Safety And The Unreasonably Dangerous Product

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Introduction

In the past few decades, the awareness and grateful acceptance of the benefits of industrial progress by the public has been tempered by increasing concern that we must be protected from injury by the products and by-products of technology. Today, from town meetings to the Congress, in our State and Federal courts, in virtually every available public forum, there is spirited and, sometimes, bitter debate concerning the safety of toys, nuclear power plants, drugs, sports equipment, vehicles of all sorts, and the machinery and equipment that we use in farming, construction and industrial plants. Willy nilly, engineers find themselves at the center of much of this controversy. They have designed and manufactured the products with which the public is concerned, the airplane that crashes because a part was not designed to fail-safe, the automobile that, under certain circumstances, may literally explode, the industrial machine that can maim due to the lack of proper safeguards. Engineers are the designers of industrial plants that produce noxious wastes and pollutants which can affect entire communities. None of this is stated to assign responsibility, or blame (if any exists), only to indicate that, today, engineers are involved with open-ended problems of design and manufacture where their technical skills alone are not enough. This leaves many engineers in the uncharted waters where law and technology meet, where the designers of products must learn the engineering significance of legal terms and how to translate this knowledge into designs that they believe are not “unreasonably dangerous”*.

*In the sense it is used here, “unreasonably dangerous” is not a lay term; it is a legal term. In general, in most courts, a product is unreasonably dangerous if it is more dangerous than the ordinary user with ordinary knowledge of the product would expect when he is using the product in a manner intended by the manufacturer. For a more detailed discussion of products liability law in the United States, the United Kingdom and Europe than can be given here, see References (1) and (2).

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Safety And The Concept Of Unreasonable Danger

In the United States and, perhaps, less often elsewhere, the ultimate decision as to whether a product or by-product is safe or, at least, not unreasonably dangerous is being made in the courts. Often this decision is being reached years and, perhaps, decades after the engineers involved made their initial determination of how the product should be designed, or manufactured. This long time between cause and effect has insulated most engineers from observing at first hand the result of their failure to take safety into account adequately. Further, there has been no coordinated, organized effort by engineers and engineering educators and the professional and technical societies that represent them to insure that safety is included as a prime consideration in the design curricula of U.S. engineering schools.

This apparent neglect of safety by designers and in the education of engineers is due, in part, to the definition of safety and to the way engineers have been taught to approach design problems. The usual definition of safety, the state of being free from risk or danger, presents designers with a dilemma. Simple logic tells us, it is not possible to design and make a product that it is truly "free from risk or danger." At the same time, experts and the courts have agreed that no product can be designed and made so as to be "foolproof" (which is defined as "involving no risk or harm, even when tampered with"). There is an apparent contradiction here. We are being asked to design and make products that are simultaneously safe but not foolproof. This leads us to the conclusion: there is no requirement in common sense or the law that products must be designed and made to be safe in the literal sense cited above. Further, we deduce that safety is a relative, not an absolute, condition and that the courts and engineering educators and designers need a new definition which they can all accept, one based in real-world pragmatism and logic.

In a literal sense, the absolute nature of the present definition of safety makes all industrial products unsafe. Without guidelines, it is difficult to translate the meaning of the definition into the kind of quantized criteria with which engineers normally work in design. Thus, in a practical sense, the definition is of little use when, first, engineering designers and, later, attorneys and judges are left to provide their own individual interpretations of its meaning.

The Industrial Age education and training most engineers have received has emphasized the use of analysis -- reductionism and mechanism -- to the
virtual exclusion of synthesis — holism. (3) On this basis, it should not be surprising that engineers today respond by displaying a preference for analytical methods that lend themselves easily to computation rather than insight and understanding which do not. Unless externally applied forces bring the safety of a product to their attention with a sense of immediacy, most product designers have other problems with which they are more concerned. As it is designed, will their product function properly? Is it efficient? Is it reliable? Does it meet the requirements of its market? Can it be manufactured at competitive cost? These questions must be answered before the product will be approved for manufacture. The answers can be found by simple extension of an engineer’s training in mathematics, mechanics, thermodynamics and the material sciences. Safety and the aesthetic characteristics of a product are qualities that cannot be analyzed in the same way. They may even interfere with a product’s ability to function, add to its cost, and make it difficult to manufacture. The conditioned response of engineers to that which cannot be quantified easily for analysis is to ignore it or, at least, to consider it of lesser importance than those considerations that lend themselves to being modelled and analyzed easily.

In (4), a useful analogy is made between health and medicine and safety and engineering. Like safety, health is a condition we define in the negative. Until recently, health was defined in medical dictionaries as simply the absence of disease. This definition, like that of safety cited earlier, is unambiguous but of little practical value to medical practitioners interested in developing a theory of health. The biology of disease abounds with theories that are the subject of continuous global discussion. Modern medical science astounds us daily with its achievements. In addition, the medical literature includes a large body of empirical knowledge about disease and how to minimize health problems. Thus, given the symptoms, a prognosis can be made that tells us what is wrong organically, what pathogens have caused the disease and the therapeutic measures that can be taken. Yet, with all their knowledge of disease no medical authority has come forward with an accepted theory of health. No one can prescribe the regimen of a person that will ensure his continued good health.

Engineers interested in safety are in much the same position as the medical practitioners interested in health. The engineering sciences are mature and support all manner of technological achievements. The engineering literature abounds with reports giving the details of accidents and other misadventures that involve the products of industry. In paraphrase of the statement in the preceding paragraph, forensic engineers can state, given the
physical facts and other evidence associated with an accident, a scenario can be developed that tells us the probable sequence of events immediately prior to the accident, what were the probable causes of the accident (including any defects in the product that contributed to or caused the accident and caused injuries to those involved) and the design and/or manufacturing changes which, if they had been done a priori, could have prevented this accident and, presumably, would prevent similar future accidents. Thus, like the forensic pathologists who can tell us at the distance of four thousand years the diseases that afflicted the pharaohs, forensic engineers can explain to us, after the fact, how an accident occurred, what went wrong and how it could have been prevented.

Like medical practitioners who seek to develop theories for the biology of disease, after an accident, forensic engineers promulgate theories to explain the unsafeness of the products involved. For all their finely honed skills in analysis and computation, engineers have been unable to relate safety and reliability, safety and stability, safety and strength, or safety and any engineering-related design factor that derives from the mechanical sciences. As yet, no engineer has developed an accepted theory of safety applicable to design. Perhaps, because no one can prescribe an approach to design that will ensure a product is truly "...free from risk or danger."

As is shown elsewhere (4), safety and design can be brought into harmony by defining safety anew in terms of qualities with real-world meaning. Using this new definition, designers can establish criteria and approaches that are capable of achievement and relate to the world as we find it (not as we would like it to be). To this end, let us define safety (in the context of product design) as the absence of unreasonable danger. The point is made in (4) and here that this definition, unlike the classic definition, permits designers and forensic engineers to develop compatible theories of safety.

Forensic engineers employed by parties to litigation as consultants and expert witnesses use the definition routinely in preparing positions for their clients. In contrast, most engineers in industry and engineering educators are unfamiliar with products liability law and the concept of an unreasonably dangerous product. They may be familiar with the general terms hazard, risk and danger, which are used widely in many fields, but they are unused to the terms that have special meanings in products liability law, such as defective condition and defective product, unreasonable danger, and state-of-the-art (in contrast to state-of-the-industry). They may
be able to infer the meaning of the term design defect or manufacturing defect, but not marketing defect.*

Engineers in industry who have this special knowledge have usually acquired it in court, after having been struck between the eyes with the shillelagh of litigation and their skills as designers and manufacturers have been judged deficient.

Most engineering educators have few opportunities to acquire first-hand experience with products that fail in a real-world sense of the word and to become familiar with the lexicon of products liability law in which special meanings are assigned to terms comprised of words used commonly in engineering for other purposes. When this is the case, they can discuss the traumatic results of such failures and the reasons for them only in an abstract sense. For example, in mechanical design classrooms, failure theories are discussed most often as a topic in mechanics of materials, a subject in mechanical engineering science, and seldom, if ever, as a subject in forensic engineering. Such theories of failure may have no relation to the real-world failure of a product or to the presence of an unreasonably dangerous condition in its design.

At times, engineering design students may be discouraged from discussing real-world failures by the authors of their textbooks. In at least one case, the authors of the required text for a design course have treated products liability litigation and the possible involvement of engineers as defenders of their design in the contentious milieu of a courtroom as an unsuitable subject for inclusion in their book. In their view, "A design book is not the place to dwell on this subject." (5) Thus, it should not be surprising that most engineering students are not aware of the importance of designing products that are safe in the sense that they are free of unreasonable danger. The subject of safety is discussed only rarely in their classrooms. They must wait until they have been graduated to acquire expertise in this facet of design and the acquisition process can be painful, indeed.

An Engineer's Lexicon Of Terms Used In Products Liability Law

Obviously, the usefulness of this new definition of safety to engineers interested in design is linked to the precise way in which the courts have

*A product may have a marketing defect, if the manufacturer has failed to give adequate warnings and instructions for its proper use.
defined such terms as a defective condition or product and unreasonable danger. A detailed discussion of the application of these terms to engineering is given in (1) and (2). Only a summary of their definitions is given here.

**Defective product.** From the viewpoint of manufacturers and engineers, perhaps the most important requirement in a product liability case based on strict liability*, surely the closest to home, is that the plaintiff must prove the existence of a defect in the product, “their” product in order to win. There is no universally accepted definition of a “defective product” and it is unlikely that such a definition could be developed. Instead, most courts recognize the need for flexibility in defining the term and have proceeded on a case-by-case basis. In a general sense, it is considered that the defect must render the product unreasonably dangerous to a lay consumer when it is being used as the manufacturer intended. There are three commonly accepted categories of defects, namely, design, manufacturing and marketing.

A design defect condemns all of the class of products made to the same design. The defect is inherent in the product’s engineering and specifications.

A manufacturing defect is usually the result of a singular act of commission or omission that occurred when the product was manufactured (for example, faulty workmanship or materials).

A marketing defect is synonymous with the failure of the manufacturer to give adequate warnings and instructions for the proper use of a product. There are three areas in which warnings and instructions can be necessary. Some products are unavoidably unsafe and are dangerous in ways that the ordinary user might not appreciate without being warned. Some dangers

*Under strict liability, the seller of a defective product is liable for all bodily injuries and property damages caused by the defective condition, even if he used all possible care, whenever:
(1) the defective condition is sufficiently hazardous to make the product unreasonably dangerous;
(2) the seller is in the business of selling this product;
(3) the defective condition existed when the product was sold;
(4) the product was used in an intended or foreseeable manner;
(5) the product was intended to reach and, in fact, did reach the user without substantial change.
can be avoided completely or their effects minimized. In such cases, the seller must tell the user how to do so. Finally, where the manufacturer can reasonably foresee that an ordinary user might be endangered unknowingly through the misuse of a product, the manufacturer must give adequate warnings and instructions that take this misuse into account.

Unreasonable danger. It is generally agreed that an unreasonably dangerous product is defined as one that is more dangerous than an ordinary user might reasonably expect when it is being used for its intended purpose and in a manner intended by the manufacturer. In part, the unreasonable danger of a product is coupled to a defective condition. Virtually always, alternative designs can be found; the design of any product is a matter of engineering judgment. As a result several tests are applied by the courts to establish whether a product was defective and, thus, unreasonably dangerous at the time it was sold. These include

1. state-of-the-art (not state-of-the-industry) at the time the product was designed and made;
2. unavoidably unsafe products;
3. misconduct by the user;
4. misuse.

Some Effects of Litigation On Design And The Design Process

In 1918, in MacPherson v. Buick Motor Company (6) the manufacturer's duty to exercise care and vigilance was extended beyond the immediate purchaser. In the next four decades, negligence, contract, and implied warranty law were deployed ever more cleverly by plaintiffs' attorneys; however, products liability cases pursued under an implied warranty theory introduced intractable conceptual problems. Tort and contract law were on a collision course until the Supreme Court of California declared, in 1962, that a manufacturer was strictly liable in tort for an injury caused by a defective product placed in the stream of commerce. (7)

In the years before strict liability was accepted in most jurisdictions, there are only a few references in the engineering literature to products liability law. Negligence law did not have great impact in engineering and among manufacturers. The shillelagh was more of a sprig than an oaken sapling.

As strict liability gained favor among plaintiffs' attorneys, the number of suits filed each year increased significantly. Individual judgments and settlements reached multi-million-dollar levels and manufacturers began to make changes in their products and organizational structures and their
approach to the users of their products. Recall programs were instituted, sometimes at the request of a government agency and sometimes in response to public pressure. The management of risk and products liability issues became the concern of company board of director meetings. The shillelagh was now truly a sapling.

Manufacturers are alarmed at the increasing number of product liability suits. An estimated 110,000 product cases are filed each year in the United States. In the decade from 1973 to 1983 the number of cases filed in federal courts increased from 1,579 to 9,221. In addition to this significant and worrisome increase in the number of cases from established causes, manufacturers who strive to create national markets for their products have a new concern. A design defect in a single product can turn the bonanza of achieving their goal into a business disaster.

In the recent past, mass suits have been filed against two companies for injuries alleged to have been caused by alleged engineering-related defects in their products. Automatic transmissions installed in about 23 million automobiles manufactured by the Ford Motor Company from 1968 to 1980 are alleged to slip from “park” to “reverse” if the engine is left running. The Center for Auto Safety estimates the liability of Ford will exceed $500 million by the time the more than 1000 suits filed have run their course. Alleged defects in the construction of the Firestone 500 tire, sold from 1973 to 1978, are claimed to cause premature wear. Of the more 8000 suits filed, Firestone claims all but a few are resolved, but the problem has cost Firestone an estimated $180 million through 1982, including the cost of recalls. The manufacturers of other products, such as drugs and contraceptives, are involved in similar major product controversies.

Foreign companies, particularly those that are unfamiliar with the no-fault character of strict liability, are finding that there are hazards to doing business in the United States, with its litigious citizens, which they are ill-prepared to face. Their engineers and engineering educators are even less aware of products liability law and the concept of design defects that can make a product unreasonably dangerous than are their counterparts in the United States. In the Western industrial world (including the countries of Europe and the Far East), negligence law based in civil codes rather than strict liability developed through case law is the usual avenue by which a person who alleges injury caused by a product can seek redress in the courts. Fundamental differences between the two legal systems and cultural diversity can influence significantly the outcome of products liability suits alleging injury by the same product for the same defect brought in, say, the
United Kingdom or Japan and the United States. Some of these differences and their effects on engineers and engineering are discussed in References (2) and (8).

In engineering, particularly in design engineering, the effect of this increased activity and attention has probably been beneficial. Designers and educators are more sensitive to the demands of safety. Technical audits and design reviews for the purpose of evaluating the safety of products are utilized regularly. Technical societies now have permanent committees charged with organizing the society's activities in design and the law. The American Society of Mechanical Engineers has such a committee in its Design Division. The National Society of Professional Engineers sponsors workshops and seminars devoted to products liability law and its impact on engineers and the firms for which they work. The National Fire Protection Association supports an extensive educational and standards program and publishes a Fire Protection Handbook, now in its Fifteenth Edition (1981).

In the courts, the designers of an allegedly defective product are held to the level of an expert and (if the plaintiff prevails) to the state-of-the-art at the time the product was designed and manufactured. Now, as never before, engineers have available to them information in the requisite quality and quantity that they can perform design tasks they may have previously considered beyond their capabilities. Only some of this improvement can be attributed to products cases and then only in special areas. As we enter what is being called the Information Age, we are being overwhelmed by a data base that includes almost indigestible amounts of design-related data on materials, products, machine components and new ideas applicable to our areas of expertise.

Software has been developed that can be used to reconstruct accidents and the failure modes of products in a timely and rational manner. This permits engineers to design and recommend safety features for a defective product. Retrofitting the product with this safety feature may prevent similar accidents from occurring in the future. However, should another accident occur involving the same product, in some courts, the fact that the manufacturer was capable of making the product with this safety feature may be used by the plaintiff.

The design-oriented literature available now that can be attributed to the influence of products liability cases includes standards (ANSI, SAE, ASTM, ASME, etc.), journals (Journal of Products Liability, available through Pergamon Press; Journal of the National Academy of Forensic
Engineers, available from the NAFE; IMPACT, a journal of safety litigation news from the Center for Auto Safety; etc.), publications of the federal government (the Federal Register, FAA, DOT, NRC, DOE, OSHA, EPA and other regulatory agencies of the U.S. government), monographs and technical books (Designers Guide to OSHA, Peter S. Hopf, McGraw-Hill, 1975; What Every Engineer Should Know About Product Liability, J. F. Thorpe and W. H. Middendorf, Dekker, 1979; Motor Vehicle Accident Reconstruction and Cause Analysis, R. Limpert, Michie, 1978; etc.).

This sampling does not cover the engineering and safety journals that publish design-oriented articles on such topics as machine guarding, pinch points, and how a designer can avoid potentially hazardous features in machinery. The sources of design information given above are simply the ones readily at hand to this author who believes that, today, in virtually all cases, no designer can claim the information on which to base a safe design is not available. The exceptions to this statement would be rare, indeed, if they exist at all.

There have been specific engineering-related changes in the design of vehicles (automobiles, motorcycles, fishing boats), cranes, flammable clothing and blankets (especially for children), spray-can-type containers, toys, household wiring, and aircraft components. Some of these improvements in products that resulted from litigation are given in the tabulation below. The list of improvements is growing as manufacturers and engineers respond to societal and government pressures to make their products more safe, in either sense of the word. The implications in engineering design of the court tests for a defective condition are clear. In most cases, state-of-the-art, unavoidable unsafeness, misconduct by the user, and misuse are considerations that a designer can take into account on the basis of foreseeability. An assessment can be made of the risks present in using the product as it is designed, the probabilities that the product is likely to fail-dangerous or fail-safe and, perhaps most importantly, how can the failure mode associated with an unreasonable danger be controlled. Fail-safe modes cannot always be achieved, but surely we can always attempt to find them. Only rarely is sophisticated technology required to make products relatively free of unreasonable danger. In most cases, it requires nothing more than the willingness to consider safety as an essential design consideration and, as part of the design process, to establish the ways in which failure, especially traumatic failure, of a product can occur. It is better, far better, that the answers to these questions be determined in the benign atmosphere of the designer's office than to attempt to provide answers for a jury in the contentious milieu of a court.
Product Improvements Resulting From Products Liability Suits

Typical Case
Larsen v General Motors
[391 Federal 2d 465 (8th Cir. 1968)]

Jasper v Skyhook Corp.
[547 Federal 2d 1140 (New Mex., 1978)]

La Gorga v Kroger Co.
[407 Federal 2d 671 (3rd Cir. 2d 1969)]

Mickle v Blackman
[166 South Eastern 2d 173 (South Carolina, 1969)]

Spruill v Boyle-Midway
[308 Federal 2d 79 (4th Cir., 1962)]

Change
Automobiles are no longer made with a steering mechanism that extends forward of the tires.

Cranes are now made with proximity devices to warn operators their booms are dangerously near electrical power lines.

Flame retardants are now used in clothing and blankets.

Automobiles are equipped with padded dashboards and collapsible, energy-absorbing steering columns.

Duty to warn has been extended from warnings of inherent dangers in the normal use of the product to foreseeable dangers associated with the normal environment in which it is used.

Closure

Two points are made here. First, the classic definition of safety is simply unsuitable as an engineering instruction to a designer. Thus, let us harmonize safety and design by using a different definition. Let us define safety (in the context of product design) as the absence of unreasonable danger. Then, by using the language of the courts and taking into account the engineering implications of the tests used there to assess the presence of design defects in a product, a designer can establish criteria against which to measure its safety before the design is released for manufacture. Second, there have been specific improvements in the design of products that can be attributed to litigation brought under products liability law. With the data base and software being generated today, engineers have at hand the means to create designs that should be safe -- or, let us say, not unreasonably dangerous.
References


