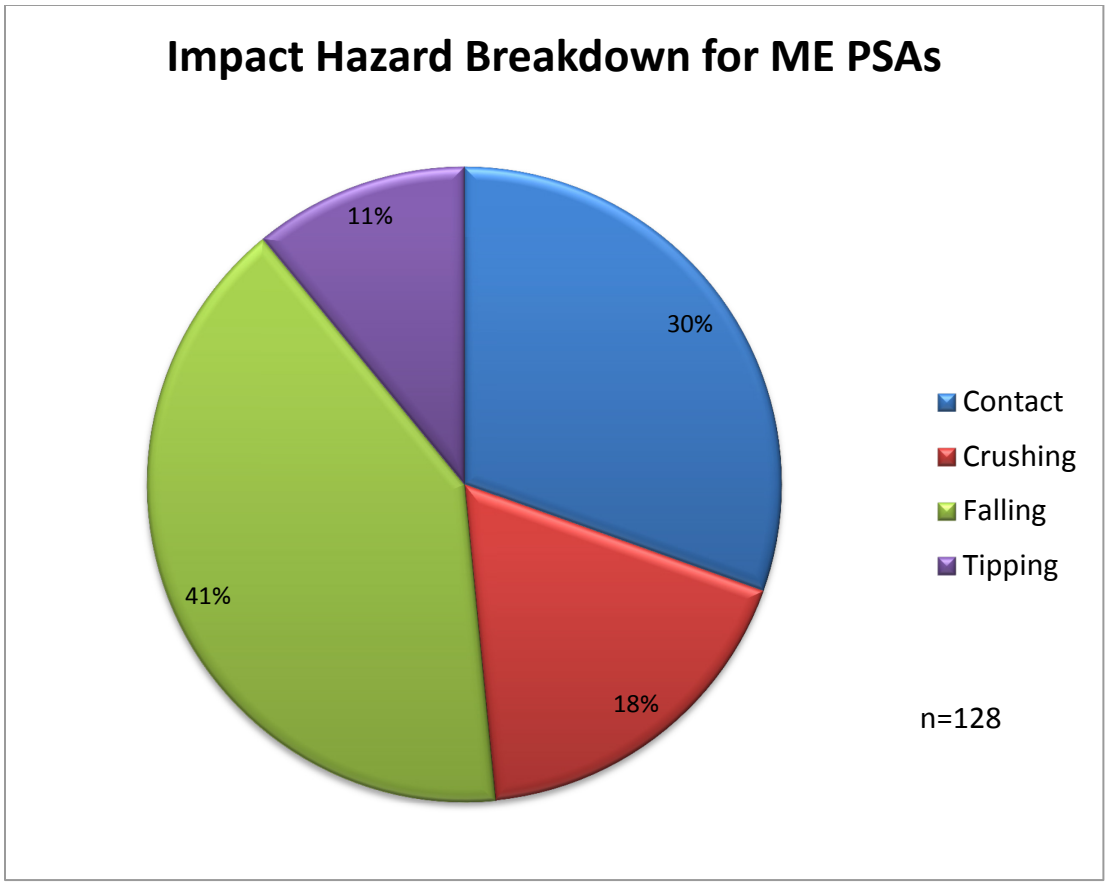


Figure 4.10: Impact Hazard Breakdown ME PSAs (FY 2013)

Falling is the largest subcategory at 41 percent, followed by *Contact,* with 30 percent. *Crushing* and *Tipping* were 18 and 11 percent, respectively.

Additionally, we recorded the actual injury that occurred, as well as the potential injury that could occur. These were categorized into eight different types of injuries: Amputation, Burn, Death, Fracture, Head Injury, Internal, Laceration, and Minor injury. Figure 4.11 shows the distribution of the injuries.

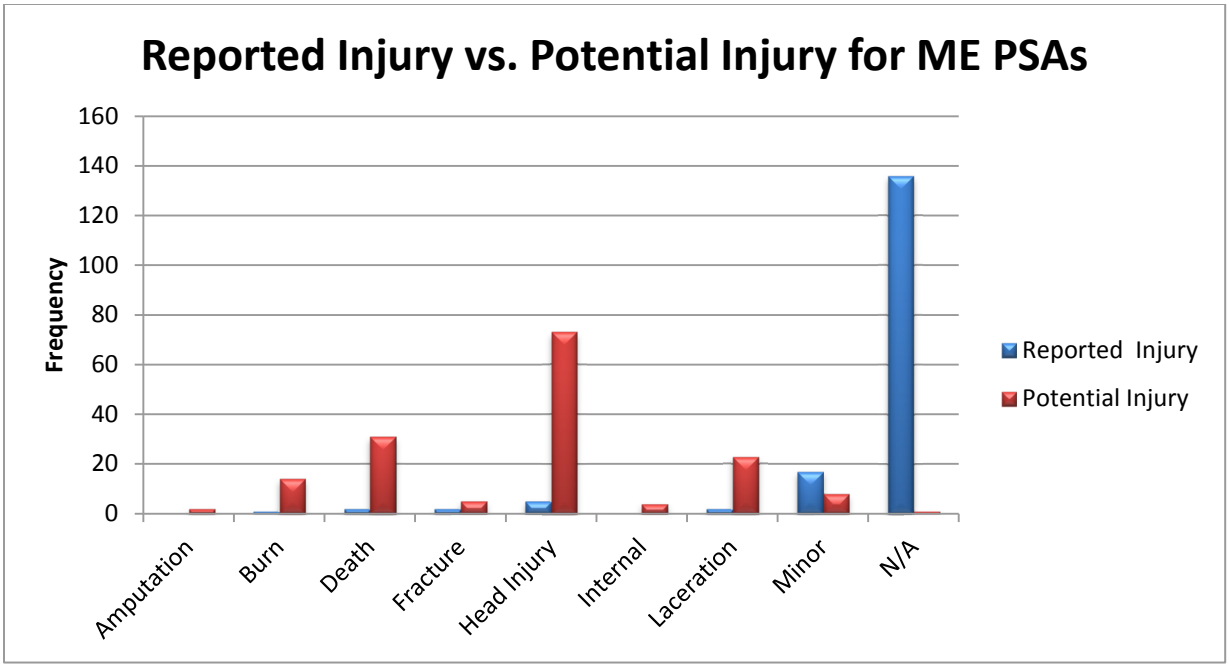


Figure 4.11: Reported Injury vs. Potential Injury for ME PSAs (FY 2013)

The majority of the PSAs did not have an injury reported. Minor injuries were most frequently reported, followed by Head Injury. Of the ME PSAs, the most frequent potential injuries were Head Injury, Death, Laceration, and Burn.

Additionally, the ME division evaluated unique elements for each PSA. These included: CAP Adequacy, Product Analysis, Conformance to Standards, and Review Bulletin (Defined in Table 3.4). The distribution of this analysis is shown below in Figure 4.12.

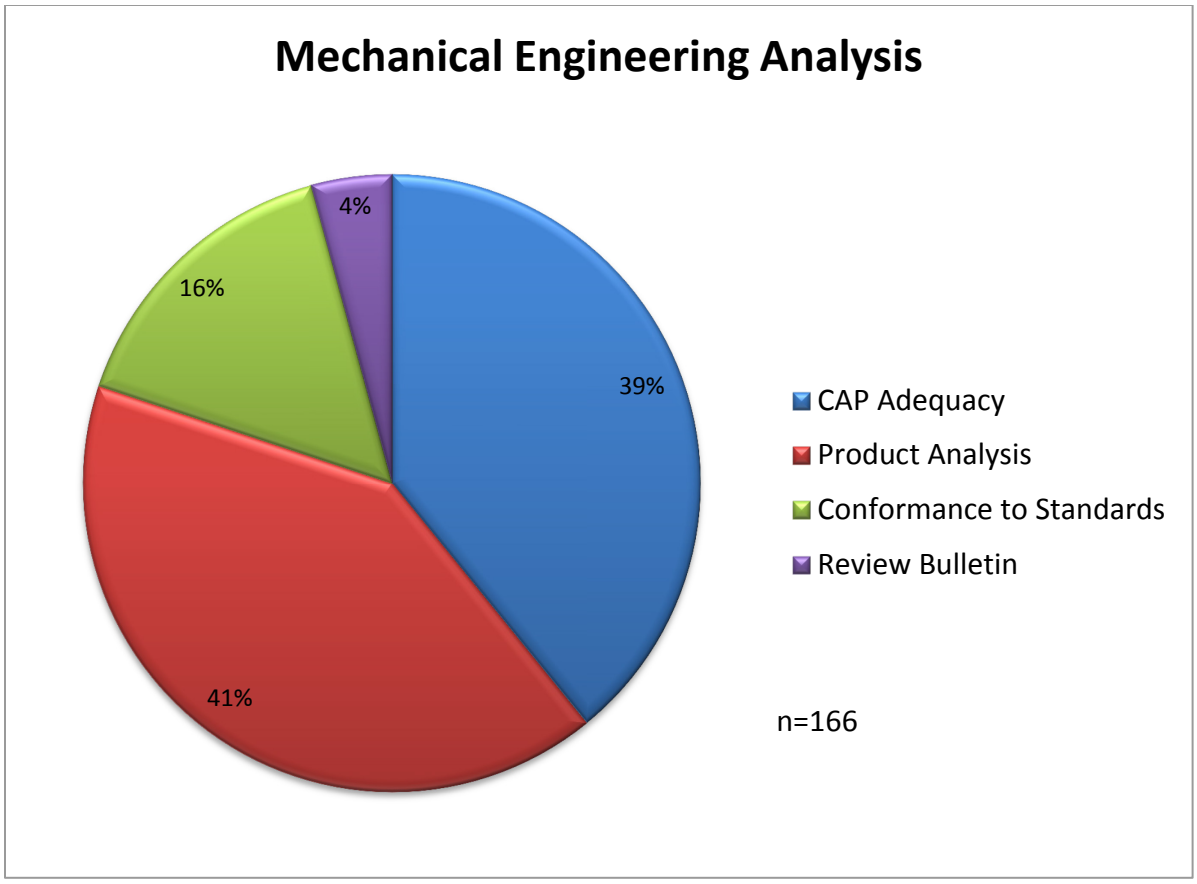


Figure 4.12: Mechanical Engineering Analysis Breakdown for FY 2013 ME PSAs

The majority of ME PSAs included product analysis (41%). There is also a significant amount of analysis completed regarding CAP Adequacy (39%).

Recurrent Product Types

Infant Products, Outdoor Recreation, and Home Goods accounted for the most recurrent product types analyzed for PSAs; therefore, these categories were broken down further by potential hazard.

Infant Products

Infant Products accounted for the majority of ME PSAs (34%), as seen in Figure 4.8. In Figure 4.13, Infant Product is broken down by potential product hazards.

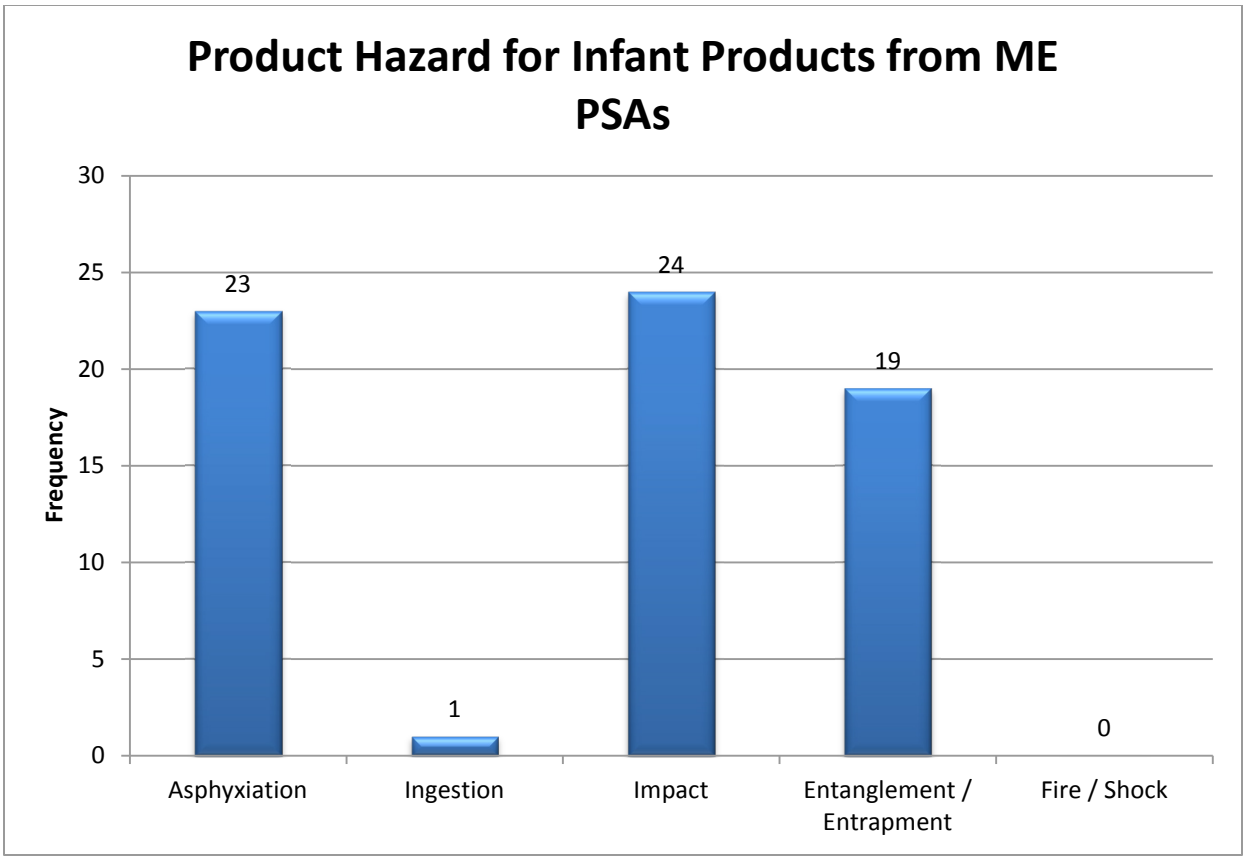


Figure 4.13: Product Hazard for Infant Product from ME PSAs (FY 2013)

The most frequent hazard for Infant Products was Impact, with 24 products posing this hazard. This was followed by Asphyxiation (23) and Entanglement and Entrapment (19).

Outdoor Recreation

Outdoor Recreation was the second largest product type category (30%), shown in Figure 4.8. The breakdown of Outdoor Recreation by potential product hazards is shown below in Figure 4.14.

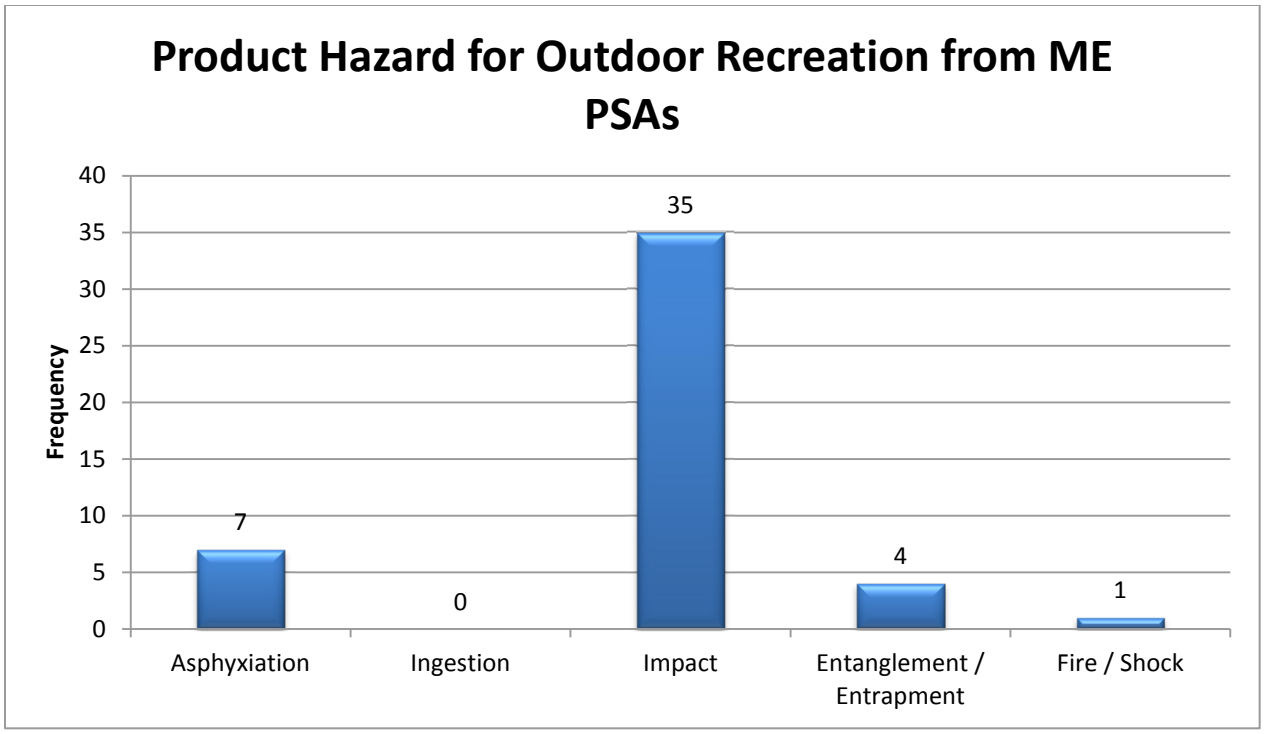


Figure 4.14: Product Hazard for Outdoor Recreation from ME PSAs (FY 2013)

Impact is the largest category with 35 different products, five times larger than Asphyxiation with 7 products. Many of the impact-related injuries involved bicycles and the user falling from the bike due to a defective part. Other incidents included high chairs with children sliding through the leg holes and recreational outdoor vehicles flipping over. Entanglement and Entrapment involved 4 different products and Fire and Shock involved a single product. There were no Ingestion hazards for outdoor recreational products.

Home Goods

Home Goods was the third largest product type category (24%), shown in Figure 4.8. Home Goods are broken down by potential product hazards in Figure 4.15.

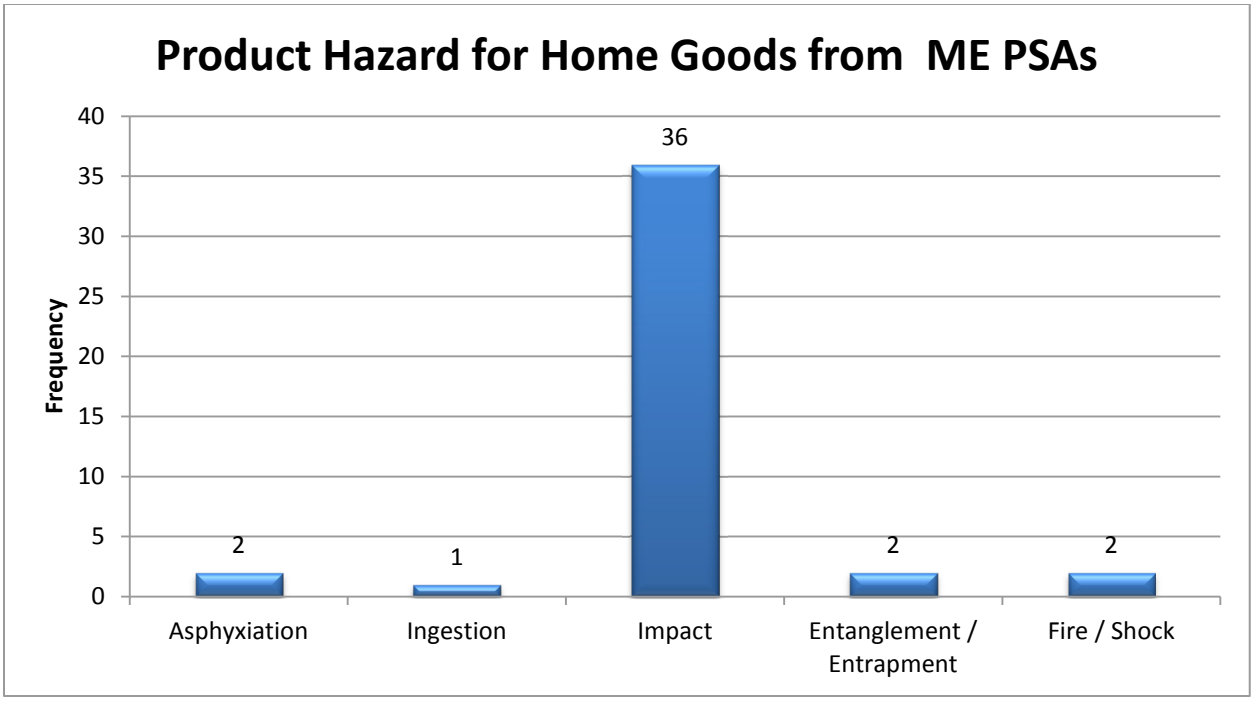


Figure 4.15: Product Hazard for Home Goods from ME PSAs (FY 2013)

Impact was the largest category with 35 products. These hazards were associated with products such as furniture and power tools. To breakdown the Impact hazard further, Table 4.2 presents the distribution by subgroup.

Table 4.2: Breakdown of Impact Hazard by Subgroups for Home Goods from ME PSAs

Impact Hazard Subgroup	Frequency
Crushing	7
Falling	4
Contact	22
Tipping	3

The most recurrent subgroup of Impact was *Contact,* with 22 products presenting this hazard.

4.1.3 Health Science PSAs

We reviewed 37 Health Science (HS) PSAs for FY 2013, out of which seven were canceled, leaving thirty PSAs from which to gather data. We split the PSAs into six different

product types: Appliances, Children's Toys, Home Goods, Indoor Recreation, Infant Products, and Outdoor Recreation (defined in section 3.1.2), shown in Figure 4.16.

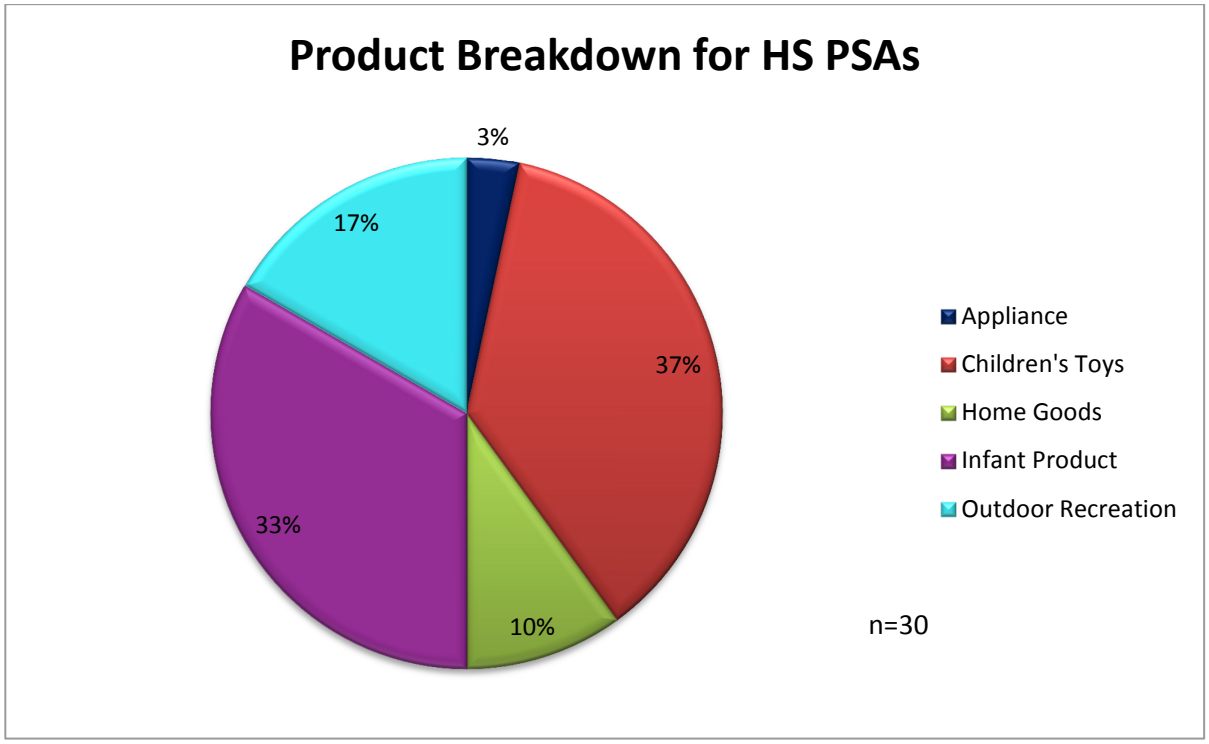


Figure 4.16: Product Breakdown for HS PSAs (FY 2013)

The majority of the HS PSAs were related to Children's Toys (37%) and Infant Products (33%). The remaining categories were Outdoor Recreation (17%), Home Goods (10%), and Appliances (3%).

The HS PSAs were also classified by the potential product hazard: Asphyxiation; Ingestion; Impact; Entanglement and Entrapment; and Fire and Shock. Figure 4.17 shows the breakdown for the Health Science PSAs.

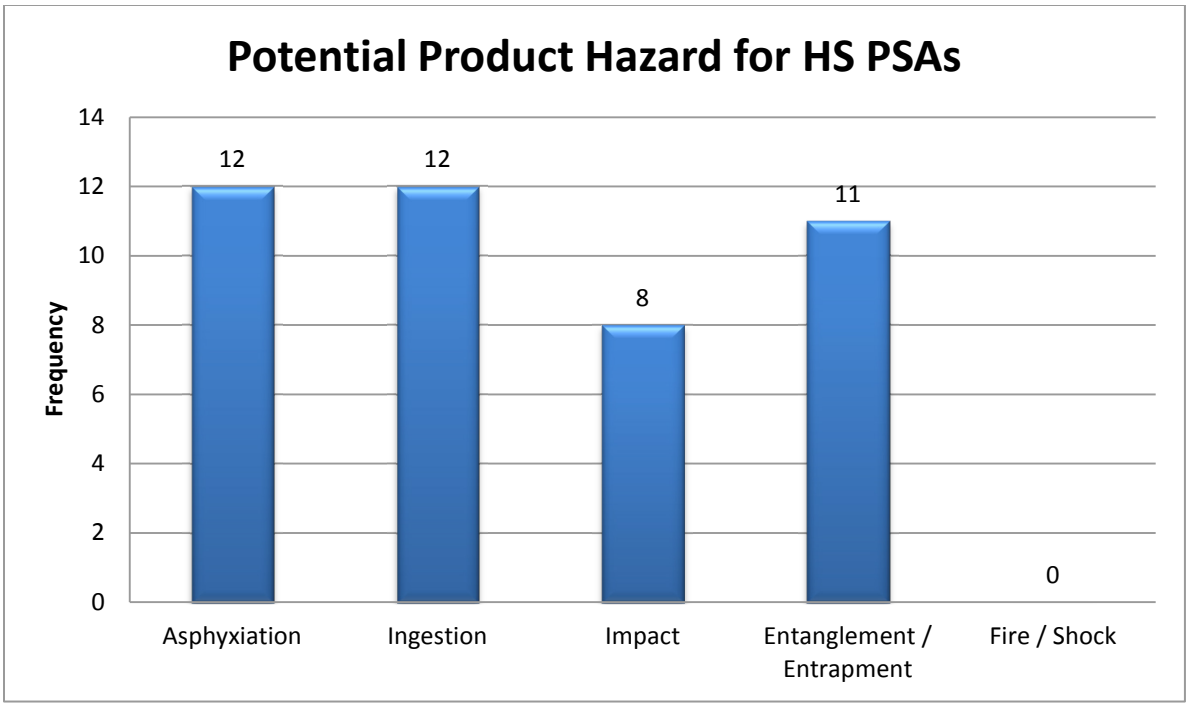


Figure 4.17: Potential Product Hazard for HS PSAs (FY 2013)

The Health Science Division had a fairly even breakdown of hazards excluding Fire and Shock, which had zero products related. Asphyxiation and Ingestion each had 12 products pose these risks.

Additionally, we recorded the actual injury that occurred, as well as the potential injury that could occur. These were categorized into eight different types of injuries: Amputation, Burn, Death, Fracture, Head Injury, Internal, Laceration, and Mirror injury. Figure 4.18 shows the distribution of the injuries.

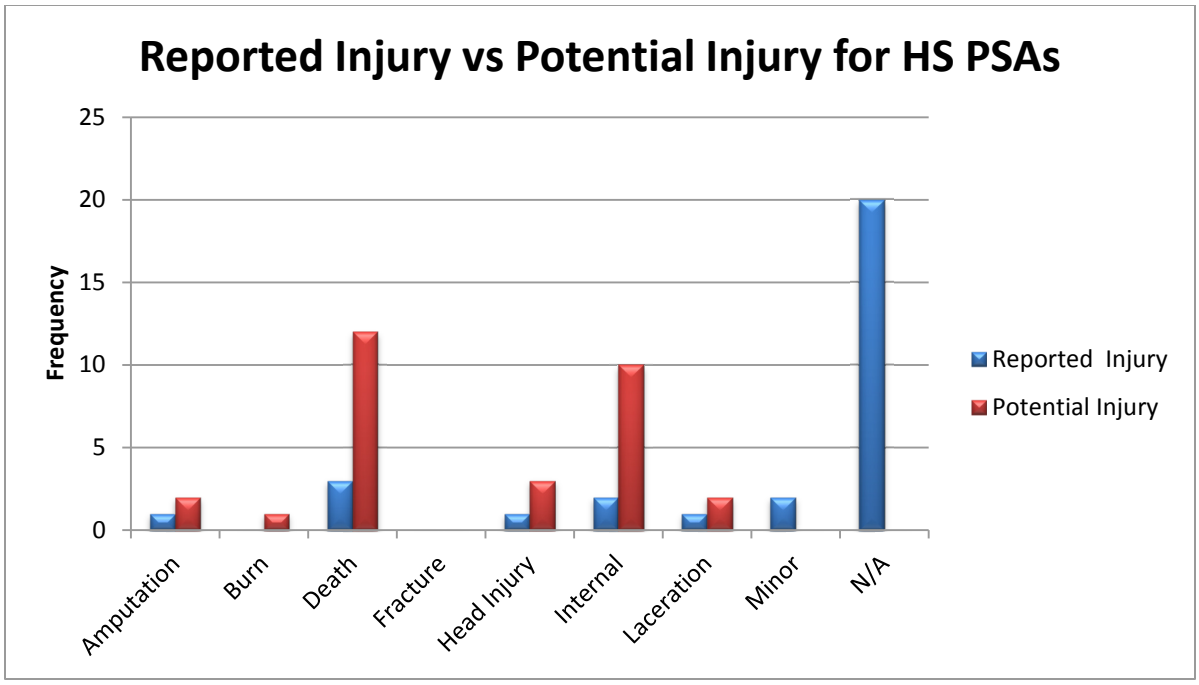


Figure 4.18: Reported Injury vs. Potential Injury for HS PSAs (FY 2013)

Throughout the HS PSAs there were no distinct recorded injuries within this small sample size (30); however, we noted that Death and Internal injuries were the most recurring injuries among HS PSAs. The most frequent category was N/A, indicating that there was no reported injury associated with the PSA.

4.1.4 Cross Division Analysis

After gathering all the data from each division's PSAs, we compared the findings. We decided to compare only Human Factors and Mechanical Engineering PSAs because the results from Health Sciences did not seem relevant to the Division of Human Factors. The Health Sciences PSAs considered the extent of injuries more than the cause of injuries.

First, we compared the products types from HF and ME PSAs. The different Product types are: Appliances, Children's Toys, Home Goods, Indoor Recreation, Infant Products, and Outdoor Recreation (defined in section 3.1.2). Figure 4.19 shows this comparison.

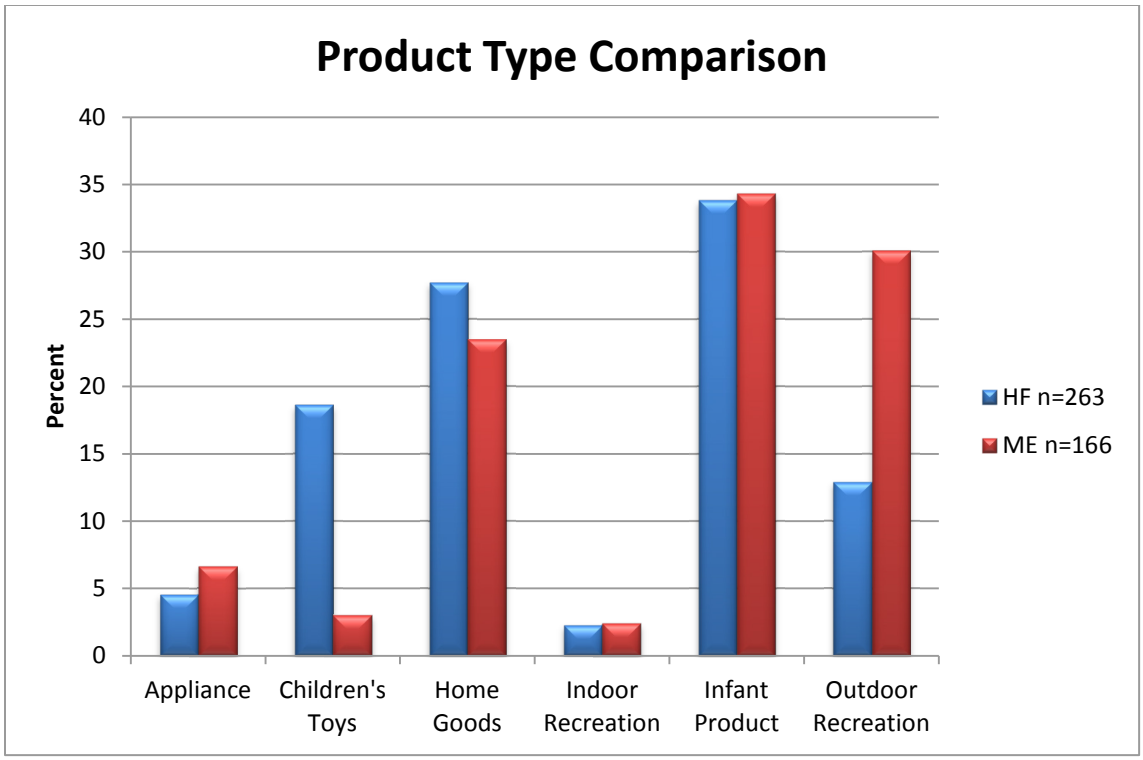


Figure 4.19: Comparison of HF and ME PSAs on Product Type

Appliances, Indoor Recreation, Home Goods, and Infant Products all have a similar percentage of analyzed product type between HF and ME PSAs. There are differences between the number of Children's Toys and Outdoor Recreation products analyzed. This could be attributed to the Outdoor Recreation equipment having more product defects and fewer misuses than Children's Toys. This graph also shows Infant Products have the most incidences with ME and HF PSAs for product defects and misuses.

In addition to comparing product types, we also compared potential product hazards between the ME and HF PSAs. We defined five different types of potential hazards: Asphyxiation; Ingestion; Impact; Entanglement and Entrapment; and Fire and Shock. Figure 4.20 shows the product hazard comparison.

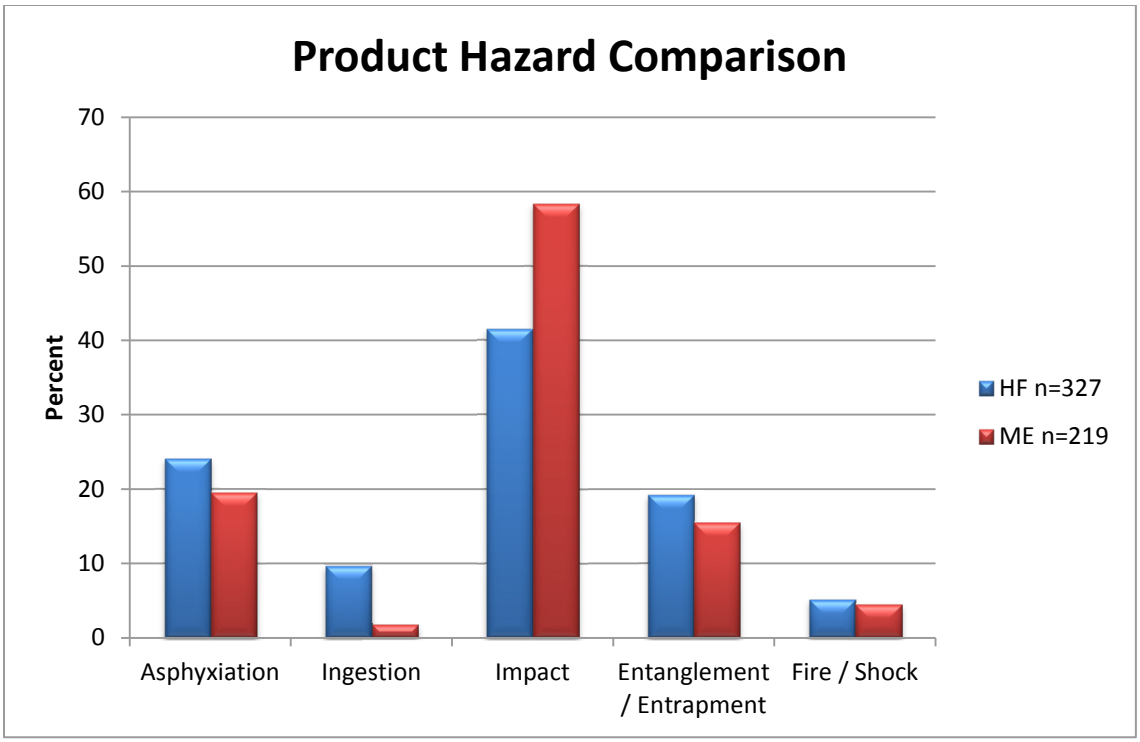


Figure 4.20: Comparison of HF (FY2011-FY2013) and ME (FY 2013) PSAs on Product Hazards

The product hazards do not suggest as strong a correlation as did the product type. The Impact category is still the largest category of all, followed by Asphyxiation, and then Entanglement and Entrapment for HF and ME PSAs.

Since the Impact hazard involved the most products, we made four subcategories: *Contact, Crushing, Falling*, and *Tipping*. The figure below, Figure 4.21, shows the Impact subgroups comparison between HF and ME.

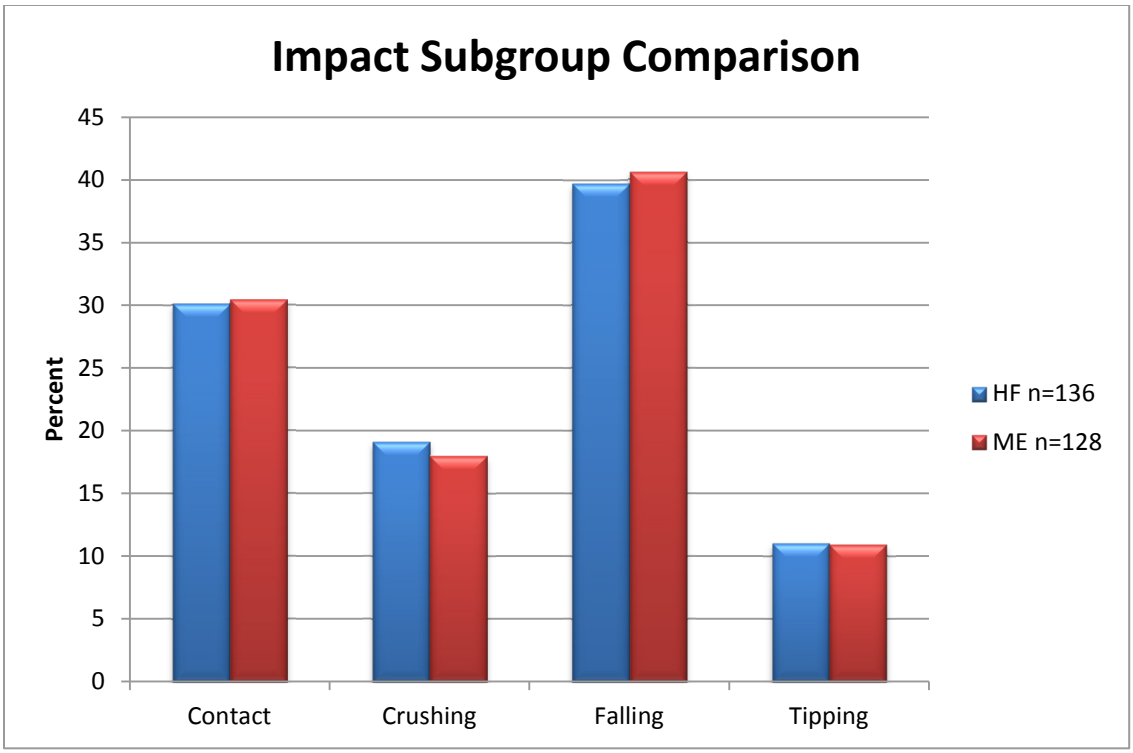


Figure 4.21: Comparison of HF (FY2011-FY2013) and ME (FY 2013) PSAs on the Impact Subgroups

The breakdown of percentages between the HF and ME for the Impact subcategories presents similar results. *Falling* is still the largest at 40 percent, *Contact* follows with 30 percent. Next, is a *Crushing* hazard at approximately 20 percent for both HF and ME. These hazard similarities are largely due to the same products being examined, such as high chairs, strollers, and play yards.

We also categorized what the potential injury could have been from a product incident. We defined eight different types of injuries: Amputation, Burn, Death, Fracture, Head Injury, Internal, Laceration, and Minor Injury. Figure 4.22 shows the comparison of potential injury between ME and HF incidents.

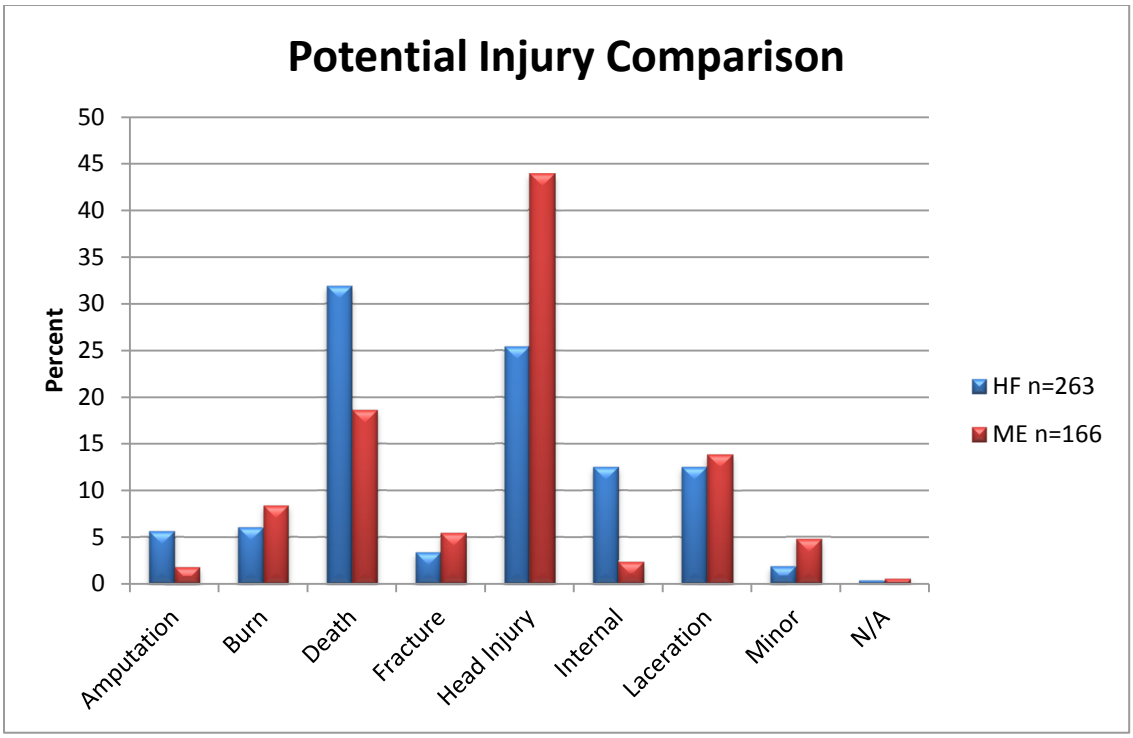


Figure 4.22: Comparison of HF (FY2011-FY2013) and ME (FY 2013) PSAs on Potential Injury

Head Injury and Death were posed by the largest number of products. HF PSAs accounted for more potential Deaths (32%), and ME PSAs had more potential Head Injuries (45%). Other than this, there was no significant data to identify other trends.

4.2 Human Interaction

This section will report the findings gathered from interviews with CPSC personnel and the reoccurring issues the agency sees with human–product interactions. This section includes CPSC personnel's thoughts on product misuse, supervision, and the importance of educating the adult consumer. Additionally, this section includes feedback from industry representatives on human factors, or lack thereof, in product development.

4.2.1 Instructions and Assembly

After interviewing CPSC personnel, it was evident that typically, firms do not use instructions and warning labels to the best possible advantage of the consumer. Respondents within the Division of Human Factors provided a unanimous assessment that firms will place warning labels on a product as a first resort, rather than try to design out a hazard. One of our respondents said, "warning labels should be a last ditch effort, not a first response." Similarly, instructions are relied upon heavily by product designers who assume that the consumer will take the time to read and understand the instructions before assembling or using a product. This is not the case, however. "People who believe they know how to perform a task are unlikely to seek out and use instructions," said one respondent. Furthermore, the respondent added the injured are typically people who are experienced with that type product, while those who are not experienced with a given product, are more likely to respect all warnings and instructions. The respondent provided the following example: a woodworker accustomed to using a table saw may use a new table saw without reading the instruction and warnings; while a new table saw user is more likely to read the instructions and warnings before operation.

Respondents shared that instructions are often inadequate and do not provide the user with sufficient information to assemble and/or operate the product. One example provided by a respondent described the inadequacy of instructions created by international firms. These firms attempt to have a concise, uniform, instruction manual for all of the countries in which they distribute their products. To accomplish this, they use images (pictograms) rather than written text to instruct the consumer. This helps the firm to avoid using multiple languages to produce the manual. Our respondent explained that, although in some cases this is found to be an

effective method of communication, images can be misinterpreted, thus leading to a poor understanding of the product and placing the consumer at risk.

These statements are supported by the data retrieved while analyzing the Human Factors PSAs from fiscal years 2011 to 2013. Figure 4.23 below shows the breakdown of assessments related to instructions, warnings, warnings and instructions, and assessments unrelated to instructions and warnings.

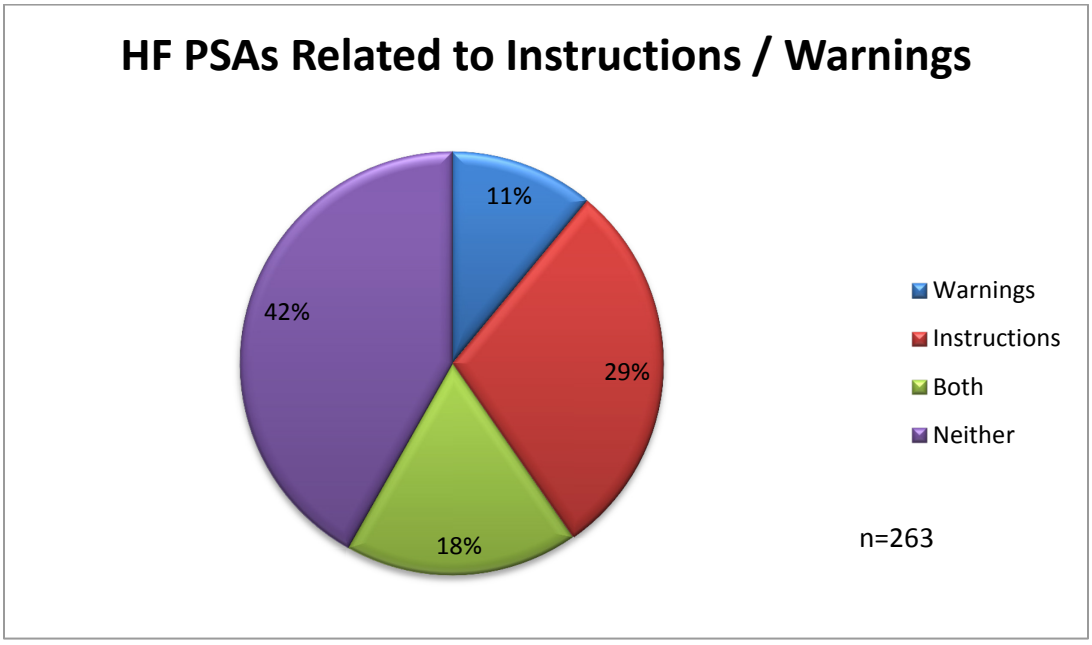


Figure 4.23: HF PSAs Related to Instructions and Warnings (FY2011-FY2013)

From this breakdown, along with examining products for foreseeable misuse and defects, there is a significant number (58%) of PSAs that examine instructions and/or warning labels. Instructions represented 29 percent of the PSAs that human factors experts were asked to review.

External respondents shared the opinions of CPSC personnel regarding instruction inadequacy. One respondent's research revealed that, when consumers open a product for the first time, they will store the instructions then start using the product until they have an issue

with assembling the product. Therefore, the instructions were not used as intended by the product developer. The respondent added that once a problem arises, consumers will complain, and manufacturers respond by stating: the "user did not read instructions." The consumer will argue, in turn, that the "product is not intuitive." The respondent said they viewed instructions and warnings as ineffective and offered the following analogy: "If your dog is ugly and you groom it; it's still ugly." This analogy suggests that instructions will not protect the consumer against a potentially hazardous product.

4.2.2 Adult Interaction

For the Human Factors PSAs, there were a large number of assessments regarding children's toys and infant products, as shown in section 4.1.1. Although the products are intended for use by children, there is frequent interaction that the parent or adult has with the product as well. This is because the child may not have the cognitive ability to assemble a product, or the child may lack the mental development to use the product in a safe manner: CPSC personnel stated that adults need to be educated on the use of the product just as much, if not more, than the child. For example, there have been numerous PSAs conducted by CPSC personnel regarding the ingestion of water absorbing polymers. One PSA refers to an injury where a child ingested one of these growing polymers because it was mistaken for a piece of candy. This resulted in the child needing surgery. Respondents from CPSC stated that these types of incidents can be avoided if the parent or adult was more informed about the proper use of the product.

Our interviewees also stated that firms often place the blame on the parent or adult regarding infant injuries, blaming adults because they were not supervising the child properly. Products will state on warning labels and/or within the instruction manual: do not leave child

unattended. Respondents raised this issue in our interviews and said that many incidents occur when the adults think to themselves, "he/she is okay, they will be fine if I leave the room for a second"; however, in reality, that one-second is when a hazardous situation can arise.

4.3 Product Development

This section reports the findings about how industries incorporate human factors in the development of products. It will include information from interviews with CPSC personnel and external interviews.

4.3.1 Human Factors in Product Development

According to the responses during our interviews, whether a company has a human factors group is largely dependent on their resources, particularly related to the size of the firm. Large companies that have an established place in the market will be more likely to have a human factors group, whereas smaller companies are less likely to have one. An interviewee informed us that a toy manufacturer has a daycare for employees' children that also serves as a testing area. Employees can bring their kids in and the engineers will monitor the children closely to observe their interactions with the product. Another respondent, who previously worked for a small design firm, stated that they could not afford to have a human factors group; instead, they have designers who oversee the writing of instructions. The respondent stated that product designers had no formal background in human factors but had enough experience with the product and potential hazards to be "good at it." Another respondent shared that new products are just derivatives of older products, especially among juvenile products, eliminating the need for a human factors expert. (S)he added that history alone could educate manufacturers on the typical use patterns.

The lack of human factors groups was noted by external contacts as well. One respondent stated that they were "stunned by the lack of human factors design conducted by manufacturers." This respondent added that most companies design to the regulations and standards then stop when the basic regulations are met, sometimes satisfying only minimum standards. At this point, the respondent shared that those manufacturers "consider the product safe." The respondent added that most companies do not continue their product safety testing due to cost. The respondent hypothesized that if the analysis was conducted on prior recalls, the result would be more than 50 percent are likely due to human factors issues (use and misuse scenarios). The respondent believes education on human factors principles and the importance of incorporating human factors into product design is necessary.

Another respondent shared this view. (S)he explained from his/her experience: "it is very rare that firms ask for help [with regard to human factors] before a product is released." This respondent added that firms will not invest in avoiding a problem or training but will "only look for help when they need it."

As for product testing, respondents informed us that few companies have human subjects that test their product. However, testing the ease of assembly and adequacy of instructions is done more frequently. Firms will ask someone within the office who has limited knowledge about the product to assemble it. This process can introduce bias, however, because the person assembling the product does not represent the general population and, as one respondent stated: "Would be unlikely to inform their boss even if the product is flawed." A CPSC representative shared that tests need to be completed by individuals with lower cognitive abilities in addition to people who are not accustomed to the product type. Respondents had similar opinions regarding product testing and the need for more consistent testing throughout industry. One respondent

shared that they were unaware of any human factors regulations or standards, noting that the extent of human usability incorporated into the process was anthropometric charts.

4.3.2 Foreseeable Misuse

Hazards often arise when a product is misused. One respondent shared that products are used in three ways: intended use, misuse, and (commonly) accepted use. The respondent expanded that accepted use is the way the consumer is actually going to use the product even though it may not be the intended use. The example provided involved a baby seat that the manufacturer intended to be placed on the ground (intended use). However, consumers frequently place baby seats on an elevated surface (accepted use), thus inadvertently creating a fall hazard.

Another respondent shared that "humans are the most unpredictable part of a system." However, CPSC interviewees also opined that there is a lack of consideration for foreseeable misuse in product design and that this is a typical root cause of product-related injuries. One external representative echoed this view, stating that one of the biggest challenges for firms is factoring in foreseeable use and misuse of children's products because child as well as parent behaviors are unpredictable. This occurs often because there is bias within the process. Some designers will use personal experience and intuition, failing to consider the entire population that will be using the product. One respondent commented: "the designer will often say, 'well my kid would never do that' and not consider the general population." This suggests that product designers will use their intuition rather than apply rigorous standards of engineering fundamentals. Another interviewee added: "there is nothing as uncommon as common sense."

One respondent shared that safety is one of the hardest elements to generalize primarily because of product usage. The respondent noted that it took engineers a long time to design for

fatigue, which is quantifiable, while safety is different. Safety is challenging to design for because of the uniqueness of the products and the necessity to account for varying users. In particular, it is "hard to anticipate" how the consumer will use the product, the commenter observed.

The CPSC will help inform companies of foreseeable misuses if the problem is an apparent issue across the industry. To give an example, one respondent referred to the issue of small magnets and how they pose ingestion and choking hazards. There was no issue with the product or a particular brand, but there were many cases of misuse of the magnets when removed from the package. This forced the CPSC to react and begin further investigation of the product and similar products. Cases like this often result in the creation of voluntary standards, and in some cases, mandatory standards or product bans.

4.4 Identifying and Communicating Hazards

Our respondents shared that the CPSC's current regulatory process is effective ─to a degree. Due to the judicial system and liability issues, the CPSC cannot provide exact fixes for products. Rather, the agency can only advise safe fixes. Respondents explained that the CPSC could never be responsible for pre-market product testing and approval with its current structure. Respondents noted how small the agency is compared to other government agencies; and one respondent observed that U.S. Air Force spent what the total budget for the CPSC amounts to "in the blink of the eye." Therefore, the CPSC is resource constrained, and, within the agency's constraints, current methods are sufficient but could be made more efficient. Furthermore, one respondent advised that there will always be product-related incidents, and therefore, "a static level of noise." The respondent added that the CPSC can only get as close to that level as possible.

An external contact shared that the CPSC is effective at communicating industry trends at ASTM standard meetings. The information provided alerts larger companies of typical use patterns and product-related risks. However, smaller companies, as well as entry-level firms, do not attend these meetings. Therefore, a broader education system is required to educate all manufacturers effectively.

When reviewing an incident, there was a consensus among respondents that collaboration among divisions is critical for generating the best analysis. This collaboration allowed the development of "joint opinions," aiding the staff when completing PSAs and communicating to firms. In the respondent's opinion, the analysis was "more complete and professional."

Additionally, during one interview, one respondent explained that an internal handbook would be useful. The respondent shared that having a handbook to explain human factors to other divisions and Compliance officers would be highly beneficial. Both internal and external contacts agreed that a universal handbook for human factors' best practices would aid in reducing the number unsafe products entering the market. One external respondent offered high praised this idea and asked this to be "made available yesterday."

4.5 Chapter Summary

In this section, we present an overview of the data collected from Human Factors, Mechanical Engineering, and Health Sciences PSAs, as well as the information collected from interviews. After analyzing the data we collected, we were able to make conclusions regarding potential product hazard trends and their relation to human factors. Our conclusions from our research will be reported in the following chapter.

Chapter 5: CONCLUSION

The purpose of this project was to research and identify product hazard trends over the past three years. This was accomplished by analyzing PSAs and conducting interviews. Our research suggests that there is a strong correlation between defects and the failure to account for human factors in the design process. This section presents the conclusions we identified from our research.

5.1 Hazard Trends

From the data obtained from PSAs and interviewees' responses, it was evident that there are a significant number of hazards related to Home Goods, Infant Products, and Children's Toys. Many of these hazards arose from the firms' inadvertent inattention to comply with the relevant voluntary and/or mandatory standards or best practices. PSAs and interviewees suggested that there is no lack of standards for products but a lack of accountability when manufacturers do not abide by standards. Furthermore, the most apparent potential hazards were related to Impact, as defined in Section 3.1.2. The majority of incidents that resulted in an Impact-related injury were caused by unintended use of the product. Unintended use can be attributed to the inadequacy of instructions and/or warning labels or the consumer's failure to read, understand, and apply warning or instructional materials. More than half of the PSAs that the Division of Human Factors analyzed from the FY 2011 to FY 2013 suggest that manufacturers and the designers or staff creating the instructions and warning labels need to be more aware of the importance of human factors engineering to prevent consumer injury.

Although we can conclude from the overall data that Impact was the most prominent potential hazard, this can vary between product types. We found that Ingestion was presented most frequently as a potential hazard with children's toys. Manufacturers failing to consider the

product's appearance once it has been removed from the packaging can be blamed for this issue. Information gathered from PSAs and interview respondents suggests that companies isolate their product design to meet specifications and fail to consider what could have been the foreseeable misuse(s) of a product. The category of Home Goods showed that a significant number of products posed Asphyxiation and Entanglement and Entrapment hazards. From the analysis of PSAs, we concluded that the high frequency of these hazards can be directly attributed to blind and shade products. This finding also supports the need to inform the manufacturer better about labeling and designing their products to account for foreseeable misuses. Lastly, Infant Products hazard trends proved to be the area where Impact hazards occurred most frequently. We found this conclusion to be related to infants submarining (fitting through an opening) and falling from strollers and high chairs due to the manufacturer's failure to comply with standards.

5.2 Communication Trends

Upon completion of our study, we believe that there is a lack of communication between firms and the CPSC; within the CPSC itself; and between firms and the consumer. From interviews with CPSC personnel and respondents outside of the agency, we concluded that manufacturers must be educated about the importance of incorporating human factors into the design process. Survey and interview respondents stated that some divisions within the CPSC do not fully understand human factors. This demonstrates the need for more collaborative efforts within the agency. We concluded that projects involving multiple divisions within CPSC would benefit the agency as a whole and improve the quality and efficiency of the overall project in particular.

The lack of communication between a firm and consumers presents the potential for increased risk of injury. Consumers must be informed of the potential misuses and hazards related to a product.

5.3 Chapter Summary

Analyzing PSAs and the information obtained through interviews led us to conclude that there is a significant piece missing in the process of assessing the safety of consumer products. The lack of awareness related to human factors puts the consumer at greater risk of injury. There will always be risk associated with the use of consumer products, but mitigating that risk as much as possible is essential. Educating product designers and manufacturers about human factors is necessary to help reduce the number of unsafe products entering the market. Suggestions on how the CPSC can help improve the safety of consumer products are explained in the following chapter.

Chapter 6: RECOMMENDATIONS

The following section details recommendations to the CPSC based upon the conclusions drawn from analysis of PSAs and interviews with CPSC personnel and external contacts. These recommendations are primarily focused on future work within the Division of Human Factors, but the suggestions could have wider applications.

6.1 Human Factors Best Practices Handbook

This section includes recommendations for the development of a best practices handbook for human factors which could be used by CPSC both externally and internally. Our team advises the best practices handbook should be developed and implemented. We have provided the Division of Human Factors with a template for such a handbook (Shown in Appendix J).

6.1.1 External Handbook

An external human factors best practices handbook could inform manufacturers and product designers about the discipline, as a whole, and its specific importance to product safety. A handbook similar to one already produced by the CPSC entitled, "Handbook for Manufacturing Safer Consumer Products" would be sufficient. The handbook would provide the CPSC with material to present to firms, either when firms experience incidents with their products or when firms make general inquiries regarding product design and development best practices. In addition, the handbook could provide material to guide proactive manufacturing firms in pre-design information.

Cost Benefit Analysis

From feedback provided by respondents, our team believes that it would be highly beneficial if the CPSC, or a future WPI project team, conducted a cost benefits analysis on the incorporation of human factors into the design process. This analysis would include looking at

the return on investment by firms, particularly focusing on costs saved when the recall process is avoided. Given the importance of sustainability in the business world, providing such material directly to manufacturers would highlight the importance of incorporating human factors product safety testing into everyday design practices. Ample case study material and literature detailing the potential costs of the product recall process should be available for the conduct of such a study.

Outreach

The external handbook would only increase product safety if the intended audience, designers and non-specialists, utilized the material. The CPSC should not only refer companies to this handbook on a case by case basic but should search for methods to proactively communicate this resource to manufacturers. Our team suggests that human factors specialists present this information at conferences, tradeshows, as well as ASTM voluntary standards meetings. Our interviewees made apparent that smaller and entry level firms are currently often uninvolved in the communication of relevant safety information. Thus the CPSC should make a special effort to inform smaller firms on human factors. A handbook would be an invaluable resource in this process.

6.1.2 Internal Handbook

From our interviews, we discovered that a handbook that covers the discipline of human factors and the daily operation of ESHF would be a useful resource. ESHF could use the same handbook described above to also educate Compliance officers and members of other CPSC divisions on common human factors practices, and thus improve internal communication in various divisions of the agency.

6.2 Database Improvement

This section includes recommendations about PSAs and the need to improve internal databases at the CPSC.

6.2.1 PSA Database Improvements

The analysis completed in this report was based on archival review of the PSAs for fiscal years 2011 to 2013. However, this form of analysis will not be able to be repeated for subsequent years without reviewing all PSAs individually. Completing this analysis yielded useful figures and hard data for the CPSC to use, and it would be worth continuing such reviews. This process could be streamlined if the CPSC were to update the PSA database to record variables such as the ones our team examined. Then current hazards could be quantified and analyzed more easily for any period of time. This would increase the operability of the database as well as require only examination of trends, as opposed to having to read through all the past PSAs. We suggest that the CPSC consider this recommendation and take action, whether internally, or completed as a future Interactive Qualifying Project for WPI students.

6.2.2 Database Communication

While reviewing Human Factors and Mechanical Engineering PSAs, the team noted that only some PSAs had hyperlinked In-Depth Investigation (IDI) numbers. Our team concluded that linking the IDI database to the PSA database would have been worthwhile because the reviewer could easily reference the incidents if more detail were available.

It would also be worthwhile for the PSAs to reference the NEISS diagnosis codes directly when describing injuries resulting from product incidents. If the PSA and NEISS databases could be linked, analysis of PSAs would be greatly enhanced.

6.2.3 PSA Cancelations

While reviewing Human Factors and Mechanical Engineering PSAs, we noted that Compliance officers canceled numerous PSAs. The reasons why Compliance officers canceled these PSAs would be important in our analysis. If there is a way to avoid cancelations, we believe increased productivity would result and less money from the agency's already-limited resources would be expended. Furthermore, it would be useful to identify the type of products associated with PSA cancelations and identify any apparent trends in cancelation actions.

6.2.4 PSA Consistency

While reviewing Human Factors and Mechanical Engineering PSAs, we noted that the quality of PSA analysis varied from report to report. Most reports included a box, filled out by a Compliance officer, recording information including product hazard and In-Depth Investigation (IDI) number. We reviewed many reports with incomplete and varying information. Some reports stated incident numbers in the body of the report but no incident numbers were included on the top of the report. To improve future analyses, it is essential that these reports are filled out consistently. We noted a difference in the way "Fast-Track" PSAs were completed versus traditional PSAs. A Fast-Track PSA is an assessment that reviews a product when a firm initiated a self-voluntary recall of a product. Inconsistency in handling PSAs makes cross-comparisons of PSAs complicated. PSA consistency should be practiced and stressed in internal training procedures.

Furthermore, within the reports, we noted several errors. For example, PSA-0134.11 provided an incorrect IDI number. Improper figure labeling is another common error. For example, PSA-0263.11 referenced Figure 2 when Figure 3 was the correct reference.

6.3 Communication

This section reports our recommendations regarding internal and external communications. In particular, we make recommendations concerning the interdivision collaboration and the process by which Compliance presents information about recalls.

6.3.1 Internal Collaboration

We concluded that CPSC interdivision collaboration on PSAs resulted in higher quality reports. Our interviewees stated that working with other CPSC divisions while conducting analysis allowed the reviewers to share their unique perspectives on the study and encouraged the creation of joint opinions. Our respondents also shared that when completing PSAs individually; completion could take up to 9 months; while completing joint PSAs reduced the timeline to about 3 months. The timeline of completion is shortened because the divisions are working jointly instead of completing them in a sequence. This strong praise of interdivision collaboration and allow our team to recommend further collaboration in the future. It is apparent, from interview responses, that interdivision partnership leads to an increase in the quality of the analysis.

6.3.2 Communication with Manufacturers

Our interviews suggested that there is room for improvement in the process by which firms communicate their Corrective Action Plans (CAP) to the CPSC. A CAP is a manufacturer's suggested attempt to fix an apparent product issue. Respondents shared that the CAP information is difficult to work with and lacks detail about the firm's internal analysis of its product. This is because the information provided by the firm has been revised to include legal terms designed to protect the firm. When CPSC engineers analyze CAPs, sometimes they must request more data from the company, data the company often has in its possession but has not

provided to the CPSC in the initial report. Our team recommends that the CPSC review this process to decrease reaction time and, consequently, increase the quality of CPSC analysis.

6.4 Chapter Summary

Addressing the concerns raised by our research, we have provided the CPSC with suggestions on future steps and research we see value in pursuing. Our primary recommendation to the agency is to generate a human factors best practices handbook for CPSC to supply to manufacturers. Our research showed that human factors awareness across industry is currently lacking, resulting in a number of unsafe products entering the marketplace. Therefore, our team has developed a template for a handbook to increase awareness of human factors (see Appendix J). Our other recommendations involve improving the agency's internal database communication and the CPSC's data storage. During the data collection portion of our investigation, we noted a number of inconsistencies and elements needing improvement. Lastly, we recommend improving the internal and external communication processes at the CPSC. Overall, this project provided insight into current industry practices and what can be done to improve them.

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Appendix A: Consumer Product Safety Commission

The Consumer Product Safety Commission (2013b) is a federal agency established in 1972, under the presidency of Richard Nixon. The CPSC's headquarters is based in Bethesda, MD, and currently has more than 500 employees. The CPSC's mission is "protecting the public against unreasonable risks of injury from consumer products through education, safety standards activities, regulation, and enforcement" (CPSC, 2010, Executive Summary). This agency strives to be a global leader for consumer product safety. The CPSC's goals to achieve this mission include: Leadership in Safety, Commitment to Prevention, Rigorous Hazard Identification, Decisive Response, and Raising Awareness.

The CPSC (2010) requires a substantial amount of federal funding because it is an independent regulatory agency. Therefore, the CPSC submits a budget request to the United States Congress as part of the annual budget presented to the President. For fiscal year 2013, the CPSC received approximately $122 million in appropriated funds. The budget is split into several categories based on the agency's goals. Figure A.1 shows a breakdown of the budget for 2013.

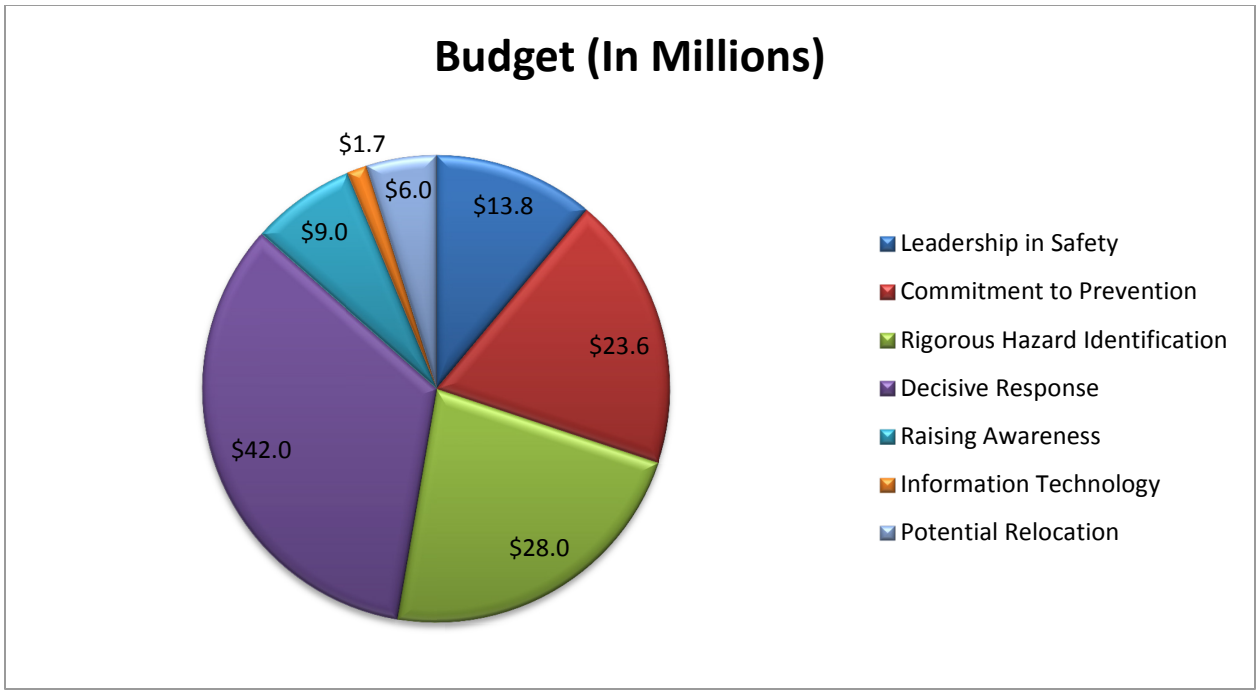

Figure A.1: CPSC Budget Breakdown FY 2013 (CPSC, 2010, CPSC STRATEGIC PLAN AND THE FY 2013 FUNDING REQUEST)

Once the funds have been appropriated, the agency distributes the funds among its offices. The Chairman of the agency oversees disbursement of these funds. Chairman, Inez Tenenbaum, who was nominated to this position by President Barack Obama in June 2009 (CPSC, 2013b), and confirmed by the United States Senate served as until November 2013. Tenenbaum was the ninth chairman in CPSC history. The Chairman is aided by four other commissioners, who are seated via the same process as the chairman. The Office of the Executive Director and the Office of the Inspector General are in the next tier of responsibility at the agency. The general structure of the U.S. CPSC is shown in Figure A.2.

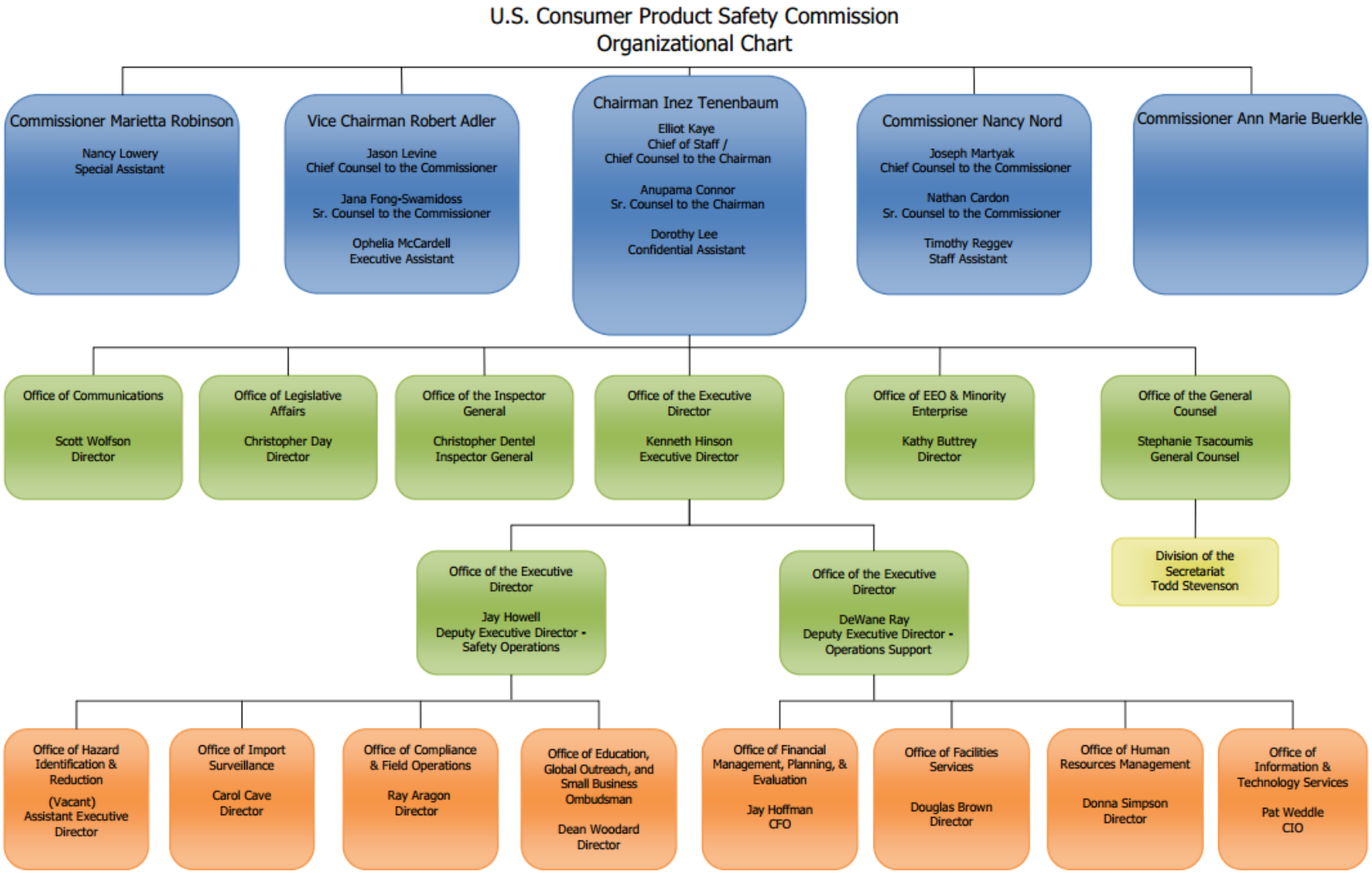

Figure A.2: U.S. CPSC Organizational Chart (USCPSC, 2013, CPSC Organization Chart)

The CPSC does not rely only on internal offices but partners with third party organizations to achieve its goals. These partner organizations include: the American Standards for Testing and Materials (ASTM), the Centers for Disease Control, the U.S. Department of Agriculture, Underwriters Laboratories (UL), and the U.S. Food and Drug Administration (Ford, 2011). ASTM plays a particularly large role in ensuring product safety because ASTM creates a set of standards that manufacturers must abide by when fabricating their products. The CPSC (2013b) also monitors consumer products imported from other countries with the help of U.S. Customs and Border Protection. This is a significant partnership considering that today many products are manufactured outside of the United States. In general, the companies and agencies that work with the CPSC are mutual partners and also abide by CPSC's mission. Lastly, UL (2013) is a global independent safety science company that helps the CPSC with the testing of consumer products. UL also helps create standards and inform businesses about how to comply with established standards. UL works closely with the CPSC and has helped the agency on many issues, including the recall of O-ring fire sprinklers.

Of the many offices within the agency and outside CPSC partners, the CPSC's Office of Hazard Identification and Reduction is most applicable to the current project. Our project team will work with these officials while conducting research into common root causes of failure in the product production and design process. The Office of Hazard Identification and Reduction will also play a large role in the success of developing a communication plan for informing firms about of those common failures.

Appendix B: What Is an IQP & How Is Our Project an IQP?

An Interactive Qualifying Project (IQP) is one of the requirements to receive a degree at Worcester Polytechnic Institute (2013). An IQP involves applied research that connects science or technology with social issues and human needs. The objective of the IQP is to provide WPI graduates a chance to understand how their careers will affect society. These projects are not structured as a course, but rather as an investigation of a social issue. Students are organized in small teams and work under the guidance of faculty members to explore a specific problem or need. These problems are not necessarily related to every student's major, although they can be related; and the projects are completed either on campus, nationally, or abroad at many different locations. After projects are investigated, students are required to provide recommendations for how to solve problems. These recommendations are then conveyed through formal reports and oral presentations to project sponsors and faculty advisors.

Our proposed project meets the criteria for an IQP because it combines both the sciences and social issues. The social issue concerning our project is public safety. We will be researching how to ensure product safety for consumers. This embodies the goals of an IQP because we will be looking at the products created by engineers and how they impact society. Currently, there is a lack of consistency in design guidelines for manufacturers of consumer products. This is a problem because consumers are put at risk of potential injury when products are designed without full consideration of human factors. Through our studies, we hope to find product design and performance trends that have led to product incidents and use the information we uncover to provide the CPSC with a strategic plan on how to mitigate these issues. By making these suggestions, we are attempting to reduce the number of products that pose risks to the public.

Appendix C: Protocol for PSA Analysis

PSA No. Date Reported:
Product: Age:

Potential Hazard(s):
Summary of Incident:

Was there a death: Yes No

Severity of the injury:

Was it caused by misuse: Yes No Unknown

Was the incident related to a product defect: Yes No
Possible suggestions/improvements for the product:

Human factors Issues:

Key words or phrases:

Other Comments:

Assessed by: Kendall Cotton Taylor Landry Adam Morehouse

Appendix D: Interview Protocol for a Company /Trade Association Representative

Interview Protocol for:
Company / Trade Association Representative

1. Introduce members of the project team
2. Describe the project:

   The Consumer Product Safety Commission's Division of Human Factors is currently conducting analysis that focuses on evaluating consumer product design incidents related to human interaction with a product. This project will focus on identifying poor human factors design and performance trends in Product Safety Assessments (PSAs) in order to proactively communicate these risks to manufacturers.

3. Discuss following target questions

Questions:

A. What are your primary responsibilities at your organization?

B. Does your organization have a human factors or usability testing group? If yes, 1) are they active in attending symposiums and writing papers and 2) what are their qualifications? If no, what does your organization do to provide a basis for understanding human factors principals?

C. How does your organization balance designing for function, cost, manufacturability, as well as human interaction and use patterns?

D. What experience do you have with human factors and how does this assist your organization?

E. Based on this experience, what are some of the most typical root causes of product related injuries?

F. Are there specific HF standards that you or your manufacturers use in design and/or testing?

G. How could the CPSC better inform/educate industry on human factors best practices?

H. Are there any other contacts in industry that you can recommend that we interview?

4. Thank the interviewee for his/her time and contribution and leave it open to come back to them for more information at a later time

Appendix E: Interview Protocol for CPSC Personnel

Interview Protocol for:
CPSC Personnel

1) Introduce members of the project team
2) Describe the project:

The Consumer Product Safety Commission's Division of Human Factors is currently conducting analysis that focuses on evaluating consumer product design incidents related to human interaction with a product. This project will focus on identifying poor human factors design and performance trends in Product Safety Assessments (PSAs) in order to proactively communicate these risks to manufacturers.

3) Discuss following target questions

Questions:

A. What are your primary responsibilities at the CPSC?

B. What experience have you had with human factors?

C. What are some of the most typical root causes of product related injuries?

D. Did the organizations that have had incidents related to their products have human factors groups? Do most organizations that you have examined balance designing for function, cost, manufacturability, as well as human interaction and use patterns?

E. Once a product trend is apparent, what steps does the CPSC take to prevent future incidences?

F. What is your opinion of how the CPSC communicates HF risks to firms? Could it be improved?

4) Thank the interviewee for his/her time and contribution and leave it open to come back to them for more information at a later time

Appendix F: Personal Communication with Bonnie Novak

U.S. Consumer Product Safety Commission (CPSC)
Worcester Polytechnic Institute (WPI) Student Project
Fall 2013

Problem: CPSC's Division of Human Factors is currently providing analysis to the CPSC Office of Compliance that focuses on consumer product design flaws related to how a user interacts with a product. A data analysis that identifies poor human factors design and performance trends in Product Safety Assessments (PSAs) needs to be conducted in order to proactively communicate these risks to manufacturers so that they could, essentially, be designed out.

Background: When an incident occurs with a consumer product, CPSC finds out and, often, collects the incident sample and sends it to the staff at the CPSC Lab in Rockville, MD to analyze. A PSA, Product Safety Assessment, is the CPSC document that provides the scientific and technical analysis conducted by CPSC Technical Staff on that specific product. The PSAs that this project will address are the examination of the sample to determine root causes. Those results, reported and documented in the PSA, could lead to recalls, voluntary standards proposals, or other actions.

Another way PSAs show up is when the CPSC Office of Compliance negotiates recalls, liaisons with companies, and ensures manufacturers are in compliance with our regulations. PSAs are initiated in response to one or more of the following reasons:

- a company has contacted the CPSC regarding one of their products and would like to initiate a recall;
- the CPSC has received complaints about a particular product from US consumers; or
- the possibility of a hazard or regulatory violation has been raised by CPSC field investigators, US Customs Service, or U.S. consumers.

Most PSAs are associated with a particular hazard which we focus on, and in general we only address hazards we are specifically asked about.

The Human Factors staff at CPSC, Human Factors Engineers and Psychologists, have expertise in assessing system design hazards for the general United States consumer population ranging from newborns to seniors. This includes usability, safety features, choking hazards, and evaluation of potential misuse of a product that could lead to injury or death. The analysis and testing conducted by the human factors staff directly contributes to consumer product safety and risk reduction. Examples of PSA analysis from the CPSC's Human Factors staff include:

- behavioral and development analysis to determine age grading of toys;
- human performance analysis to determine human interaction with products; and
- usability and design of instructions and labels provided with consumer products.

CPSC will sponsor WPI in conducting the research needed to identify the human factors trends in the PSAs and provide the leads for WPI students to contact and survey industry representatives in order to compare those trends. Those design issues can then be communicated to educate industry. So, the project will allow WPI students to examine already-submitted PSAs, identify common root-cause issues, and develop a communication plan for informing firms of these common failures. The plan would have 2 intents. First, we want companies to use this knowledge to avoid making products that will be involved in some sort of incident. Second, when a company sends in a report, it's complete, and CPSC doesn't have to go back to them and ask for the missing bits.

Purpose: Gathering and analyzing this data will provide CPSC with the information necessary to proactively define the human factors hazards seen most frequently across a sample of products evaluated over the course of one year. This list of hazards could then be compared to those that industry reports in their documented history of human factors incidents, over the same timeframe, to determine the similarities and differences in the reported incidents. Proactively communicating the overlapping trends and high-driving hazards to manufacturers could lead to a reduction in those faulty design characteristics.

Student Project: Students will be asked to review Human Factors Product Safety Assessment analyses that were conducted in the past. Students will characterize the trends in the product designs that led to the incidents and indicate the human factors design and/or human performance interaction criteria that contributed to the incident. Students will then conduct interviews with recommended manufacturers in order to determine 1) what human factors (usability, design, human error) incidents were documented and what steps were taken for mitigation (e.g., redesign, labeling, packaging, education), 2) what standardized human factors design criteria the company uses, if any, and 3) how the company incorporates operational scenarios, including intended use and reasonable foreseeable misuse of the product, into their design and development.

The student project would produce a report that has the following recommended sections.

1) An analysis of the human factors design and usability hazards identified from the Product Safety Assessments conducted by the Division of Human Factors.
2) A description of incidents, design criteria, and operational scenarios reported from firms interviewed for the project, as well as processes and methodologies used to address them.
3) A communications plan for socializing the human factors design issues to designers and manufacturers to increase education and reduce likelihood of those faulty designs reoccurring.
4) Further recommended research and next steps based on work conducted for this project.

Resources available:

- Product Safety Assessment analyses conducted by Human Factors staff.
- List of names and contact information for recommended industry representatives to interview.
- Analysis of Publicly Available Human Factors and Human Systems Integration Standards, Best Practices, and Guidelines. Created by the National Institute of Standards

and Technology (NIST) in partnership with the Department of Homeland Security Science & Technology (DHS S&T) Directorate.

- Human Engineering Design Criteria Standards Part 3: Interim Steps. Created by the National Institute of Standards and Technology (NIST) in partnership with the Department of Homeland Security Science & Technology (DHS S&T) Directorate.

Sponsor: Bonnie Novak, Director, Division of Human Factors. 301.987.2311. bnovak@cpsc.gov

Appendix G: Human Factors PSAs (FY2011-FY2013) Excel Data

PSA No.	Product Type	Product	HF Analysis	Reported Injury	Potential Injury	Asphyxia-tion	Ingestion	Impact	Entanglement / Entrapment	Fire / Shock
0841.11	Appliance	Blender	Both	Laceration	Laceration			Contact		
0321.11	Appliance	Ceiling Fan	Both	Head Injury	Death			Crushing		
0941.13	Appliance	Ceiling Fan	Both	N/A	Head Injury			Contact		
0812.12	Appliance	Ceiling Fan	Instructions	N/A	Head Injury			Contact		
0978.11	Appliance	Freezer	Instructions	N/A	Head Injury			Crushing		
0371.12	Appliance	Gas grill	Instructions	Burn	Burn					1
0820.13	Appliance	Gas Grill	Both	Burn	Burn					1
0802.12	Appliance	Grill	Both	N/A	Burn					1
0417.13	Appliance	Microwave popcorn bowl/maker	Instructions	Burn	Burn					1
0010.12	Appliance	Motion Sensing Wall Switch	Instructions	N/A	Burn					1
0720.13	Appliance	Refrigerator	Instructions	Minor	Head Injury			Crushing		
0167.11	Appliance	Toaster	Instructions	N/A	Burn					1
0132.13	Canceled									
0185.11	Canceled									
0191.12	Canceled									
0218.13	Canceled									
0233.11	Canceled									
0289.11	Canceled									
0292.13	Canceled									
0321.12	Canceled									

0353.12	Canceled									
0360.12	Canceled									
0433.11	Canceled									
0604.13	Canceled									
0623.11	Canceled									
0656.12	Canceled									
0680.12	Canceled									
0696.12	Canceled									
0698.12	Canceled									
0699.12	Canceled									
0700.12	Canceled									
0701.12	Canceled									
0702.12	Canceled									
0705.12	Canceled									
0758.12	Canceled									
0774.12	Canceled									
0789.12	Canceled									
0837.11	Canceled									
0844.13	Canceled									
0852.12	Canceled									
0869.12	Canceled									
0883.11	Canceled									
0905.12	Canceled									
0976.12	Canceled									
0986.12	Canceled									
0350.13	Children's Toy	Crib Toy	Both	Head Injury	Death	1			1	
0684.13	Children's Toy	Doll carrying case	Instructions	Laceration	Laceration			Contact		
0749.11	Children's Toy	Dolls	Neither	Minor	Death	1				

0002.13	Children's Toy	Growing Polymer	Neither	N/A	Internal		1			
0082.13	Children's Toy	Growing Polymer	Neither	N/A	Internal		1			
0083.13	Children's Toy	Growing Polymer	Neither	N/A	Internal		1			
0641.13	Children's Toy	Growing Polymer	Neither	Internal	Internal		1			
0662.13	Children's Toy	Growing Polymer	Neither	N/A	Internal		1			
0729.13	Children's Toy	Growing Polymer	Warnings	N/A	Internal		1			
0848.13	Children's Toy	Growing Polymer	Warnings	N/A	Internal		1			
0883.13	Children's Toy	Growing Polymer	Warnings	N/A	Internal		1			
0920.13	Children's Toy	Growing Polymer	Warnings	N/A	Internal		1			
1025.13	Children's Toy	Growing Polymer	Warnings	N/A	Internal		1			
0725.11	Children's Toy	Inflatable ball	Neither	N/A	Death	1				
0039.12	Children's Toy	Inflatable Ball Pit	Neither	N/A	Death	1			1	
0057.13	Children's Toy	Kiddie Car	Neither	N/A	Head Injury			Tipping		
0457.13	Children's Toy	Play slide	Neither	Head Injury	Head Injury			Fall		
1064.11	Children's Toy	Pool Toy	Neither	N/A	Death	1			1	
1065.11	Children's Toy	Pool Toy	Neither	N/A	Death	1			1	
0696.11	Children's Toy	Remote controlled puppy	Neither	Minor	Internal	1				
0472.11	Children's Toy	Riding Toy	Both	Laceration	Head Injury			Tipping		
0229.11	Children's Toy	Scooter	Neither	Laceration	Laceration			Crushing		
0968.11	Children's Toy	Slide	Warnings	Fracture	Head Injury			Fall		
0005.13	Children's Toy	Small Magnets	Instructions	N/A	Internal		1			
0225.13	Children's Toy	Small Magnets	Neither	N/A	Internal		1			
0287.13	Children's Toy	Small Magnets	Neither	N/A	Internal		1			
0480.13	Children's Toy	Small Magnets	Both	N/A	Internal		1			
0697.12	Children's Toy	Small Magnets	Both	Internal	Internal		1			
0703.12	Children's Toy	Small Magnets	Both	N/A	Internal		1			

0704.12	Children's Toy	Small Magnets	Both	Internal	Internal		1			
0706.12	Children's Toy	Small Magnets	Both	Internal	Internal		1			
0893.12	Children's Toy	Small Magnets	Both	N/A	Internal		1			
0907.12	Children's Toy	Small Magnets	Both	Internal	Internal		1			
0194.12	Children's Toy	Snorkel Set	Warnings	Laceration	Laceration			Contact		
0723.13	Children's Toy	Sound Sword	Neither	Laceration	Head Injury			Contact		
0469.11	Children's Toy	Star connecting pieces	Instructions	N/A	Minor			Contact		
0755.11	Children's Toy	Stroller	Warnings	N/A	N/A					
0865.11	Children's Toy	Swimming Pool Set	Both	N/A	Death	1				
0106.12	Children's Toy	Toddler Activity Center	Neither	Minor	Laceration	1			1	
0067.12	Children's Toy	Toy Building kit	Warnings	N/A	Internal		1			
0126.12	Children's Toy	Toy Building kit	Neither	N/A	Death	1				
1028.11	Children's Toy	Toy Car	Neither	Laceration	Head Injury			Contact		
0653.12	Children's Toy	Toy crab	Neither	Minor	Burn					1
0544.12	Children's Toy	Toy guitar	Neither	Minor	Death	1				
0585.11	Children's Toy	Toy Stroller	Neither	Laceration	Laceration			Crushing		
0447.11	Children's Toy	Toy tugboat	Neither	Laceration	Laceration			Contact		
0049.12	Children's Toy	Tricycle	Neither	Amputation	Amputation			Crushing		
0191.11	Children's Toy	Tricycle	Neither	Minor	Laceration			Contact		
0812.11	Children's Toy	Trike Display	Neither	Minor	Head Injury			Contact		
0498.13	Home Good	Bean Bag chair	Neither	Death	Death	1				
0591.13	Home Good	Bean Bag chair	Instructions	N/A	Death	1				
0631.12	Home Good	Bed frame	Instructions	N/A	Minor			Tipping		
0684.12	Home Good	Bed frame	Instructions	N/A	Head Injury			Tipping		
0788.13	Home Good	Bed Rail	Both	Death	Death	1			1	

0005.12	Home Good	Blind/Shade	Neither	N/A	Death	1			1	
0021.11	Home Good	Blind/Shade	Neither	N/A	Death	1			1	
0022.11	Home Good	Blind/Shade	Neither	N/A	Death	1			1	
0054.11	Home Good	Blind/Shade	Neither	N/A	Death	1			1	
0284.11	Home Good	Blind/Shade	Neither	N/A	Death	1			1	
0417.11	Home Good	Blind/Shade	Neither	N/A	Death	1			1	
0417.12	Home Good	Blind/Shade	Warnings	N/A	Death	1			1	
0482.12	Home Good	Blind/Shade	Neither	Amputation	Death	1			1	1
0488.12	Home Good	Blind/Shade	Both	Death	Death	1			1	
0503.12	Home Good	Blind/Shade	Neither	Minor	Death	1			1	1
0529.12	Home Good	Blind/Shade	Instructions	N/A	Death	1			1	
0556.11	Home Good	Blind/Shade	Neither	N/A	Death	1			1	
0564.13	Home Good	Blind/Shade	Neither	Death	Death	1			1	
0612.12	Home Good	Blind/Shade	Instructions	N/A	Death	1			1	
0629.12	Home Good	Blind/Shade	Both	N/A	Death	1			1	
0646.11	Home Good	Blind/Shade	Neither	N/A	Death	1			1	
0647.12	Home Good	Blind/Shade	Neither	N/A	Death	1			1	
0668.13	Home Good	Blind/Shade	Instructions	N/A	Death	1			1	
0678.11	Home Good	Blind/Shade	Warnings	N/A	Death	1			1	
0734.13	Home Good	Blind/Shade	Neither	Death	Death	1			1	
0875.12	Home Good	Blind/Shade	Warnings	Head Injury	Death	1			1	
0885.11	Home Good	Blind/Shade	Warnings	N/A	Death	1			1	
0893.11	Home Good	Blind/Shade	Warnings	N/A	Death	1			1	
0949.12	Home Good	Blind/Shade	Instructions	N/A	Death	1			1	
0969.12	Home Good	Blind/Shade	Instructions	N/A	Death	1			1	
0401.13	Home Good	Child lock	Instructions	Internal	Death		1			
0507.11	Home Good	Child lock	Warnings	Internal	Internal		1			
0580.11	Home Good	Child lock	Neither	N/A	Death	1				

0861.11	Home Good	Child Lock	Warnings	N/A	Internal		1			
0542.13	Home Good	Children's beds	Instructions	N/A	Minor			Fall		
0832.11	Home Good	Desk Chair	Instructions	Minor	Laceration			Crushing		
0142.13	Home Good	Detergent	Neither	N/A	Internal		1			
0143.13	Home Good	Detergent	Neither	N/A	Internal		1			
0144.13	Home Good	Detergent	Neither	N/A	Internal		1			
0145.13	Home Good	Detergent	Neither	N/A	Internal		1			
0753.12	Home Good	Detergent Packets	Neither	N/A	Internal		1			
0050.12	Home Good	Dresser	Instructions	Laceration	Laceration			Crushing		
0408.12	Home Good	Dresser	Neither	Death	Death			Crushing		
0910.12	Home Good	Dresser	Both	N/A	Death	1		Crushing	1	
0913.12	Home Good	Dresser	Both	Death	Death	1		Crushing	1	
0163.17	Home Good	Floor lamp	Instructions	Minor	Burn					1
0592.12	Home Good	Floor lamp	Neither	Burn	Burn					
0200.12	Home Good	Folding Chair	Neither	Fracture	Amputation			Crushing		
0454.12	Home Good	Folding Chair	Neither	Minor	Head Injury			Fall		
0566.12	Home Good	Folding chair	Neither	Amputation	Amputation			Crushing		
0937.12	Home Good	Food Slicer	Both	Amputation	Amputation			Contact		1
0343.11	Home Good	Futon/ Bunk bed	Neither	Death	Death	1			1	
0904.11	Home Good	Glass Vase	Neither	Laceration	Laceration			Contact		
0982.11	Home Good	Hand Truck	Instructions	Fracture	Head Injury			Contact		
1048.11	Home Good	Hand Truck	Instructions	Head Injury	Head Injury			Contact		
0640.13	Home Good	Kids chair	Neither	Minor	Head Injury			Fall		
0083.11	Home Good	Knife/ Ax	Warnings	N/A	Laceration			Contact		
0354.11	Home Good	Log Splitter	Both	Laceration	Amputation			Contact		
0086.12	Home Good	Motion Sensing Wall Switch	Instructions	N/A	Burn					

1080.11	Home Good	Mower	Both	Minor	Laceration			Fall		
0051.11	Home Good	Plastic Chair	Neither	Minor	Head Injury			Fall		
0269.12	Home Good	Powered Mop	Instructions	Burn	Burn					
0018.11	Home Good	Mower	Instructions	N/A	Amputation			Contact		
0325.11	Home Good	Steam Cleaner	Neither	Burn	Burn					1
0636.11	Home Good	Step stool	Neither	Minor	Head Injury			Fall		
0126.11	Home Good	Storage Bench	Neither	N/A	Death	1			1	
0238.11	Home Good	Storage Unit	Neither	Death	Death	1			1	
0168.11	Home Good	Sweat shirt Strings	Neither	N/A	Death	1			1	
0507.12	Home Good	Toilet system	Instructions	Laceration	Laceration			Contact		
0876.13	Home Good	Wall Lamp	Instructions	Death	Death	1			1	
0892.11	Home Good	Weed Trimmer	Both	N/A	Laceration			Contact		
0920.11	Home Good	Weed Trimmer	Both	N/A	Laceration			Contact		
0896.12	Home Good	Window Lock	Neither	N/A	Head Injury			Fall		
0469.12	Indoor Recreation	Arm crank exercise machine	Neither	Fracture	Head Injury			Fall		
0001.12	Indoor Recreation	Elliptical	Instructions	N/A	Head Injury			Fall		
0271.11	Indoor Recreation	Inversion table	Instructions	Fracture	Head Injury			Fall		
0281.11	Indoor Recreation	Massage Device	Both	Death	Death	1			1	
0403.11	Indoor Recreation	Squat rack	Instructions	N/A	Fracture			Crushing		
0156.13	Indoor Recreation	Workout Bench	Instructions	Fracture	Fracture			Crushing		
0092.11	Infant Product	Baby Bather	Warnings	Head Injury	Head Injury			Fall		
0225.12	Infant Product	Baby Bather	Both	Head Injury	Head Injury			Fall		

0553.12	Infant Product	Baby Bather	Instructions	Head Injury	Head Injury			Fall		
0555.11	Infant Product	Baby Bather	Neither	Fracture	Fracture			Fall		
1025.11	Infant Product	Baby Bather	Warnings	N/A	Head Injury			Fall		
0581.12	Infant Product	Baby exerciser	Neither	Minor	Head Injury			Tipping		
0626.12	Infant Product	Baby lift/incliner	Neither	Minor	Death	1				
0172.11	Infant Product	Baby Monitor	Neither	Death	Death	1			1	
0302.13	Infant Product	Baby Monitor	Neither	Death	Death	1			1	
0563.11	Infant Product	Baby Monitor	Both	N/A	Death	1			1	
0890.13	Infant Product	Baby Monitor	Both	Death	Death	1			1	
0992.13	Infant Product	Baby Monitor	Instructions	N/A	Death	1			1	
0411.11	Infant Product	Baby seat	Both	Head Injury	Head Injury			Tipping		
0467.12	Infant Product	Baby Seat	Instructions	Head Injury	Head Injury			Tipping		
0958.11	Infant Product	Baby Seat	Warnings	Minor	Head Injury			Tipping		
0822.11	Infant Product	Bath Seat	Both	N/A	Death	1				
0089.11	Infant Product	Blanket	Neither	N/A	Death	1			1	
0608.12	Infant Product	Booster Seat	Instructions	Minor	Head Injury			Fall		
0706.11	Infant Product	Booster Seat	Neither	Head Injury	Head Injury			Fall		
0930.11	Infant Product	Car Seat Adapter	Warnings	N/A	Head Injury			Tipping		
0834.13	Infant Product	Car Seat Adaptor	Instructions	Minor	Head Injury			Fall		
0738.13	Infant Product	Child Carrier	Instructions	Minor	Head Injury			Fall	1	
0886.13	Infant Product	Cradle	Both	Head Injury	Head Injury			Fall	1	
0451.13	Infant Product	Cradle swing	Neither	Death	Death			Fall		

0701.11	Infant Product	Cradle Swing	Neither	Burn	Burn			Fall		1
0911.11	Infant Product	Cradle Swing	Neither	Minor	Head Injury			Fall		
0251.11	Infant Product	Crib	Neither	Death	Death	1				
0267.12	Infant Product	Crib	Instructions	N/A	Laceration			Fall		
0318.11	Infant Product	Crib	Instructions	N/A	Head Injury			Fall		
0670.13	Infant Product	Exerciser/Activity center	Instructions	Head Injury	Head Injury			Contact		
0142.12	Infant Product	High Chair	Warnings	Minor	Laceration			Contact		
0173.11	Infant Product	High Chair	Neither	Laceration	Laceration			Contact		
0174.11	Infant Product	High Chair	Neither	N/A	Laceration			Contact		
0208.11	Infant Product	High Chair	Neither	N/A	Laceration			Contact		
0209.11	Infant Product	High Chair	Neither	N/A	Laceration			Contact		
0223.12	Infant Product	High Chair	Instructions	Laceration	Head Injury			Fall		
0439.11	Infant Product	High Chair	Both	N/A	Head Injury			Tipping		
0441.12	Infant Product	High Chair	Instructions	N/A	Laceration			Contact		
0462.13	Infant Product	High Chair	Instructions	N/A	Head Injury			Fall		
0483.13	Infant Product	High Chair	Instructions	N/A	Head Injury			Fall		
0586.12	Infant Product	High Chair	Both	N/A	Head Injury			Fall		
0601.12	Infant Product	High Chair	Instructions	Minor	Head Injury			Fall		
0602.12	Infant Product	High Chair	Instructions	N/A	Head Injury			Fall		
0625.13	Infant Product	High Chair	Instructions	N/A	Head Injury			Fall		
0690.11	Infant Product	High Chair	Instructions	N/A	Head Injury			Fall		
0796.13	Infant Product	High Chair	Neither	N/A	Head Injury			Fall	1	

0863.13	Infant Product	High Chair	Neither	N/A	Head Injury			Fall		
0943.12	Infant Product	High Chair	Both	N/A	Death	1				
0444.12	Infant Product	Play Yard	Neither	Amputation	Amputation			Crushing		
0494.12	Infant Product	Play Yard	Neither	Death	Death	1			1	
0683.11	Infant Product	Play yard	Neither	N/A	Death	1				
0978.12	Infant Product	Play Yard	Both	N/A	Death	1				
0989.12	Infant Product	Play Yard	Warnings	N/A	Death				1	
1034.11	Infant Product	Play yard	Both	Death	Death	1			1	
0500.12	Infant Product	Positioner	Neither	N/A	Death	1			1	
0948.13	Infant Product	Positioner	Neither	Death	Death	1			1	
0861.12	Infant Product	Recliner	Warnings	Death	Death	1		Fall		
0502.12	Infant Product	Rocker	Neither	Head Injury	Head Injury			Tipping		
0077.12	Infant Product	Rocking Crib	Instructions	Death	Death	1				
0808.11	Infant Product	Sheet Saver	Neither	N/A	Death				1	
0762.11	Infant Product	Sip Cup	Neither	Head Injury	Head Injury			Contact		
0133.11	Infant Product	Stepstool/ toilet	Neither	Laceration	Laceration			Crushing		
0008.11	Infant Product	Stroller	Instructions	Laceration	Laceration			Fall		
0048.12	Infant Product	Stroller	Instructions	Laceration	Amputation			Crushing		
0105.11	Infant Product	Stroller	Instructions	Laceration	Laceration			Fall		
0240.12	Infant Product	Stroller	Instructions	N/A	Death	1			1	
0270.11	Infant Product	Stroller	Instructions	Laceration	Laceration			Fall		
0275.11	Infant Product	Stroller	Instructions	N/A	Death	1			1	
0278.11	Infant Product	Stroller	Neither	Minor	Amputation			Crushing		
0294.12	Infant Product	Stroller	Instructions	N/A	Head Injury			Tipping		
0319.12	Infant Product	Stroller	Neither	Minor	Laceration			Crushing		
0454.11	Infant Product	Stroller	Neither	Minor	Death	1			1	

0455.11	Infant Product	Stroller	Neither	Minor	Death	1			1	
0547.11	Infant Product	Stroller	Both	Amputation	Amputation			Crushing		
0558.13	Infant Product	Stroller	Both	Fracture	Fracture			Crushing		
0617.13	Infant Product	Stroller	Both	Minor	Minor			Contact		
0625.11	Infant Product	Stroller	Neither	N/A	Head Injury			Tipping		
0699.11	Infant Product	Stroller	Instructions	Minor	Death	1			1	
0718.13	Infant Product	Stroller	Both	Laceration	Amputation			Crushing		
0741.11	Infant Product	Stroller	Neither	N/A	Head Injury			Tipping		
0807.11	Infant Product	Stroller	Instructions	Minor	Head Injury			Fall		
0900.11	Infant Product	Stroller	Neither	Death	Death	1			1	
0939.11	Infant Product	Stroller	Warnings	N/A	Amputation			Contact	1	
1014.11	Infant Product	Stroller	Instructions	N/A	Internal	1	1			
1043.13	Infant Product	Stroller	Instructions	Laceration	Amputation			Crushing		
0819.11	Infant Product	Teether	Neither	Laceration	Internal		1			
0055.12	Infant Product	Wearable Blanket	Neither	Death	Death	1				
0146.12	Infant Product	Wearable Blanket	Neither	Laceration	Laceration			Contact		
0865.13	Infant Product	Wearable Blanket	Instructions	Internal	Internal	1				
0426.11	Outdoor Recreation	Bat	Instructions	N/A	Minor			Contact		
0352.12	Outdoor Recreation	Bicycle Carrier	Instructions	Amputation	Amputation			Crushing		
0140.12	Outdoor Recreation	Bicycle Handlebars	Instructions	Laceration	Head Injury			Fall		
0099.13	Outdoor Recreation	Bicycle Pedal	Instructions	Laceration	Head Injury			Fall		
0932.11	Outdoor Recreation	Bicycle Trailer	Instructions	N/A	Head Injury			Fall		
0884.13	Outdoor Recreation	Canoe Cart	Both	Minor	Head Injury			Contact		
0942.13	Outdoor	Canoe Cart	Both	Minor	Head			Contact		

	Recreation				Injury					
0506.12	Outdoor Recreation	Fireworks	Neither	Internal	Internal		1			
0524.11	Outdoor Recreation	Fuel filter	Neither	N/A	Burn					1
0331.12	Outdoor Recreation	Gel Fuel	Warnings	N/A	Burn					1
0961.11	Outdoor Recreation	Gel Fuel	Warnings	Death	Death					1
0008.12	Outdoor Recreation	Hand Truck	Instructions	Head Injury	Head Injury			Contact		
0247.12	Outdoor Recreation	Hand Truck	Warnings	N/A	Laceration			Contact		
0093.13	Outdoor Recreation	Inflatable Ball	Neither	N/A	Death	1				
0177.13	Outdoor Recreation	Inflatable Ball	Neither	N/A	Death	1				
0255.13	Outdoor Recreation	Inflatable Ball	Neither	N/A	Death	1				
0026.12	Outdoor Recreation	Inflatable Pool Slide	Both	Death	Death			Contact		
0059.12	Outdoor Recreation	Inflatable Slide	Instructions	Death	Death			Tipping		
0850.12	Outdoor Recreation	Inflatable Slide	Warnings	Head Injury	Head Injury			Fall		
0263.11	Outdoor Recreation	Playground	Neither	Death	Death	1			1	
0564.11	Outdoor Recreation	Playground	Neither	N/A	Head Injury				1	
0669.11	Outdoor Recreation	Playground	Neither	Head Injury	Fracture			Fall		
0797.11	Outdoor Recreation	Pogo Stick	Instructions	Head Injury	Head Injury			Fall		
0282.12	Outdoor Recreation	Ride-On Toy Vehicle	Neither	Amputation	Amputation			Crushing		
0836.11	Outdoor Recreation	Shape-ups Shoes	Both	N/A	Fracture			Contact		

0649.12	Outdoor Recreation	Slide	Neither	N/A	Head Injury			Fall		
0645.13	Outdoor Recreation	Snowboard bindings	Instructions	N/A	Fracture			Fall		
0330.12	Outdoor Recreation	Swing Set	Instructions	Minor	Fracture			Fall		
0134.11	Outdoor Recreation	Trampoline	Instructions	Laceration	Laceration			Fall		
0567.11	Outdoor Recreation	Trampoline	Instructions	Minor	Fracture			Fall		
0815.12	Outdoor Recreation	Trampoline	Both	Laceration	Laceration			Contact		
1063.11	Outdoor Recreation	Trampoline	Both	Laceration	Laceration			Contact		
0254.12	Outdoor Recreation	Utility Vehicle	Neither	Burn	Burn					1
0967.13	Outdoor Recreation	Zip line	Instructions	N/A	Head Injury			Fall		

Appendix H: Mechanical Engineering PSAs (FY2013) Excel Data

PSA No.	Product Type	Product	ME Analysis	Reported Injury	Potential Injury	Asphyxiation	Ingestion	Impact	Entanglement / Entrapment	Fire / Shock
0066.13	Appliance	Coffee Maker	CAP Adequacy	N/A	Burn			Contact		1
0170.13	Appliance	Coffee Maker	CAP Adequacy	N/A	Burn			Contact		1
0903.13	Appliance	Blender	CAP Adequacy	N/A	Laceration			Contact		
0987.13	Appliance	Blender	CAP Adequacy	N/A	Laceration			Contact		
0896.13	Appliance	Ceiling Fan	CAP Adequacy	N/A	Head Injury			Contact		
1050.13	Appliance	Coffeemaker	CAP Adequacy	N/A	Burn			Contact		
0889.13	Appliance	Microwave Pan	CAP Adequacy	N/A	Burn					1
0573.13	Appliance	Coffee Maker	Product Analysis	N/A	Burn					1
0240.13	Appliance	Deep Fryer	Product Analysis	N/A	Burn					1
0614.13	Appliance	Freezer/Refrigerator	CAP Adequacy	Minor	Fracture			Crushing		
0029.13	Appliance	Refrigerator	Product Analysis	Fracture	Head Injury			Crushing		
0207.13	Canceled									
0385.13	Canceled									
0840.13	Canceled									
0877.13	Canceled									
0939.13	Canceled									
0944.13	Canceled									
0949.13	Canceled									
1020.13	Canceled									

1034.13	Canceled									
1038.13	Canceled									
0362.13	Children's Toy	Stuffed animal	CAP Adequacy	N/A	Laceration			Contact		
0838.13	Children's Toy	Training Wheels	CAP Adequacy	N/A	Head Injury			Fall		
0632.13	Children's Toy	Doll Trunk	Product Analysis	N/A	Laceration			Contact		
0475.13	Children's Toy	Small Magnetic Balls	Product Analysis	N/A	Internal		1			
0995.13	Children's Toy	Wagon	CAP Adequacy	Minor	Head Injury			Fall		
0266.13	Home Good	Chandelier	CAP Adequacy	N/A	Head Injury			Crushing		
0117.13	Home Good	Cookware	CAP Adequacy	N/A	Burn					1
0245.13	Home Good	Garlic Slicer	CAP Adequacy	N/A	Laceration			Contact		
0307.13	Home Good	Jar lifter	CAP Adequacy	N/A	Burn			Contact		1
0327.13	Home Good	Knife	CAP Adequacy	N/A	Laceration			Contact		
0273.13	Home Good	Lasagna Pan	CAP Adequacy	N/A	Laceration			Contact		
0351.13	Home Good	Leaf Blower/ Vacuum	CAP Adequacy	N/A	Laceration			Contact		
0280.13	Home Good	Toilet system	CAP Adequacy	N/A	Laceration			Contact		
0239.13	Home Good	Track lightening	CAP Adequacy	N/A	Laceration			Crushing		
0850.13	Home Good	Ceiling Electrical Box	CAP Adequacy	N/A	Minor			Contact		
0998.13	Home Good	Circular Saw	CAP Adequacy	N/A	Laceration			Contact		
1012.13	Home Good	Light Fixture	CAP Adequacy	N/A	Head Injury			Contact		
0994.13	Home	Magnet Board	CAP	N/A	Laceration			Contact		

	Good		Adequacy							
1022.13	Home Good	Skillets	CAP Adequacy	N/A	Burn			Contact		
0587.13	Home Good	Glass tumbler	Conformance to Standards	N/A	Laceration			Contact		
0706.13	Home Good	Ottoman	Conformance to Standards	N/A	Death	1			1	
0882.13	Home Good	Ottoman	Conformance to Standards	N/A	Death	1			1	
0716.13	Home Good	Acrylic straws	Product Analysis	N/A	Minor			Contact		
0112.13	Home Good	Chandelier	Product Analysis	N/A	Head Injury			Crushing		
0373.13	Home Good	Chandelier	Product Analysis	N/A	Minor			Crushing		
0471.13	Home Good	Children's Bed	Product Analysis	N/A	Minor			Tipping		
0313.13	Home Good	Dining Chair	Product Analysis	N/A	Fracture			Tipping		
0758.13	Home Good	Folding Chair	Product Analysis	N/A	Head Injury			Fall		
0334.13	Home Good	Glass Topped Vanity	Product Analysis	N/A	Laceration			Contact		
0440.13	Home Good	Lamp Shades	Product Analysis	N/A	Minor			Contact		
0764.12	Home Good	Lighting Fixture	Product Analysis	N/A	Laceration			Contact		
0540.13	Home Good	Silverware	Product Analysis	N/A	Internal		1			
0805.13	Home Good	Skillets	Product Analysis	N/A	Burn			Contact		
0474.13	Home Good	Television Mounting Sys.	Product Analysis	N/A	Head Injury			Crushing		
0429.13	Home Good	Toilet System	Product Analysis	N/A	Minor			Contact		
0497.13	Home Good	Toilet System	Product Analysis	N/A	Laceration			Contact		

0028.13	Home Good	TV stand	Product Analysis	N/A	Fracture			Crushing		
0261.13	Home Good	TV stand	Product Analysis	N/A	Fracture			Crushing		
0991.13	Home Good	Composite Decking	Review Bulletin	N/A	Head Injury			Fall		
0929.13	Home Good	Dining Chair	Product Analysis	Minor	Head Injury			Fall		
0569.13	Home Good	Halogen Light Bulb	Product Analysis	Minor	Laceration			Contact		
0650.13	Home Good	Touch Screen Monitor	Product Analysis	Minor	Laceration			Contact		
0605.13	Home Good	Glass top tables	Product Analysis	Laceration	Laceration			Contact		
1009.13	Home Good	Toilet Seat	Conformance to Standards	Fracture	Head Injury			Tipping		
0308.13	Indoor Recreation	Excursive band	CAP Adequacy	N/A	Laceration			Contact		
0152.13	Indoor Recreation	Excursive equipment	CAP Adequacy	N/A	Fracture			Crushing		
0531.13	Indoor Recreation	Exercise Equipment	Product Analysis	Minor	Head Injury			Crushing		
0135.13	Indoor Recreation	Weight Bench	Product Analysis	Laceration	Amputation			Crushing		
0123.13	Infant Product	Stroller	CAP Adequacy	N/A	Laceration			Crushing		
0134.13	Infant Product	Stroller	CAP Adequacy	N/A	Head Injury			Fall		
0807.13	Infant Product	Car Seat Adaptor	CAP Adequacy	N/A	Head Injury			Fall		
1015.13	Infant Product	Car Seat Adaptor	CAP Adequacy	N/A	Head Injury			Crushing		
0815.13	Infant Product	High Chair	CAP Adequacy	N/A	Head Injury			Fall		
0611.13	Infant Product	Stroller tray	CAP Adequacy	N/A	Death	1				
0989.13	Infant Product	Wearable Blanket	CAP Adequacy	N/A	Internal	1	1			

0087.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury			Tipping		
0485.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury	1		Fall	1	
0486.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury	1		Fall	1	
0487.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury	1		Fall	1	
0488.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury	1		Fall	1	
0489.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury	1		Fall	1	
0490.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury	1		Fall	1	
0491.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury	1		Fall	1	
0492.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury	1		Fall	1	
0584.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury	1		Fall	1	
0599.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury	1		Fall	1	
0630.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury	1		Fall	1	
0933.13	Infant Product	High Chair	Conformance to Standards	N/A	Head Injury			Fall		
1047.13	Infant Product	High Chair	Conformance to Standards	N/A	Death	1		Fall	1	
0269.13	Infant Product	Stroller	Conformance to Standards	N/A	Death	1			1	
0270.13	Infant Product	Stroller	Conformance to Standards	N/A	Death	1			1	
0830.13	Infant Product	Stroller	Conformance to Standards	N/A	Amputation			Crushing		
0928.13	Infant Product	Baby Walker	Product Analysis	N/A	Head Injury			Fall		
0332.13	Infant Product	Child Lock	Product Analysis	N/A	Internal		1			

0160.13	Infant Product	Crib	Product Analysis	N/A	Head Injury			Fall		
0199.13	Infant Product	Crib	Product Analysis	N/A	Death	1			1	
0200.13	Infant Product	Crib	Product Analysis	N/A	Death	1			1	
0201.13	Infant Product	Crib	Product Analysis	N/A	Death	1			1	
0202.13	Infant Product	Crib	Product Analysis	N/A	Death	1			1	
0203.13	Infant Product	Crib	Product Analysis	N/A	Death	1			1	
0204.13	Infant Product	Crib	Product Analysis	N/A	Death	1			1	
0205.13	Infant Product	Crib	Product Analysis	N/A	Death	1			1	
0206.13	Infant Product	Crib	Product Analysis	N/A	Death	1			1	
0208.13	Infant Product	Crib	Product Analysis	N/A	Death	1			1	
0209.13	Infant Product	Crib	Product Analysis	N/A	Death	1			1	
0210.13	Infant Product	Crib	Product Analysis	N/A	Death	1			1	
0386.13	Infant Product	High Chair	Product Analysis	N/A	Head Injury	1		Fall		
0550.13	Infant Product	High Chair	Product Analysis	N/A	Head Injury			Fall		
0467.13	Infant Product	Stroller	Product Analysis	N/A	Minor			Tipping		
0388.13	Infant Product	Stroller tray	Product Analysis	N/A	Head Injury	1				
0433.13	Infant Product	Travel Bed	Product Analysis	N/A	Death	1			1	
0588.13	Infant Product	Stroller	CAP Adequacy	Minor	Minor			Contact		
0881.13	Infant Product	Stool	Conformance to Standards	Minor	Head Injury			Fall		

0829.13	Infant Product	Stroller	Conformance to Standards	Minor	Head Injury			Crushing		
0432.13	Infant Product	Bath Seat	Product Analysis	Minor	Death	1				
0533.13	Infant Product	Booster Seats	Product Analysis	Minor	Head Injury			Tipping		
0636.13	Infant Product	Cradle	Product Analysis	Minor	Head Injury			Tipping		
0581.13	Infant Product	Crib	Product Analysis	Minor	Head Injury			Tipping		
0551.13	Infant Product	Travel sys. Adaptor	Product Analysis	Minor	Head Injury			Tipping		
0642.13	Infant Product	Child Carrier	Conformance to Standards	Head Injury	Head Injury			Fall		
0798.13	Infant Product	High Chair	Conformance to Standards	Head Injury	Head Injury			Tipping		
0612.13	Infant Product	High Chair	Product Analysis	Head Injury	Head Injury			Tipping		
0304.13	Infant Product	Baby Monitor	Conformance to Standards	Death	Death	1			1	
0431.13	Infant Product	Cradle/swing	Product Analysis	Death	Death	1				
0633.13	Infant Product	Stroller	Product Analysis	Amputation	Amputation			Crushing		
0059.13	Outdoor Recreation	Bicycle BB	CAP Adequacy	N/A	Head Injury			Fall		
0115.13	Outdoor Recreation	Bicycle fork	CAP Adequacy	N/A	Head Injury			Fall		
0217.13	Outdoor Recreation	Bicycle fork	CAP Adequacy	N/A	Head Injury			Fall		
0318.13	Outdoor Recreation	Bicycle fork	CAP Adequacy	N/A	Head Injury			Fall		
0001.13	Outdoor Recreation	Bike	CAP Adequacy	N/A	Head Injury			Fall		
0061.13	Outdoor Recreation	Bike	CAP Adequacy	N/A	Head Injury			Fall		
0238.13	Outdoor Recreation	ROV fuel hose	CAP Adequacy	N/A	Burn					1

0078.13	Outdoor Recreation	Scuba equipment	CAP Adequacy	N/A	Death	1			1	
0353.13	Outdoor Recreation	Snowmobiles	CAP Adequacy	N/A	Burn					1
0837.13	Outdoor Recreation	Utility Vehicle	CAP Adequacy	N/A	Fracture			Crushing		
0681.13	Outdoor Recreation	Arrows	CAP Adequacy	N/A	Laceration			Contact		
0817.13	Outdoor Recreation	Avalanche Airbag	CAP Adequacy	N/A	Head Injury			Crushing		
0786.113	Outdoor Recreation	Bike - Seat Post	CAP Adequacy	N/A	Head Injury			Fall		
0971.13	Outdoor Recreation	Bike Calipers	CAP Adequacy	N/A	Head Injury			Fall		
1044.13	Outdoor Recreation	Bike Derailleur	CAP Adequacy	N/A	Head Injury			Fall		
0541.13	Outdoor Recreation	Bike fork	CAP Adequacy	N/A	Head Injury			Fall		
0597.13	Outdoor Recreation	Dirt Bike	CAP Adequacy	N/A	Death			Fall		
0749.13	Outdoor Recreation	Dive Computer	CAP Adequacy	N/A	Death	1				
0983.13	Outdoor Recreation	Golf Car	CAP Adequacy	N/A	Head Injury			Crushing		
0634.13	Outdoor Recreation	Golf Cart	CAP Adequacy	N/A	Fracture			Crushing		
0546.13	Outdoor Recreation	Machete	CAP Adequacy	N/A	Laceration			Contact		
1033.13	Outdoor Recreation	Mini-Bike	CAP Adequacy	N/A	Head Injury			Fall		
0794.13	Outdoor Recreation	Motorcycle	CAP Adequacy	N/A	Head Injury			Fall		
1024.13	Outdoor Recreation	Scuba Air Hose	CAP Adequacy	N/A	Death	1				
0795.13	Outdoor Recreation	Signaling Device	CAP Adequacy	N/A	Death	1				
0629.13	Outdoor Recreation	Snowboard Bindings	CAP Adequacy	N/A	Head Injury			Fall		

1035.13	Outdoor Recreation	Utility Vehicle	CAP Adequacy	N/A	Head Injury			Fall		
0441.13	Outdoor Recreation	Bicycle Areo Bars	Product Analysis	N/A	Head Injury			Fall		
0393.13	Outdoor Recreation	Bike	Product Analysis	N/A	Fracture				1	
0364.13	Outdoor Recreation	Bike fork	Product Analysis	N/A	Head Injury			Fall		
0445.13	Outdoor Recreation	Bike Fork	Product Analysis	N/A	Head Injury			Fall		
0496.13	Outdoor Recreation	Bike fork	Product Analysis	N/A	Head Injury			Fall		
0560.13	Outdoor Recreation	Bike Stem	Product Analysis	N/A	Head Injury			Fall		
0356.13	Outdoor Recreation	Scuba Diving Hose	Product Analysis	N/A	Death	1				
0091.13	Outdoor Recreation	Water Ball	Product Analysis	N/A	Death	1		Fall	1	
0176.13	Outdoor Recreation	Water Ball	Product Analysis	N/A	Death	1		Contact	1	
0254.13	Outdoor Recreation	Water Ball	Product Analysis	N/A	Death	1		Contact	1	
0434.13	Outdoor Recreation	Water Helmets	Product Analysis	N/A	Head Injury			Contact		
0347.13	Outdoor Recreation	ATV	Review Bulletin	N/A	Head Injury			Crushing		
0691.13	Outdoor Recreation	ATV	Review Bulletin	N/A	Head Injury			Tipping		
0277.13	Outdoor Recreation	ROV	Review Bulletin	N/A	Head Injury			Crushing		
0174.13	Outdoor Recreation	Snowmobiles	Review Bulletin	N/A	Death			Tipping		
0638.13	Outdoor Recreation	Utility Vehicle	Review Bulletin	N/A	Burn			Contact		
0892.13	Outdoor Recreation	Utility Vehicle	Review Bulletin	N/A	N/A			Fall		
0726.13	Outdoor Recreation	Bike	CAP Adequacy	Minor	Head Injury			Fall		

0464.13	Outdoor Recreation	Bike Brakes	Product Analysis	Minor	Head Injury			Fall		
0416.13	Outdoor Recreation	Swing set chain	Product Analysis	Minor	Fracture			Fall		
0043.13	Outdoor Recreation	Bicycle steering tube	CAP Adequacy	Head Injury	Head Injury			Tipping		
0719.13	Outdoor Recreation	Gas Can	Product Analysis	Head Injury	Head Injury			Contact		
0088.13	Outdoor Recreation	ROV	CAP Adequacy	Burn	Burn					1

Appendix I: Health Sciences PSAs (FY2013) Excel Data

PSA No.	Product Type	Product	HS Analysis	Injury	Potential Injury	Asphyxiation	Ingestion	Impact	Entanglement / Entrapment	Fire / Shock
0288.13	Appliance	Refrigerator	Extent of Injury	Head Injury	Head Injury			Crushing		
0111.13	Canceled									
0348.13	Canceled									
0825.13	Canceled									
0976.13	Canceled									
1011.13	Canceled									
1014.13	Canceled									
1046.13	Canceled									
0006.13	Children's Toy	Small Magnets	CAP Adequacy	N/A	Death		1			
0024.13	Children's Toy	Growing Polymer	Health Effects	Internal	Internal		1			
0114.13	Children's Toy	Spinning Bean	Health Effects	Internal	Internal		1			
0148.13	Children's Toy	Small Magnets	Health Effects	N/A	Internal		1			
0297.13	Children's Toy	Growing Polymer	Health Effects	N/A	Internal		1			
0478.13	Children's Toy	Blocks	Safety Issue Identification	N/A	Internal	1	1			
0513.13	Children's Toy	Growing Polymer	Health Effects	N/A	Internal		1			
0730.13	Children's Toy	Growing Polymer	Health Effects	N/A	Internal		1			
0773.13	Children's Toy	Travel Trunk (Dolls)	Extent of Injury	Minor	Laceration			Contact		
0935.13	Children's Toy	Growing Polymer	Health Effects	N/A	Internal		1			
1041.13	Children's Toy	Growing	Health	N/A	Internal		1			

		Polymer	Effects							
0020.13	Home Good	Charging Station	Extent of Injury	N/A	Burn			Contact		
0537.13	Home Good	Bean Bag Chair	Safety Issue Identification	Death	Death	1			1	
0561.13	Home Good	Pillow	Safety Issue Identification	N/A	Death	1			1	
0303.13	Infant Product	Movement Monitor	Safety Issue Identification	Death	Death	1			1	
0358.13	Infant Product	Play Yard	Safety Issue Identification	N/A	Death	1			1	
0366.13	Infant Product	Soothers	Health Effects	Death	Death	1	1		1	
0502.13	Infant Product	Snack Tray	Safety Issue Identification	N/A	Death	1			1	
0761.13	Infant Product	Stroller	Extent of Injury	Amputation	Amputation			Crushing		
0797.13	Infant Product	High Chair	Safety Issue Identification	N/A	Head Injury			Fall		
0871.13	Infant Product	Stroller	Extent of Injury	Laceration	Amputation			Crushing		
0963.13	Infant Product	High Chair	Safety Issue Identification	N/A	Death	1			1	
0968.13	Infant Product	Cradle	Safety Issue Identification	Minor	Head Injury			Fall		
1005.13	Infant Product	Stroller	Extent of Injury	N/A	Death	1			1	
0094.13	Outdoor Recreation	Water Ball	Safety Issue Identification	N/A	Death	1			1	
0178.13	Outdoor Recreation	Water Ball	Safety Issue Identification	N/A	Death	1			1	
0243.13	Outdoor Recreation	Soccer Ball	Health Effects	N/A	Internal		1			
0256.13	Outdoor Recreation	Water Ball	Safety Issue Identification	N/A	Death	1			1	
0619.13	Outdoor Recreation	Knife	Extent of Injury	N/A	Laceration			Contact		

HUMAN FACTORS HANDBOOK FOR PRODUCT SAFETY

U.S. Consumer Product Safety Commission

December 2013

Table of Contents:

The Purpose of the Handbook

The underlying premise of the Handbook is that safety must be designed into and built into consumer products in the United States in conformance with the requirements of product safety systems planned, established, and implemented at the direction of executive management. However, human factors integration into the design process has been found to be limited. This Handbook defines and identifies the elements of human factors.

This Handbook has been developed and provided as a public service by the U.S. Consumer Product Safety Commission (CPSC). The CPSC is the U.S. government agency responsible for the safety of consumer products in the United States. The CPSC fulfills this role through issuing mandatory product safety standards, as well as through working cooperatively with industry to develop numerous consensus (also called voluntary) safety standards. In addition, the Commission monitors consumer product-related injuries and deaths, and works with companies to recall defective products from the marketplace.

Background-The Consumer Product Safety Problem

Congress wanted to protect consumers from unreasonable risks of injury from consumer products when it enacted the Consumer Product Safety Act (CPSA) Public Law 92-573:
"The Congress finds that (1) an unacceptable number of consumer products which present unreasonable risks of injury are distributed in commerce; (2) complexities of consumer products and the diverse nature and abilities of consumers using them frequently result in an inability of users to anticipate risks and to safeguard themselves adequately; (3) the public should be protected against unreasonable risks of injury associated with consumer products."

While there is ample data demonstrating the magnitude of the product safety problem, there is far less data for isolating the root causes of product-related safety hazards. Conventionally, the causes of product safety hazards are classified as man-related, environmental and product-related. These categories, of course, overlap. It is difficult to disentangle one from the other. But irrespective of root causes, it can be said that manufacturers have the greatest potential and therefore the largest responsibility for reducing hazards. Manufacturers' potential for reducing product defects that raise consumer safety concerns exists in their capability to design and fabricate products that take account of human and environmental factors. On this subject, the National Commission on Product Safety[1] commented as follows:

> ". . . the greatest promise for reducing risks resides in energizing the manufacturer's ingenuity.

[1] "Final Report of the National Commission on Product Safety." June 1970.

> “We do not mean that manufacturers by themselves can do all that is needed to achieve an optimal safety record. We mean that with Government stimulation they can accomplish more for safety with less effort and expense than any other body—more than any other body—more than educators, the courts, regulatory agencies, or individual consumers.
>
> "Manufacturers have it in their power to design, build, and market products in ways that will reduce if not eliminate most unreasonable and unnecessary hazards. Manufacturers are best able to take the longest strides to safety in the least time."

After observing "danger is a regrettable but unavoidable facet of life," the Commission goes on to conclude:

> "Prospects for measurable reform of human behavior are distant. Similarly, there is little hope for an early improvement of the home environment. The limited power of conventional educational methods has been described by our witnesses.
>
> "Consequently, while continuing to educate and seeking even better ways, there seems little choice but to concentrate on reducing unreasonable hazards by encouraging additional care in the design and manufacture of products.
>
> "The law has tended in recent years to place full responsibility for injuries attributable to defective products upon the manufacturer.
>
> "But beyond his liability for damages, a producer owes society-at-large the duty to assure that unnecessary risks of injury are eliminated. He is in the best position to know what are the safest designs, materials, construction methods, and modes of use. Before anyone else, he must explore the boundaries of potential danger from the use of his product. He must be in a position to advise the buyer competently how to use and how to maintain and repair the product."

How best can industry assume its responsibility for product safety? Substantially, this question was answered in a Report of April, 1973, entitled "Safety in the Marketplace" prepared by the Sub-Council on Product Safety of the National Business Council for Consumer Affairs. After emphasizing the responsibility of manufacturers for assuring the safety of their products, the Sub-Council goes on to advise that product safety is ". . . best accomplished by a comprehensive systems approach." This Handbook was developed to translate the phrase "comprehensive systems approach" into specific actions that collectively constitute a system.

Handbook for Introducing Human Factors

INTRODUCTION

Manufacturers must assure the safety of consumer products. This is achieved through the design, production and distribution of the products they manufacture.

SUMMARY

This Handbook identifies the essential elements of Human Factors. Its provisions are presented in three sections. Section I, below, defines the purpose of the Handbook and its applicability. Section II, defines Human Factors and identifies its elements. Section III relates to recurrent Human Factors issues. Section IV discusses human factors best practices. Section V explores the importance of integrating human factors in the design process. Finally, Section VI provides resources of additional material for human factors education.

Section I: PURPOSE AND APPLICABILITY

A. PURPOSE

The purpose of this Handbook is to provide background on the discipline of human factors to executive industrial management for establishing systems to prevent and detect safety hazards in consumer products. It is made available to manufacturers, retailers, importers and buyers by the CPSC staff to encourage self-regulation with the expectation that such activities will result in safer consumer products and fewer product related injuries.

B. APPLICABILITY

The provisions of this Handbook are intended for educating industry on human factors. All implementations of human factors is voluntary but highly advised by the Consumer Product Safety Commission.

Section II: Definition and Elements

A. DEFINITION

The discipline of human factors can be defined as “the study of how humans accomplish work-related tasks in the context of human-machine system operation, and how behavioral and non-behavioral variables affect that accomplishment” (Wickens, 1999).

B. HIEARCHY

The Human Factors profession prescribes a hierarchy of methods to address hazards that is ordered according to effectiveness (Fowler, 1980; Sanders & McCormick, 1993; cf. Tillman & Tillman, 1991). Design the dangerous features out of the product. If that is not feasible, protect against the hazards by guarding or shielding. If no other option is available, provide adequate warnings and instructions for proper use and foreseeable misuse. Instructions and warnings are a last resort because they rely on human variables such as attention, perception, comprehension, memory, and motivation. Although instructions are essential, people tend to read them only when they cannot proceed without them, and then they skim to find the information they need. Warnings may be skipped because they are perceived as unlikely to contain the relevant information. Even when they use instructions, people may fail to notice important details, and may misread or misinterpret what they have read. If the instructions require later action, they may forget or fail to follow through.

C. ELEMENTS

1) **Labeling & Warnings**
2) **Age Determination**
3) **User Interaction**
    a. **Intervention Strategies**
    b. **Intuitive use**
    c. **Environmental Factors**

Section III: Recurrent Product Issues

A. FORESEABLE MISSUE

- Define foreseeable misuse
- Define methods for identifying foreseeable misuses
- Identify strategies to reduce the likelihood

B. INSTRUCTIONS / WARNINGS

- Discuss appropriate use of instructions and warnings
- Refer to Instructions and Warnings Handbook
- Explain effectiveness of instructions and warnings
- Provide data – such as how many HF PSAs analysis these elements

C. Topic C

Section IV: Best Practices

A TEST GROUPS

B. HUMAN FACTORS SPECIALIST INCORPORATION

C. Topic C

Section V: Why to Incorporate Human Factors

A. UNSAFE PRODUCTS

- Products that meet regulations and/or standards but still pose a product defect.
- Most recalls are due to HF

B. COST BENEFIT ANALYSIS

- To show if it is more beneficial to have HF engineers in house, contract out, or recall products

C. Topic C

Section VI: Resources

A. Introduction

This section provides additional resources that can be referenced if more information on human factors is desired. These sources include research done by experts in the field as well as contact information of universities that offer human factors programs.

B. Relevant Research

- Campbell, J. L. (1996). The development of human factors design guidelines. International Journal of Industrial Ergonomics, 18(5–6), 363-371.
    - Research that …….
- Liu, Y. (2003). Engineering aesthetics and aesthetic ergonomics: theoretical foundations and a dual-process research methodology. Ergonomics, 46(13-14), 1273-1292.
    - Research that ……
- Sanders, Mark S. & McCormick, E.J. (1993). Human Factors in Engineering and Design (7th Ed.; p. 681). New York: McGraw-Hill, Inc.
    - Research that …..
- Wickens, C. D., & Hollands, J. G. (1999). Engineering psychology and human performance. Upper Saddle River, New Jersey: Prentice Hall.
    - Research that ……
- Woodson, W.E., Tillman, B. & Tillman, P. (1992). Human Factors Design Handbook (2d Ed.; p. 309). New York: McGraw-Hill, Inc.
    - Research that ……
- Source

C. University Contacts

Undergraduate

- Program and Contact

Masters

- Program and Contact

PHD

- Program and Contact

REFERENCES