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FEATURES

The ARCHIVES of Safety and Health is an electronic publication of The Safety and Health Historical Society, a benefit for patrons and contributors of the organization. The author and Editor is Roger L. Brauer, Ph.D., PE.

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The Safety and Health Historical Society is a nonprofit corporation in Illinois, founded on September 18, 2015. It holds 501(c)3 tax exempt status from the Internal Revenue Service. Fees are tax exempt.

Its purpose is to identify, collect, preserve and display materials and objects, publish historical knowledge and recognize historically significant contributions by individuals, companies and organizations related to the protection of people, property and the environment.

The structure encourages participation by any individual, company, society, government organization or other organization interested in recognizing the contributions to safety and health in workplaces, products, systems, equipment and other aspects of work and daily life.

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The George W. Harper Collection

An initial and primary resource for safety and health historical information is the George W. Harper collection. Professor Harper taught safety engineering at the University of Illinois in Champaign-Urbana after a career in industry. He was a founding director and officer of the Board of Certified Safety Professionals. SHHS has this collection of about 25,000 journal articles and other publications covering the period from about 1915 to the late 1970s and grouped into approximately 700 topics. The SHHS web site has a list of topics and the number of items within each. Eventually, SHHS will scan some items for direct access on its web site.

SAFETY THROUGH DESIGN: AN OLD CONCEPT FOR ACCIDENT PREVENTION

Introduction

The safety-through-design concept that engineering design can impact the safety of equipment, vehicles, buildings, as well as manufacturing and construction processes. This approach for protecting workers and the public has been around since the early 1900s and before then. Many people in current safety practice are familiar with the emphasis on safety through design that re-emerged in the last 15 years or so as an important area of practice.

Engineers have an ethical responsibility to protect the safety, health and welfare of the public in their professional practice. The primary focus of this is prevention of accidents, injuries and illness related to their designs. Many others often help engineers to understand their role and apply effective designs.

Prevention Through Design and Safety Through Design - A Recent Effort

In 2007 the National Institute for Occupational Safety And Health (NIOSH) conducted a workshop on Prevention Through Design. According to John Howard, the NIOSH Director, "one of the best ways to prevent and control occupational injuries, illness, and fatalities is to 'design out' or minimize hazards and risks early in the design process.[1]" In order to respond to the need to increase prevention through design efforts, NIOSH developed the Prevention Through Design (PtD) National Initiative. The workshop brought interested organizations, industries and individuals together to help organize that effort.

The NIOSH PtD National Initiative led to efforts to increase education of engineers about the importance of preventing injuries, illnesses and death through design[2] and efforts of other organizations to promote PtD in construction[3] and other industries.

Prior to that in the late 1990s, the National Safety Council organized a similar activity at a smaller scale. It had the title Safety Through Design. That led to the publication of a book[4] that captures many of the practices one can apply in design to prevent accidents and incidents and related injuries, illnesses and deaths.

Those involved in this recent effort deserve much credit for revival of the importance of preventing accidents and incidents by identifying hazards and risks and eliminating or reducing them through design.

However, this concept is not new. It has been around for a long, long time. The focus of design efforts varied over time depending on where the greatest risks and losses occurred.

Mid-20th Century Safety Through Design

Safety through design also got attention in the mid-20th century. For example, the 1955 Edition (5th Edition) of the National Safety Council's longstanding *Accident Prevention Manual*[5] stated:

> Company policies should be such that safety can be designed and built into the job, rather than added after the job has been put into operation. The design engineer should be conscious of the fact that the safety department is most anxious to help in discovering job hazards and removing them.
>
> Each level of engineering should be given the responsibility for building safety into the job, right through the production phase. Such responsibility should extend to product design, machine design, plant layout and condition of premises, selection and specification of materials, production planning, time study, methods, duties of production foreman, and work of employees assigned to the job.
>
> When safety is properly inculcated in the planning of new operations or processes, there will be little need to secure management's backing for incorporating safety features before operations are started.

The 5th Edition of the *Accident Prevention Manual* also devoted a whole chapter to "Removing the Hazard from the Job." Much of the emphasis was on the need for safe design. In addition, the chapter offered an early version of the concept known today as the "Hierarchy of Controls."

The 4th Edition of *Industrial Accident Prevention* by H. W. Heinrich[6] stated the following:

> The best opportunity to prevent accidents on machines lies with the machine manufacturer and his staff of designers and draftsmen. If accident prevention receives the consideration that it so well deserves in the creative stages of machine manufacture, the finished product will need relatively little alteration to be reasonably safe.

Early Safety Through Design Concepts

The purpose of this paper is to identify how some from the past pressed for safety through design long before any recent focus on the concept.

An Ancient Concept

One cannot discuss safety through design and early emphasis for it without some quotes from ancient documents.

In the Bible, Moses pointed to safety through design in his admonition:

> When you build a new house, you shall make a parapet for your roof, that you many not bring the guilt or blood upon your house, if anyone fall from it.[7]

A safety through design concept also links to liability and indemnification. Hammurabi's Code contains several provisions. One of them reads as follows:

> If a builder builds a house for a man and does not make its construction firm, and the house which he has built collapses and causes the death of the owner of the house, that builder shall be put to death. If it destroys property, he shall restore whatever it destroyed, and because he did not make the house which he built firm and it collapsed, he shall rebuild the house which collapsed at his own expense.[8]

Early 20th Century Context

In the early 20th century, the concept of safety through design got significant attention among organizations focused on accident prevention and reduction in high rates of injuries and death among workers.

During the early 20th century, manufacturing created opportunities for safety through design as processes and machines continued to expand the industrial revolution. There was a growing need for skilled workers as society continued to shift from an agricultural economy to a manufacturing economy.

In addition, low worker skills were compounded by communication problems. There was a large influx of immigrants from various countries and each spoke their native language and knew little or no English.

Machines used in early manufacturing required power transmission mechanisms, since electrical power was not readily available. Electric motors were not a source of power for most early industrial machines. Power generation and distribution often involved centralized water or steam power. The power moved through line shafts, pulleys, belts, gears and other mechanisms to individual machines. Power transmission systems created many danger points. Many machines had operational elements that also had danger points. As a result, there was a strong focus on guarding as an accident prevention method.

Many accident cases illustrate the reason for the focus on machines and guarding. For example, a woman working at a machine dropped something to the floor. When she bent to pick it up from under the machine, her hair caught in an unprotected belt and pulley. The machine pulled the hair from her scalp.

Another example is a press without an automatic braking device for the end of a cycle. An operator might reach into the point of operation at just the wrong time and lose a finger or hand.

See also the story of Lorenzo Coffin (page 13) and the railroad hazards he fought to improve through legislation and design changes.

An early 20th century focus on safety through design also involved training for those responsible for factory and construction safety and worker protection. They had to learn how to incorporate safety in their design while employed by manufacturing or construction companies. Many with safety responsibilities were engineers. Engineering societies also engaged in emphasizing safety through design.

Machine manufacturers and their designers gave attention to the primary function of the machines and making them safe. There was a high rate of inventions and patents to make more effective, efficient and safe machines. The competition among manufacturers rose rapidly to achieve the best machines.

Insurance Company Services. Workers' compensation also influenced safety through design. The concept of workers' compensation and workers' compensation insurance emerged with the first United States worker compensation law in 1911. Many insurance companies selling worker's compensation insurance hired engineers to focus on reducing accidents and associated insurance claims. The companies trained their engineers in loss prevention. Part of that effort was on safety through design and redesign to help employers and employees. Some companies operated laboratories and special facilities to find better designs and accident prevention methods.

Safety Museums. Another approach was the introduction of safety museums. A few were located in major U.S. and European cities. Their purpose was to exhibit effective hazard controls so workers and employers could see some of the available solutions to dangers in their workplaces. The most significant U.S. safety museum was the American Museum of Safety in New York City. It was largely and effort of engineering societies headquartered in New York City. It no longer exists.

Early Design Standards. With the introduction of the steam engine and the growth in use of steam power, the frequency of boiler explosions and other failures of steam equipment, there was a need to develop better designs and to standardize many design features. Boiler explosions were quite common. However, one explosion that gained broad attention was the incident at the Grover Show Factory in Brockton, MA on March 10, 1905. The event killed 58 people and injured 117 others and leveled the factory. In 1911 the American Society of Mechanical Engineers (ASME) recognized the challenge and worked to produce the first boiler and pressure vessel design standards. ASME published the first ASME Boiler and Pressure Vessel Code in 1914.[9]

Promoting Safety Through Design in the Engineering Community. In September 1915, Frederick Remsen Hutton, Sc.D., a past president of ASME made a presentation at the International Engineering Congress in San Francisco, CA. He was also Vice President of the American Museum of Safety. In Paper No. 129[10], he addressed the topic of Safety Engineering as an important approach for engineers to achieve safety. He gave many examples of improvements through design for manufacturing and other machines.

His examples included a full enclosure for a source of power, an engine. The design included specific openings for an operator to lubricate and assess the machine's performance.

He illustrated an electric motor enclosure with an interlock that requires shutting off the motor. He illustrated safeguards to prevent racing of power supplies and associated flywheels.

He offered several examples of safeguards for power transmission involving shafts, belts, and gears. The examples addressed various worker conditions, such as long hair for a woman. He explained how to provide protection for maintenance workers, such as oilers. He

addressed the problem of protruding set screws and bolt heads on rotating shafts and couplings.

He discussed proper ladder design and protective features for individuals who oiled and serviced machines.

He explained the importance of procedures that we know today as lockout-tagout procedures for energized equipment.

He discussed hazards associated with overhead cranes, falling objects and falls of operators. He addressed hazards associated with elevators as vertical transportation devices. Included was an explanation for the importance of interlocking the protective gate with the elevator car's starting mechanism.

He illustrated safeguards for a variety of machining tools, woodworking tools and other powered tools. He explained the principles involved in hood design for capturing particles and other contaminants during manufacturing operations.

Overall, the presentation was a comprehensive review of hazards during a wide range of manufacturing operations and design solutions for equipment and operations. His goal was to provide a lot of examples of what engineering design can do to minimize workplace injuries. What is noteworthy also is that many of the details preceded any published standards that safety practitioners and engineers rely on today.

Engineering Revision

Early emphasis on safety through design adopted a new term for the part of the concept. The new term was *engineering revision*.

Discussion around 1910 involved two main points of application for engineering when applied to design. The first occurred when a company manufactured a new product or created a new process. The engineering role for safety was to eliminate hazards that could lead to accidents.

In many cases, employers had existing machines and processes that produced accidents. The engineering role was to make changes to add safeguards or to "revise" the machine or process. The role gained the common use of the term *engineering revision* for two to three decades.

The role of engineers in eliminating hazards and reducing the frequency and severity of accidents became one of two main approaches for safety. To understand the context, one must understand the other focus, education. As noted earlier, the lack of skilled workers, the dangers of machines and processes and the complexities of communication produced a strong need to train workers for completing their tasks safely. This was something that engineering alone could not solve.

Many involved in the safety movement realized that educating workers to do their jobs safely was not sufficient. In a 1925 pamphlet[11] by the College Committee of the National Safety Council, the report also recognized "safeguards" as temporary while a more fundamental means of eliminating hazards was needed–engineering revision. Safeguards included such devices as enclosures for power transmission equipment and guards for various points of operation.

The publication defined engineering revision as a more fundamental change in machine or operation. It noted that engineering revision requires more expert knowledge of operations and entire processes. It stated that engineering revision often involves the installation of new equipment, improving and refining present equipment, and re-designing various processes.

A National Safety Council publication on safe practices[12] stated that the term engineering revision was coined by Dr. L. W. Chaney of the U.S. Bureau of Labor Statistics. He said:

> Engineering revision is safety engineering in the truest sense of the term. It includes the widest possible application of engineering skill to the safety of industrial plants. It includes the design and location of buildings with special reference to the necessary connection with transportation facilities, ready and safe access to every point where workers must go, the provision of adequate and properly arranged lighting, the provision of machines designed from the safety standpoint, the guarding of such machines of faulty design at the plant is unfortunate enough to have, the proper attention to all dangerous conditions.

The publication also explains that "engineering revision is the most fundamental method of actually preventing accidental injuries. Through safety education and supervision, workers are influenced to avoid accident hazards; safeguards cover up these hazards; but engineering revision removes or reduces the hazards right at their source."

The publication also discusses "Safety Through Design" and states:

> The engineer cannot only correct many existing hazards, but he can also eliminate many hazards before they are created. When called upon to design new buildings, equipment and processes, he can make sure that safety is built into each project as an integral part of the design and construction.

In a paper presented by Dr. L.W. Chaney[13] he gave examples of engineering revision from the steel industry.

He explained that the Bessemer and open hearth processes started out with relatively small production batches. The processes had serious hazards. However, with the growing demand for steel, the companies increased the size of batches several times, typically from 6-ton to 12 and 15-ton vessels. That increased the rate of serious injury and death. Manipulation of hot steel involved manual labor by large crews who manipulated larger and larger ladels and pouring operations. It inolved large crews to move hot ingots into rolling machines.

One engineering revision introduced placing moulds on small cars to move them.

Another major change was the introduction of electrical power. Prior to 1890 steel production consumed no electric power. By 1909 the industry consumed nearly 20 percent of manufacturing electric power. One application was movement of ingots to the rolls. With electricity, the ingots were moved from a soaking pit to electrically operated cars which dumped them onto motor driven rolls.

With process changes, there were major increases in productivity and reductions in crew sizes and reduced rates of injury and death.

In commenting on the importance of both education and engineering to reduce accidents, the author concluded: "I can but insist that application of engineering skills are far and away the most important factor."

In an article[14] published in the late 1930s, D. D. Fennell, the National Safety Council President, noted that there are two important factors in safety engineering: environment and human behavior. He concluded that "engineering for safety is aimed primarily at the environment, although the phrase "intelligently operated" implies that part of the work must be aimed at human behavior.

Much later, the human behavior part became ergonomics, a specialty in engineering and safety engineering that designs workplaces to fit the capabilities of workers.

Summary

The idea of safety through design or prevention through design emerged along with the general need to help protect people from hazards and prevent unneeded injuries, illness and death at work or for the public. The primary responsibility for design of products, machines, buildings, workplaces and processes rests with engineers. They have an obligation to eliminate and reduce hazards and to prevent harm to people in their designs. This responsibility has extended throughout human history and remains today.

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Did You Know?

One of the earliest textbooks in safety and health was authored by the Director of the American Museum of Safety, William H. Tolman, Ph.D.

The citation is:
William H. Tolman and Leonard B. Kendall, *SAFETY - Methods for Preventing Occupational and Other Accidents and Disease,* Harper & Brothers Publishers, New York, 1913.

The 422 page book had 24 chapters under four parts:

- General Conditions
- Danger Zones
- Industrial Hygiene
- Social Welfare

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https://babel.hathitrust.org/cgi/pt?id=hvd.hxnzij

SOCIETIES INVOLVED IN SAFETY AND HEALTH HISTORY

Background

With the industrial revolution, interest grew for making machines and workplaces safe. Prior to and following 1900, interest grew among engineers and others. In many cases the interest and social responsibility led to new professional organizations devoted to safety and health of the workplace.

During the early 1900s, major attention was on machine safety, fire safety, railroad safety, and safety and health in many other industries. The need for additional areas of focus continued to grow over the years.

Below is summary information about the origins of professional organizations and societies along with a chart of their involvement in worker safety and health. Not covered are industry groups, specific companies, government organizations, publishers, and other entities that also contributed.

Should you have historical information on other professional organizations that should be included in this list and chart, please provide the information to the editor of *The Archives of Safety and Health.* Future editions of this publication intend to provide more details on the historical contributions of individual organizations and groups. We invite readers to craft draft articles on contributors for potential publication.

ASCE The American Society of Civil Engineers was founded on November 5, 1852. The origin name was American Society of Civil Engineers and Architects. The name was changed to American Society of Civil Engineers in 1868 after architects formed their own professional society. The society implemented sanitation, clean water, transportation, and many other public safety improvements.

APHA The American Public Health Association, founded in 1872, is dedicated to improving the health of all U.S. residents. It advocates implementation of scientific advances into public health policy and practice.

ASME In response to several steam boiler failures, a group of individuals established the American Society of Mechanical Engineers in 1880 and began publishing codes and standards for various mechanical devices.

NFPA At a meeting held in New York City on November 8, 1896 that focused on sprinkler installation rules, the attendees also established a new association named the National Fire Protection Association. It's first annual meeting was held May 18-19, 1897.

ASABE The American Society of Agricultural Engineers began in 1907. With the expansion of the organization's domain, in 2005 it became the American Society of Agricultural and Biological Engineers.

ASSE ASSE was founded in New York City on October 14, 1911 as the United Association of Casualty Inspectors shortly after the infamous Triangle Shirtwaist Factory Fire that occurred in March of the same year and killed 146 garment workers. In 1914, the organization changed its name to the American Society of Safety Engineers.

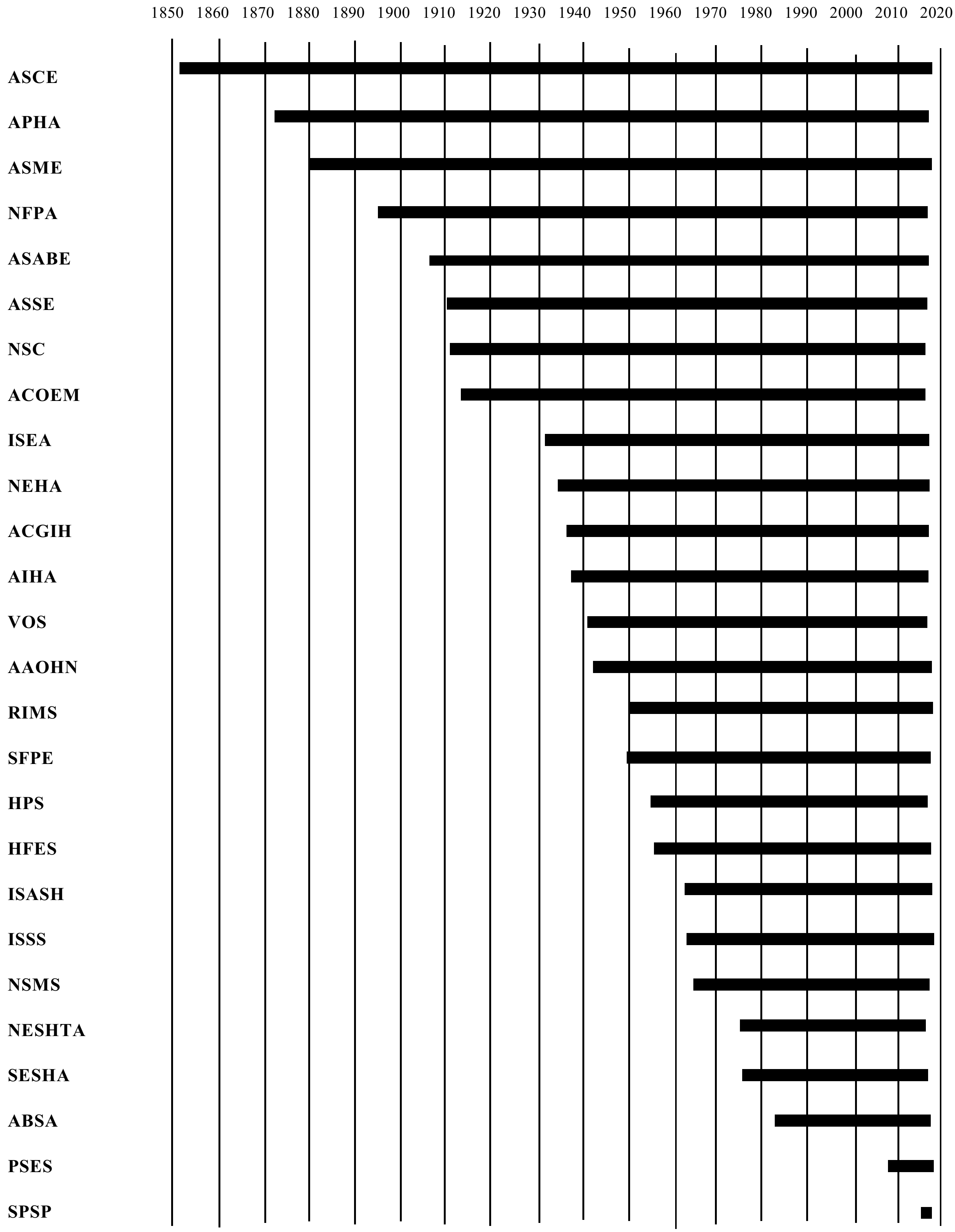
NSC At the Second Safety Congress in 1913, delegates formed the National Council for Industrial Safety as a clearinghouse of safety information available to all concerned.. A year later the organization changed to the National Safety Council.

ACOEM The American Association of Industrial Physicians and Surgeons was formed in 1916. Later it became the American Occupational Medicine Association. In 1946 another organization was founded, the American Academy of Occupational Medicine. The two merged in 1988 to form the current organization, American College of Occupational and Environmental Medicine.

ISEA The International Safety Equipment Association was founded in 1933 as the Industrial Safety Equipment Association. It changed to its current name in 2002.

NEHA The National Environmental Health Association began in California in 1937 with a focus on environmental health practitioners.

SAFETY AND HEALTH MEMBERSHIP ORGANIZATION HISTORY



ACGIH The National Conference of Governmental Industrial Hygienists first met on June 27, 1938. In 1946 the organization changed its name to the American Conference of Governmental Industrial Hygienists.

AIHA The American Industrial Hygiene Association was founded in 1939 by non-physician members of the American Association of Industrial Physicians and Surgeons.

VOS The Veterans of Safety was founded October 9, 1941 in Chicago. Its full members have 10 years of experience in safety, health and environmental practice.

AAOHN The American Association of Occupational Health Nurses began in 1942 as the American Association of Industrial Nurses. In 1977 it adopted its current name.

RIMS The Risk and Insurance Management Society was founded in 1950 and has a focus on risk management.

SFPE The Society of Fire Protection Engineers was established in 1950 and was officially incorporated in 1971.

HPS The Health Physics Society had its organizational meeting in June 1955 in Columbus, OH with a focus on radiation protection.

HFES The Human Factors and Ergonomics Society was founded on September 25, 1957 in Tulsa, OK. At first it was the Human Factors Society of America, then the Human Factors Society, Inc. It adopted the current name in 1992.

ISASH The International Society for Agricultural Safety and Health began as the National Institute for Farm Safety in 1962. It grew out of a division of the National Safety Council stemming from 1937.

ISSS The practice of system safety engineering evolved from the aerospace industry. Shared interest in the practice led to the formation of the System Safety Society in 1962 and was formally incorporated on December 1, 1963 as the Aerospace System Safety Society. Now its name is the International System Safety Society.

NSMS The Safety Management Society resulted from a meeting on September 28, 1966. Attendees shared a common interest in accident prevention based on a Value Management course they attended. Later, the name became the National Safety Management Society which formally incorporated in 1968.

NESHTA The National Environmental, Safety and Health Training Association began in 1977 with support from the United States Environmental Protection Agency. Originally, its name was National Environmental Training Association, Inc. In the 1980's it expanded its mission and adopted the current name.

SESHA The Semiconductor Environmental Safety and Health Association was formed in 1978 as the Semiconductor Safety Association. Later the name was changed to the current name. It has a focus on high technology industries.

ABSA Founded in 1984, the American Biological Safety Association promotes biological safety as a scientific discipline and the biosafety profession. Practice began in military laboratories. The ABSA constitution was written in 1984 and ratified by members in 1987.

PSES The Product Safety Engineering Society is part of the Institute of Electrical and Electronic Engineers. The main focus is on product safety engineering methodologies and techniques for equipment and devices.

SPSP The Society of Product Safety Professionals was formed in 2016 for those engaged in consumer product safety.

INJURIES WHILE FILMING *THE WIZARD OF OZ*

In 1938 to 1939 MGM Studios spent record amounts of money and applied new techniques while filming the classic movie, *The Wizard of Oz*. Many have written about the production of the film. It advanced film making to a new level.

During filming some members of the cast sustained injuries. In some cases the injuries delayed the filming process.

Background

In the early days of film making, injuries and death were not uncommon. Accidents were often under-reported. Frequently, the production philosophy was "keep on filming to stay under budget."

There are many hazards during filming. Examples are many electrical wires and equipment, hot lights, ladders, heavy and suspended equipment, power tools, and trip hazards. Cabling and carpentry items are everywhere. Often neglected is preplanning to deal with potentially hazardous situations.

The *Wizard of Oz* was groundbreaking. It filmed in Technicolor, which required bright lighting and sometimes raised the sound stage temperature to 100 degrees. The film incorporated many special effects.

Case #1. Allergic Reactions for the Tin Man

The original Tin Man in the film was Buddy Epson. He recorded all of the songs for the film before beginning filming his role.

He underwent testing of several approaches to make him look like a tin man. Finally, they glued a cap on his head and glued on a rubber nose. They covered these items and his skin with clown white and then put powdered aluminum dust on his face and head. After finishing tests, he took a deep breath. Two weeks later he could hardly breath. He went to a hospital where they determined that his lungs were coated with the aluminum dust. He spent two weeks there. Most likely it was an allergic reaction. At the time, pure aluminum dust was considered harmless. It was given to miners to breathe in order to protect their lungs from silicosis.

Some reports say Epson was placed in an oxygen tent and others say an iron lung. Some reports claim he experienced a collapsed lung. Following the two week hospital stay, Epson faced a six week recovery period. In any case, his tendency toward bronchitis remained the rest of his life. Because of his illness, he was replaced.

Jack Haley was Mr. Epson's replacement. The production team switched makeup. Instead of applying the aluminum as a powder, the makeup team made it into a paste and painted it on. However, the paste caused Mr. Haley to experience a severe eye infection and was off work for four days. The Tin Man character had succumbed to a second, job-related incident.

Case #2. Flying Monkeys Fall

The flying monkey scene in the movie involved many miniature models of the creatures suspended from a gantry by piano wire.

In addition, there were about a dozen real people who played the part of a flying monkey. Most were small people. Some were jockeys and some were little people who also played Munchkins. One of the actors was 13 years old.

The costumes included battery packs on the actors' backs that caused the wings to flap. The actors were suspended above the sound stage using thin piano wire about the diameter of pencil lead.

Several of the actors received significant injuries when the supporting wire broke and they fell several feet to the floor.

Case #3. The Wicked Witch of the West Receives Burns

The most famous injury during the film involved Margaret Hamilton, who played the Wicked Witch of the West. In one scene, she was to vanish in a burst of flame and smoke. The plan was for her to drop through a trap door and get carried into a pit by an elevator device just as the pyrotechnic devices were ignited.

The first take went well. However, management wanted a second scene. That occurred after lunch. There were about four attempts with mistakes in each. On the next attempt, the smoke and flames came too quickly. Part of Ms. Hamilton's costume and props caught on fire. The fire burned off her eyelashes and right eyebrow. She burned her upper lip and badly burned an eyelid, second degree burns. However, she did not realize the burns she suffered. She looked down and saw there was no skin from her wrist to her fingernails on the right hand, third degree burns.

Then the pain set in. It became worse as film staff tried to remove the green makeup. Green makeup was toxic because it contained copper. Makeup staff knew the green makeup had to be completely removed. Normally, the makeup staff used acetone to remove the green makeup at the end of a day of filming. With the burns they used alcohol. It was a painful process. Then the MGM physician coated the burns with salve and bandaged them.

She recovered in a hospital and at home for six weeks. Upon her return to the studio, she refused to participate in any additional pyrotechnics scenes.

Ms. Hamilton had a stunt double and stand-in, Betty Danko. She, too, was severely burned in a scene. During a skywriting sequence at the Emerald City, she sat on a smoking pipe configured to look like the Witch's broomstick. The pipe exploded during the third take. She spent 11 days in the hospital. The burns on her legs left permanent scars.

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●http://www.irishexaminer.com/lifestyle/features/the-wizard-of-oz-dark-side-of-the-rainbow-286270.html
●http://oz.wikia.com/wiki/Margaret_Hamilton
●http://www.telegraph.co.uk/culture/film/10938938/Hollywoods-health-and-safety-nightmare.html
●http://listverse.com/2017/05/21/top-10-terrible-accidents-from-the-early-days-of-film/
●http://www.imdb.com/title/tt0032138/trivia
●http://www.kansas.com/entertainment/movies-news-reviews/article1236642.html

Work in the film industry continues to be hazardous. One grieving father who lost his daughter in a train accident during filming is trying to change that. The following web sites tell the story of his daughter's death.

●www.hollywoodreporter.com/news/midnight-rider-accident-sarah-jones-death-gregg-allman-685976
●http://www.hollywoodreporter.com/news/midnight-rider-sarah-jones-autopsy-780791
http://deadline.com/2014/10/midnight-rider-death-timeline-sarah-jones-train-accident-investigation-1201266684/
●http://deadline.com/2014/10/midnight-rider-death-timeline-sarah-jones-train-accident-investigation-1201266684/
●https://www.youtube.com/watch?v=IzbqHx-DxJc
●http://deadline.com/gallery/midnight-rider-train-accident-sarah-jones-death-site-photos/#!14/sarah-jones-portrait-2/

Visit the following web sites to learn what the father is doing to improve safety and health in the film industry.

●www.sarahjonesfilmfoundation.org
●http://safetyforsarah.com

ON THIS DATE

September 30 - October 5, 1912: First Cooperative Safety Congress held in Milwaukee, WI and sponsored by the Association of Iron and Steel Electrical Engineers. See NSC History Time Line to see an original promotional poster. [http://viewer.zmags.com/publication/89ffce6b#/89ffce6b/4]

LORENZO COFFIN: A RAILROAD SAFETY FANATIC OF THE 1800s

This is a story about Lorenzo Coffin and his effort to save lives of railroad workers and reduce the rate of serious injuries.

Who Was Lorenzo Coffin?

Lorenzo Stephen Coffin was born in Alton, New Hampshire on April 9, 1823 and died on January 17, 1915 in Fort Dodge, IA.

Mr. Coffin was the son of a farmer and Baptist minister. He gained education at a local academy and then at Oberlin College in Ohio. He was a farmer, agricultural leader, social reformer, and humanitarian.

Mr. Coffin moved to Iowa in 1854 as land sales opened to settlers. He acquired 160 acres near Fort Dodge. His new life in Iowa had a slow and difficult start. Shortly after arriving in Iowa, his wife died. He lost his first four crops to prairie fires and grasshoppers. He lived in his initial small cabin for 17 years.

With the outbreak of the Civil War, he volunteered for service and served in the 32nd Iowa Infantry. He advanced from private to sergeant.

Following the Civil War, he returned to farming and became rather successful. His greatest success included raising a variety of pure-bred animals. That led to his election as president of the Iowa Breeders Association and a frequent lecturer to farm organizations within and outside Iowa. He became the farm editor for the *Fort Dodge Messenger* newspaper. He helped establish several farm organizations and farmer-owned businesses. Mr. Coffin served on the Iowa immigration board that sought to attract settlers. He served in many other capacities for various social causes during his lifetime.[1]

What Caused His Fanatical Concern About Railroad Safety?

In the 19th century, railroad transportation grew rapidly. The state of New Jersey issued the first railroad charter in 1827. By 1830 there were 23 miles of railroad in the United States. By 1850 there were 9,021 miles. Eventually, the railroads grew to 200,000 miles of track. Congress had authorized the building of the Transcontinental Railroad through the Pacific Railroad Act that President Lincoln signed on July 1, 1862. That funded railroad construction westward from the Mississippi River. The Transcontinental Railroad reached completion in 1869.

In 1883 Lorenzo Coffin began serving on the Iowa Railroad Commission. It was in this role that he got engaged in safety. Following the Civil War and during railroad expansion, railroading was the most hazardous occupation in the United States. Improving safety in the railroad industry became a passion for Mr. Coffin. He learned of the severe hazards first-hand from railroad workers.

Figure 1. Just one of may kinds of amputations from hazardous couplings. (From www.railwaysurgery.org and a textbook on railway surgery: Clinton B. Herrick, *Railway Surgery. A Handbook on the Management of Injuries*, William Bood and Co., New York, 1899.)

A range of safety problems plagued early railroads. The dangers led to a high level of injury and death, mainly among railroad employees, but also among passenegers. Many rail lines ran through highly populated areas, which added to the risks for railroads and citizens. Hazards related to coupling and braking gained Mr. Coffin's attention.

Undoubtedly, he met several railroad workers who had lost limbs, such as that found in Figure 1.

Railway injuries created a large amount of business for manufacturers of artificial limbs. A journal called *The Railway Surgeon* carried many advertisements for legs, hands, and arms. Figure 2 provides one example that Lorenzo Coffin was likely to have known about.

Figure 2. Just one example of advertisements for artificial limbs and devices for injured railroad workers. (From www.railroadsurgery.org)

Consider the records of the time. About 1880, 70 percent of all train crews could expect injury within five years of service. In 1881, more than 30,000 railroad men died or received disabling permanent injuries.

Table 1 shows the statistics of the United States government[2] for the year ending on June 30, 1904.

Table 1. Interstate Commerce Commission Railroad Injury and Death Statistics for 1904.

	Killed	Injured
Passengers	441	9,111
Employees	3,632	67,067
Non-trespassers	839	2,499
Trespassers	5,105	5,194

Non-trespassers and trespassers were people outside railroad operations. Non-trespassers mainly represented people killed or injured at crossings. Trespassers were often people who walked the tracks or hitched a ride on a passing train. People walked the tracks because there were few good walkways or roads and railroad roadbeds provided convenient routes for those on foot. Children under fourteen were ten percent of trespassers.

Table 2 provides railroad casualty statistics for 1902 through 1911[3].

The author of Reference 2 made the following conclusions in 1906:

> It is not the great train accidents that make the large majority of the total deaths and injuries on the railroads of this country, about which so much is said in the public press, but it is the little cases unheralded in the press, or in the courts, that make the totals so large. The little things that are happening every day, on every railroad in the country, which go on happening every year in the same old way. They are the cases which could and should be avoided by the exercise of greater care and thoughtfulness–more of them come from thoughtlessness than any other cause. After all it is the *man*, not the safety appliance, that we must depend on to prevent accidents.

The same author's view of accident causation reflected the view of many at that time:

> Accidents caused by carelessness, thoughtlessness, or neglect of employees are the large majority of all that happen, and if we could eliminate them, or one-half of them, there would be little cause for complaint on the part of the management of companies, or criticism on the part of the public, and the claim agent would have a bed of roses instead of the busiest and hardest worked office on the road. I believe that when the employees really understand the matter many of them will be eliminated.

Table 2. Railroad Casualty Data: 1902-11

	Railroad Employees			% of Total Work Force		Passengers	
Year	Killed	Injured	Total Work Force	Killed	Injured	Killed	Injured
1902	2,793	38,790	1,189,000	0.23	3.01	271	6,323
1903	3,520	42,568	1,313,000	0.27	3.24	442	7,856
1904	3,063	42,094	1,296,000	0.24	3.25	526	9,002
1905	3,588	51,170	1,382,000	0.26	3.70	369	10,514
1906	4,132	59,244	1,521,000	0.27	3.90	539	12,112
1907	4,218	64,930	1,672,000	0.25	3.88	571	14,324
1908	2,514	49,537	1,438,000	0.18	3.45	337	11,643
1909	2,843	57,926	1,503,000	0.19	3.85	333	13,593
1910	3,778	----	1,699,000	0.22	----	441	12,768
1911	3,322	----		----	---- ----	317	15,278

A study of railroad accident types and severity[4] looked at those occurring in Colorado from July 1884 to June 1885. Table 3 lists the types of accidents and their severity. The results give a general picture of the accident situation in the railroad industry at the time.

The medical industry responded to the number and severity of injuries. A specialty emerged called a railroad surgeon. Some railroads employed their own railroad surgeons. Advertisements offered a variety of prosthetic devices in magazines. Many ads targeted railroad victims who had lost hands, arms and legs in railroad accidents.

What Did Lorenzo Coffin Do To Improve Railroad Safety?

Lorenzo Coffin became an outspoken advocate for improvement in railroad safety. He lobbied the public, legislators in his state and federal legislators for improvements.

His effort led to the first railroad safety legislation in Iowa, the Iowa Safety Appliance Act of 1890. The act required newly repaired railroad cars to have safety or automatic couplers. A short time later all cars had to have them. In 1878 more than half of all injuries to Iowa trainmen were due to coupler mishaps. By January 1893 the act required Iowa trains to have enough cars with air brakes to allow the engineer to stop the train from the locomotive.[5]

He worked hard to convince railroad unions of the value of railroad safety appliances and eventually gained endorsement from them. That expanded the demand. The groups pursued public support. He worked tirelessly to achieve federal legislation similar to that passed in Iowa. The federal legislation focused solely on worker safety. Finally, in 1893 Congress passed the first Railroad Safety Appliance Act.

Implementation took time, probably close to twenty years. Ultimately, the injury and death toll dropped and the railroad industry saw the benefits of safer operations.

This initial federal legislation led to other laws focused on railroad safety. Lorenzo Coffin had opened the door to safer railroads. The Act required improved and safer couplers and implementation of braking from controls in the locomotives. Later legislation modified the initial act. Some legislation established other protection for railroad workers. Other laws introduced a blocking and signal system that greatly reduced the crashes between oncoming trains.

What Was the Railroad Safety Appliance Act of 1893?

The federal Railroad Safety Appliance Act of 1893 standardized automatic couplers and braking systems. Previously, a few states, such as Iowa, had enacted similar legislation for railroad safety appliances.

Link-and-Pin Coupling

Before this legislation, railroads used simple link-and-pin couplers. Figure 3 gives an example. It was the most common coupler for railroad cars in the early days.

Table 3. 1884-85 Colorado Railroad Accident Type and Severity

		Severity			
Type	Total Cases	Minor	Moderate	Severe	Deaths
Working on RR Track	53	29	6	15	3
Coupling	44	16	4	24	0
Collision	37	25	3	6	3
Fall	30	14	5	5	6
Maneuvering on Train	28	13	9	4	2
Hit by Something	24	9	5	3	7
Lifting/Handling Something	16	11	1	4	0
Working at Shop	16	8	3	5	0
Other/Unknown	6	4	0	1	1
Broken Train	7	1	2	4	0
Fire	2	0	2	0	0
Total	263	130	40	71	22
Percent of Total	100	49	15	27	8

Figure 3. Example of a Link-and-Pin Coupling.

A trainman had to hold the link and insert one end into the slot at the end of a coupling. Then he dropped a pin into the hole in the coupling to keep the link in place. When lifting the link and guiding it into the coupler of an adjacent car in motion, there was a significant chance of getting fingers or a hand crushed between the couplers. The risk was much higher when the cars moved together quickly.

Several Websites of interest listed at the end of this article further illustrate the link-and-pin coupling. Websites E and F provide videos of the process.

Hand Brake

Early railroad car designs had a brake for each car. A trainman or brakeman had to activate the brake by turning a hand wheel at the top of the car. A trainman or brakeman had to climb a built-in ladder to the top of a car to access the hand wheel and turn it (see Figure 4). Often a trainman fell during the operation. The risk was much higher when there was rain, mud, snow and ice and a train was moving.

If an engineer wanted to slow his train down, he would blow his whistle, and brakemen would scramble from car to car, setting the clumsy hand brakes. Those early hand brakes were often quite primitive and worked much like stagecoach brakes. Wooden blocks operated by a lever pressed against the wheels.

A brakeman worked at a height of 12 to 14 feet above the tracks. A brakeman often carried a thick brake "club" to help create leverage when turning the wheel or freeing up stuck hand wheels. Because he had to set the brake wheel on each car, a brakeman had to run along the top of the railway cars and leap from one to another to get to the next brake wheel. In bad weather and when a train was moving, this activity got tricky and more dangerous. Falling between moving cars was usually fatal.

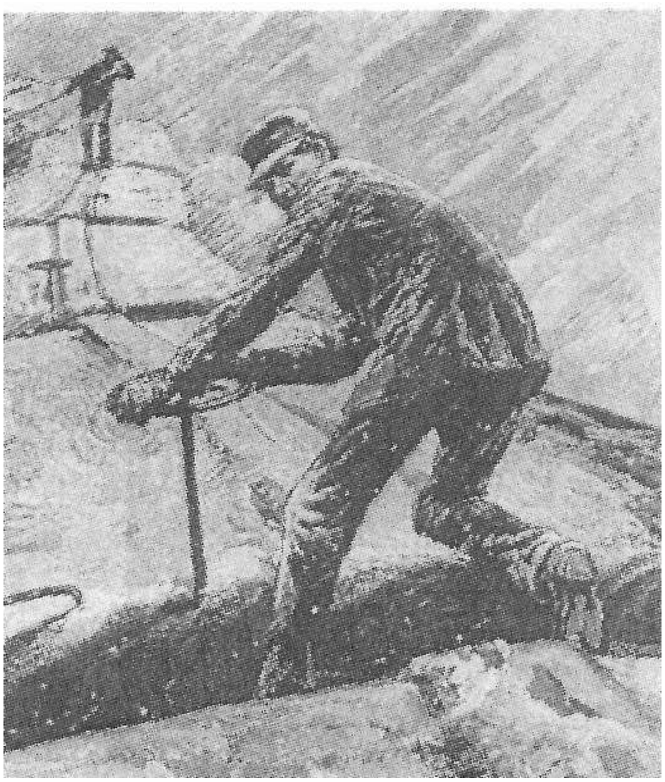

Figure 4. Trainmen manually turned a hand wheel on each car to set the brake.

Often there were two brakemen on a train. The primary brakeman began his tasks at the front of the train. A second brakeman, known as a rear brakeman or flagman, worked the same tasks beginning at the rear of the train. The two progressed toward the middle of the train until all brakes were set.[7]

Requirements of the Act

The full title of the original act was "An Act to Promote the Safety of Employees and Travelers upon Railroads by Compelling Common Carriers Engaged in Interstate Commerce to Equip Their Cars with Automatic Couplers and Continuous Brakes and Their Locomotives with Driving-wheel Brakes, and for Other Purposes." The first section of the Act required enough cars to have train brakes (such as air brakes) so an engineer could control the speed of a train from the locomotive without the need for a brakeman to set hand brakes.

In a second section of the Act, cars had to have couplers that could coupled and uncoupled automatically without the need for men to go between the ends of the cars. There were a few other features required in other sections. The sixth section imposed a $100 fine for each violation of the act.

The Act authorized the American Railway Association to set standards, subject to Interstate Commerce Commission approval. The Act took effect in 1900.

What Was the Impact of the Legislation Led by Lorenzo Coffin?

A major result of the legislation was implementing improvements in couplers and braking systems. Another impact was establishing national standards for these features on railroad cars.

From an employee and public safety perspective, the new law eventually reduced the extremely high rates of injuries and deaths. Eventually, the railroad companies found that safety positively affected their business and financial success.

Credit for the improvements in couplers and braking systems and reductions in injuries and death must also point to inventors offering change. These two changes owe credit to the creativity of Eli Janney and George Westinghouse. Their inventions demonstrate the value of safety through design.

The Janney Coupler Replaces the Link and Pin Coupler

Many inventors received patents for automatic railroad couplers. By 1887 the number of railroad coupler patents exceeded 4,000. The automatic coupler the industry accepted following the Railroad Safety Appliance Act of 1893 was that of Eli Janney.

Eli Janney was born in Virginia in 1831. Before the Civil War, he had a small farm, ran a small shop, and was the local postmaster. He joined the Confederate Army, eventually rising to the rank of major.

After the war he was a clerk in a dry goods shop. However, he devoted his spare time to inventions. One of his goals was to create a safer and more efficient coupler system for railroad cars. He often carved models of his inventions from wood.

In 1873, Eli Janney received a patent for his coupler (See Figure 5), which was a knuckle-style coupler that worked much like interlocking fingers between two hands.

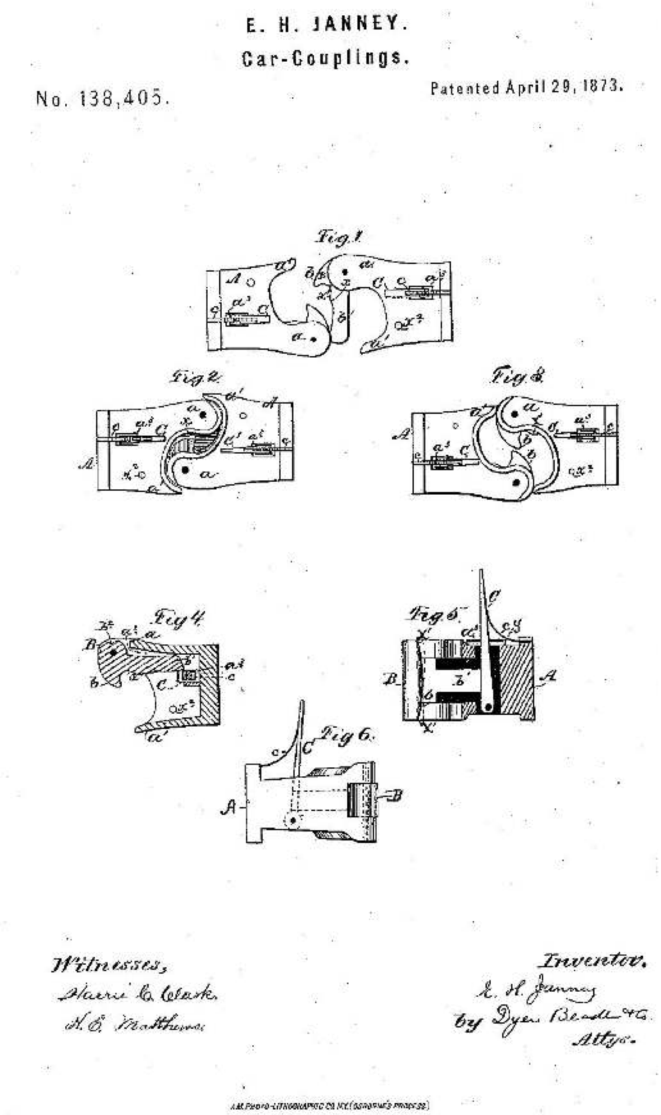

Figure 5. The Janney Automatic Coupler

The patent document noted his device was "an automatically working car coupling, in such a manner that the coupling and uncoupling are performed without endangering the operator's life by going between the cars." He sold his patent rights to a manufacturing company. Nine years later his patent was selected over 40 other proposals to meet the requirements of the Railroad Safety Appliance Act.[7,9]

The Westinghouse Air Brake Replaces the Handwheel Brake System

George Westinghouse was born in Central Bridge, New York in 1846. During the Civil War, he served in both the Union Army and Navy. He attended Union College and the University of Schenectady. He was an inventor and industrialist.

He had numerous patents, many related to the railroad industry. He received his first patent for an air brake system in 1869. Subsequently and prior to the Railroad Appliance Safety Act of 1893, he obtain over 30 more patents related to air brake systems that solved many operational details. Some railroads had begun using his system prior to the Act. With the passage of the Act, his system became mandatory.

In 1870 he created the Westinghouse Air Brake Company to manufacture and sell his braking system.

A compressor at the engine fills a compressed air tank. Compressed air released from the tank goes through pipes to all cars in a train. All cars connect to the system. The compressed air causes the braking shoes to release from the wheels. When pressure decreases or is lost, the braking shoes contact the wheels to stop the train. The amount of pressure helps control the rate of slowing or stopping. The engineer in the locomotive controls the level of pressure in the system by moving a control valve. The Westinghouse air brake incorporates a separate pressure tank on each car. It also has a triple valve feature that provides a more efficient and reliable braking system.[8]

One of the most important aspects of the Westinghouse design was that it was ***fail-safe***. With no air pressure, the brakes kept a train from moving.

Web Sites of Interest K and L offer visuals to help explain the Westinghouse air brake system that remains in use today.

Reduction in Injury and Death Rates

Estimates vary about the overall reduction in injuries and death produced by the Railroad Safety Appliance Act of 1893 that resulted from Lorenzo Coffin's efforts. Before adoption of the Janney coupler, about 40% of railyard injuries and deaths involved coupling accidents. By 1902, only 4% of railroad accidents were due to car coupling.[7] Others estimated a 90% reduction in injuries and deaths from both the Janney coupler and the Westinghouse air brake. Regardless, thousands of railroad workers benefitted from the tireless work of Mr. Coffin. Clearly, his work saved thousands of lives and prevented even more debilitating injuries.

How is Lorenzo Coffin Remembered?

Few safety professionals today know who Lorenzo Coffin was or anything about him. They know little about the horrendous accident record in the railroad industry in Lorenzo Coffin's day. At least his grave has gained a bit of recognition for his determined efforts to reduce the death and injury toll among railroad workers. Lorenzo Coffin's grave near Fort Dodge, IA is on the National Register of Historic Places, a distinction reserved for a few. That distinction marks the personal commitment and achievement of a private citizen, Lorenzo Coffin, who saw the need for safer workplaces. As Mr. Coffin stated in 1913: "I discovered it was taken as a matter of course that railroad men of necessity be maimed and killed."

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[1]Natte, Roger. "Coffin, Lorenzo Stephen" *The Biographical Dictionary of Iowa.* University of Iowa Press, 2009.

[2]R. C. Richards, *Railroad Accidents - Their Cause and Prevention*, The Association of Railway Claim Agents, 1906. [https://www.gutenberg.org/ebooks/38731]

[3]*An Evaluation of Railroad Safety*, Office of Technology Assessment, Congress of the United States, May 1978. (NTIS order #PB-281169) [https://www.princeton.edu/~ota/disk3/1978/7808/780801.PDF]

[4] Evgenia Shnayder, *When the Loss of a Finger is Considered a "Minor" Injury: Accidents, Occupation, Severity and Geography on Colorado Railroads, July 1884-June 1885*, Center for Spacial and Tactual Analysis, Stanford University, Stanford, CA, 2015. [https://web.stanford.edu/group/spatialhistory/cgi-bin/site/pub.php?id=65]

[5] John Williams-Searle, "Courting Risk: Disability, Masculinity, and Liability on Iowa's Railroads, 1868-1900", *The Annals of Iowa,* Volume 58, Number 1 (Winter 1999), State Historical Society of Iowa. [http://ir.uiowa.edu/cgi/viewcontent.cgi?article=11060&context=annals-of-iowa]

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[7] Arshad Mahmud, *Eli Janney Hamilton*, American Society of Mechanical Engineers, Engineering Topics. [https://www.asme.org/engineering-topics/articles/transportation/eli-janney-hamilton]

[8] Robert B Shaw, *A History of Railroad Accidents, Safety Precautions and Operating Practices*, 1978.

[9] Dee Brown, *Hear That Lonesome Whistle Blow*, Holt, Rinehart and Winston, 1977.

Other References

Mark Aldrich, *Death Rode the Rails: American Railroad Accidents and Safety, 1828-1965*, Johns Hopkins University Press, Baltimore, MD, 2006.

Stewart H. Holbrook, *The Story of American Railroads*, Crown Publishers, New York, NY, 1947.

Web Sites of Interest:

Medical

A http://railwaysurgery.org/Limbs.htm

Other Railroad Dangers

B https://www.youtube.com/watch?v=yUc3wd4It8g

Link and Pin Couplers

C http://www.victorianweb.org/cv/rrmuseums/baltimore/7.html
D http://cprr.org/Museum/Ephemera/Link-Pin_Couplers.html
E https://www.youtube.com/watch?v=d5r1VJ5Q2sA
F https://www.youtube.com/watch?v=8MCP7eTLrrg
G http://ridgwayrailroadmuseum.org/workcar.html (Last photograph)
H http://harveycountyvoices.blogspot.com/2013/04/tools-from-our-collection-link-and-pin.html

Braking Systems

I https://books.google.com/books?id=ZyEDAAAAMBAJ&pg=RA2-PA43&dq=popular+science+1951+how+your+train+stops&hl=en&ei=7YO-TJHqI8bPnAfCscWKDg&sa=X&oi=book_result&ct=result&resnum=2&ved=0CDMQ6AEwAQ#v=onepage&q&f=trueK
J https://www.youtube.com/watch?v=kvXW_PEdLFM

K https://www.youtube.com/watch?v=hFFmQdV9QLU
L http://www.patent-invent.com/air_brake_patent.html

FOOD FOR THOUGHT IN 1920 (and maybe for today)

EDITORIAL

FROM *SAFETY ENGINEERING* (The Safety Press, Vol. 40, No. 1, July 1920, page 25)

The Scope of Engineering For Safety

Inspired by the question raised in a recent issue of *Safety Engineering* "Shall there be a special branch of the engineering profession for safety engineers?" a prominent western engineer suggest the idea that not only is all engineering safety engineering but that all organized human endeavor is directed toward safety.

Our correspondent points out that primitive man, without any conscious engineering ability, performed the first safety act when he constructed his hut or piled a protective barrier of stones at the entrance to his cave; that human society has for its fundamental object the protection which comes from cooperation and mutual assistance.

That is all true, but in the subsequent complication of human relationships---particularly in the last two centuries of invention, manufacturing and commerce---specialization has set in so that today no civilized being can construct his own house, make his own clothes or provide for his own transportation from place to place.

EDITORIAL (Continued)

Each of us does his own little bit. All of us wear shoes but a very small number of the human race can make a comfortable pair. All of us wear garments of cloth, but the great majority of people haven't the faintest idea of the operation of a loom. All of us eat meat but most of us would turn with horror from the thought of killing an ox.

All of us eat bread but the average man, particularly in the city, could not raise wheat nor could he grind it. All of us live in houses with glass windows, which we accept as a matter of course, but none but a very few, in proportion to the whole population, can make a pane of window glass. Therefore, while Safety Engineering is truly as universal in its application as window glass and shoes and bread and meat it can most properly and effectively be practiced by specialists who study hazards and their correction and who with a mind concentrated on this particular branch can work with greater effectiveness.

There is no reason why every one should feel that he is a safety engineer any more than there is that every man should make his own shoes or weave his own clothing. And as this discussion progresses we become more and more convinced that Safety Engineering should be a specialized branch of engineering and that it should be practiced by men especially trained for this work.

1915: IMPROVING EMPLOYEE IN-PLANT BEHAVIOR

From *Safety Engineering*, Volume 30, Number 1, July 1915, page 83.

Viewing with alarm the steady increase in its shops and on the street of the practice popularly known as "goosing" and believing that, unchecked, these acts would soon become a cause of an increased number of injuries, especially in the factory, the Avery Company, Peoria, Ill., decided to make a determined stand against goosing practices. To that end it issued to all departments of the Avery factory the letter below:

AVERY COMPANY BULLETIN ON "GOOSING"

No. 950
June 1, 1915

To All Departments: Of all fool acts, about the most foolish, senseless, asinine act is that commonly known as "goosing."

The unfortunate victim is never safe from attacks, without the least regard for time or place, by those who call themselves his friends. It is a pity that the victim doesn't smash his enemy upon the nose, but more the pity, the victim is usually a good sport who takes the joke (?) as he thinks a good sport should.

The condition of being "goosy" is easily acquired by anyone who is subjected to those attacks by his companions. It grows gradually, and insidiously, the victim dreading to have his companions approach him from the rear until finally he loses absolutely all control of himself when "goosed." This act is senseless enough when in a perfectly safe place, but it certainly has no place in a factory where the victim is in danger of becoming injured, perhaps killed.

One jump into a moving machine, a live switch, a pile of stock, or off a platform, or into a hole, may cripple the victim for life, if not kill him. Should such an accident occur in the Avery factory, the Avery Company would probabaly be called upon to pay the cost. Certainly the Avery Company is called upon to afford its employee all the protection possible. We feel it our duty to do so, and have decide to take a determined stand against "goosing."

EFFECTIVE AT ONCE.
The Penalty of Goosing Another Workman Is Immediate Discharge.

We believe that you will all agree with us that the penalty is just one and that "forewarned is forewarned." Please post this letter where all can read.

Avery Company

The Avery Company expected that this letter would be taken in a spirit of levity by the workmen, but much to its gratification the bulletin was well received. Practically all of the foremen and many of the workmen stated in unmistakable terms their approval of the letter and concurred in the sentiment expressed. Several foremen remarked that it was the most effective bulletin that the safety department had posted.

The practice had grown to such an extent that workmen who operated dangerous machines never felt secure from the attacks of the would be practical joker who took delight in taking advantage of their weakness. Many workmen who were susceptible would throw whatever they had in their hands in an entirely irresponsible manner when attacked. In fact, the majority of those who are susceptible become irresponsible for the moment.

The workman who is rolling sheet iron with his fingers close to the rolls or a man operating square shears, in fact any man who is doing any one of a great number of operations in a factory, is a poor subject for a joke of any kind.

The moral effect of the Avery letter has extended beyond the shop, even to the extent that where, as before, the practice was carried into the street cars among the men returning from their work, the men now act in a much more gentlemanly manner than they did prior to the posting of the letter.

Believing that its success in stopping "goosing" may prove of value to other employers and persons interested in the safety movement, the Avery Company gives to *Safety Engineering* the benefit of this experience. Elimination of unsafe practices is as essential as proper safeguarding of unsafe machines.