

Lachlan passed away in January 2010. As a memorial, this site remains as he left it.

Therefore the information on this site may not be current or accurate and should not be relied upon.

For more information follow [this link](#)

(This Webpage Page in No Frames Mode)

Welcome to Lachlan Cranswick's Personal Homepage in Melbourne, Australia

Extracts from [National Safety Council's](#) Accident Facts 1941 Edition : containing the information on 87% of unsafe acts involved 78% of mechanical causes

Plus some Extracts from H.W. Heinrich, "Industrial Accident Prevention", 3rd edition, 1950, McGraw-Hill Book Company Inc

Lachlan's homepage is at <http://lachlan.bluehaze.com.au/>

[\[Back to Lachlan's Homepage\]](#) | [\[What's New\]](#) | [\[Industrial safety resources\]](#)

For information on the history and background of the [NSC's](#) "Hierarchy of Controls" vs H.W. Heinrich inspired Behavior-Based Safety (BBS) programs refer to "[NOT WALKING THE TALK: DuPont's Untold Safety Failures](#)" by United Steelworkers International Union, September 2005

- At <http://dupontsafetyrevealed.org/Not%20Walking%20the%20Talk/Walking%20the%20Talk-%20Duponts%20Untold%20Safety%20Failures-%20Final.pdf>
 - The National Council for Occupational Safety and Health : 4/25/06 : Workplace Health and Safety Dirty Dozen Report: http://dupontsafetyrevealed.org/DirtyDozen/NCOSH_Dirty_Dozen.pdf
-

[\[JPG images of Page 18, NSC Accident Facts 1941 Edition - What Causes Industrial Accidents\]](#)

[\[JPG images of Page 19, NSC Accident Facts 1941 Edition - 2 out of 3 Accidents have both personal and mechanical causes\]](#)

[\[JPG images of Page 74, NSC Accident Facts 1941 Edition - Table of Unsafe Acts and Mechanical Causes of Occupational Accidents, Pennsylvania\]](#)

[\[JPG images of Page 75, NSC Accident Facts 1941 Edition - Table of Unsafe Acts and Causes of Permanent Disabilities and Deaths, by Industry\]](#)

Page 18, NSC Accident Facts 1941 Edition

What Causes Industrial Accidents?

NO ONE can say exactly how many industrial accidents are due to a particular cause. Most accidents have a combination of causes. Furthermore, not all industrial accidents are properly investigated.

Questions of industrial accident causation may ultimately be answered by the proposed American Standards Association code for compiling industrial accident causes - a classification system designed for

compiling statistical information, and also as a guide to accident investigation.

The proposed code is organized around the following accident factors:

- (1) Agency and agency part, (2) unsafe mechanical or physical condition,
- (3) accident type, (4) unsafe act, (5) unsafe personal factor.

Agencies and causes most closely associated with the actual injury are recorded; This sets aside any contributing causes, and further eliminates obscure, subjective causes. Naturally, contributing causes, as well as proximate causes, revealed by investigation, should be corrected.

Experience in applying the proposed code has revealed that individuals code an accident differently. This handicaps statistical use of the code.

The Pennsylvania Dept. of Labor & Industry showed an unsafe act for 97 percent of 1940 reported cases, and mechanical cases for 97 per cent.

Industrial Accident Cause Studies	Pennsyl- vania Reported Cases	National Safety Council Studies		
		No. 1 1,000 Serious Cases	No. 2 4,200 Serious Cases	No. 3 1,000 Cases
UNSAFE ACTS				
Total Cases	100%	100%	100%	100%
Overloading, poor arranging	48		7	10
Unsafe equip., improper use of equipment	19		15	16
Unnecessary exposure to danger	17		27	24
Making safety devices inoperative	8	Not tabulated	5	15
Working on moving or dangerous equip.	2		13	6
Operating at unsafe speed	1		3	7
Other unsafe act	2		18	7
No unsafe act	3		12	13
MECHANICAL CAUSES				
Total Cases	100%	100%	100%	100%
Hazardous arrangement, procedure	65	34	35	34
Defective agencies	24	15	15	18
Unsafe dress or apparel	8	9	6	15
Improper illumination or ventilation	*		1	2
Improper guarding	*	27	25	9
No mechanical cause	3	15	18	22
PERSONAL CAUSES				
Total Cases		100%	100%	100%
Improper attitude	Not tabulated	48	48	31
Lack of knowledge or skill		35	30	48
Bodily defects			3	3
No personal cause		17	19	18

•Pennsylvania—109,475 cases reported to the Department of Labor and Industry during 1940.
•N.S.C. Study No. 1—1,000 permanent disabilities and deaths, representative cross-section of industry.
•N.S.C. Study No. 2—4,200 permanent disabilities and deaths, total cases reported in detail.
•N.S.C. Study No. 3—1,000 cases, including temporary total disabilities, heavily weighted by the experience of a few large companies.
*Less than half of one per cent.

A National Safety Council study of 1,000 cases, including temporary total disabilities, showed unsafe acts for 87 per cent of the cases, and mechanical causes for 78 per cent. Pennsylvania showed less than half of one per cent under improper guarding, while the Council study showed 9 per cent.

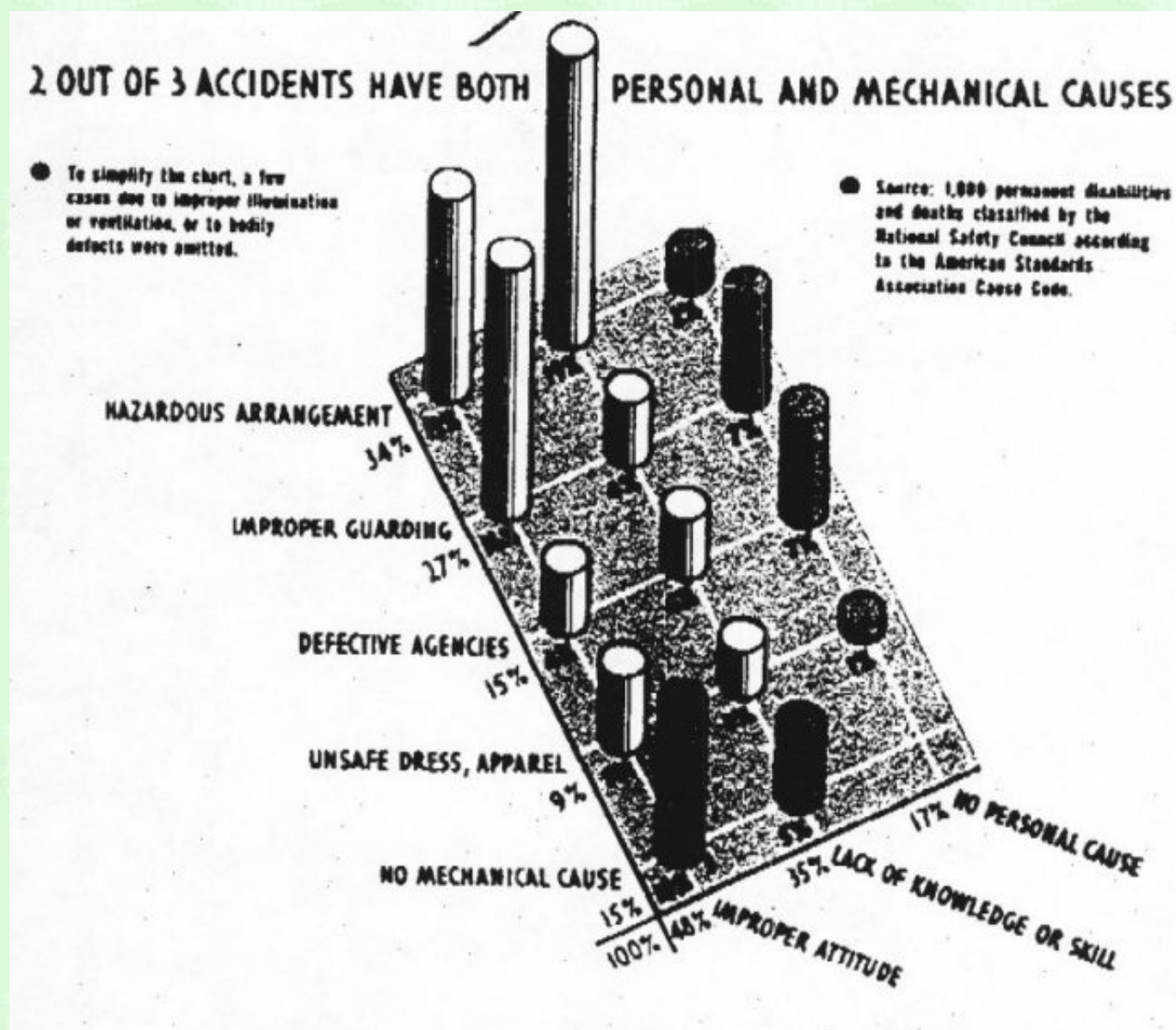
Causes Differ With Severity. National Safety Council studies of serious injuries attribute one-fourth to improper guarding, as compared with only one-tenth in the study which included less severe injuries.

Usefulness of Cause Data. General summaries of cause data for widely differing operations are of only background value. However, when cause information is separated by industry, by agency, or by other pertinent factor, more useful facts appear. For example, Pennsylvania showed "defective agencies" as a mechanical cause in two of five hand tool accidents.

A National safety Council analysis showed working on moving equipment as the unsafe act in 20 per cent of the food industry's accidents.

The Council used the cause code as a guide in analysis of 2,000 accidents in the paper and pulp industry. It was not only necessary to handle each agency separately, but was further important to classify according to the job being performed, before tabulating causes and unsafe acts.

Further experience with the proposed code should eliminate inconsistencies in classification, and reveal other ways of using the code.



Extracts from H.W. Heinrich, "Industrial Accident Prevention", 3rd edition, 1950, McGraw-Hill Book Company Inc

Page 10 to 16:

CHAPTER 2: BASIC PHILOSOPHY OF ACCIDENT PREVENTION

This chapter is of an explanatory and preliminary nature. Having agreed upon the three underlying principles and the five steps of industrial accident prevention as outlined in Chap. 1, it follows that the most practical and effective means of application toward accomplishing the desired objectives should now be described. The methods advocated in subsequent chapters, although wholly conventional, are not selected at random but follow a consistent pattern. This is because they are based on 10 axioms which constitute the basic philosophy of industrial accident prevention.

SECTION 1. AXIOMS OF INDUSTRIAL SAFETY

1. The occurrence of an injury invariably results from a completed sequence of factors-the last one of these being the accident itself. The accident in turn is invariably caused or permitted by the unsafe act of a person and/or a mechanical or physical hazard (see Section 2).
2. The unsafe acts of persons are responsible for a majority of accidents (see Section 3).
3. The person who suffers a disabling injury caused by an unsafe act, in the average case has had over 300 narrow escapes from serious injury as a result of committing the very same unsafe act. Likewise, persons are exposed to mechanical hazards hundreds of times before they suffer injury (see Section 4).
4. The severity of an injury is largely fortuitous-the occurrence of the accident that results in injury is largely preventable (see Section 4).
5. The four basic motives or reasons for the occurrence of unsafe acts provide a guide to the selection of appropriate corrective measures (see Section 5).
6. Four basic methods are available for preventing accidents -engineering revision, persuasion and appeal, personnel adjustment, and discipline (see Section 5).
7. Methods of most value in accident prevention are analogous with the methods required for the control of the quality, cost, and quantity of production (see Section 6).
8. Management has the best opportunity and ability to initiate the work of prevention, therefore it should assume the responsibility (see Section 7) .
9. The supervisor or foreman is the key man in industrial accident prevention. His application of the art of supervision to the control of worker performance is the factor of greatest influence in successful accident prevention. It can be expressed and taught as a simple four-step formula (see Section 7 and Chap. 17).

10. The humanitarian incentive for preventing accidental injury is supplemented by two powerful economic factors: (1) the safe establishment is efficient productively and the unsafe establishment is inefficient; (2) the direct employer cost of industrial injuries for compensation claims and for medical treatment is but one-fifth of the total cost which the employer must pay (see Section 8) .

In view of the influence that these axioms have on the text in succeeding chapters, it is appropriate to offer certain substantiation and enlargement.

SECTION 2. THE ACCIDENT SEQUENCE 2

The Five Factors in the Accident Sequence. A preventable accident is one of five factors in a sequence that results in an injury.

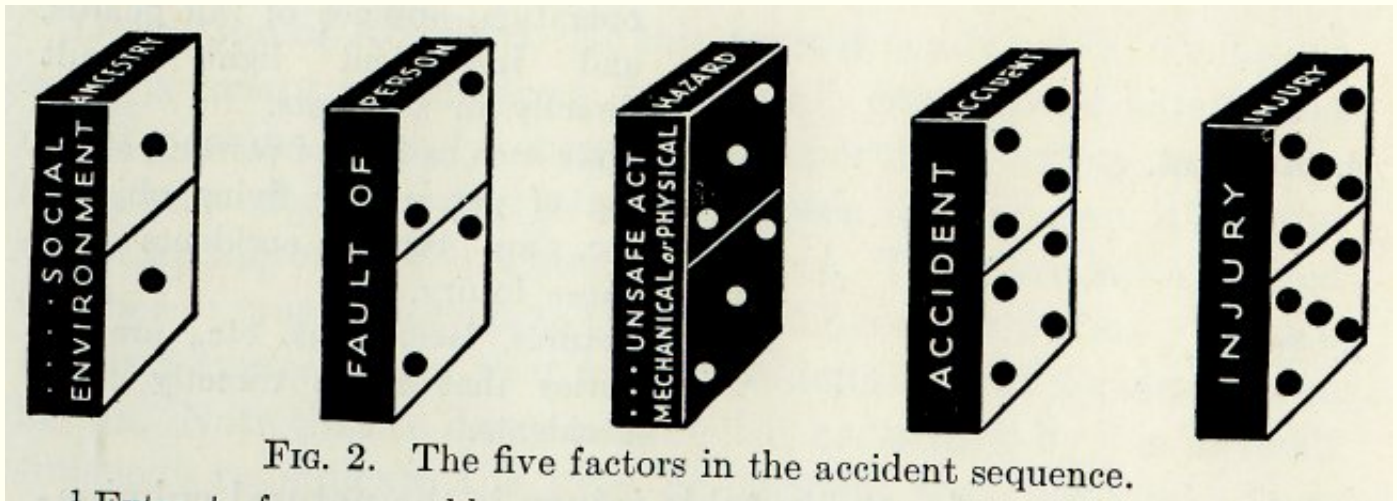


FIG. 2. The five factors in the accident sequence.

Fig. 2: The five factors in the accident sequence.

1) Extracts from an address presented before the Down River Section of the Detroit Safety Council by the author.

The injury is invariably caused by an accident and the accident in turn is always the result of the factor that immediately precedes it.

In accident prevention the bull's eye of the target is in the middle of the sequence—an unsafe act of a person or a mechanical or physical hazard.

The several factors in the accident occurrence series are given in chronological order in the following list: Accident Factors Explanation of Factors

1. Ancestry and social environment. Recklessness, stubbornness, avariciousness, and other undesirable traits of character may be passed along through inheritance. Environment may develop undesirable traits of character or may interfere with education. Both inheritance and environment cause faults of person.
2. Fault of person. Inherited or acquired faults of person; such as recklessness, violent temper, nervousness, excitability, inconsiderateness, ignorance of safe practice, etc., constitute proximate reasons for committing unsafe acts or for the existence of mechanical or physical hazards.
3. Unsafe act and/or mechanical or Unsafe performance of persons, such physical hazard. as standing under suspended loads, starting machinery without warning, horseplay, and removal of safeguards; and mechanical or physical hazards, such as unguarded gears, unguarded point of operation, absence of rail guards, and insufficient light, result directly in accidents.

4. Accident. Events such as falls of persons, striking of persons by flying objects, etc., are typical accidents that cause injury.

5. Injury. Fractures, lacerations, etc., are injuries that result directly from accidents.

The occurrence of a preventable injury is the natural culmination of a series of events or circumstances, which invariably occur in a fixed and logical order. One is dependent on another and one follows because of another, thus constituting a sequence that may be compared with a row of dominoes placed on end and in such alignment in relation to one another that the fall of the first domino precipitates the fall of the entire row. An accident is merely one factor in the sequence.

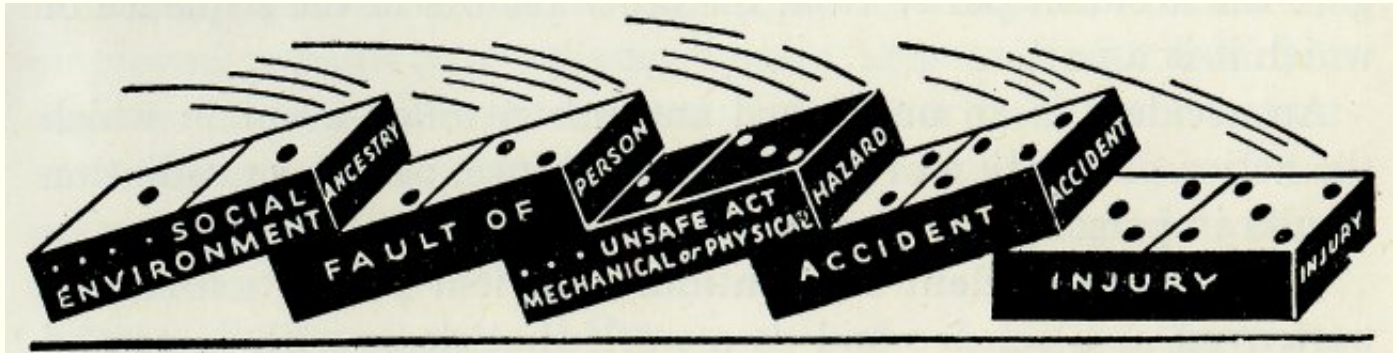


FIG. 3. The injury is caused by the action of preceding factors.

Fig. 3. The injury is caused by the action of preceding factors.

If this series is interrupted by the elimination of even one of the several factors that comprise it, the injury cannot possibly occur.

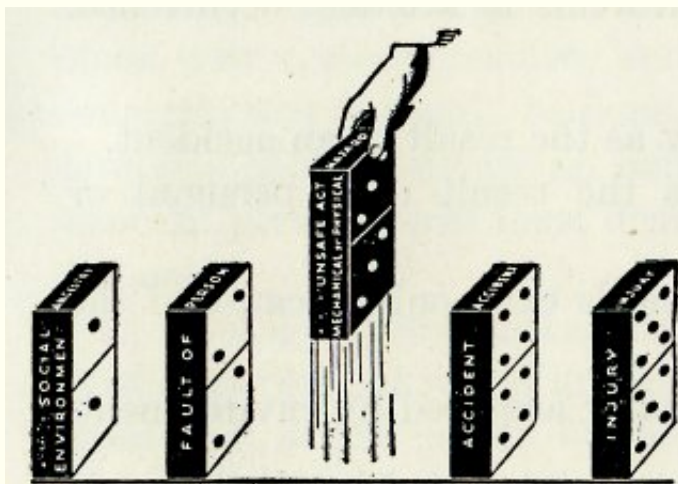


FIG. 4. The unsafe act and mechanical hazard constitute the central factor in the accident sequence.

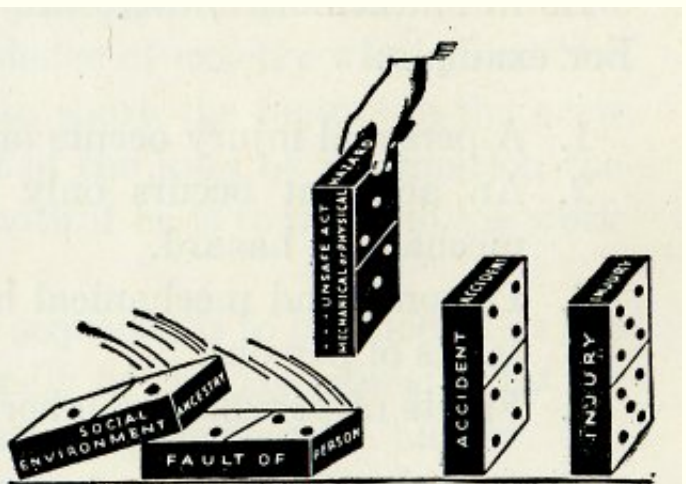


FIG. 5. The removal of the central factor makes the action of preceding factors ineffective.

Fig. 4. The unsafe act and mechanical hazard constitute the central factor in the accident sequence.

Fig. 5. The removal of the central factor makes the action of preceding factors ineffective.

Definition of Accident. At this point it is advisable to consider what is meant by the term "accident." Students of safety and many persons actively engaged in supervising safety activities often misunderstand the relation between the accident itself and the other factors in the accident sequence. There are but a limited number of true accidents as these are defined in this text. "Struck by" is a typical event that meets the definition of accident given herein. Note that to describe an event as

"struck by," is of itself sufficient to indicate the kind of accident that occurred. It is informative to indicate who was struck, what the object was that struck the injured person, why the object fell or moved, why the injured person exposed himself to injury, the extent of the injury, and many other facts of interest; but the simple phrase "struck by" still remains fully descriptive of the accident itself. In successful safety work it is necessary to distinguish clearly between the several facts of accident occurrence and especially to segregate the accident per se from the other factors in the sequence of which it is a part.

An accident is an unplanned and uncontrolled event in which the action or reaction of an object, substance, person, or radiation results in personal injury.(2)

Science in Accident Prevention. Accident prevention can be portrayed as a science and as a work that deals with facts and natural phenomena. It is a problem that may be solved by the same kind of reasoning that is successfully applied to many other problems concerning which there seems to be a better general understanding.

As in mathematics, there are theorems in accident occurrence. For example:

1. A personal injury occurs only as the result of an accident.
2. An accident occurs only as the result of a personal or mechanical hazard.
3. Personal and mechanical hazards exist only because of the faults of persons.
4. Faults of persons are inherited or acquired by environment.

The accident-prevention engineer is interested in all the accident factors but is not directly concerned with all of them. His work relates primarily to the accident and its prevention. Consequently his activities should center upon the factors immediately preceding the accident itself; these being the unsafe act and/or the mechanical hazard, and the proximate reasons why these exist.

Happily, the first event or circumstance in the list of factors does not always result in establishing the series that produces an

2) The treatment of the subject in this text is confined to "personal-injury accidents," including occupational disease. It is of interest to note, however, that property damage, with or without personal injury, results from similar accident types and that prevention of property damage is attained by applying the methods herein specified for accident-injury prevention. Many things may occur to break the chain. A person having inherited or acquired faults may not act unsafely or may not permit a mechanical hazard to exist. If he does violate a safe-practice rule it is possible that an accident may not occur. Even when a person falls or is involved in some other kind of an accident, there may be no resulting injury. Most important, too, is the fact that supervision and management may control the actions of employed persons and prevent unsafe acts and may guard or remove mechanical hazards even though previous events and circumstances are unfavorable. However, when and if an injury does occur it is invariably the result of the preceding complete series of factors.

Practical Application of Factors in the Accident Sequence. Knowledge of the factors in the accident sequence guides and assists in selecting a point of attack in prevention work. It permits simplification without sacrifice of effectiveness. It also permits expansion of safety work into the underlying field of human behavior and affords opportunity for the application of general educational plans, with a more complete knowledge of exactly what should be done and why it should be done. In short, the factors in the accident sequence constitute an index of the kind of information the accident preventionist must

deal with if he is to perform his work efficiently.

If one single factor of the entire sequence is to be selected as the most important, it would undoubtedly be the one indicated by the unsafe act of the person or the existing mechanical hazard. No preventable accident has ever occurred or ever will occur without the existence of one or both of these circumstances. A great deal of effective safety work can be done, therefore, even if application of accident-prevention measures is restricted to these two points alone.

A typical accidental injury may serve as an illustration. Assume that an employee in a manufacturing plant sustains a fractured skull as the result of a fall from a ladder. Investigation discloses that he descended the ladder with his back to it in disregard of instructions, and caught his heel on one of the upper rungs. The effort to train and instruct him and to supervise his work was not effective enough to prevent this unsafe practice. Further inquiry also indicated that his social environment was conducive to the forming of unsafe habits and that his family record was such as to justify the belief that reckless tendencies had been inherited.

Here is a chain of circumstances and events that tie in with one another in unmistakable fashion. If ancestry and social environment had been free from criticism, it is probable that the injured person might have had a safer and better attitude and would have been more subject to control through supervision. If supervision had been more effective, the employee might not have committed the unsafe act even though he was inherently inclined to be reckless. If the unsafe act had not been committed, assuredly this particular accident would not have occurred, even if all the preceding factors had tended to promote it; and if the accident had not occurred there could have been no injury.

It is clear from this listing of factors that there is a central point of attack in practical accident-prevention work. When an injury has occurred it becomes a matter of history, and so, too, does the accident. Prevention must deal with the immediate conditions and circumstances out of which other similar accidents may be created.

Common sense dictates that preventive effort be directed first toward the thing most easily and quickly corrected. Referring to the analogy between the list of accident factors and the row of dominoes shown in Fig. 5, it is clear that in the case of an accident and injury resulting from an unsafe act, the unsafe act immediately precedes the accident; and, if it is removed from the line, the action of any one or all of the factors that precede the accident will be ineffective. Therefore, the first logical direction of safety work should be toward the elimination of similar unsafe acts. It is reasonable, furthermore, to proceed toward the correction of the unsafe act by directing attention to the factor immediately preceding it; that is, the reason for its commission, and from then on to dig into the background of the accident as far as may be necessary to accomplish results. Similar action is indicated for the prevention of accidents that are caused primarily by unguarded machines or other mechanical or physical hazards.

Page 16 to 19:

SECTION 3. MAN VS. MACHINE

The most ardent supporters of the belief that man-failure accident causes are predominant are, nevertheless, firmly convinced that mechanical guarding and correction of mechanical and physical hazards is a fundamental and a first requirement of a complete safety program. They believe, and act on the belief, that safety begins with safe tools, safe machines, safe processes, and safe environment. This attitude is not at all inconsistent with the emphasis placed herein on the importance of man failure as a causative factor, and is more readily visualized when one considers "corrective action." In the same breath it can be truthfully said that although man failure causes the most accidents, mechanical

guarding and engineering revision are nevertheless important factors in preventing the most accidents.

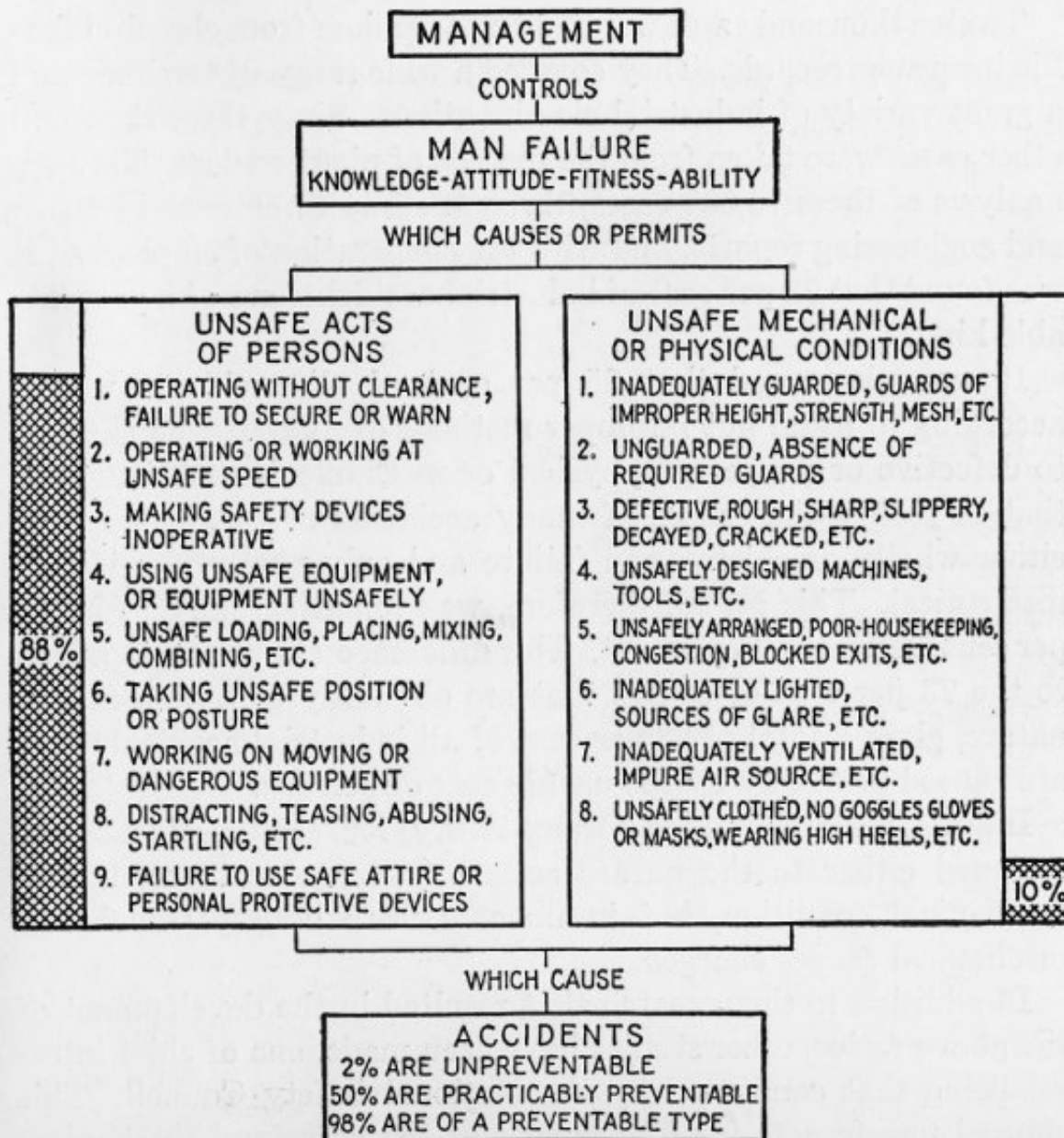


FIG. 6. Chart of direct and proximate accident causes.

Fig 6: Chart of direct and proximate accident causes

It has been known in a general way, for a number of years, that physical hazards were becoming less important as a factor in accident causation, but there is no evidence that the extent of this diminution has been measured by authoritative research. The causes and cures of the majority of industrial accidents have not been clearly and definitely fixed, nor has the extent of preventability been determined.

This criticism would be nonconstructive if nothing more helpful could be added to it. Progress has been made, however. The origin of industrial accidents has been successfully traced within practical limits, with the result that much has been proved that heretofore has only been suspected. In addition, the discovery has been made that the actual facts exceed expectations. Figure 6 shows graphically the results of research into the causes of accidents. It is amplified and explained in the following paragraphs.

Twelve thousand cases were taken at random from closed-claim-file insurance records. They covered a wide range of territory and a great variety of industrial classifications. Sixty-three thousand other cases were taken from the records of plant owners. Through analysis of these 75,000 cases, through study of actuarial records and engineering reports, and with the cooperation of employers, it was found that 98 per cent of industrial accidents are of a preventable kind.

It was discovered that 25 per cent of all accidents would, according to usual but improper methods of analysis, be charged to defective or dangerous physical or mechanical conditions, but that in reality the causes of many accidents of this group were either wholly or chiefly man failure and only partly physical or mechanical. This group, therefore, was found actually to be 10 per cent instead of 25 per cent. This difference (15 per cent) added to the 73 per cent of causes that are obviously of a man-failure nature, gives a total of 88 per cent of all industrial accidents that are caused primarily by the unsafe acts of persons.

In this research major responsibility for each accident was assigned either to the unsafe act of a person or to an unsafe mechanical condition, but in no case were both personal and mechanical causes charged.

In addition to the research that resulted in the development of the above ratios, other studies have been made, one of chief interest being that conducted by the National Safety Council. This showed unsafe acts for 87 per cent of the cases and mechanical causes for 78 per cent. An analysis made in 1940 of cases reported by the state of Pennsylvania * showed an unsafe act and a mechanical cause for an equal number of accidents. One reason for the difference in the number of accidents charged to personal or mechanical causes in the three studies described above is that in the last two the method permitted both kinds of causes to be assigned for the same accident, whereas in the study first mentioned only the cause of major importance was assigned. Admittedly, judgment must be used in selecting the major cause when a mechanical hazard and an unsafe act both contribute to accident occurrence. Personal judgment may lead to error, but it is defensible and necessary and in the majority of cases results in fair conclusions.

For example, an employee may be injured by the flying fragment of a burst grinding wheel that was but partly enclosed, because in complete disregard of instructions he attempted to snag a heavy casting on a wheel that was designed for light tool work only.

The grinding wheel could have been more fully guarded, yet it will be agreed generally that the unsafe practice was primarily at fault.

In another case a worker who has been instructed to turn in worn and unsafe tools and under no circumstances to use unsafe tools, nevertheless retains in his possession a badly mushroomed chisel. He uses it and a piece of the burred head flies off, strikes and injures his cheek. To be sure, a mechanical hazard is a cause of the accident and should be eliminated. More important, however, from the viewpoint of practical safety in this instance is the personal cause-using unsafe tools-and also the personal subcause-misunderstanding of instruction. It is by means of such reasoning that the majority of industrial accidents are charged to man failure rather than to mechanical fault.

From still other studies varying results have been secured, but all agree in general that man failure is predominantly the outstanding proximate and direct cause of industrial accidents.

age or as the beginning of the phase of its newer and stronger development. Whatever the future may hold, we of today live, work, play, and die in a machine are the playthings, the tools, the apparent necessities, and the conveniences of today. Yet the machine is less harmful than the actions of man.

In 1948, 32,000 men, women, and children were killed in motor-vehicle accidents, 16,500 in industry, and 35,000 in homes. Neither machines nor mechanical devices can be blamed for the great majority of these deaths.

The installed capacity of the electric utilities in the United States at the end of 1948 was 55,000,000 kw. It is estimated that this capacity will be doubled by 1958.

Late in 1948, by means of a system known as "Ultrafax," which combines television and photography, the whole of the 1037-page novel "Gone with the Wind" was transmitted word for word, from the Wardman Park Hotel in Washington, D.C., to the Library of Congress in 90 seconds flat. Transmission was at the rate of a million words a minute.

In a single machine, logs may be converted to matches or tooth-picks and be packaged and labeled ready for the consumer. Another machine draws plain paper, from an immense roll and in two seconds produces a printed newspaper, with its pages cut and folded to proper size and arranged in numerical order, ready for the public with news of births and deaths, gangster warfare, conventions, society, sports, and politics. Man is surrounded by this maze of power and machinery, and the consequent toll of death is appalling-yet the machine itself cannot be held at fault.

A costly high-powered automobile carrying six persons crashed into the rear end of a heavily loaded truck. Two persons were killed and four others were seriously injured. The driver of the automobile was a scatterbrained youth seventeen years of age. He and his companions had been drinking. The car was speeding at more than 60 miles an hour, at night and with lights dimmed. The boy had passed such rudimentary examination for a driver's license as the state laws required, just three days before the accident. The taillight of the truck was obscured by dirt. Was machinery at fault?

An explosion killed three men at work in a quarry. The operations were highly mechanized. Compressed-air rock drills, gasoline-powered shovels, blasting machines, and high explosives were used. Four of five charges had exploded. The fifth had failed to go off. Everyone on the job, from the foreman to the helpers, knew the dangers of the situation. They knew that a suitable time interval should be allowed to elapse before approaching the unexploded charge and that other precautions should be taken. Despite this common knowledge, two of the men proceeded immediately to examine the wiring. No one thought to call them back. There was no necessity for haste. The men had everything to lose by it and nothing to gain. The delayed shot went off when they had barely started their inspection. They and another workman lost their lives. Can this justly be blamed on mechanization of industry?

In a period of six months, two little girls lost their lives under identical conditions, in a garage equipped with heavy-duty elevators. The elevators were used to hoist automobiles from the street level to an upper storage space. The public was forbidden to ride. In each case the owner of the car and his little girl disobeyed the rules. In each case the child was allowed to play around the elevator while the parent attended to the storage of the auto-mobile. The elevator-shaftway walls were constructed with "set-backs" so that recesses or openings were formed between the car platform and the walls. Both children fell through these openings. Local building laws prohibited such construction. Inspectors had strongly urged protection, but their recommendations had been disregarded. Shall we rest content with charging the fault to the machine age?

A huge steel-framed building was being erected. The usual evidences of mechanization existed in the form of trucks carrying steel beams and stone, and of derricks, hoists, riveting hammers, and suspended working platforms. A nearsighted laborer wheeled a barrow overloaded with brick along a platform high in the air. No screen was provided to catch falling objects. The platform had no toeboard at its outer edge to keep unsecured material from falling off. Someone had left loose pipe lying on the platform.

The planks of the platform were uneven and were not fastened in place. The laborer, in trying to push the wheel of the barrow over the end of a plank, stepped on the loose pipe, slipped, and over-turned the entire load of brick into the street below. A woman was struck by one of the falling bricks, and her skull was fractured. Two other persons were painfully injured by the falling bricks. Is it fair to say that machinery or mechanization was at fault?

A workman lost his life in a steel rolling mill. He was engaged in oiling the bearings of a mill capable of producing 5,000 tons of steel rails a day. Not understanding the value of protective devices, he removed a portion of one of the gear guards, reached in, and was caught and killed. Four other workers and a foreman stood close by. Were industry and the machine responsible?

Instances such as these are not rare. Rather, they typify accident occurrence. Differing only in the nature of the work performed, the machinery involved, the extent and severity of injury, and the specific kind of unsafe act or circumstance, hundreds of thousands of fatal and nonfatal but serious injuries occur in this country annually. Man-not machine-is at fault.

To be sure, extraordinary hazards exist chiefly because of the introduction of machines. And it is true, further, that many serious and perplexing problems, social and economic, arise because of mechanization. These problems necessitate adjustments that are often costly. In the final analysis, however, it must be admitted that man invented the machine, built it, and put it to work. He alone gave it life and motion. It moves when and where he directs, at the speed he desires, and stops when he stops it or when the energy he gave it expires.

The high-powered automobile in which the two young persons were killed, as described in the first example, was but a beautifully finished and inoffensive ornament as long as it stood in the garage. Man turned on the ignition. Man forced down the accelerator. Man drove it recklessly until it crashed into another vehicle.

The machine is dangerous as man makes it so. It is the use of the machine-more correctly, the abuse of it--that creates danger.

Nor is the appalling degree of man failure fully portrayed by its direct results in loss of life, limb, and dollars. Misunderstanding of instructions, recklessness, violent temper, and lack of knowledge or training result in unsafe acts for many of which no penalties whatever are exacted in the form of personal injuries or property damage. For example, automobiles left unsafely parked on grades run wild through busy streets and crash into buildings, and no one is hurt. Steelworkers "ride the ball" and are hoisted hundreds of feet into the air in the erection of skyscrapers, yet they do not always fall. Guards on heavy machines are removed, men stand under suspended loads, get on and off moving vehicles, leave obstructions in walkway areas, pile material insecurely, refuse to wear goggles, gloves, masks, and other protective equipment, and yet injuries are relatively frequent.

The situation reminds one of an honestly conducted lottery where most of the tickets fail to draw anything, whereas a certain fraction of them draws small prizes, and a still smaller fraction draws big ones. In the case of the lottery, however, the prizes are hoped for and desired, whereas in the accident

situation the case is the reverse. It is hard to understand why those who have been in the habit of playing lotteries are so confident that the occasional event certainly will come to pass once in so often, whereas in the accident field, where the mathematical principles involved are so closely similar, men seem to feel an equal degree of confidence that the occasional event never will come to pass.

It would appear that the laws of chance provide a substantial safeguard. No one individual, however, knows whether he will pay the penalty for the first or the last or some intermediate unsafe act. The moral is to profit by the opportunity to learn, to realize that repeated violations of common-sense safe practice eventually and invariably lead to injury, and to avoid or prevent repetition of them.

With regard to the accidents that occur from automobiles on the streets and highways, the remedy is one of engineering, education, and enforcement, with emphasis on education. With regard to industrial accidents, the remedy is also one of engineering, education, and supervision, but with profitable emphasis on supervision, because the employer-employee relationship makes possible supervisory control of employee selection, instruction, and performance.

If knowledge is power and if accidents arise primarily out of the unsafe acts of men, then power in the conservation of life against the ravages of accidents must come first from adequately aroused interest and then from knowledge of specific unsafe acts of persons and the reasons why those acts are committed.

Page 24 to 36

SECTION 4. FOUNDATION OF A MAJOR INJURY

Accidents-Not Injuries-the Point of Attack. Analysis proves that for every mishap resulting in an injury there are many other similar accidents that cause no injuries whatever. From data now available concerning the frequency of potential-injury accidents, it is estimated that in a unit group of 330 accidents of the same kind and involving the same person, 300 result in no injuries, 29 in minor injuries, and 1 in major or lost-time injury. The accompanying diagram graphically portrays the net result of this research.

Accident prevention has been, and is to an extent even now, based largely upon an analysis of the causes leading to a major accident. This situation exists, for the most part, because of a misunderstanding of what an accident really is. As a rule, precise terminology is of relatively small importance, except when it is found that it indicates misdirection in both thought and action.

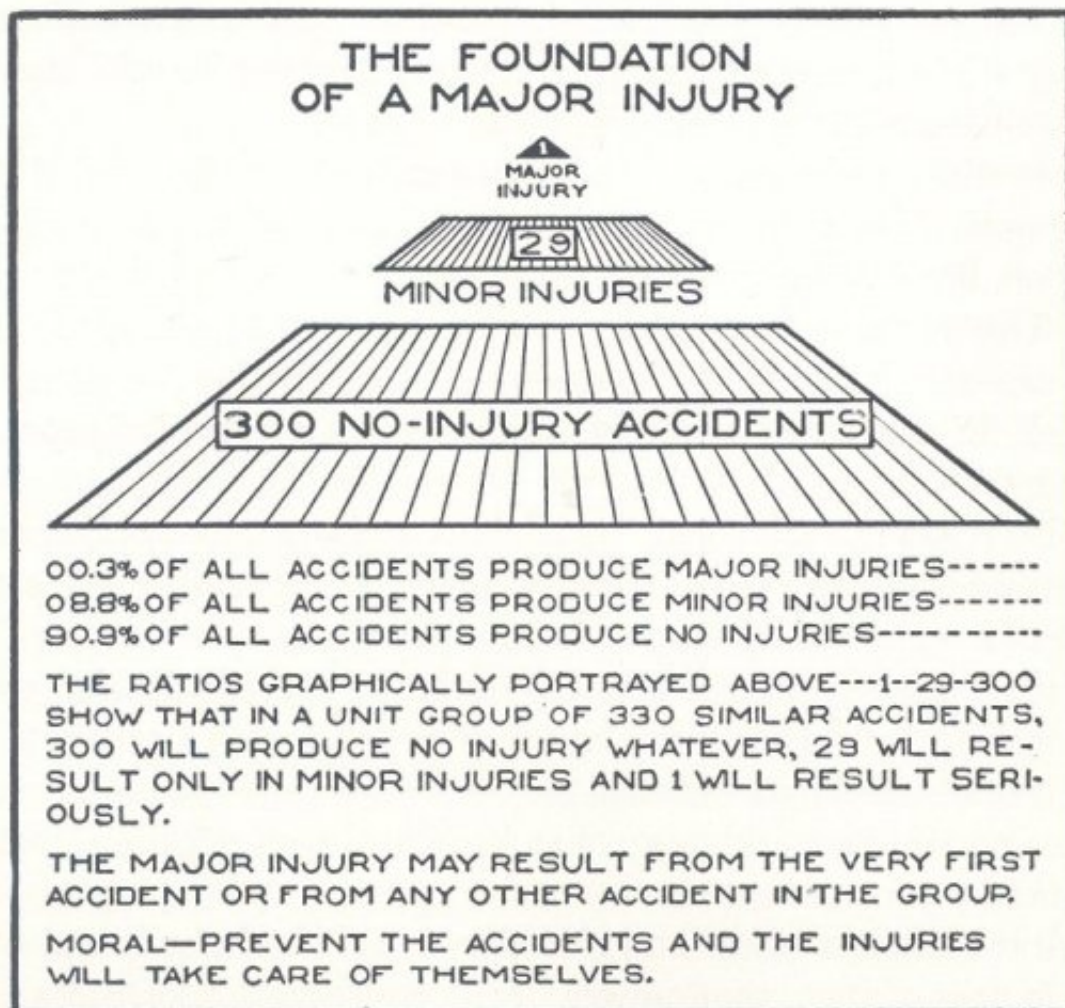


FIG. 7. The foundation of a major injury. The 300 accidents shown in the lower block are not merely unsafe practices. They all are falls or other accidents which resulted in narrow escapes from injury.

Fig. 7. The foundation of a major injury. The 300 accidents shown in the lower block are not merely unsafe practices. They all are falls or other accidents which resulted in narrow escapes from injury.

Then, the matter of words or phrases becomes decidedly important. Throughout industry, reference is made to major and minor accidents. The two are definitely segregated. No-accident contests and campaigns are usually based upon lost-time or major-accident frequency. Tables and statistics feature lost-time accidents (or others in the so-called "major group") that involve fatalities, fractures, dismemberments, and other serious injuries; and, in general, attention is centered upon these more spectacular occurrences to the exclusion, in part at least, of adequate consideration of minor accidents. Not only is this true with regard to cause-and-type analysis and tabulation, but subsequent action in prevention work follows along the same line.

The expression "major or minor accidents" is misleading. In one sense of the word there is no such thing as a major accident. There are major and minor injuries, of course, and it may be said that a major accident is one that produces a major injury. The accident and the injury are, however, distinct occurrences; one is the result of the other, and in the continued use of the expression "major accident," and in the acceptance of its definition as one that results seriously, there is a decided handicap to effective work. In reality, when the terms "accident" and "injury" are so merged, it is assumed that no accident is of serious importance unless it produces a serious injury. Yet thousands of accidents having

the potentiality of producing serious injuries do not so result. There are certain types of accident, of course, where the probability of serious injury may vary in accordance with circumstances. For example, a type of accident such as a fall, if occurring on a level field of soft earth or on a rug-covered floor in the home, may not be potentially so serious as the fall of a steel erector on the top of a skyscraper. Yet, the former may, and often does, result in a severe injury.

In any case, in prevention work, the importance of any individual accident lies in its potentiality of creating injury and not in the fact that it actually does, or does not, so result. When lost-time or so-called "major" accidents only are selected for study, as a basis for records and for guidance in prevention work, efforts are often misdirected, valuable data are ignored, and statistical exposure is unnecessarily limited.

An injury is merely the result of an accident. The accident itself is controllable. The severity or cost of an injury that results when an accident occurs is difficult to control. It depends upon many uncertain and largely unregulated factors-such as the physical or mental condition of the injured person, the weight, size, shape, or material of the object causing the injury, the portion of the body injured, etc. Therefore, attention should be directed to accidents rather than to the injuries that they cause.

Further, in the length of time over which experience is analyzed (usually from one month to one year), the average plant, or department of a plant, does not develop sufficient exposure to justify the use of the comparatively small number of serious injuries, either as an indication of progress in accident-prevention work or as a safe guide to the real causes of the predominating types of accident.

In basing accident-prevention work upon the cause analysis of major injuries alone, therefore, not only is the importance of the accidents that produced them overestimated, and the field of research thus limited, but the resulting data also are seriously misleading when used to determine the proper corrective action to be taken. These facts become readily apparent when it is recognized that the major injury does not always result from the first accident in the series of which it is a part. It may occur as a result of the last accident or at any intermediate point, or it may be the result of an exceptional isolated accident type that might never occur again. Basic truths determined by averaging a sufficient spread of data are always of greater value than assumptions having a basis in isolated cases selected chiefly because they are spectacular.

Some years ago, in a certain community close to the water front, more than one thousand persons became ill within a period of a week, and one person died. An autopsy held over the deceased indicated uremia, probably aggravated by impure food, and the circumstances pointed to shellfish as a cause of the trouble. The authorities acted promptly, but not until several other persons had become seriously ill was it discovered that the first fatality was not indicative of the real cause of the epidemic: As a matter of fact, the town water was polluted.

This incident illustrates two points:

1. The real source of the majority of ills is a better guide to action in case of an epidemic than is the source of an isolated case that may be selected chiefly because it is spectacular, or because it results seriously.
2. An ailment of any kind, whether it is of major or minor gravity, may be potentially serious; and the indications of the greater volume of minor cases are vitally significant in the treatment of plagues and epidemics and as a guide to the safeguarding not only of the individual but of the community as well.

The existing situation in the work of preventing accidents is similar. The occurrence of accidents is frequent enough to warrant comparison with plagues or epidemics. When fatalities or serious injuries

occur in industry courts of inquiry are held, state authorities require reports of compensable cases, and, in general, attention is concentrated upon these serious injuries, while the vastly greater volume of minor cases, - whose significance as a whole is more pointed, is practically ignored.

Much has been said of near accidents-meaning actual accidents that produce no injury whatever, although having the potentiality of doing so. These improper occurrences-these slips and fumbles; these near injury events - because of their proportionately greater volume, present to the capable person who is intelligent enough to take advantage of it, a splendid opportunity to anticipate and prevent actual injuries.

The number of such no-injury or potential-injury accidents in comparison to actual accident injuries has always been a nebulous quantity, and it probably will never be known exactly. Nevertheless, a minimum has been established which in itself is so high that it proves conclusively the necessity for supervisory control enforced through adequate executive action. It substantiates the belief that the foreman is the key man in industrial accident- prevention work. It ties in even more closely and forcibly the relation of profitable production and accident prevention, since the real causes of accidents are likewise the real causes of decreases in efficiency, production, and profits and denote conditions that are morally and economically improper.

In view of these facts, it should be obvious that accident-pre-vention work is misdirected when it is based wholly upon the analysis of major injuries.

The 300-29-1 Ratio. In the unit accident group (330 cases) shown on the chart, under the caption "Foundation of a Major Injury," a major accident is any case that is reported to insurance carriers or to the state compensation commissioner. The great majority of these reported or major accidents are not fatalities or fractures or dismemberments; they do not all involve lost time, nor are they all lost-time accidents on account of which compensation is paid. Considering all these facts, it may readily be deduced that an analysis as to cause and remedial action, based upon one accident resulting in a fatal or lost-time or permanent injury (or so-called "major-accident case") out of a total of 330 or more similar accidents all of which are capable of causing injuries, is limited and misleading.

The determination of this no-injury accident frequency followed a most interesting and absorbing study. The difficulties can readily be imagined. There were few existing data on minor injuries-to say nothing of no-injury accidents. Case after case was discarded because of lack of information. Many others were included at a 1-to-1 ratio (first accident produced an injury), although in all probability there had been dozens, or perhaps hundreds, of previous no-injury accidents. Nevertheless, each injury case was included, where there was any substantial indication of the existence or lack of prior accidents.

It was also necessary to place a practical limitation upon the data. For example, an injury resulted from a mechanical defect. This defect had existed throughout the life of the machine. Over a period of several years, each revolution of the machine had exposed the operator to an injury. Finally, the exact balance of variable circumstances occurred, and an injury resulted. This did not fall within practical limitations and was rejected. In other rejected cases employees were assigned to work for which, by temperament and ability, they were unsuited and were ultimately injured as a direct result. Here, again, are potential injuries, but they are not true accidents and are too intangible to record. Practically all accidents caused by machines were excluded, even though the latter would have raised the no-injury frequency materially.

It needs but little thought for the average person to conclude that the no-injury accident ratio herein expressed is not exaggerated. How many drivers of automobiles would care to assert that they had

never had narrow escapes from injury when driving across railroad grade crossings without being absolutely sure that no train was coming, when cutting in and out of traffic, when attempting to beat the traffic lights, when passing cars on grades and hills or when, because of momentary inattentiveness, they were surprised by the sudden appearance of a pedestrian or another car directly ahead and dangerously close? And when accidents and injuries do so occur, what would probably be the ratio of accidents or narrow escapes from injury to actual injuries? When an employee in a plant stumbles, falls, and sustains an injury, is it reasonable to say that he never stumbled or fell before?

No intelligent employee who is jealous of his physical well-being will deliberately expose himself unnecessarily to danger. On the other hand, employers will scarcely admit the propriety of countenancing practices that so clearly decrease both economy and safety. If, therefore, because of errors of judgment, faulty instruction, and poor discipline, slips and falls and other accidents occur that result in injuries, it may reasonably be concluded that there should be a firm determination to proceed with a worth-while work on a newer and more effective basis. By concentrating upon the prevention of accidents rather than injuries and by recognizing the fact that no accident, whether or not it results in an injury, is too insignificant to receive consideration, a successful attack may be launched against one of the most serious problems confronting the executives of industry.

Illustrations. Here are a few of the specific cases from which the ratios previously mentioned were determined:

CASE 1

An employee, in going to and from work, took a short cut that obliged him to climb a fence and cross a railroad siding that was a part of the plant premises. Cars spotted at this point frequently prevented a clear vision of the tracks, and the noise of the plant machinery (24-hour operation) made it difficult to hear warning whistles and bells. One day, at noon, this man stepped from behind a freight car directly into the path of an oncoming engine, was struck and badly injured. Crossing the tracks at this point was forbidden, and notices to that effect were posted. A fence was provided. Trainmen used whistles and bells. In short, the situation was normal, except for nonenforcement of instructions. The employee admitted that he had crossed the tracks four times a day for two and one-half years-or approximately three thousand times prior to his injury-and that in many of these instances he had stumbled, fallen, and had narrowly escaped injury.

CASE 2

An employee slipped and fell on a wet floor and fractured his kneecap. For more than six years it had been the practice to wet down too great an area of floor space at one time and to delay unnecessarily the process of wiping up. Slipping on the part of one or more employees was a daily occurrence. The ratio of no-injury slips to the injury was 1,800 to 1.

CASE 3

In splitting a board, a circular-saw operator suffered the loss of his thumb when, in violation of instructions, he pushed the board past the saw with his fingers, instead of using the push stick that had been provided for the purpose. He stated that he had always done such work in this manner and had never before been hurt. He had performed similar operations on an average of twenty times a day for three months and had therefore exposed his hand in this way over one thousand five hundred times. During this period he had sustained several minor cuts and hundreds of "close shaves."

CASE 4

A millwright attempted to put a 5-inch belt on a revolving pulley 24 inches in diameter. Tight and loose pulleys were not provided, no belt pole was used, the employee wore a loose jumper with long sleeves and stood on a shaky stepladder while slipping on the belt from the under side. He was caught and killed. Investigation indicated that this method of slipping on the belt had been employed daily for several years. The ratio here is 600 to 1.

CASE 5

Potential-injury accidents not only endanger an individual but also frequently lead to disasters that take the lives of many persons at once. This is illustrated by the following:

Seventeen passengers in a motorbus were killed or seriously injured when a fire occurred while the bus was being fueled. The gasoline-station attendant was an inveterate cigar smoker and invariably failed to remove the cigar from his mouth when filling gasoline tanks. The ratio in this case was several thousand to one. Other recorded instances show that the repetition of no-injury accidents eventually leads to explosions, fires, and resultant panics, wrecks, and other catastrophes that cause tremendous loss of life.

The foregoing statements and figures furnish convincing proof of the unsoundness of the theory that serious injuries, or major accidents as industry erroneously terms them, invariably should be made the basis of accident-prevention work; on the other hand, they also show that, on the average, accidents of various kinds are of equal weight. The natural conclusion follows, moreover, that in the largest injury group-the minor injuries-lie the most valuable clues to accident causes. Equally evident is the conclusion that the unsafe practices and conditions which result in neither major nor minor injuries should be corrected before injuries result.

In making a survey of 100 typical manufacturing plants, it was found that, in the majority of them, the causes of the serious injury accidents, over a given period, did not fairly picture the unsafe practices and conditions needing first attention. Accident-prevention work in these plants was misdirected, since it was based largely upon the investigation of major injuries, and many other serious injuries of a slightly different nature later occurred.

It would be unfair to many progressive and clear-thinking plant executives to infer that this condition is universally found. As a matter of fact, it has been partly through the cooperation of certain employers who are now concentrating on minor injuries 4 ft 18 perhaps unnecessary to say that there are instances in which an injury occurs the very first time an error is made and that the examples selected for illustration, although of frequent occurrence, are probably also unusual. The ratio of 10 accidents to 1 injury, however, which actually results from research, is ultraconservative.

Inasmuch as potential-injury accidents are all occurrences that may readily be observed, it is apparent that an alert supervisor-one who has the interests of both employee and employer at heart-has a splendid opportunity to check accident-producing conditions long before an injury actually occurs.

and through a study of the data furnished by them that much of the theory that forms the basis of this text has been substantiated. Undoubtedly a healthy condition exists when attention is concentrated upon the prevention of fatalities and serious injuries. This work should not be neglected, but the general problem will be more speedily solved if the causes of the accidents that produce all injuries, regardless of severity, are first selected as a basis for work. In the average case it is not necessary that a permanent system be established for a complete cause analysis of first-aid accidents. However, it is extremely valuable to do a thorough job at periodical intervals or where there are indications that changes have occurred.

SECTION 5. REASONS (PERSONAL SUBCAUSES) FOR UNSAFE HABITS

If one were obliged to choose between "safe, capable, and experienced men who work under unsafe conditions" and "unsafe, incapable, and inexperienced men who work under safe conditions," he would probably choose the safe-man combination as the one most likely to produce a clear accident record. Nevertheless the guarding of machines and -mechanical hazards has been and always will be a fundamental of a complete safety program. Incidentally, guarding and other action of an "engineering-revision" nature often provide a remedy even for accidents caused chiefly by man failure. From every point of view it is unwise to depend automatically and invariably on any arbitrarily selected method when the accident problem centers about unsafe personal practice. Especially is it indefensible to continue such remedial action when it has been unsuccessful.

By far the most sensible thing to do is to find the reasons why unsafe acts are committed and then to select a practical remedy from the list of those available.

To a certain extent, of course, consideration has always been given to the need for finding why persons do unsafe things. But such consideration too often has been intermittent and casual - seldom has it been conscious and continuous. This line of investigation has not been planned and carried on as a separate step - rather, when done at all, it has been instinctive and incidental, although actually it is a most important single factor in accident analysis and in the selection and application of helpful remedies.

There have been cases where his football career has interfered with an architect's education. The architect then made a mistake, the engineer failed to check, the structure was faulty, a slight overload resulted in collapse, and a poorly supervised workman exposed himself unnecessarily and was killed. These circumstances are all related and are part of the cause-and-effect chain, like the story of "The House That Jack Built."

The reader is asked at this point, however, to keep in mind that this discussion is concerned primarily with the "first, direct, and proximate reasons why persons commit unsafe acts" and does not refer to the gamut of so-called "basic" causes of accidents.

A few illustrations may serve to prove that there is a need for finding the reasons for unsafe acts and that when these are discovered they lead to the proper selection and application of effective measures in accident prevention.

Example 1. An accurate and thorough analysis had been made of public and property damage accidents in which a commercial fleet of automotive vehicles had been involved over a period of years. Mechanical equipment was found to be safe. The drivers were at fault. Specifically, they followed too closely for the speed at which they were driving. Question-what was the remedy?

Previously, in this case, remedial action, which had been selected at random, consisted merely in issuing instructions (and attempting to enforce them) to the drivers to follow cars at a safe distance. This had not served to reduce the accident frequency, however. There were several groups of drivers and several departments of work. Finally, the decision was reached to find out the "why" or the reason for the violations, preparatory to planning a better remedy. The results were startling.

In one group of drivers it was found that the few who were responsible for the poor record were inherently reckless. The remedy became a simple matter of managerial personnel procedure.

The drivers in group two were not reckless at all, but they were wholly unconvinced that it was unsafe to follow closely. The remedy, obviously, was a special form of education. In a third group there were

many drivers with defective' eyesight who were unable to judge distances accurately. The remedy was found to lie in ocular examination and the provision of glasses with prescription lenses.

Group-four drivers found it impossible to follow at a safe distance because of time-schedule requirements. In heavy city traffic the creation of a gap of much more than a car length or two provided a temptation for another driver to pass and pull in ahead. This necessitated dropping back again, thus creating another gap. In short, any attempt to live up to the rule for following safely destroyed all chance of meeting the time schedule. The remedy lay in rerouting and in revision of schedules. The remedial actions indicated by the reasons enumerated in this example were made effective, and, as may readily be anticipated, the accident frequency dropped immediately and substantially.

It is of interest to note that although four distinctly different methods of correction were used, they were applied effectively to exactly the same unsafe practice.

Example 1 was taken from the automotive work of an industrial concern, but this discussion relates to all -industrial activities. An example that applies to the chemical industry follows.

Example 2. In this case employees violated the company safe-practice rule relating to washing before eating luncheon. All efforts in the way of instruction, supervision, and education had failed to produce results. The reason for the unsafe act was finally found, and it developed that the washrooms were uncomfortably drafty and that the water was cold and hard. In short, the unsafe act was committed largely because it was inconvenient and uncomfortable to follow safe practice. When ventilation was improved, more suitable free-lathering soap provided, and warm water made available, the men readily made proper use of wash-room facilities. This is one of the many instances where engineering revision is found to be an answer to man-failure accident-and-health problems. The moral, moreover, is that success came about only when cause analysis was carried to the point where the reason for the unsafe act was ascertained.

Example 3. In this instance, extreme difficulty was encountered in getting shipping-department employees to stop the practice of jumping off loading platforms. Here it was found that the men were by no means convinced that jumping approximately three feet was at all unsafe. They were not reckless, it was quite convenient to use the stairs at either end of the platform, and no other probable reason, except the one selected, was applicable. A table in Chap. 6 shows that education is the remedy when men act unsafely because they are not convinced that their actions are unsafe.

The safety engineer, being now adequately informed, proceeded to develop an effective educational campaign designed to remove all possible doubt as to the hazards of jumping. He obtained the services of a surgeon-physician who gave talks illustrated by charts. The charts showed the bone and muscular structure of man as compared to that of four-footed jumping animals such as the dog and the antelope. It was conclusively demonstrated that man is poorly equipped, indeed, when it comes to jumping, by comparison with such animals. A dog lands on well-padded toes, and the shock is absorbed by several more joints and by less rigid anatomical structure than is the case with a man. It was pointed out, further, that the abdominal support of man was designed for horizontal (four-footed) carriage, and that in walking erect the original support was necessarily ineffective and was replaced by a thin membrane. The very first lecture was so impressive that an employee who was the chief offender was observed to tighten his belt as he left the room and to "hold himself in" as he stepped carefully over the threshold of the doorway, saying at the same time, "I'm sold."

Suffering heavily by contrast with these examples is the slip-shod, hit-or-miss guesswork which presupposes that a single form of prevention work-education or guarding, for example-will suit any

and all occasions.

Surely, it would be a waste of time to preach the doctrine of safety to a group of drivers who already believed in it and who drove unsafely only because they could not see well enough to judge distance properly. Especially would it be wasteful if the defects in vision were not known and consequently if nothing were done about it. How much simpler and more direct and effective is the procedure finally adopted in Example 1, namely, finding the reason for the unsafe act and basing the remedy on that reason. Surely, too, it would be useless to fit glasses to drivers, such as those in group four of Example 1, or to educate or discipline them. Those drivers were physically sound, they were fully aware of the danger in following the car ahead too closely, and they were not at all reckless—they were forced to drive unsafely by improper routing and timing.

The method whereby unsafe acts are to be corrected must suit the reasons for the occurrence of the unsafe acts.

How many kinds of these reasons and remedies are there? Is the question involved and complicated? Does it enter the field of psychology or psychiatry? Is it one that the average safety engineer can solve? Fortunately, from the viewpoint of progress, the answers to these questions are all cheerfully simple and encouraging. Indeed, psychology of a sort is involved, but at the supervisory level it need only be of an elemental and understandable nature which the average safety engineer or industrial supervisor can readily apply. The matter therefore is not impractical or too complicated. In fact the reasons for the commission of unsafe acts are so few that it has been found practicable to list them in Chap. 6.

Briefly these reasons or causes for the unsafe acts of persons may be placed under four general heads, namely:

1. Improper attitude.
2. Lack of knowledge or skill.
3. Physical unsuitability.
4. Improper mechanical or physical environment.

Note 1. These items apply primarily to the persons who commit the unsafe acts. They can be said to be the first, proximate, or direct reasons. Other reasons are underlying. For example, an employee who fails to wear goggles (the unsafe act) may not be convinced that such action is really unsafe (the proximate or direct reason for the unsafe act) because he was inadequately supervised (the underlying or subreason). It is axiomatic, however, that error is invited if we act on underlying data without first having determined and made use of the more direct facts. Note 2. From the foregoing it is clear that remedial action in accident prevention may be grouped roughly in four classifications:

1. Engineering revision. Guarding, redesign, relocation, etc.
2. Persuasion and appeal. Instruction and reinstruction in safe practices, providing proof and illustration, inspiring enthusiasm, persuading, convincing, and appealing to motivating characteristics. Application of psychology.
3. Personnel adjustment. Assignment of workers to relatively less hazardous work. Medical attention and psychology.

4. Discipline. Enforcement of rules, militaristic methods, penalties, etc. Applicable in rare cases and as a last resort only.

In the field of industrial accident prevention, as in other fields, there is progress and a constantly broadening vision. Out of the haze and ambiguity of past years, definite factors begin to take shape. It is now known that falls of persons and other types of accidents can occur only as the result of unsafe acts or because of mechanical or physical hazards. Little difficulty is experienced in correcting the mechanical hazards, but the correction of unsafe acts will remain troublesome unless there is a better understanding of the reasons or motives that permit these unsafe acts to occur. The purpose of this discussion is to point out that definite causative factors lie directly behind the occurrence of unsafe acts, that they are few in number, practicable of identification, and extremely valuable as direct clues to the selection of corrective action.

Page 273

Summary of Guarding Principles

.
. .
.

Nothingstanding the fact that man failure causes most industrial accidents, the unguarded machine is potentially dangerous and is far too important to neglect. Mechanical guarding is an accepted and approved practice. It is worth while. While in this field should be continued with perfection as the goal, meanwhile striving for greater success in the more profitable zone of attack upon accidents, which lies in the control of man failure.

[\[Back to Lachlan's Homepage\]](#) | [\[What's New\]](#) | [\[Industrial safety resources\]](#)

(This Webpage Page in No Frames Mode)

If you are feeling sociable, my new E-mail address is [\[address now invalid\]](#) (replace the *at* with an @) . Old E-mail addresses might be giving forwarding or reliability problems. Please use clear titles in any Email - otherwise messages might accidentally get put in the SPAM list due to large amount of junk Email being received. So, if you don't get an expected reply to any messages, please try again.
