

1983

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Recommended Citation

John Saba, *Aircraft Crashworthiness in the United States: Some Legal and Technical Parameters*, 48 J. AIR L. & COM. 287 (1983)
<https://scholar.smu.edu/jalc/vol48/iss2/9>

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AIRCRAFT CRASHWORTHINESS IN THE UNITED STATES: SOME LEGAL AND TECHNICAL PARAMETERS

JOHN SABA*

I. INTRODUCTION

MAN WAS BORN TO FLY. But once he learned to fly, man had to learn to cope with the problem of occasionally crashing. The development of aviation product liability law, particularly in the United States, has provided a legal context for coping with this problem. To better understand the legal context in which aircraft crashes should be viewed, an examination of accidents at a technological level and at a statistical level is necessary.

On a technological level, aircraft gradually have become more sophisticated and more "airworthy" as aerodynamic construction, new materials, modern avionics, and more powerful engines have permitted aircraft to fly faster, higher, and farther. Technological progress in making aircraft more "crashworthy," however, has not been so impressive. In many instances, the deficiency in crashworthiness has compounded the consequences of many aircraft accidents.

On a statistical level, a positive development has been the gradual decrease in the overall accident rate in general aviation (as measured by each 100,000 hours flown)¹ as well as in commercial aviation (as measured by either passenger miles

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¹ Tye, *Civil Aviation Safety*, AIRCRAFT ENG'G. Sept. 1980, at 2.

flown or number of flights).² This decrease in the overall accident rate has occurred despite rapid growth in the number of aircraft. This improvement should be understood in the context of two factors.

First, general aviation aircraft accidents³ cause approximately eight times more fatalities than automobile accidents and fifty times more deaths than commercial transport aircraft crashes, as measured by deaths per passenger mile.⁴ Furthermore, on the basis that during the past decade more than 100,000 general aviation aircraft occupants were involved in 39,458 accidents, some studies have predicted that a 60 percent chance exists that a general aircraft currently in production eventually will be involved in an accident.⁵ This percentage assumes a 20-year life expectancy for the aircraft.⁶

Second, studies have shown that most crashes occur during the take-off, approach, and landing phases of the flight.⁷ During these phases, aircraft are travelling at a relatively low altitude and a slow speed. In a majority of these crashes, huge sections of the fuselage and most occupants' bodies remain intact.⁸ Thus, the timing of these accidents raises the question of whether the occupants could have survived these crashes if the aircraft had been more crashworthy.

On the legal level, principles and theories gradually have been developed and refined to accommodate the growth in litigation of aircraft crash claims. In the early years of international air service, the plaintiffs' bar was frustrated by the regime of fixed and limited liability protecting the air carriers under the Warsaw Convention of 1929.⁹ Plaintiffs' attorneys,

² D. THURSTON, DESIGN FOR SAFETY 12 (1980).

³ "General aviation aircraft" are defined as "those airplanes certificated under 14 C.F.R. § 23 [sic] and predecessor regulations, having a gross weight of 12,500 pounds or less." National Transportation Safety Board, *Safety Report: The Status of General Aviation Aircraft Crashworthiness* 1 (1980) [hereinafter cited as *1980 Report*].

⁴ Schaden, *Aircraft Crashworthiness*, Trial, Jan. 1978, at 40, 41.

⁵ *1980 Report* *supra* note 3, at 1.

⁶ *1980 Report*, *supra* note 3, at 1.

⁷ *Analysis of World Jet Aircraft Accidents By Phase of Flight: 1962-1977*, British Airways Air Safety Review, March 1978, at 3.

⁸ P. EDDY, E. POTTER, & B. PAGE, DESTINATION DISASTER 8 (1976).

⁹ For a comprehensive examination of the Warsaw Convention and the amending

in their tireless search for the highest damages available to aircraft crash victims, increasingly directed their suits at the airframe and component manufacturers.¹⁰ The liability of aircraft manufacturers was and continues to be open-ended.

United States courts, with the sophisticated foundation of existing common law principles of general product liability law, assumed leadership in the development of aviation product liability law. Initially, courts only would impose liability on airframe and component manufacturers for deaths and injuries arising from a crash *caused* by defects in the manufacture and the design of the aircraft. Recently, however, some American courts have been willing to extend principles developed in automobile accident litigation to the aviation field, thereby imposing liability on aircraft manufacturers for defects that *enhance* or *exacerbate* the injuries or deaths of crash victims.¹¹

This paper focuses on the airframe and components manufacturers' tort liability for deficient aircraft crashworthiness. In the opinion of this author, the manufacturers' tort liability is linked so intimately to a complicated matrix of technical factors and legal issues that some reform of the present process of court adjudication of crashworthiness cases is required. In line with this reasoning, this paper is divided into four parts: (1) a definition of key concepts; (2) an examination of certain technical factors affecting aircraft crashworthiness; (3) a review and an analysis of the origins and the development of legal concepts and doctrines governing the manufacturers' tort liability for aircraft crashworthiness; and (4) some recommendations to remedy certain deficiencies in the present system of litigation of aircraft crashworthiness claims.

protocols and agreements, see C. SHAWCROSS & M. BEAUMONT, *AIR LAW* 337-72 (4th ed. 1977).

¹⁰ See L. Kreindler, *Aviation Accident Law*, ch. 7 (1981) [hereinafter cited as Kreindler] for an extensive examination of litigation involving the liability of aircraft manufacturers.

¹¹ See *infra* notes 119-60 and accompanying text.

II. DEFINING CRASHWORTHINESS AND "DESIGN" DEFECT

A. *Crashworthiness*

Crashworthiness¹² may be defined in many different ways. On a general level, crashworthiness refers to the degree an aircraft is "fit to crash." On a legal level, crashworthiness primarily focuses on the capacity of the vehicle to protect its occupants from enhanced or aggravated injuries or death in a survivable crash.¹³ For example, the legal community would be concerned with whether the vehicle could protect the passengers during the "second collision," when the passengers' bodies collide with the interior of the vehicle.¹⁴

B. *Design Defects*

Deficient crashworthiness is usually the consequence of a defect in design.¹⁵ Design defects arise when the product

¹² In this paper, for the purpose of consistency, the term "crashworthiness" is utilized. Other concepts that are sometimes used to refer to the same phenomenon and its consequences include "second accident" or "second impact" (respecting the passengers' bodies colliding with the interior of the vehicle) and "enhanced" or "post crash" injuries (respecting the injuries resulting from not only the second collision but also the environment created by the crash).

¹³ Donnelly, *Aircraft Crashworthiness-Plaintiff's Viewpoint*, 42 J. AIR L. & COM. 57-59 (1976).

¹⁴ Galerstein, *A Review of Crashworthiness*, 45 J. AIR L. & COM. 187, 196 (1979) [hereinafter cited as Galerstein].

¹⁵ It is important to distinguish "design" defects from "marketing" and "manufacturing" defects. Marketing defects arise when the product emerges from the manufacturing process without manufacturing and design defects. Nevertheless, the product is marketed with inadequate warnings or instructions respecting possible risks involved in the use of the product and how to minimize the harmful consequences from such risks. Manufacturing defects arise when the product emerges from the manufacturing process in a condition not intended by the manufacturer. The product is not constructed or assembled according to the manufacturer's design and production standards, being different from other products coming off the same production line. See Keeton, *Product Liability and the Meaning of Defect*, 5 ST. MARY'S L.J. 30, 33-34 (1973) [hereinafter cited as Keeton I.]. See also Keeton, *Manufacturer's Liability: The Meaning of "Defect" in the Manufacture and Design of Products*, 20 SYRACUSE L. REV. 559, 562 (1969) [hereinafter cited as Keeton II.]. From a tactical perspective an attorney should allege both a manufacturing and a design defect when it is possible that one of these has caused or contributed to a death or injury. This is the preferred approach because in practice an inherent difficulty exists in distinguishing these two types of defects. Often an interdependency occurs between a design defect and a manufacturing defect such that the design of a product affects quality control and thus manufacturing defects. As a result, a change in design may reduce or elimi-

emerges from the manufacturing process in a condition intended by the manufacturer. The product is constructed or assembled according to the manufacturer's design and production standards, being identical with other products coming off the same production line. The entire product line, however, is "defective" because all products were improperly designed.¹⁶ Several types of design defects exist. These defects include concealed dangers, missing features, and a lack of crashworthiness.¹⁷

III. TECHNICAL PARAMETERS OF AIRCRAFT CRASHWORTHINESS

Commentators, courts, and lawyers considering aircraft crashworthiness issues often fail to attach sufficient significance to the real constraints and trade-offs imposed by technological design factors. Technical design factors may affect the number of deaths and the severity of injuries in a crash. To help interested persons understand some of these problems, this paper examines five basic technological design factors including airframe crashworthiness/cabin integrity, restraint systems, cabin and cockpit environment, energy absorption, and post-crash hazards.¹⁸ The first four factors relate to the "dynamic" phase of the actual occurrence and development of the crash and the impact. The last factor, post-crash hazards, is associated with the "static" phase which

nate manufacturing defects. Abramson, *Defining the Design Defect in Aircraft Products Liability Cases*, 45 J. AIR L. & COM. 167, 173 (1979) [hereinafter cited as Abramson]. It should be noted that for the purpose of theoretical consistency, this paper handles deficient crashworthiness as a problem of design defect.

¹⁶ See Henderson, *Judicial Review of Manufacturers' Conscious Design Choices: The Limits of Adjudication*, 73 COLUM. L. REV. 1531, 1543-44 (1973) [hereinafter cited as Henderson]. The finding by a court of a design defect generally results in substantially higher costs for a manufacturer than a finding of a market or a manufacturing defect. See Comment, *Strict Products Liability: Giving Content to the Term "Defect" in Design Cases*, 40 OHIO ST. L.J. 209, 213 (1979) [hereinafter cited as Comment]. In such a case, the manufacturer faces not only lawsuits seeking a remedy for injuries and/or deaths but also the financial hardship of recalling or terminating the production of the product.

¹⁷ See D. NOEL & J. PHILLIPS, *PRODUCTS LIABILITY IN A NUTSHELL* 138-78 (1981) for an excellent survey of the scope of design defects.

¹⁸ MOTT, *Crashworthiness and Postcrash Hazards from the Airline Flight Attendant's Point of View*, in AIRCRAFT CRASHWORTHINESS 627 (K. Saczalski ed. 1975) [hereinafter cited as Mott].

involves the emergency evacuation of the aircraft by the survivors of the accident.¹⁹

A. Airframe Crashworthiness/Cabin Integrity

Airframe designers understand that the first step in reducing injuries and deaths during an aircraft crash is to insure that the aircraft cabin stays intact. The aircraft cabin should maintain a "protective shell" around the occupants during and after impact. This "protective shell" prevents the occupants from being thrown from the aircraft or from being crushed.²⁰

Today, most airframe structures, despite the gradual improvement in their design, cannot adequately withstand crash forces and protect their occupants. While the human body can withstand 40 "g" forces²¹ in the forward direction without broken bones or internal injuries, many aircraft are designed to tolerate substantially less deceleration with minimal structural damage. For example, most general aviation aircraft can withstand only about 20 "g" forces ("g's").²²

Although designers have created many aircraft with relatively low deceleration tolerances of "g" forces, contemporary design technology permits the construction of significantly more crashworthy vehicles. For example, airframe designers have known for some time that harder metals in the nose structure would minimize the collapsing of the fuselage²³ and would reduce the digging in of the nose,²⁴ thereby increasing the occupants' chances of surviving a crash. More ductile metals used elsewhere in the aircraft²⁵ also have been known to improve crashworthiness. Therefore, much of the deficiency in

¹⁹ See W. JOHNSON & A. MAMALIS, *CRASHWORTHINESS OF VEHICLES* 90 (1978) [hereinafter cited as Johnson].

²⁰ THOMPSON & CLARK, *General Aviation Crashworthiness* in *AIRCRAFT CRASHWORTHINESS* 45 (K. Saczalski ed. 1975)

²¹ The letter "g" represents the gravitational attraction upon objects at sea level (32.2ft/Sec.²). For more information on this concept and its application to general aviation aircraft in crash circumstances see *1980 Report*, *supra* note 3, at 5.

²² Schaden, *supra* note 4, at 42.

²³ J. GODSON, *UNSAFE AT ANY HEIGHT* 185 (1970) [hereinafter cited as Godson].

²⁴ Johnson, *supra* note 19, at 87-88.

²⁵ Godson, *supra* note 23, at 186.

crashworthiness of recently constructed airframes primarily may be attributed to designers' decisions based on factors such as cost, weight, and performance. This deficiency does not arise from a lack of technology.

B. *Restraint Systems*

A second technological design factor that may reduce injuries and deaths in an aircraft crash is the installation of adequate restraint systems that "prevent an occupant, cargo, or equipment from becoming a missile during a crash sequence."²⁶ Although technology generally exists today to provide adequate restraint systems, problems persist in regard to seats, seat belts, cabin furnishings, and debris²⁷ which break loose from the cabin at relatively low impact levels. These problems can transform potentially survivable crashes into injurious and/or fatal crashes. Injuries and deaths largely continue because of inadequate minimum airworthiness and crashworthiness standards.

The problem of flying objects exists on two levels. First, tangible items within the cabin tend to be restrained in an inadequate manner. Galleys or overhead storage bins may spill their contents during an aircraft crash. These contents include carry-on baggage, meal trays, and emergency equipment. Consequently, these flying objects may cause death or serious injuries by striking the passengers. Furthermore, these objects may block the aisles during evacuation. The problem of flying objects might be remedied through higher crashworthiness standards that often require relatively inexpensive and simple changes. For example, in the case of carry-on baggage, aircraft manufacturers might be required to provide some restraining device to secure the baggage under the seat.²⁸

Second, a problem exists in both the anchoring and the nature of seats and seatbelts. Seats and seatbelts tend to be in-

²⁶ Johnson *supra* note 19, at 90.

²⁷ "Debris" includes carry-on baggage, meal trays, and emergency equipment that may break loose on impact.

²⁸ Mott, *supra* note 18, at 646.

adequately attached to the cabin structure. Thus, in crashes involving even moderate deceleration, the seats and seatbelts often tear away from their anchoring,²⁹ thereby exposing the aircraft occupants to increased danger of injury and death. A primary cause of seats and seatbelts tearing away is the inadequate minimum crashworthy design standards for seat and seatbelt anchorings established by Federal Aviation Regulations (FARs). Present regulations only require that aircraft seatbelts be designed to withstand 9 "g's,"³⁰ somewhat less than 1,500 pounds of holding strength for the average 170 pound occupant. The inadequacy of the FARs is obvious when the FARs are compared to the more stringent requirements of other regulatory bodies: the United States Air Force minimum standard is 17 "g's" for its aircraft; the United States Navy standard is 40 "g's" for its aircraft; and the United States Department of Transportation requires a much higher standard of 29 "g's" for automobile seatbelts.³¹

Even if the seatbelts are ideally anchored, it is clear that the single-lap belt required for passengers provides only marginal protection, merely restraining a passenger's pelvis. The protection for the upper torso is inadequate. The head, trunk, and appendages are free to flail about in a disintegrating cabin, striking or being struck by objects which penetrate or crush them. Studies show that many crash fatalities are caused by head impact injuries, many of which could have been prevented if lap-and-shoulder belts had been installed and used.³²

Ironically, the standard of crashworthiness for automobiles is higher than the standard for aircraft. Automobiles are required to have lap-and-shoulder belts in the front seat for both the driver and the passenger.³³ Present FARs do not re-

²⁹ 1980 Report, *supra* note 3, at 5.

³⁰ 14 C.F.R. §§ 23.561, 23.785 (1982). A more detailed discussion of crashworthy design standards will occur later in this paper.

³¹ Schaden, *supra* note 4, at 43.

³² 1980 Report, *supra* note 3, at 2. For example, in the case of general aviation accidents, seventy percent of these accidents result in head injuries; one quarter may be avoidable by using "lap-and-shoulder belts."

³³ 49 C.F.R. § 571.208 (1981).

quire that lap-and-shoulder belts be provided for aircraft passengers. Lap-and-shoulder belts only need to be installed in the piloting crew's seats in commercial aviation aircraft and in the front seats of general aviation aircraft.³⁴ Numerous studies have recommended, however, that the ideal restraint for both crew and passengers is a dual strap shoulder harness rather than the single diagonal strap generally in use today.³⁵ More stringent government standards requiring such improved restraint systems would involve minimal financial costs in comparison to potential safety benefits.

C. *The Cabin and Cockpit Environment*

A third technological design factor affecting the number and the extent of injuries and/or deaths in an aircraft crash is the injurious or non-injurious nature of the cabin and cockpit interior environments. Projections, barriers, and loose or broken away objects in the immediate vicinity of the occupant continue to cause injuries or death.³⁶ More specifically, head impact usually occurs when the occupant "jackknives over the seatbelt and contacts hard, sharp, unyielding, rigid structures."³⁷ Severe injuries and deaths also occur in the cabin on crash impact as the occupants' bodies hit the seats in front of them and protuberances and sharp corners such as those of the armrests and ashtrays. The lethal potential of the cockpit environment occurs when the head and flailing appendages contact hard and non-yielding control columns, rudders, and instrument panels.³⁸

Deaths and serious injuries caused by body impact with projections and hard surfaces persist even though technology since the 1950's makes it possible to significantly delethalize both the cockpit and the cabin environments. Smoother surfaces, protective padding, and safety conscious designs would

³⁴ 14 C.F.R. §§ 91.33, 91.39 (1982). See the discussion of present FARs governing seatbelt installation and use in *1980 Report*, *supra* note 3, at 15-16.

³⁵ D. THURSTON, *DESIGN FOR SAFETY* 88 (1980).

³⁶ Johnson *supra* note 19, at 90.

³⁷ See *1980 Report*, *supra* note 3, at 6. This report cites a 1977 study by R. G. Snyder on civil aircraft restraint systems.

³⁸ *Id.* at 6. Again, the Snyder study is cited.

reduce and minimize possible injuries and deaths. For example, pilot control yokes could be installed without horns and the instrument panels could be made not only with softer metal and padded surfaces but also with energy absorbing characteristics such as shock mounts for the panel.³⁹

D. *Energy Absorption*

A fourth crashworthiness factor is energy absorption, defined as the ability of the airframe structure, restraint systems, and cabin environment to absorb crash forces by progressively yielding or deforming so as to cushion and to distribute impact forces.⁴⁰ Energy absorption is clearly an element of the three factors previously examined. As discussed earlier in the paper, deaths and injuries in crashes might be reduced if aircraft were designed with energy-absorbing characteristics such as the following: an airframe with a rigid nose structure and a fuselage consisting of ductile metals; shock absorbing seats; and smoother surfaces, more padding, and softer metals in the cabin and cockpit environments.

E. *Post-crash Hazards*

The final crashworthiness factor involves those features of the aircraft designed to facilitate or to impede a surviving occupant's ability to escape the aircraft safely during the "static" emergency evacuation phase of the crash.⁴¹ The na-

³⁹ See Thompson, *supra* note 20, at 47.

⁴⁰ Mott, *supra* note 18, at 627.

⁴¹ See C. SNOW, J. CARROLL & M. ALLGOOD, SURVIVAL IN EMERGENCY ESCAPE FROM PASSENGER AIRCRAFT FAA Office of Aviation Medicine, 55 (1970) [hereinafter cited as SNOW]. The evacuation occurs in the context of the following sequence of circumstances:

1. The events leading to the accident;
2. The impact profile, including secondary, tertiary and additional impacts, plus twisting and other angular positive and negative accelerations;
3. The immediate post-impact period, which may be complicated by smoke, fire, panic, submersion, waveactions and other factors;
4. The later period, which may be characterized by exposure to elements, rough water, and lack of appropriate survival gear.

S. MOHLER, J. SWEARINGEN, E. MCFADDEN & J. GARNER, HUMAN FACTORS IN EMERGENCY EVACUATION, FAA Office of Aviation Medicine, 55 (1964) [hereinafter cited as

ture and duration of the emergency evacuation may be affected by a number of post-crash hazards. Some of these post-crash factors are largely outside the scope of control and liability of the aircraft manufacturers and/or the carrier. Such factors include the passengers' behavior, the exterior environment, the weather, and the time of day or night of the crash.⁴² Certain post-crash factors, however, are significantly within the scope of control and liability of the manufacturers and/or the carrier. These factors include distortion and damage to the cabin,⁴³ the crew's behavior which is conditioned by its training and experience,⁴⁴ configurational features, emergency lighting and equipment, fire, smoke, and toxic gases. Two of these factors will be discussed in more detail.⁴⁵

1. *Configurational Features*

Configurational features that control access to exits and evacuation flow rates greatly influence the possibility of a passenger's survival during emergency evacuations.⁴⁶ Seating density and seating location as well as aisle width are the prod-

Mohler].

⁴² See Snow, *supra* note 41, at 1.

⁴³ See *supra* notes 20-40 and accompanying text.

⁴⁴ The crew's behavior is not a matter within the manufacturer's control.

⁴⁵ In addition to the two factors discussed in greater detail in the text, problems surrounding such factors as emergency lighting and emergency equipment should also be considered. Emergency lighting that fails can be a significant post-crash hazard. Indeed, if the crash occurs at night or the cabin is overwhelmed by fire and/or smoke, the occupants may find it virtually impossible to locate the emergency exits. Emergency equipment, including life preservers and fire and oxygen equipment, may be inadequate as to their location and/or their nature as well as not having clear instructions as to their use, thereby creating an unnecessary post-crash hazard.

⁴⁶ "In aircraft accidents in which decelerative forces do not result in massive cabin destruction and overwhelming trauma to passengers, survival is determined largely by the ability of the uninjured passenger to make his way from a seat to an exit" and then out of the aircraft "within time limits imposed by the thermo-toxic environment." Snow, *supra* note 41, at 55. Total abandonment of the aircraft is the ultimate goal of an emergency evacuation. It has been demonstrated that in good emergency evacuation conditions, a commercial jet aircraft can be evacuated with an average individual time of slightly above one second. This evacuation time is slightly more than one-half the average individual time required for the emergency evacuation of a piston aircraft. Mohler, *supra* note 41, at 13-14. Furthermore, insofar as each actual emergency evacuation is a unique incident full of unexpected events, the actual evacuation time varies from case-to-case.

ucts of a compromise that aircraft and seat manufacturers must make. The compromise involves airline operators' economic pressures seeking more seats, less weight, and more comfort, and the Federal Aviation Administration's (FAA's) desire for more crashworthiness safety in the form of stronger seats and more space for adequate emergency evacuation.⁴⁷ The tragic irony is that cost pressures too often prevail, with aircraft designers making a trade-off which may doom many passengers and crewmembers in a future crash.

The first configurational factor, the location and density of seats, is particularly a problem in cost-effective aircraft. Numerous seats are often crowded onto the aircraft such that inadequate space exists in the aisles and around the emergency exits for rapid and safe evacuation. Although the inadequate space may prevent safe evacuation, the space between seats may satisfy FARs. For example, Hasbrook's ⁴⁸ investigation of the July 11, 1961, Denver, Colorado, jet aircraft crash suggested that some of the deaths were partly attributable to the narrow (15.5 inches) aisles between the rows of triple seats. The narrow aisles made it virtually impossible for attendants in the tourist section to go forward and to accelerate the passengers toward the rear exit.⁴⁹ Furthermore, the danger always exists that inadequately anchored seats may break loose from the floor on crash impact and pile up in front of the emergency exits, preventing people from escaping the aircraft.⁵⁰

The size, number, location, and operation of emergency exits and escape slides is another set of configurational factors that may pose post-crash hazards. The evacuation process may be complicated by emergency exits that are too small, insufficient in number, and not easily accessible. The opening of emergency doors and hatches and the employment of escape slides may be hampered by complicated procedures and inad-

⁴⁷ *Safety and Comfort: The Airliner Cabin*, 117 FLIGHT INT'L 479 (1980).

⁴⁸ A. H. Hasbrook is an aircraft crashworthiness expert who has reported on the problem in a number of studies. See 1980 Report *supra*, note 3, at 34, for a small bibliography of some of Hasbrook's reports.

⁴⁹ Gonzales, *Airline Safety: A Special Report*, PLAYBOY, July 1980 at 222 [hereinafter cited as Gonzales]. Gonzales also cites a 1962 Hasbrook study.

⁵⁰ *Bruce v. Martin-Mariette Corp.*, 544 F.2d 442-44 (10th Cir. 1976).

equate instructions. Furthermore, despite earnest efforts by manufacturers to remedy the problem, the crash impact generally results in a torqued fuselage causing emergency exit doors and hatches to jam and become inoperable.⁵¹

F. *Post-crash Fire, Smoke, and Toxic Gases*

Studies of many aircraft accidents show that a post-crash fire is highly likely after a crash, and that once ignition occurs in the presence of large quantities of uncontained fuel, the fire will burn intensely and spread rapidly. The post-crash fire, therefore, significantly reduces the chances for the occupants to survive and to escape.⁵² For example, one FAA study estimates that in a survivable turbine-powered aircraft accident, "not only do 95 percent of fatalities occur when a post-crash fire is involved," but also fire, smoke, and gas hazards are responsible for 40 percent of such fatalities.⁵³

The first aspect of the post-crash hazard involves the probability of a post-crash fire occurring. If after the crash no fire breaks out, or a fire breaks out that is restricted and retarded by various means, an occupant's ability to survive and thereby to escape improves. The post-crash fire hazard is affected by factors such as the nature and location of the fuel tank and the fire extinguishing system. While various crash-worthy fuel systems that reduce both fuel spillage and ignition of spilled fuel have been researched, developed, and tested,⁵⁴ aircraft manufacturers generally are reluctant to incorporate such systems into aircraft because of the high costs.

The second aspect of the post-crash hazard involves the emission of excessive heat, smoke, and toxic gases from flam-

⁵¹ Godson, *supra* note 23, at 101. A 1969 Flight Safety Foundation study of twenty-six accidents in the 1957-67 period revealed that only about one-quarter of the emergency exits were used in post-crash emergency evacuation circumstances because most of the other exits were jammed. This study is cited in Gonzales, *supra* note 49, at 220-22.

⁵² Robertson & Adamczyk, "Crashworthy Fuel Systems," in *Aircraft Crashworthiness* 670, 669-82 (K. Saczalski ed. 1975) [hereinafter cited as Robertson].

⁵³ Bulloch, *Survivability in Aircraft Fires: New Standards are Needed*, 34 *Interavia* 557 (1979) [hereinafter cited as Bulloch].

⁵⁴ Robertson, *supra* note 52, at 678-79. This article cites the research and development of crashworthy fuel systems sponsored by the United States Army.

mable cabin furnishings and materials. Flammable cabin furnishings include the wall lining, ceiling and flooring materials, partitions, galley, toilet fittings, seats, and carpets.⁵⁵ Flammable materials include windows and electrical wiring.⁵⁶ Although aircraft manufacturers and the FAA have known for many years of the hazardous nature of chemicals contained in certain cabin materials such as polyurethane used in the seat upholstery of most aircraft today and have known that the state-of-the-art permits replacement of these chemicals, no significant move has been made to eliminate their use. In fact, the FAA has not promulgated a single rule on smoke and toxic-gas emissions in over a decade. Thus, heat, smoke, and poisonous gas related deaths continue to occur from otherwise survivable accidents.⁵⁷

This survey of the technological parameters of the aircraft crashworthiness problem is not conceived as an indictment of the airframe and components manufacturers. Manufacturers must make tradeoffs in design. These tradeoffs are based on considerations such as reducing costs, increasing performance and reliability, and improving safety. Only with a realistic appreciation of the complex technical problems faced by manufacturers can one comprehend the development of the law respecting a manufacturer's liability for aircraft crashworthiness.

IV. LEGAL PARAMETERS OF AIRCRAFT CRASHWORTHINESS

Certain legal principles, standards, and issues have been developed to accommodate personal injury and death actions based on claims of deficient aircraft crashworthiness.⁵⁸ These

⁵⁵ Bullock, *supra* note 53, at 557.

⁵⁶ *Id.*

⁵⁷ *Id.* at 558. An example of the continuing problem is the July 11, 1973 crash of a Varigo Boeing 707 near Paris. Only one of the 117 passengers was rescued alive, most found asphyxiated, still strapped in their seats. *Id.* at 557.

⁵⁸ Much of the discussion of the legal parameters of aircraft crashworthiness involves a reorganization, modification, and regurgitation of material included in another article written by this author, Saba, *Aircraft Crashworthiness and the Manufacturer's Tort Liability in the United States*, 7 *Annals Air & Space L.* 171, 177-208 (1982).

principles, standards, and issues will be discussed in the following manner: (1) on an administrative level, the crashworthy design standards developed by the FAA; (2) on the judicial level, the origins, development, and present status of airframe and component manufacturers' tort liability; and (3) the advantages and disadvantages of litigating claims of deficient aircraft crashworthiness. This examination is undertaken with the goal of ultimately recommending certain changes to improve upon the present system of litigating aircraft crashworthiness cases.

A. *Crashworthy Design Standards*

Administratively, the aircraft manufacturer's liability is regulated by crashworthy design standards formulated by the FAA. The FAA formulates these standards by exercising its congressionally granted power of promulgating FARs.⁵⁹ FARs establishing minimum crashworthy design standards cover such factors as restraint systems,⁶⁰ the cabin interior,⁶¹ and the emergency exits.⁶² Existing FARs are plagued by three key problems.

First, the FARs establish "minimum" standards which are often excessively low and inadequate. For example, as discussed earlier, although the average human can tolerate 40 "g's" of forward deceleration, the present FAR governing seat belts only requires 9 "g's" tolerance.⁶³ It should be reiterated that other regulatory bodies such as the United States Air Force and Navy have established superior and more stringent requirements than contemporary FAA standards.⁶⁴ Today, a helicopter manufacturer who designs and certifies his helicopter to mandatory FAA crashworthiness standards holds a significant commercial advantage over a manufacturer who satisfies the much more stringent Air Force and Navy stan-

⁵⁹ 49 U.S.C. § 1421(a)(1) (1976).

⁶⁰ 14 C.F.R. § 25.785 (1982) (governing seating, seat belts, and harnesses).

⁶¹ 14 C.F.R. § 25.853 (1982).

⁶² 14 C.F.R. § 25.805-.811 (1982) (governing emergency exits).

⁶³ See 14 C.F.R. § 25.561 (1982).

⁶⁴ See *supra* note 31 and accompanying text.

dards. If the helicopter should crash, however, the commercially advantaged manufacturer may find that the plaintiffs' attorneys cite Air Force or Navy standards as proof of a design defect, even though the latter standards only involve voluntary compliance.

A second problem exists because the FARs are often too vague, giving manufacturers insufficient guidance on crashworthy designs.⁶⁶ One such FAR states that the aircraft "structure must be designed to give each occupant every reasonable chance of escaping serious injury in a minor crash landing".⁶⁸ Although this ambiguous language creates insufficient guidelines, some vagueness is necessary to give manufacturers enough flexibility to solve unanticipated problems.⁶⁷

A third problem plaguing the FARs is that an aircraft manufacturer's compliance with the FARs is not conclusive proof of a safe aircraft because the FARs are only of a minimum nature. When FARs are inferior to common law established standards, courts may consider the safety of the product regardless of whether the product complies with FARs.⁶⁸ The safety consideration is complicated by the fact that the courts have not developed uniform design standards. This lack of uniformity is due to the judiciary's failure to establish a single objective definition and test for determining a design defect.⁶⁹ Thus, aircraft manufacturers suffer the uncertainty of not knowing whether they are bound by the minimum crashworthiness standards established in the FARs or the higher crashworthiness standards established by the courts on a case-by-case basis.⁷⁰

⁶⁶ Comment, *Uncrashworthy Aircraft and the Manufacturer's Liability*, 13 Akron L. Rev. 553, 558 (1980) [hereinafter cited as Comment, *Uncrashworthy Aircraft*].

⁶⁷ 14 C.F.R. § 23.561(b) (1982).

⁶⁸ Marcy, *The Crashworthiness Doctrine and the Allocation of Risks in Commercial Aviation*, 52 S. Cal. L. Rev. 1581, 1605 (1979) [hereinafter cited as Marcy].

⁶⁹ This problem was suggested by Justice Linde in *Wilson v. Piper Aircraft Corp.*, 282 Or. 61, 57 P.2d 1322, 1334-35 (1978), *reh'g denied*, 282 Or. 411, 579 P.2d 1287 (1978).

⁷⁰ See *infra* notes 71-309 and accompanying text for a discussion of the courts' failure to develop a single objective test for design defect and uniform standards, including many examples of this problem.

⁷¹ See *infra* notes 317-19 and accompanying text.

B. *The Origins and Development of the Aircraft
Crashworthiness Doctrine*⁷¹

The discussion of the origins and the development of the aircraft crashworthiness doctrine will be subdivided as follows: (1) the roots and basic principles of negligence-based products liability law; (2) the automobile crashworthiness doctrine; (3) the roots of the aircraft crashworthiness doctrine; (4) the aircraft crashworthiness doctrine matures: strict liability in tort; (5) the return to the negligence standard under the proposed statutory alternative of the Model Uniform Product Liability Act; and (6) the nature of the action that invokes the crashworthiness doctrine.

1. *The Roots and Basic Principles of Negligence-Based
Products Liability Law*

Industrialization and the mass production of goods created the need for an effective cause of action in tort for consumers and users injured by defective products. For many decades, consumers were confronted with a common law rule known as the *Winterbottom* rule.⁷² The *Winterbottom* rule prevented an injured plaintiff-consumer from bringing a negligence-based products liability suit unless the plaintiff was in privity of contract with the manufacturer.⁷³ The shackles of contractual privity were significantly abandoned in the 1916 New York Court of Appeals decision of *MacPherson v. Buick Motor Co.*⁷⁴ In *MacPherson*, Justice Cardozo held an automobile manufacturer liable to the ultimate purchaser of a vehicle for injuries suffered by the purchaser's wife when one of the wheels, made of defective wood, crumbled into fragments and

⁷¹ This paper focuses on the tort liability of the aircraft manufacturer but excludes a discussion of the principles of express and implied warranty.

⁷² *Winterbottom v. Wright*, 152 Eng. Rep. 402 (1842).

⁷³ See W. PROSSER, *THE LAW OF TORTS* 641 (4th ed. 1971) [hereinafter cited as Prosser]. Some exceptions to the requirement of contractual privity were made. Notably, manufacturers were deemed liable to a third party for negligence in the sale of "imminently" or "inherently" dangerous products. See, e.g., *Thomas v. Winchester*, 6 N.Y. 397 (1852).

⁷⁴ 217 N.Y. 382, 111 N.E. 1050 (1916).

caused the vehicle to collapse.⁷⁵ Justice Cardozo based the manufacturer's liability on negligence rather than on contract. Justice Cardozo was of the opinion that the manufacturer owes a duty of care directly to the foreseeable purchasers and users of the product.⁷⁶

A products liability/negligence action requires that a plaintiff prove the following elements: (a) the defendant owed a duty of care to the foreseeable plaintiff;⁷⁷ (b) the defendant breached his duty by negligently providing a "defective" product; (c) the breach of duty was both the actual and proximate cause of the plaintiff's damages; and (d) the plaintiff suffered damages.⁷⁸ The principles of negligence-based liability have been extended to manufacturers who are responsible not only for manufacturing and marketing defects but also for design defects.⁷⁹ This negligence in design liability was first extended to manufacturers of airframes and component parts in *Maynard v. Stinson Aircraft Corp.*⁸⁰

2. *Automobile Crashworthiness Doctrine*

The question of whether the nature and the scope of the duty of care owed by manufacturers to consumers extends to

⁷⁵ *Id.* at 384-85, 111 N.E. at 1051.

⁷⁶ *Id.* at 391, 111 N.E. at 1053. Justice Cardozo stated as follows:

If the nature of a thing is such that it is reasonably certain to place life and limb in peril when negligently made, it is then a thing of danger. . . . If to the element of danger there is added knowledge that the thing will be used by persons other than the purchaser, and used without new tests, then irrespective of contract, the manufacturer of this thing of danger is under a duty to make it carefully. . . . We have put aside the notion that the duty to safeguard life and limb, when the consequences of negligence may be foreseen, grows out of contract and nothing else. We have put the source of the obligation where it ought to be. We have put its source in the law.

Id.

⁷⁷ Foreseeable plaintiffs include users, consumers, and bystanders. Aircraft occupants would also be considered foreseeable plaintiffs.

⁷⁸ See 63 Am. Jur. 2d *Products Liability* §25 (1972).

⁷⁹ For definitions of these concepts, see *supra* notes 12-17 and accompanying text.

⁸⁰ 1 Av. Cas. 698 (CCH) (Mich. Cir. Ct. 1937). In *Maynard*, the plaintiff claimed that the in-flight fire which destroyed his aircraft was caused by two design defects—excessively short exhaust stacks and a carburetor drain opening too close to the exhaust stacks. The court held the aircraft manufacturer liable for negligence in design because its design created an unnecessary fire hazard. *Id.* at 699-700.

designing crashworthy vehicles was first posed in automobile crash circumstances. Today, a decreasing minority of jurisdictions adhere to the restrictive view of the manufacturer's duty announced in *Evans v. General Motors Corp.*⁸¹ The restrictive view precludes crashworthiness suits based on negligent design. An increasing majority of jurisdictions, however, adhere to the broader view of the manufacturer's duty established in *Larsen v. General Motors Corp.*⁸² The broader view recognizes an automobile crashworthiness doctrine and permits suits based on negligent design.

a. *The "Evans" approach*

In *Evans v. General Motors Corp.*, the plaintiff's decedent was killed when his automobile was struck broad-side by another vehicle.⁸³ The plaintiff sued General Motors alleging that the death was proximately caused by the negligent design of the decedent's automobile.⁸⁴ The vehicle was designed with an 'X' frame, a frame that did not have side-frame rails to protect the driver in the event of a side impact collision.⁸⁵ The Court of Appeals for the Seventh Circuit found in favor of the defendant manufacturer by effectively rejecting any crashworthiness doctrine of recovery.⁸⁶

The appellate court's decision in *Evans* was underpinned by a narrow definition of the automobile manufacturer's duty. According to the court, the manufacturer did not owe a duty to consumers to design a crashworthy or accident-proof vehi-

⁸¹ 359 F.2d 822 (7th Cir. 1966). Decisions following the *Evans* approach include: *Schemel v. Gen. Motors Corp.*, 384 F.2d 802 (7th Cir. 1967); *Willis v. Chrysler Corp.*, 264 F. Supp. 1010 (S.D. Tex. 1967); *Walton v. Chrysler Corp.*, 229 So. 2d 568 (Miss. 1969).

⁸² 391 F.2d 495 (8th Cir. 1968). It should be noted that most decisions following *Larsen* are federal court decisions predicting what the state courts would hold. Decisions following the *Larsen* approach include: *Bremier v. Volkswagen of Am., Inc.*, 340 F. Supp. 949 (D.D.C. 1972); *Dyson v. Gen. Motors Corp.*, 298 F. Supp. 1064 (E.D. Pa. 1969); *Ford Motor Co. v. Evancho*, 327 So. 2d 201 (Fla. 1976); *Mickle v. Blackman*, 252 S.C. 202, 166 S.E.2d 173 (1969).

⁸³ 359 F.2d at 823.

⁸⁴ *Id.* at 823-24.

⁸⁵ *Id.* at 823.

⁸⁶ *Id.* at 824-25.

cle⁸⁷ because the intended purpose or "use" of an automobile is for driving and not for crashing.⁸⁸ This restricted duty existed "despite the manufacturer's ability to foresee the possibility that such collisions might occur."⁸⁹ Furthermore, on a policy level, the court recommended as a desirable goal the formulation of stricter design standards that require manufacturers to construct crashworthy vehicles.⁹⁰ The court stated, however, that the establishment of such standards would be a "legislative function" and not the consequence of "judicial interpretation of existing law."⁹¹

Many commentaries criticizing *Evans* focused on two weaknesses in the court's reasoning.⁹² First, the majority of the court failed to understand the truly basic issue in the case—whether the manufacturer had a duty "to use such care in designing its automobiles that reasonable protection is given purchasers and users against death and injury from accidents which are expected and foreseeable yet unavoidable despite careful use."⁹³ Second, the *Evans* court largely based its decision on the New York case of *Campo v. Scofield*⁹⁴ which was subsequently overruled.

b. *The "Larsen" approach*

In *Larsen v. General Motors Corp.*,⁹⁵ the plaintiff received

⁸⁷ *Id.* at 824.

⁸⁸ *Id.* at 825.

⁸⁹ *Id.*

⁹⁰ *Id.* at 824.

⁹¹ *Id.*

⁹² See, e.g., Golden, *Automobile Crashworthiness—The Judiciary Responds When Manufacturers Improperly Design Their Cars*, 46 INS. COUNS. J. 335, 341 (1979) [hereinafter cited as Golden].

⁹³ 359 F.2d at 827 (Kiley, J., dissenting).

⁹⁴ 301 N.Y. 468, 95 N.E.2d 802 (1950). The *Campo* Court was overruled in *Micallef v. Miehle Co.*, 39 N.Y.2d 376, 348 N.E.2d 571 (1976). In *Campo*, the court was concerned with whether a manufacturer had a duty to design a machine with a safety guard or stopping device to prevent injury to a user resulting from a patent defect. The New York Court of Appeals affirmed a lower court decision that the defendant manufacturer owed no such duty since obvious dangers are excluded from the scope of "intended use." 301 N.Y. at 469-72, 95 N.E.2d at 803-04. This decision is questionable authority for deciding a manufacturer's liability for the frame design of an automobile. Golden, *supra* note 92, at 341.

⁹⁵ 391 F.2d 495 (8th Cir. 1968).

serious injuries when the impact of a head-on collision caused a severe thrust of the steering mechanism into the plaintiff's head.⁹⁶ The plaintiff sued General Motors alleging that his injuries and/or their exacerbation were proximately caused by the negligent design of the steering shaft.⁹⁷ The Court of Appeals for the Eighth Circuit held in favor of the plaintiff,⁹⁸ thereby establishing a precedent that introduced the doctrine of crashworthiness into automobile crash litigation.

The court of appeals' decision in *Larsen* rejected the reasoning of *Evans* in two basic respects. First, the court posited a broader definition of the automobile manufacturer's duty. The court held that the manufacturer has a qualified duty to design a relatively crashworthy vehicle, not a crashproof vehicle, but one incorporating design factors minimizing or lessening the injurious effects of a crash.⁹⁹ The *Larsen* court assumed that "duty" included a broader interpretation of the intended "purposes" or "use" of the vehicle than had the *Evans* court. The *Larsen* court was of the opinion that although crashing is not an intended purpose of an automobile, crashes are clearly foreseeable and a statistically unavoidable consequence of the normal and intended use of an automobile for which the manufacturer must design.¹⁰⁰ A second distinguishing feature is that unlike the *Evans* approach that leaves the formulation of crashworthiness standards to the legislature, *Larsen* took the judicial activist position that courts have a role in supplementing existing statutes and regulations in the area of automobile crashworthiness.¹⁰¹

One often-repeated criticism of *Larsen* is directed at the court's logic which assumes that a manufacturer has a duty to design crashworthy vehicles simply because automobile colli-

⁹⁶ *Id.* at 496-97.

⁹⁷ *Id.* at 497. The steering shaft of this automobile was not designed like that of other cars to minimize the rearward displacement or impact. Indeed, in cases of front-end collision the steering shaft would be pushed back toward the driver's head just like a spear. *Id.* at 497 n.2.

⁹⁸ *Id.* at 502.

⁹⁹ *Id.* at 502-03.

¹⁰⁰ *Id.* at 502.

¹⁰¹ *Id.* at 506.

sions are foreseeable by the manufacturer. One critic argued that "[f]oreseeability . . . is not to be equated with duty; it is . . . but one factor, albeit an important one, to be weighed in determining the issue of duty."¹⁰² Despite the court's questionable assumption, an overwhelming majority of jurisdictions adopted and continue to use the *Larsen* approach while rejecting the *Evans* perspective.¹⁰³

3. *The Roots of the Aircraft Crashworthiness Doctrine*

Although the doctrine of crashworthiness has received widespread acceptance in the field of automobile accident litigation, the doctrine only recently has been invoked successfully in a small number of aviation accident cases. The lack of knowledge possessed by courts respecting the crashworthiness doctrine and the courts' failure to apply the doctrine in aviation cases is due to two factors. First, many of the aviation crashworthiness cases are not reported because the cases are settled before they go to trial.¹⁰⁴ Second, crashworthiness cases that are adjudicated generally do not proceed beyond the trial court level, resulting in decisions that either are not reported or if reported, are not easily accessible.¹⁰⁵

In the small number of litigated and reported aircraft crashworthiness cases, courts divided between applying the *Evans* and the *Larsen* approaches. The first school of thought follows the *Evans* approach and rejects the adoption of the crashworthiness doctrine in aviation accident litigation. This view is best exemplified by decisions of courts located in Mississippi. Consistent with the application of the *Evans* logic in automobile accident litigation,¹⁰⁶ a Mississippi federal court in

¹⁰² *Dreisonstok v. Volkswagenwerk*, 489 F.2d 1066, 1070 (4th Cir. 1974).

¹⁰³ This statement should be qualified by the fact that most decisions following *Larsen* are federal court decisions. See *supra* note 82.

¹⁰⁴ Comment, *Uncrashworthy Aircraft*, *supra* note 65, at 558. A problem is that most of the aircraft crashworthiness cases are never appealed. Thus, the cases do not reach the widely reported and readily available level of supreme court and court of appeal decisions.

¹⁰⁵ *Id.*

¹⁰⁶ *Gen. Motors Corp. v. Howard*, 244 So. 2d 726 (Miss. 1971); *Ford Motor Co. v. Simpson*, 233 So. 2d 797 (Miss. 1970); *Walton v. Chrysler Motor Corp.*, 229 So. 2d 568 (Miss. 1969).

Williams v. Cessna Aircraft Corp.,¹⁰⁷ as well as the Mississippi Supreme Court in *Pattillo v. Cessna Aircraft Corp.*,¹⁰⁸ refused to adopt the doctrine of aircraft crashworthiness.

In *Williams v. Cessna Aircraft Corp.*, an aircraft crashed after its engine caught fire.¹⁰⁹ On impact, the pilot's seat collapsed and the safety harness broke loose such that the pilot was violently catapulted into the instrument panel and was killed.¹¹⁰ The plaintiff's widow alleged that the negligently designed and inadequately constructed restraint and energy-absorption systems of the aircraft contributed to the decedent's death.¹¹¹ The United States District Court for the Northern District of Mississippi decided in favor of the defendant manufacturer stating that Mississippi law imposed no duty on the manufacturer to design a seat and a safety harness that could withstand a high speed crash.¹¹² The federal court rejected the crashworthiness doctrine, considering itself obligated to follow the precedent established by Mississippi state courts. The holdings of the Mississippi state courts coincided with *Evans* in regard to automobile accident cases.¹¹³

In 1980, the Mississippi Supreme Court in *Pattillo v. Cessna Aircraft Corp.*, reaffirmed its rejection of the crashworthiness doctrine both in automobile and in aviation accident litigation.¹¹⁴ In *Pattillo*, pilot error caused an airplane to crash during dense fog and adverse weather conditions.¹¹⁵ On impact, the decedent's passenger seat and seatbelt tore loose such that the decedent was thrown into the yoke, into the instrument panel, and then out of the aircraft.¹¹⁶ The plaintiffs alleged that the negligently designed and negligently manufactured restraint system of the aircraft contributed to

¹⁰⁷ 376 F. Supp. 603 (N.D. Miss. 1974).

¹⁰⁸ 379 So. 2d 1225 (Miss. 1980).

¹⁰⁹ 376 F.Supp. at 605.

¹¹⁰ *Id.*

¹¹¹ *Id.*

¹¹² *Id.* at 607.

¹¹³ *Id.* at 607-08. See *supra* note 106 for Mississippi State Court decisions rejecting the crashworthiness doctrine.

¹¹⁴ 379 So. 2d at 1227.

¹¹⁵ *Id.* at 1225.

¹¹⁶ *Id.*

the decedent's death.¹¹⁷ The court, following the holding in *Evans*, decided in favor of the defendant manufacturer rejecting the doctrine of crashworthiness. The Mississippi Supreme Court reiterated its position established in automobile crashworthiness cases and cited for support the cases relied upon by the federal court in *Williams*.¹¹⁸

A second school of thought, however, exists in respect to the manufacturer's liability for the crashworthiness of aircraft. This school follows the *Larsen* approach and accepts the doctrine of crashworthiness in aviation accident litigation. Decisions, usually rendered at the trial court level, that pursued the *Larsen* approach, based the manufacturer's liability on principles of negligent design and/or breach of implied warranty and/or strict liability. While these trial court decisions do not add to or modify existing principles of law, their application of the crashworthiness doctrine is demonstrative of the growing acceptance of the doctrine in aviation accident litigation. The following cases exemplify the application of the crashworthiness doctrine to general aviation accidents.

Smith v. Cessna Aircraft Co.,¹¹⁹ decided in 1972, is probably the first decision to apply the crashworthiness doctrine to an aviation crash. *Smith* involved a general aviation airplane that crashed after attempting a take-off. After the initial impact, little damage occurred to the aircraft and no injuries occurred to the occupants.¹²⁰ A post-crash fire, however, resulted in three deaths and the injury of one passenger.¹²¹ The plaintiffs sued the aircraft manufacturer on the theories of negligence, warranty, and strict liability.¹²² Many of the plaintiffs' "allegations invoked uncrashworthy features."¹²³ The plaintiffs were successful in their claims.¹²⁴

¹¹⁷ *Id.*

¹¹⁸ *Id.* at 1226-27.

¹¹⁹ No. 70-9255-L (Dist. Ct. of Dallas County, 193d Judicial Dist. of Texas, Oct. 6, 1972), abstracted in 16 AM. TRIAL LAW. NEWSLETTER 30 (1973). This case is also cited in Comment, *Uncrashworthy Aircraft*, *supra* note 65, at 561 n.57.

¹²⁰ Comment, *Uncrashworthy Aircraft*, *supra* note 65 at 561.

¹²¹ *Id.*

¹²² *Id.*

¹²³ *Id.*

¹²⁴ *Id.*

In 1973, the California Superior Court decided *Fuller v. Capitol Sky Park*.¹²⁵ In *Fuller*, the plaintiff pilot negligently caused the crash of his crop duster plane. On impact, the pilot's seatbelt broke such that he was thrust out of the aircraft and suffered permanent paraplegia.¹²⁶ The plaintiff sued the manufacturer alleging that the seatbelt was defective. The trial court found the manufacturer liable under the doctrine of crashworthiness and held that the plaintiff's injuries were exacerbated and proximately caused by the defective seatbelt system.¹²⁷

In *Eichstedt v. Cessna Aircraft Co.*¹²⁸, an aircraft hit a canyon wall as a result of pilot error.¹²⁹ Mr. Eichstedt, a passenger, survived the initial impact with his portion of the aircraft cabin remaining largely intact. He crawled to safety but later died from internal injuries that arose during the "dynamic" phase of the crash.¹³⁰ The plaintiffs sued the aircraft manufacturer alleging that Eichstedt's death was caused by the improper installation of seatbelts, the absence of a shoulder harness, and the inadequately anchored seats.¹³¹ (Eichstedt's seat left its mark upon impact).¹³² The "three alleged defects presented crashworthiness issues and were pursued under theories of negligence, warranty and strict liability."¹³³ The jury finding that design of the aircraft was uncrashworthy held for the plaintiff.¹³⁴

Other general aviation cases exist in which the issue of aircraft crashworthiness was seriously considered by the court even though the case was not decided on that basis. For exam-

¹²⁵ *Fuller v. Capitol Sky Park*, No. 203674 (Super. Ct., Sacramento Div. Feb. 1973), (cited in comment, *Uncrashworthy Aircraft*, *supra* note 65, at 562 n.59 abstracted in 16 Am. Trial Law. Newsletter 331 (1973)).

¹²⁶ Comment, *Uncrashworthy Aircraft*, *supra* note 65, at 562.

¹²⁷ *Id.*

¹²⁸ *Eichstedt v. Cessna Aircraft Co.*, No. 282029 (Dist. Ct. of Washoe County Nev., Aug. 1977) (cited in Comment, *Uncrashworthy Aircraft*, *supra* note 65, at 562 n.60).

¹²⁹ Comment, *Uncrashworthy Aircraft*, *supra* note 65, at 562.

¹³⁰ *Id.*

¹³¹ *Id.*

¹³² *Id.*

¹³³ *Id.*

¹³⁴ *Id.*

ple, in *Wilson v. Piper Aircraft Corp.*,¹³⁵ the plaintiffs failed to convince the court either that the crash of the aircraft was caused by engine failure due to defective design or that the passengers' deaths were caused by the inadequate crashworthiness of the aircraft. The plaintiffs claimed that the restraint system was deficient because no shoulder harnesses were installed and the seatbelts and the attachments were torn loose from the cabin on impact.¹³⁶ Although the court held for the defendant, the court seriously considered evidence respecting the crashworthiness issue. If more evidence had been produced, the court might have decided in favor of the plaintiff on the basis of deficient aircraft crashworthiness.¹³⁷

The New York decision of *Cousins v. Instrument Flyers, Inc.*,¹³⁸ directly involved the issue of crashworthiness. In *Cousins*, the plaintiff was injured when the leased plane that he was piloting ran out of fuel and crash-landed.¹³⁹ The plaintiff alleged that his injuries were contributed to and/or were caused by the defective design of the aircraft.¹⁴⁰ The plaintiff claimed that the aircraft was uncrashworthy in the following respects: (i) the restraint system of the aircraft was inadequate; (ii) the seat attachment was inadequate; (iii) a hazardous cabin environment existed; and (iv) no energy absorption device could be found in the front section of the aircraft.¹⁴¹ The court held for the defendant manufacturer on the basis that contributory negligence was a complete defense under New York law to a strict products liability claim.¹⁴² Thus, because the plaintiff's claim was rejected on the basis of contributory negligence, the court never decided the issue of crashworthiness. Nevertheless, an argument can be made that absent a contributory negligence defense, the court might

¹³⁵ 282 Or. 61, 577 P.2d 1322, *rehearing denied*, 282 Or. 411, 179 P.2d 1287 (1978).

¹³⁶ 577 P.2d at 1329.

¹³⁷ See Comment, *Uncrashworthy Aircraft*, *supra* note 65, at 561.

¹³⁸ 58 A.D.2d 336, 396 N.Y.S.2d 655 (1977).

¹³⁹ *Id.*

¹⁴⁰ 396 N.Y.S.2d at 656-57.

¹⁴¹ *Id.*

¹⁴² *Id.* at 657.

have decided in favor of the plaintiff because New York law recognizes the "second impact" theory.¹⁴³

A more recent decision recognizing the applicability of the aircraft crashworthiness doctrine is *Trust Corp. v. Piper Aircraft Corp.*¹⁴⁴ In *Trust Corp.*, pilot error caused an aircraft to strike a telephone wire shortly after take-off.¹⁴⁵ The pilot died in the subsequent crash.¹⁴⁶ The plaintiff sued the aircraft manufacturer for the death of the decedent alleging that the pilot restraint system was defective. The plaintiff claimed that the pilot's seat lacked shoulder harnesses that would have prevented the pilot's fatal injury upon impact.¹⁴⁷

The district court did not decide the issue of liability. The court stated, however, that under Montana law, comparative liability principles applied in such "ground collision" products liability actions.¹⁴⁸ Furthermore, the court stated that a crashworthiness action "is viable even though the cause of the accident was not the defective condition alleged to have enhanced the injuries."¹⁴⁹

At this point it is appropriate to diverge from general aviation accident litigation to introduce a case in which the manufacturer of a commercial aircraft was sued on the basis of the crashworthiness doctrine. Although the plaintiffs did not succeed in *Bruce v. Martin-Marietta Corp.*,¹⁵⁰ the fact that the court diligently and systematically considered the crashworthiness claim is a persuasive basis for expecting a favorable acceptance of the crashworthiness doctrine in future

¹⁴³ Comment, *Uncrashworthy Aircraft*, *supra* note 65, at 560. See *supra* note 12 and accompanying text respecting the concept of "second impact."

¹⁴⁴ 506 F. Supp. 1093 (D. Mont. 1981).

¹⁴⁵ *Id.* at 1094.

¹⁴⁶ *Id.*

¹⁴⁷ *Id.*

¹⁴⁸ *Id.* at 1098. The court granted the plaintiff's motion to strike those defenses. The motion asserted that the plaintiff was contributorily negligent and, therefore, not permitted to recover. The court added, however, that "conduct by the plaintiff which could be termed contributory negligence, assumption of risk, and misuse, shall in the future be used, if applicable, only to compare fault and reduce damages, if any are proved." *Id.* at 1099. See *supra* note 12 and the accompanying text respecting the concept of "second collision."

¹⁴⁹ 506 F. Supp. at 1094.

¹⁵⁰ 544 F.2d 442 (10th Cir. 1976), *aff'g*, 418 F. Supp. 829 (W.D. Okla. 1975).

cases of commercial aircraft crashes.

In *Bruce*, a commercial aircraft crashed into a mountain.¹⁵¹ The accident resulted in the deaths of thirty-two of the forty occupants.¹⁵² While the crash itself was survivable, the impact caused the seats in the passenger cabin to break loose from the floor and to be thrown against the bulkhead of the cabin.¹⁵³ Consequently, the seats being torn from the cabin floor not only injured the passengers but also blocked the exit.¹⁵⁴ Thus, when a post-crash fire erupted, emergency evacuation was thwarted by the blocked exit such that passengers either perished or were seriously injured.¹⁵⁵ The plaintiffs, injured passengers and relatives of deceased passengers, sued on the basis of negligence, breach of express and implied warranty, and strict liability,¹⁵⁶ claiming that the defendant manufacturer¹⁵⁷ failed to design, manufacture, and/or maintain a crashworthy aircraft in terms of both its restraint system¹⁵⁸ and its capacity to minimize the post-crash fire hazard.¹⁵⁹

The district court granted the defendant manufacturer's

¹⁵¹ *Id.* at 444.

¹⁵² *Id.*

¹⁵³ *Id.* The "bulkhead" is an upright partition in the cabin of an aircraft separating compartments.

¹⁵⁴ *Id.*

¹⁵⁵ *Id.*

¹⁵⁶ The plaintiffs alleged that "the crash resulted from the defendants' negligence in the design, manufacture, inspection, service, maintenance and equipping of the aircraft; the crash was caused by defective engines; the defendants were negligent in failing to equip and maintain [the] aircraft to include crashworthy design characteristics; the seats and seat attachments did not minimize the possibility of failure by forces acting on the seats during the crash. The aircraft did not incorporate design and manufacturing techniques to minimize the possibility of fire in the event of a crash; the crash constituted a breach of implied and express warranties by the defendants that the aircraft was crashworthy, the injuries received were as a result of the failure of the defendants to incorporate crashworthy features in the aircraft for which, the defendants are strictly liable." *Bruce v. Martin—Marietta*, 418 F. Supp. 829, 830 (W.D. Okla. 1975), *aff'd*, 544 F.2d 442 (10th Cir. 1976).

¹⁵⁷ *Bruce*, 544 F.2d at 444. The plaintiffs sued the aircraft manufacturer, Martin-Marietta Corporation, and the air carrier, Ozark Airlines.

¹⁵⁸ 418 F. Supp. at 830. The plaintiffs alleged that "the seats and seat attachments did not minimize the possibility of failure by forces acting on the seat during the crash." See *supra* note 156 for the text of the essential elements of the complaint.

¹⁵⁹ 418 F. Supp. at 836. See *supra* note 156 for the the essential elements of the complaints.

motion for summary judgment.¹⁶⁰ The court's decision was based on the plaintiffs' failure to prove a defect in design. The court was of the opinion that the disputed features of the aircraft satisfied all the minimum standards of engineering design requirements and federal regulations.¹⁶¹

The Court of Appeals for the Tenth Circuit affirmed the district court's decision.¹⁶² The appellate court, however, was particularly concerned with establishing the manufacturer's liability on the basis of strict liability in tort under section 402A of the RESTATEMENT (SECOND) OF TORTS (RESTATEMENT).¹⁶³ The appellate court stated that the RESTATEMENT required the plaintiffs to prove that the product was "dangerous beyond the expectation of the ordinary consumer."¹⁶⁴ The appellate court found no such proof because the plaintiffs had "not shown that the ordinary consumer would expect a plane made in 1952 to have the safety features of one made in 1970."¹⁶⁵ The appellate court found in favor of the defendant manufacturer on the basis of the state-of-the-art defense.¹⁶⁶

Bruce is significant in two respects. First, the case indicated the willingness of the courts to at least consider the crashworthiness doctrine in the field of commercial aviation litigation. While in this particular case, the court concluded that the plaintiffs had insufficient proof of a design defect, it may be inferred that the ordinary consumer in 1970 expected greater safety features of an aircraft manufactured in 1970.¹⁶⁷ Second, the court of appeals' emphasis on the principles of strict liability in establishing the manufacturer's responsibility to passengers is indicative of the development of the crashworthiness doctrine beyond the realm of negligence and breach of warranty theories.

¹⁶⁰ 418 F. Supp. at 836. The trial court also granted Ozark Airlines' motion for summary judgement. *Id.* at 845.

¹⁶¹ *Id.* at 836.

¹⁶² 544 F.2d at 442.

¹⁶³ *Id.* at 447.

¹⁶⁴ *Id.*

¹⁶⁵ *Id.*

¹⁶⁶ *Id.*

¹⁶⁷ Comment, *Uncrashworthy Aircraft*, *supra* note 65, at 559-60.

4. *The Aircraft Crashworthiness Doctrine Matures: Strict Liability in Tort*

The present progress in applying strict liability principles in the field of aircraft crashworthiness has lagged far behind the development of the doctrine of crashworthiness in the automobile field. Although manufacturers have been found liable under the theory of strict liability in many aviation cases since the 1960's,¹⁶⁸ the theory of strict liability was not extended significantly to problems of aircraft crashworthiness until the 1978 landmark decision of *McGee v. Cessna Aircraft Co.*¹⁶⁹ Although on remand the trial court ultimately entered judgment in favor of the defendant manufacturer, the court of appeals did accept the principles of strict liability in aviation crashworthiness circumstances.

In *McGee* a general aviation airplane crashed shortly after take-off.¹⁷⁰ On impact, the plaintiff, a passenger, suffered no serious injuries. The plaintiff, however, was rendered unconscious as a result of the crash, and was dragged from the burning wreckage by fellow occupants.¹⁷¹ The plaintiff's legs were amputated because of the extensive third degree burns experienced in the post-crash fire.¹⁷²

The plaintiff sued the aircraft manufacturer on the basis of both negligence and strict liability principles.¹⁷³ The plaintiff urged that her injuries were the result of design defects in the fuel system, such that the plane was inherently unsafe.¹⁷⁴ The plaintiff contended that the fuel system was designed defectively because the fuel reservoir tank was constructed and was located in such a manner that the tank was highly susceptible to being ruptured on crash impact by a collapsing nosewheel strut. As a result of the rupture, the plaintiff claimed that the

¹⁶⁸ See S. SPEISER & C. KRAUSE, 2 AVIATION TORT LAW 515 (1979) [hereinafter cited as Speiser].

¹⁶⁹ 82 Cal. App. 3d 1005, 147 Cal. Rptr. 694 (1978) discussed *infra* at note 177 and accompanying text.

¹⁷⁰ 82 Cal. App. 3d at 1008, 147 Cal. Rptr. at 695.

¹⁷¹ *Id.*

¹⁷² *Id.*

¹⁷³ *Id.* at 1007, 147 Cal. Rptr. at 695.

¹⁷⁴ *Id.* at 1007-08, 147 Cal. Rptr. at 695.

fuel was likely to leak into the cabin thereby creating a post-crash hazard.¹⁷⁵ Citing the 1972 California Supreme Court decision of *Cronin v. J.B.E. Olson Corp.*¹⁷⁶ as extending strict liability principles to design defects generally and deficient crashworthiness problems specifically, the *McGee* court opened the floodgates, permitting aviation crashworthiness suits to be brought under strict liability principles.¹⁷⁷

a. *The roots, policy justification, and requirements of strict liability*

The origins of the strict products liability theory lie in *Greenman v. Yuba Power Products, Inc.*¹⁷⁸ In this case, Justice Traynor announced the "*Greenman* rule": "A manufacturer is strictly liable in tort when an article he places on the market . . . proves to have a defect that causes injury to a human being."¹⁷⁹ Subsequently, the strict products liability theory was incorporated in the RESTATEMENT in section 402A which imposes strict liability on a seller of an "unreasonably dangerous" defective product that causes harm to the user or consumer.¹⁸⁰ Furthermore, the strict liability theory was made clearly applicable to airplanes.¹⁸¹

¹⁷⁵ *Id.* The particular Cessna aircraft involved in the crash had a non-retractable nosewheel attached to the aircraft by a metal strut. This supporting strut was connected in such proximity to the accumulator tank that on impact the strut ruptured the accumulator tank and a fire started.

¹⁷⁶ 8 Cal. 3d 121, 501 P.2d 1153, 104 Cal. Rptr. 433 (1972).

¹⁷⁷ *McGee v. Cessna Aircraft Co.*, 82 Cal. App. 3d 1005, 1012, 147 Cal. Rptr. 694, 698 (1978).

¹⁷⁸ 59 Cal. 2d 57, 377 P.2d 897, 27 Cal. Rptr. 697 (1962).

¹⁷⁹ *Id.* at 62, 377 P.2d at 900, 27 Cal. Rptr. at 700.

¹⁸⁰ RESTATEMENT (SECOND) OF TORTS § 402A (1965), which provides:

(1) One who sells any product in defective condition unreasonably dangerous to the user or consumer or to his property is subject to liability for physical harm thereby caused to the ultimate user or consumer or to his property, if (a) the seller is engaged in the business of selling such a product, and (b) it is expected to and does reach the user or consumer without substantial change in the condition in which it is sold.

(2) The rule stated in Subsection (1) applies although (a) the seller has exercised all possible care in the preparation and sale of his product, and (b) the user or consumer has not bought the product from or entered into any contractual relation with the seller.

¹⁸¹ *Id.*

Although the theory of strict products liability has not been legislatively enacted in any American jurisdiction, an overwhelming majority of states have judicially adopted either section 402A of the RESTATEMENT or its equivalent.¹⁸² The public policy rationales invoked by the courts to justify the application of strict products liability principles are numerous. First and foremost, the strict liability theory is seen as an effective method of spreading losses caused by accidents. The theory insures that "the cost of injuries resulting from defective products are borne by the manufacturers that put such products on the market rather than by the injured persons who are powerless to protect themselves."¹⁸³ Second, the strict liability theory serves as an economic incentive for manufacturers to design and to manufacture safer products because the manufacturer's potential liability is much greater under strict products liability principles than under negligence principles.¹⁸⁴ Thus, the strict liability theory relieves the injured plaintiff of the problems of proof characteristic of the warranty and negligence theories because the manufacturer may be held strictly liable even if the manufacturer took reasonable care in the manufacture and the design of the product.¹⁸⁵

The plaintiff must prove the following five essential elements to succeed on the strict products liability theory: (1) the defendant owed a strict duty to the plaintiff to provide a product free from "defect;" (2) the defendant breached his

¹⁸² Several courts adopted strict products liability principles in aviation accident cases. One of the first aviation accident cases in which strict liability principles were applied was *Goldberg v. Kollsman Instrument Corp.*, 12 N.Y.2d 432, 191 N.E.2d 81, 240 N.Y.S.2d 592 (1963). See SPEISER, *supra* note 168, at 516-17 for citations to a number of aviation cases recognizing the strict liability theory including: *Lindsay v. McDonnell Douglas Aircraft Corp.*, 485 F.2d 1288 (8th Cir. 1973); *Cousins v. Instrument Flyers, Inc.*, 44 N.Y.2d 698, 376 N.E.2d 914, 405 N.Y.S.2d 441 (1978); *Berkebile v. Brantly Helicopter Corp.*, 462 Pa. 83, 337 A.2d 893 (1975).

¹⁸³ *Greenman v. Yuba Power Products, Inc.*, 59 Cal. 2d 57, 63, 377 P.2d 897, 901, 27 Cal. Rptr. 697, 701 (1962).

¹⁸⁴ See Hoenig, *Product Design and Strict Tort Liability: Is There a Better Approach?*, 8 Sw. U.L. Rev. 109, 131 (1976). Some commentators, however, have disputed the view that strict liability actually encourages greater care than negligence liability. See, e.g., Keeton I, *supra* note 15, at 34.

¹⁸⁵ See *Berkebile v. Brantly Helicopter Corp.*, 462 Pa. 83, 337 A.2d 893, 898-99 (1975). See also Prosser, *The Assault upon the Citadel (Strict Liability to the Consumer)*, 69 YALE L.J. 1099 (1960).

duty by providing a defective product; (3) in terms of cause-in-fact, the defect existed when it left the control of defendant manufacturer and was a substantial factor in causing the plaintiff's damages; (4) the defect was the proximate cause of the plaintiff's damages; and (5) the plaintiff suffered damages.¹⁸⁶ This paper focuses on the first two elements of the strict products liability cause of action. In regard to these elements, the primary concern of the courts and the commentators is the definition of "defect."

b. *The development of strict liability: The meaning of "defect"*

Strict products liability is not absolute liability. The requirement of a "defect" imposed by both the *Greenman* rule and the RESTATEMENT, distinguishes the theories of strict liability and absolute liability.¹⁸⁷ The absolute liability theory renders a manufacturer automatically liable for all injuries involved in the use of his product, regardless of whether a defect is present. In contrast, the existing strict products liability theory imposes liability upon a manufacturer short of absolute liability but beyond negligence by requiring the plaintiff to prove the existence of a "defect" in the product.¹⁸⁸

Courts and commentators have sought to achieve, in the hope of developing a coherent strict liability theory, a uniform and single definition and test of "defect." The courts, however, have failed to achieve this goal. The roots of the dilemma can be traced back to the *Greenman* decision in which

¹⁸⁶ A number of different authors and cases state these various requirements in different ways. See, e.g., *Berkebile v. Brantly Helicopter Corp.*, 462 Pa. 83, 337 A.2d 893 (1975). Each requirement is characterized by a number of problem areas. While courts and commentators agree that in strict liability compensatory damages are recoverable for personal injuries, the courts are divided as to whether punitive damages are recoverable. See, e.g., *Greenman v. Yuba Products Inc.*, 59 Cal. 2d 57, 377 P.2d 897, 27 Cal. Rptr. 697 (1962); Haskell, *The Aircraft Manufacturer's Liability for Design and Punitive Damages—The Insurance Policy and Public Policy*, 40 J. AIR L. & COM. 595 (1974) [hereinafter cited as Haskell]. See also Owen, *Punitive Damages in Products Liability Litigation*, 74 Mich. L. Rev. 1257, 1268-71 (1976).

¹⁸⁷ Comment, *Strict Products Liability*, *supra* note 17, at 210.

¹⁸⁸ See *Barker v. Lull Engineering Co.*, 20 Cal. 3d 413, 432, 573 P.2d 443, 456, 143 Cal. Rptr. 225, 238 (1978). See also *Cronin v. J.B.E. Olson Corp.* 8 Cal. 3d 121, 133, 501 P.2d 1153, 1162, 104 Cal. Rptr. 433, 442 (1972).

the court failed to provide any test to determine whether a particular product is actually defective. Furthermore, section 402A of the RESTATEMENT merely muddled the definitional problem by adding the "unreasonably dangerous" requirement for defectiveness.¹⁸⁹

The problem of defining "defect" is complicated by the broad scope of the term in that the term encompasses both manufacturing and design defects. In one instance, the definition and the determination of a manufacturing "defect" is a relatively simple matter because the court may use the "deviation-from-the-norm" test: the product is compared to the manufacturer's own production standards.¹⁹⁰ In another instance, however, the definition and the determination of a design "defect" may be a confused and complicated process, depending upon whether the defect is the result of an inadvertent design choice or a conscious design choice.¹⁹¹

An inadvertent design choice involves the manufacturer's design engineer unintentionally overlooking some safety consideration. As a result, the particular design chosen does not accomplish what the design would have accomplished had the engineer considered the safety issue.¹⁹² Defects arising from such inadvertent design choices are determined in the same relatively easy and objective manner as those defects which involve manufacturing flaws. The simple "deviation-from-the-norm" test may be applied. Thus, strict liability for inadvertent design choice also represents liability for deviation from the manufacturer's own standards. It is assumed that had "the risks of the inadvertent design choice been made clear to the manufacturer, a different design would have been chosen or warning provided."¹⁹³ The conscious design choice involves

¹⁸⁹ See Birnbaum, *Unmasking the Test for Design Defect: From Negligence [to Warranty] to Strict Liability to Negligence*, 33 VAN. L. REV. 593, 597-99 (1980) [hereinafter cited as Birnbaum I].

¹⁹⁰ See Traynor, *The Ways and Meanings of Defective Products and Strict Liability*, 32 TENN. L. REV. 363, 367 (1965).

¹⁹¹ See Henderson, *supra* note 16, at 1552.

¹⁹² Walkowiak, *Product Liability Litigation and the Concept of Defective Goods: 'Reasonableness' Revisited?* 44 J. AIR L. & COM. 705, 719 (1979) [hereinafter cited as Walkowiak].

¹⁹³ *Id.* at 722. See Henderson, *supra* note 16, at 1548.

the manufacturer's design engineer being aware of and accepting certain risks associated with the intended design of the product in exchange for the increased benefits or the reduced costs which the design engineer believes justify the conscious acceptance of those risks.¹⁹⁴

Thus, strict liability is imposed on the manufacturer for different purposes. In the case of manufacturing flaws or inadvertent design choices, strict products liability is imposed to penalize an ineffective attempt by the manufacturer to achieve an intended objective.¹⁹⁵ In the case of conscious design choices, strict products liability is imposed to penalize the manufacturer's choice of design such that a "social choice" is substituted for the design engineer's choice.¹⁹⁶ The formulation of a social choice is a difficult and subjective task depending upon a particular court's preference to protect the consumer's or the user's interest or to protect the manufacturer's interest.¹⁹⁷ The complex variety of social choice trade-offs assumed by different courts¹⁹⁸ has resulted in a maze of definitions and tests being developed to determine what constitutes a "defective" product in conscious design defect cases.¹⁹⁹ Due to the belief that the deficiency of crashworthiness in an aviation product is generally the result of a conscious design

¹⁹⁴ Henderson, *supra* note 16, at 1548.

¹⁹⁵ See Walkowiak, *supra* note 192, at 721.

¹⁹⁶ *Id.* at 722.

¹⁹⁷ See Birnbaum I, *supra* note 189, at 600-01. The definition and test formulated depends upon the particular trade-off the court has made between the consumer's or user's interest in receiving compensation for accident-incurred losses without suffering the heavy evidentiary burdens of warranty and negligence actions and the manufacturer's interest in not being absolutely liable for all injuries sustained from the use of its products. *Id.* at 600-01.

¹⁹⁸ This confusion and complexity of definitions and tests has reinforced and has been reinforced by the failure of many courts and commentators to clearly and precisely delineate negligence and strict liability notions. See Birnbaum I, *supra* note 189, at 601. It is not surprising that while some courts, such as those in Maryland and Nebraska, appear to only handle design defect cases under negligence principles, other courts, such as those in California, handle such cases under both negligence and strict liability theories. See, e.g., Volkswagen of Am., Inc. v. Young, 272 Md. 201, 321 A.2d 737, 746 (1974); Friedrich v. Anderson, 191 Neb. 724, 217 N.W.2d 831, 836-37 (1974); McGee v. Cessna Aircraft Corp., 82 Cal. App. 3d 1005, 147 Cal. Rptr. 694 (1978).

¹⁹⁹ See Birnbaum I, *supra* note 189, at 600-01.

choice, the spectrum of alternative definitions and tests developed to determine whether a product is defective due to a conscious design choice will be examined.

(1). *The "consumer expectations" test*

The "consumer expectations" test, set out in section 402A of the RESTATEMENT, provides that a product is considered "unreasonably dangerous" when it is "dangerous to an extent beyond that which would be contemplated by the ordinary consumer who purchases it, with the ordinary knowledge common to the community as to its characteristics."²⁰⁰ The principal advantage of the "consumer expectations" test is that the test begins to focus the jury's attention toward the product itself and away from the manufacturer's conduct.²⁰¹ This shift in focus has eased the application of the strict liability theory as compared to the negligence theory.

The "consumer expectations" test has been criticized for being too vague, imprecise, and subjective.²⁰² Moreover, five specific limitations to the test exist. First, the test tends to short-circuit the analytical process,²⁰³ insofar as once a court determines what an ordinary consumer's expectations are, the case is disposed of in a routine manner without the court considering the risk and utility factors that were involved with the design.²⁰⁴ The "consumer expectations" test may prejudice consumers or users²⁰⁵ and reward callous manufacturers when a danger or a risk is patent and apparent to the ordinary consumer.²⁰⁶ If the court is of the opinion that the risk is patent and apparent, then the court may consider the risk to be within the reasonable contemplation of the ordinary

²⁰⁰ RESTATEMENT (SECOND) OF TORTS Section 402A, comment i (1965).

²⁰¹ Birnbaum, *A Re-Evaluation of the Concept of Design Defects in Products*, FED'N OF INS. COUNS. Q., Winter 1978, at 199, 200 [hereinafter cited as Birnbaum II]

²⁰² *Id.*

²⁰³ Twerski, *From Defect to Cause to Comparative Fault—Rethinking Some Product Liability Concepts*, 60 MARQ. L. REV. 297, 309 (1977).

²⁰⁴ See Birnbaum I, *supra* note 189, at 613.

²⁰⁵ *Id.*

²⁰⁶ See *Luque v. McLean*, 8 Cal. 3d 136, 145, 501 P.2d 1163, 1169, 104 Cal. Rptr. 443, 449 (1972). See also *Stenberg v. Beatrice Foods Co.*, 576 P.2d 725, 730-31 (Mont. 1978).

consumer. As a result, the court may find that the product is not unreasonably dangerous and therefore not defective. Thus, the deterrent effect of strict products liability is weakened insofar as this test gives manufacturers little incentive to remedy certain patent deficiencies.²⁰⁷ For example, a manufacturer might refuse to remedy an inadequate restraint system or a noncrashworthy fuel system in aircraft, thinking a court might find the aircraft so unreasonably dangerous that the danger would be within the contemplation of the consumer.

Second, although the "consumer expectations" test is good for cases involving commercial losses, the test is inadequate in personal injury and in death circumstances²⁰⁸ of aircraft crashes. Third, it is questionable whether an objective test may be formulated or an existing test may be consistently and objectively applied from court to court. Each court and each jury are likely to have a different interpretation of what a reasonable consumer would expect.²⁰⁹

Fourth, although purchasers and crew members of aircraft may have sufficient expertise to develop reasonable expectations, the "consumer expectations" test is prejudicial to aircraft passengers injured in a crash. Passengers are neither consumers nor users and therefore lack sophisticated knowledge about the product.²¹⁰ Furthermore, courts subjectively speculate and assume that purchasers and passengers have definite expectations respecting the dangerousness of the product. For technologically complicated products such as aircraft, however, purchasers and passengers may not know how safely the product could or should have been made.²¹¹ Fifth, certain consumer expectations of a product may be excessively low in that the expectations are below the minimum stan-

²⁰⁷ Abramson, *supra* note 15, at 179.

²⁰⁸ Keeton, *The Meaning of Defect in Products Liability Law—A Review of Basic Principles*, 45 Mo. L. REV. 579, 589 (1980) [hereinafter cited as Keeton III].

²⁰⁹ See Birnbaum I, *supra* note 189, at 614.

²¹⁰ Abramson, *supra* note 15, at 179.

²¹¹ See *Heaton v. Ford Motor Co.*, 248 Or. 467, 435 P.2d 806 (1967); Keeton, *Products Liability—Design Hazards and the Meaning of Defect*, 10 CUM. L. REV. 293, 303-05 (1979).

dards established by federal regulations.²¹² Thus, while strict adherence to the "consumer expectations" test might result in a finding of a non-defective product, the manufacturer of the product actually may have violated FARs and therefore be deemed negligent "per se."²¹³ Significantly, other consumer expectations of a product, however, may be excessively high, surpassing the technological and/or financial abilities of the manufacturer.²¹⁴

The "consumer expectations" test has been approved by many commentators and courts. The Court of Appeals for the Tenth Circuit in *Bruce v. Martin-Marietta Corp.*, held that to establish strict liability under section 402A of the RESTATEMENT the plaintiff must prove the defectiveness of the product according to the "consumer expectations" test.²¹⁵ The court was of the opinion that the state-of-the-art at the time of the manufacture of the aircraft would help to determine the expectations of the ordinary consumer.²¹⁶ In *Bruce*, the court ruled in favor of the defendant manufacturer, stating that the plaintiffs had "not shown that the ordinary consumer would expect a plane made in 1952 to have the safety features of one made in 1970."²¹⁷

(2). *The "risk-utility" balancing test*

A second test for deciding whether the design of a product is "unreasonably dangerous" and thus defective is the "risk-utility" balancing test (risk-utility test). This test has three principal approaches. These approaches are the "reasonably prudent manufacturer" approach, the "consumer expectations" approach, and the strict "risk-utility" approach.

²¹² The FARs are an example of minimum federal standards respecting aircraft crashworthiness. See *supra* notes 59-70 and accompanying text for a discussion of FARs.

²¹³ Abramson, *supra* note 15, at 179.

²¹⁴ *Id.*

²¹⁵ 544 F.2d 442, 447 (10th Cir. 1976). See *supra* notes 150-67 and accompanying text.

²¹⁶ *Id.*

²¹⁷ *Id.*

(a). *The "reasonably prudent manufacturer" approach*

Deans Wade²¹⁸ and Keeton²¹⁹ first proposed, and some courts subsequently have adopted and modified, a "risk-utility" test. This test asks whether a "reasonably prudent manufacturer" with imputable prior knowledge of the unsafe condition of the product, would have sold the product after considering its risks and its utility.²²⁰ The application of the "risk-utility" test involves two steps. The first step distinguishes the strict products liability standard from the negligence standard by making an assumption of constructive knowledge: the "scienter" of the dangerous condition of the product is imputed to the manufacturer. The "scienter" may be imputed to the manufacturer at the time of manufacture, at the time the product is sold,²²¹ or at the time of trial.²²² The second step of the test is the determination of whether the product is considered "unreasonably dangerous." Courts compare the magnitude of the "risk" created by the scientifically perceived dangerous condition of the product with the "utility" of the product. If a reasonable person would conclude that the "risk"²²³ in using the product outweighs its "utility", the product is deemed "unreasonably dangerous" and therefore defective.²²⁴ In line with this reasoning, a number of factors must be considered to determine whether the product is "unreasonably dangerous." Dean Wade suggested the following seven factors:

1. The usefulness and the desirability of the product—its

²¹⁸ Dean Wade and Dean Keeton have propounded different forms of the "risk-utility" test in a number of published commentaries over the last three decades. Many other commentators and some courts have attempted to fine tune or discredit the suggested tests. See Wade, *On the Nature of Strict Tort Liability for Products*, 44 Miss. L.J. 825, 834-40 (1973) [hereinafter cited as Wade I]; Wade, *Strict Tort Liability of Manufacturers*, 19 Sw. L.J. 5, 15-17 (1965) [hereinafter cited as Wade II].

²¹⁹ See Keeton I, *supra* note 15, at 36-38.

²²⁰ See Wade II, *supra* note 218, at 15.

²²¹ Dean Wade made this assumption in his test. Wade I, *supra* note 218, at 837-40.

²²² Dean Keeton made this assumption in his test. See Keeton II, *supra* note 15, at 568. See *infra* note 234.

²²³ Dean Keeton uses the terms "danger-in-fact" and "risk" synonymously.

²²⁴ Keeton III, *supra* note 208, at 592.

utility to the user and to the public as a whole;

2. The safety aspects of the product—the likelihood that the product will cause injury, and the probable seriousness of the injury;

3. The availability of a substitute product which would meet the same need and not be unsafe;

4. The manufacturer's ability to eliminate the unsafe character of the product without impairing its usefulness or making it too expensive to maintain the utility of the product;

5. The user's ability to avoid danger by the exercise of care in the use of the product;

6. The user's anticipated awareness of the dangers inherent in the product and their avoidability because of general public knowledge, the obvious conditions of the product, or of the existence of suitable warnings or instructions;

7. The feasibility on the part of the manufacturer of spreading the loss by setting the price of the product or carrying liability insurance.²²⁵

The "reasonably prudent manufacturer" approach contains certain theoretical advantages. First, the test encourages a relatively scientific and objective examination of the design of the product by focusing the court's attention toward the product itself in the context of certain given criteria.²²⁶ Second, the plaintiff's burden is eased through the presumption of the manufacturer's "scienter" of the unsafe condition of the product.²²⁷

Several limitations, however, exist to this approach. First, although the difference between negligence and strict products liability is slight when a manufacturer such as a producer of aircraft is the defendant, a significant difference exists as to the standards when intermediary wholesalers and retailers are involved as defendants.²²⁸ Second, the presumption of the manufacturer's "scienter" may be perceived as inequitable by

²²⁵ Wade I, *supra* note 218, at 837-38. See Keeton I *supra* note 15, at 37-38. Different schemes of criteria have been proposed by other commentators. See e.g., Fischer, *Products Liability—The Meaning of Defect*, 39 Mo. L. Rev. 339, 359 (1974).

²²⁶ Keeton III, *supra* note 208, at 593. Keeton I, *supra* note 15, at 31.

²²⁷ Keeton I, *supra* note 15, at 31.

²²⁸ Phillips, *The Standard for Determining Defectiveness in Products Liability*, 46 U. CIN. L. REV. 101, 103 (1977).

manufacturers. Manufacturers may consider that too much of the costs of accidents are being imposed upon them.²²⁹ In practice, however, plaintiff-victims of aircraft crashes may perceive their burden in strict products liability actions to be the same burden plaintiffs have in negligence actions. The victims who sue under the strict products liability theory still lack the sophisticated knowledge that manufacturers possess to prove such things as the technical and the economic feasibility of making a safer design.²³⁰ Third, the public policy objective of strict products liability, to give manufacturers the economic incentive to design and to manufacture improved and safer products, is jeopardized by the "reasonably prudent manufacturer" approach. When this approach is applied to an aircraft manufacturer, a risk exists that the manufacturer's superior knowledge will reduce the likelihood of it being found liable.²³¹

On a judicial level, the "reasonably prudent manufacturer" approach of the "risk utility" test was applied by the New Jersey Supreme Court in *Cepada v. Cumberland Engineering Co.*²³² and in *Suter v. San Angelo Foundry & Machine Co.*²³³ These cases are further authority for hindsight balancing of the "risk-utility" criteria, with the manufacturer's prior knowledge of the risk being imputed to the manufacturer at the time of trial²³⁴ rather than at the time of manufacture or

²²⁹ Keeton I, *supra* note 15, at 31.

²³⁰ Wade I, *supra* note 218, at 826.

²³¹ Holford, *The Limits of Strict Liability for Product Design and Manufacture*, 52 TEX. L. REV. 81, 93 (1973).

²³² 76 N.J. 152, 386 A.2d 816 (1978). In *Cepada*, the plaintiff was injured while operating a pelletizing machine from which a bolted safety guard had been removed. The plaintiff alleged that the machine was defective because it was designed without a safety device such as an electronic interlock which would have automatically stopped the machine if the guard was not in place.

²³³ 81 N.J. 150, 406 A.2d 140 (1979). In *Suter*, the plaintiff was injured when his hand was caught in the cylinders of a sheet-metal rolling machine. The plaintiff alleged that a design defect occurred because the manufacturer had failed to install a rotary guard around the court lever.

²³⁴ *Suter v. San Angelo Foundry & Machine Co.*, 81 N.J. at 171-72, 406 A.2d at 150-51; *Cepada v. Cumberland Eng'g Co.*, 76 N.J. at 172, 386 A.2d at 825. This approach is derived from Dean Keeton's formulation of the test that scienter is imputed to the manufacturer "at the time of trial." See Keeton II, *supra* note 15, at 568.

sale.²³⁵ This expansion of the manufacturer's liability in the direction of absolute liability has destroyed any possible state-of-the-art defense. Manufacturers may be held liable for the dangerous propensities of a product that were scientifically unknowable at the time the product was manufactured and sold,²³⁶ but which propensities were subsequently discovered through additional research and development. Such a hindsight approach when applied to aircraft accident litigation may be onerous on aircraft manufacturers whose industry is so rapidly changing that risks of harm previously unknown are continually being discovered through advanced technology.

The 1978 Oregon Supreme Court decision of *Wilson v. Piper Aircraft Corp.*,²³⁷ not only reiterated the Wade/Keeton "risk-utility" approach,²³⁸ but also refined the "reasonably prudent manufacturer" approach to protect the manufacturer from absolute liability without destroying the potential of strict products liability. The court provided that in cases in which the risk was unknowable at the time of the manufacture of the product, manufacturers would only be held strictly liable if a possible alternative design was not only technologically "feasible" but was also technologically and economically "practicable at the time of manufacture."²³⁹ The *Wilson* court did not remedy the problem that particularly plagues aviation accident plaintiffs, the problem of lacking knowledge respecting technological and economic factors affecting product design.

(b) *The consumer expectations approach*

Some courts have developed a "consumer expectations" ap-

²³⁵ Dean Wade formulated his "risk-utility" test such that scienter is imputed to the manufacturer at the time the manufacturer placed the product into the stream of commerce. See Wade I, *supra* note 218, at 839-40.

²³⁶ Birnbaum I, *supra* note 189, at 622, 627.

²³⁷ 282 Or. 61, 577 P.2d 1322, *reh'g denied*, 282 Or. 411, 579 P.2d 1287 (1978). See *supra* notes 135-37 and accompanying text for a discussion of *Wilson*.

²³⁸ 282 Or. at 63, 577 P.2d at 1325.

²³⁹ 282 Or. at 69, 577 P.2d at 1327.

proach with a "risk-utility" basis.²⁴⁰ This approach incorporates both of these apparently distinct standards into a single test,²⁴¹ thereby creating much confusion and error in the application of the "consumer expectations" approach. In order to determine if a product is dangerous beyond the ordinary consumer's expectations, the court must first determine what the hypothetical ordinary consumer would reasonably contemplate.²⁴² Unlike the straight "consumer expectations" test that is based upon some vague notion of what the ordinary consumer expects,²⁴³ the "consumer expectations" approach to the "risk utility" test provides the court with specific "risk utility" factors to consider such as the cost and the feasibility of minimizing or eliminating the risk.²⁴⁴ The "risk utility" factors are to be weighed in determining what an ordinary consumer would reasonably contemplate. Because jurors do not need the ordinary consumer notion to weigh the various factors,²⁴⁵ it is probably preferable to invoke a straightforward "risk utility" test unencumbered with the difficulties of this "consumer expectations" approach.

(c). *The strict "risk-utility" approach*

The Texas Supreme Court in the 1979 automobile crashworthiness case of *Turner v. General Motors Corp.*,²⁴⁶ developed a new standard for "unreasonably dangerous." The court proposed a strict "risk-utility" test that redirects the jury's focus from an examination of the "reasonably prudent manufacturer's" conduct and/or the ordinary "consumer's ex-

²⁴⁰ See *Aller v. Rodgers Mach. Mfg. Co.*, 268 N.W.2d 830 (Iowa 1978); *Estate of Ryder v. Kelly-Springfield Tire Co.*, 91 Wash. 2d 111, 587 P.2d 160 (1978); *Seattle-First Nat'l Bank v. Tabert*, 86 Wash. 2d 145, 542 P.2d 774 (1975).

²⁴¹ The single standard approach is to be contrasted to the dual standard approach adopted in *Barker v. Lull Eng'g Co.*, 20 Cal. 3d 413, 573 P.2d 443, 143 Cal. Rptr. 225 (1978). The *Barker* court proposed a test based on two standards: (1) a form of the "consumer expectations" standard and (2) a form of the "risk-utility" analysis. See *infra* text accompanying notes 256-85 for further discussion of this approach.

²⁴² *Seattle-First Nat'l Bank v. Tabert*, 542 P.2d at 779.

²⁴³ See *Birnbaum I*, *supra* note 189, at 615.

²⁴⁴ *Seattle-First Nat'l Bank v. Tabert*, 542 P.2d at 779.

²⁴⁵ See *Birnbaum I*, *supra* note 189, at 617.

²⁴⁶ 584 S.W.2d 844 (Tex. 1979).

pectations" to an examination of the product itself.²⁴⁷ This approach is beneficial insofar as it minimizes the possibility of introducing negligence considerations. The strict "risk utility" approach is, however, a two edged sword for the manufacturer. If the actual risks associated with the product outweigh its utility, the product will be considered unreasonably dangerous despite the manufacturer's diligence or good faith. If the utility of the product outweighs the risks associated with its use, the product will not be "unreasonably dangerous" even though the manufacturer knew of the risks.²⁴⁸

The *Turner* test involves the jury making its "risk-utility" analysis on the basis of relevant factors introduced by the litigants through their presentation of evidence, rather than by a jury instruction enumerating specific guidelines.²⁴⁹ A danger of the strict "risk-utility" approach is that the court is primarily allowing the jury to rely on some visceral sense of whether the product involved more risk than utility. For example, in cases involving products with which the jury has had little experience such as cases involving aircraft and component parts of aircraft, the presence of a seriously injured plaintiff in the courtroom might cause the jury to discriminate against the manufacturer. Thus, the jury might consider the product too risky even though the manufacturer might have adequately designed the product with every safety feature technologically possible.²⁵⁰

²⁴⁷ Note, *Products Liability: Turner v. General Motors Corp.*, 45 J. AIR L. & COM. 774, 787-88 (1980). In *Turner*, 584 S.W.2d at 850, the court specifically rejected the bifurcated test proposed in *General Motors Corp. v. Hopkins*, 548 S.W.2d 344 (Tex. 1977) and *Henderson v. Ford Motor Co.*, 519 S.W.2d 87 (Tex. 1974).

²⁴⁸ Note, *Turner v. General Motors Corp.*, 31 BAYLOR L. REV. 375, 386 (1979).

²⁴⁹ 584 S.W.2d at 849. See Note, *Strict Liability and the Demise of the "Henderson" Bifurcated Test in Design Defect Cases—"Turner v. General Motors Corp."*, 11 TEX. TECH L. REV. 953, 969-70 (1980). The *Turner* court outlined the following simple model instruction for the jury:

Do you find from a preponderance of the evidence that at the time the [product] in question was manufactured by [the manufacturer] the [product] was defectively designed? By the term "defectively designed" as used in this issue is meant a product that is unreasonably dangerous as designed, taking into consideration the utility of the product and the risk involved in its use.

584 S.W.2d at 847 n.1.

²⁵⁰ Birnbaum I, *supra* note 189, at 634.

(3). *The elimination of the "unreasonably dangerous" requirement: the Cronin approach*

The third broad approach to defining "defect" in conscious design defect cases abandons the requirement of section 402A of the RESTATEMENT, that the plaintiff prove that the defect in the product is "unreasonably dangerous." The *Cronin* approach was introduced in the 1972 California Supreme Court decision of *Cronin v. J.B.E. Olson Corp.*²⁵¹ In the court's view, the RESTATEMENT deviated from the strict products liability principles of *Greenman* by requiring the plaintiff to prove not only the necessary element of a "defect" in the product but also by requiring the plaintiff to prove the unnecessary element of an "unreasonably dangerous" product.²⁵²

The *Cronin* approach has been affirmed in subsequent California court decisions including the previously discussed aircraft crashworthiness case of *McGee v. Cessna Aircraft Co.*²⁵³ and by the Pennsylvania Supreme Court.²⁵⁴ Even though the *Cronin* approach benefits the plaintiff by making it easier to render the manufacturer strictly liable, many courts and commentators criticize the approach for failing to substitute another concept for the "unreasonably dangerous" concept. Many courts and commentators believe that the term "defect" should be given a substantive definition. Without a substantive definition, jury decisions may be based on whim due to the lack of certain guidelines.²⁵⁵

The ambiguity and confusion created for courts that adopted the *Cronin* approach necessitated the development of more precise tests to clarify the meaning of "defect." Two of the tests developed are the *Barker* approach and the *Azzarello* approach.

²⁵¹ 8 Cal. 3d 121, 501 P.2d 1153, 104 Cal. Rptr. 433 (1972).

²⁵² *Id.* at 133, 501 P.2d at 1162, 104 Cal. Rptr. at 442.

²⁵³ 82 Cal. App. 3d 1005, 1017, 147 Cal. Rptr. 694, 701 (1978). *See supra* notes 169-77 and accompanying text.

²⁵⁴ *See Azzarello v. Black Bros. Co.*, 480 Pa. 547, 391 A.2d 1020 (1978); *Berkbile v. Brantly Helicopter Corp.*, 462 Pa. 83, 337 A.2d 893 (1975).

²⁵⁵ *See Wade, On Product "Design Defects" and Their Actionability*, 33 Van L. Rev. 551, 557 (1980).

(a). *The "Barker" approach*

The California Supreme Court tried to clarify the meaning of "defect," within the context of *Cronin*, in its 1978 decision of *Barker v. Lull Engineering Co.*²⁵⁶ The court proposed a test based on two standards, a form of the "consumer expectations" standard and a form of the "risk-utility" analysis. Accordingly, a product may be found defective if the plaintiff proves the following: (1) the product "failed to perform as safely as an ordinary consumer would expect when used in an intended or reasonably foreseeable manner;"²⁵⁷ (2) "the product's design proximately caused injury";²⁵⁸ and (3) "the defendant fail[ed] to prove, in light of the relevant factors, that on balance the benefits of the challenged design outweigh[ed] the risk of danger inherent in such design."²⁵⁹ Some of the relevant factors that a jury might consider in using the second standard were specifically mentioned by the court, included the following:

the gravity of the danger posed by the challenged design, the likelihood that such danger would occur, the mechanical feasibility of a safer alternative design, the financial cost of an improved design, and the adverse consequences to the product and to the consumer that would result from an alternative design.²⁶⁰

Although an argument can be made that the *Barker* court established the "consumer expectations" standard and the "risk-utility" standard as two independent alternative tests for determining design defects,²⁶¹ it is more likely that the court intended the two standards as two separate prongs of a single test. This latter view is supported by both the language of the *Barker* decision and the policies set forth in past Cali-

²⁵⁶ 20 Cal. 3d 413, 573 P.2d 443, 143 Cal. Rptr. 225 (1978).

²⁵⁷ *Id.* at 426-27, 573 P.2d at 452, 143 Cal Rptr. at 234.

²⁵⁸ *Id.* (emphasis omitted).

²⁵⁹ *Id.*

²⁶⁰ *Id.* at 431, 573 P.2d at 455, 143 Cal. Rptr. at 237.

²⁶¹ See the discussion of this viewpoint in Comment, *Strict Products Liability*, *supra* note 17, at 223-24.

for California strict products liability decisions.²⁶² A two-prong alternative approach as opposed to a two test approach, benefits plaintiffs by increasing the possibility that manufacturers will be held strictly liable. If a plaintiff fails to satisfy the "consumer expectations" test, the plaintiff still can prevail if the defendant manufacturer is unable to show that the utility of the design outweighs its risks.²⁶³ The advantages and disadvantages of applying the *Barker* test are best understood, however, by examining three important questions raised by the *Barker* decision.

Question 1. A question exists as to whether the adoption of the "consumer expectations" standard in the first prong of the *Barker* test reintroduces the "unreasonably dangerous" requirement abandoned in *Cronin* insofar as both the RESTATEMENT definition of the "unreasonably dangerous" concept and *Barker's* first standard are based on the ordinary consumer's expectations. Despite arguments to the contrary,²⁶⁴ the better view is that *Barker* is consistent with *Cronin* and varies from the RESTATEMENT for the following reasons. First, the court in *Barker* reaffirmed its reasoning in *Cronin* for rejecting the "consumer expectations" test announced in the RESTATEMENT. The court stated that the "consumer expectations" test constituted "an undue restriction on the application of strict liability principles"²⁶⁵ by imposing too onerous a burden of proof on the plaintiff.²⁶⁶ Second, the "consumer expectations" standard in *Barker* is less onerous for the plaintiff than that of the RESTATEMENT because *Barker* sets only a minimum standard that a manufacturer's product must satisfy.²⁶⁷ The less onerous burden on the plaintiff partly remedies the problem of technologically sophisticated manufacturers escaping liability

²⁶² See Comment, *Strict Products Liability*, *supra* note 17, at 224-25.

²⁶³ Levy and Ursin, *Tort Law in California: At the Crossroads*, 67 CAL. L. REV. 497, 503 (1979).

²⁶⁴ See Walkowiak, *supra* note 192, at 733-34.

²⁶⁵ *Barker v. Lull Eng'g Co.*, 20 Cal. 3d 413, 425-26, 573 P.2d 443, 451, 143 Cal. Rptr. 225, 233 (1978).

²⁶⁶ *Id.* See Comment, *Strict Products Liability*, *supra* note 17, at 219-20.

²⁶⁷ *Barker v. Lull Eng'g Co.*, 20 Cal. 3d at 425-26, n.7, 573 P.2d at 451, n.7, 143 Cal. Rptr. at 233, n.7.

due to consumers' lack of knowledge and their tendency to form excessively low expectations as to the safety features and dangers in products.²⁶⁸ Third, unlike the RESTATEMENT standard in which the plaintiff must prove at a minimum that the product was "more" dangerous than the ordinary consumer would expect, according to the *Barker* approach, the plaintiff only needs to show that the ordinary consumer would expect the product to be safer.²⁶⁹ Nevertheless, an argument can be made that in practice it is difficult to conceive of an ordinary consumer of air travel understanding the danger involved in an aircraft crash.²⁷⁰

If the plaintiff discharges the initial burden of proving that the product fails to satisfy ordinary "consumer expectations," the defendant will be held strictly liable for injuries resulting from a design defect. If the plaintiff, however, fails to discharge this burden, the second prong of the test comes into operation.²⁷¹

Question 2. A question exists as to whether the *Barker* court's innovative shifting of the burden of proof to the defendant in the second prong of the approach has more consequence in theory, than in practice. The second prong places upon the plaintiff the initial burden of proving a "prima facie" case that the design of the product proximately caused his injury. If the plaintiff discharges this burden of proof, the burden of proof then shifts to the defendant manufacturer to

²⁶⁸ See Birnbaum I, *supra* note 189, at 604. See *supra* notes 210-14 and accompanying text for a discussion of the disadvantages of the "consumer expectations" test.

²⁶⁹ *Barker v. Lull Eng'g Co.*, 20 Cal. 3d at 425, 573 P.2d at 451, 143 Cal. Rptr. 233. See Comment, *Strict Products Liability*, *supra* note 17, at 219.

²⁷⁰ Galerstein I, *supra* note 14, at 199. Galerstein has proposed the following approach to remedy the problem:

The court might have more logically preserved the "unreasonably dangerous" language as a measure of design defect and simply denied defendant the defense of the ordinary consumer's expectations. Such an approach would have preserved the single necessary standard for measurement of a design defect and would have served to protect the unknowing public from its own possible underestimation of the dangers involved.

Id.

²⁷¹ *Barker v. Lull Eng'g Co.*, 20 Cal. 3d at 430, 573 P.2d at 454, 143 Cal. Rptr. at 236.

prove that the benefit of the design outweighed its risks.²⁷²

In theory, the *Barker* requirement that the plaintiff make a prima facie case almost automatically shifts the burden onto the defendant manufacturer. Indeed, one commentator²⁷³ suggested that in aircraft crashworthiness cases, the plaintiff's burden of establishing a prima facie case is effectively not an obligation:

No aircraft crash can occur in which the injured party cannot 'prove' that had the aircraft been designed differently, injury would not have been caused or enhanced. If the cabin collapsed, the cabin could have been made stronger; if the landing gear was crushed, the gear could have been constructed with more energy absorption characteristics.²⁷⁴

In practice, however, the minimal proof the plaintiff must provide to establish a prima facie case can be expected to vary case by case.²⁷⁵ For example, in the automobile accident case of *Korli v. Ford Motor Co.*²⁷⁶, despite large amounts of evidence presented by the plaintiff, the California Court of Appeals considered the evidence insufficient to satisfy the prima facie requirement of *Barker*.²⁷⁷

Furthermore, once the burden of proof is shifted to the defendant, the *Barker* approach does not significantly change the plaintiff's and the defendant's relative burdens of proof.

²⁷² *Id.* at 431, 573 P.2d at 455, 143 Cal. Rptr. at 237. The shifting of the burden of proof to the defendant in the second prong of the test is an attempt by the California Supreme Court to overcome the criticism made of most "risk-utility" tests that the tests allocate to the plaintiff the burden of proving that the risk created by the product outweighs its social utility. The court justified this shifting of the burden with two reasons: (1) "one of the principal purposes behind the strict product liability doctrine is to relieve an injured plaintiff of many of the onerous evidentiary burdens inherent in a negligence cause of action," and (2) design defect cases involve "technical matters peculiarly within the knowledge of the manufacturer." 20 Cal. 3d at 431, 473 P.2d at 455, 143 Cal. Rptr. at 237.

²⁷³ The commentator is George Galerstein who is Chief Legal Counsel of Bell Helicopter Textron, Fort Worth, Texas. Mr. Galerstein has written a number of articles on the topic of aircraft crashworthiness. See *supra* note 14 and *infra* note 316 for two of his articles.

²⁷⁴ Galerstein I, *supra* note 14, at 199-200.

²⁷⁵ See Birnbaum I, *supra* note 189, at 609.

²⁷⁶ 84 Cal. App. 3d 895, 149 Cal. Rptr. 98 (1978) (decertified opinion by order of the court in advance sheets only).

²⁷⁷ *Id.* at 905-06, 149 Cal. Rptr. at 104-05.

The defendant manufacturer continues to have the burden of proving that the utility of the design outweighed its risks;²⁷⁸ in turn, the plaintiff attempts to rebut this evidence. The defendant manufacturer is still advantaged with superior technical knowledge.²⁷⁹

Question 3. The third significant question evoked by the *Barker* decision concerns whether the adoption of a form of "risk-utility" analysis in the second prong of the test "rings of negligence" by reintroducing the "unreasonably dangerous" requirement eliminated in *Cronin*. Some commentators argue that *Barker* introduces negligence principles through the backdoor. As a jury weighs the risks against the utility of a product to determine whether the product is in an "unreasonable condition,"²⁸⁰ the jury is actually focusing on the manufacturer's conduct rather than the product.²⁸¹ The *Barker* court, however, held that the second prong was clearly a strict liability standard rather than a negligence standard. The court was of the opinion that the jury's attention is directed to the product, not to the manufacturer's conduct.²⁸² The court further stated that the "risk-utility" analysis is to be done "upon hindsight" rather than at the time of manufacture, as in the case of negligence.²⁸³ In the end, even though the *Barker* approach only has been adopted by a few courts,

²⁷⁸ See, e.g., *Pherson v. Goodyear Tire & Rubber Co.*, 590 F.2d 756 (9th Cir. 1978).

²⁷⁹ See *Birnbaum I*, *supra* note 189, at 609.

²⁸⁰ See Comment, *Strict Products Liability*, *supra* note 16, at 221.

²⁸¹ *Id.* at 221. The criticism assumes that when a jury determines that the risk of danger inherent in the challenged design outweighs the benefits of this design, the jury is basically finding that the product is in an "unreasonable condition." It has been suggested that any difference between the terms "unreasonable condition" and "unreasonably dangerous" is one of semantics rather than of substance. The jury in the end is focusing on the manufacturer's conduct in determining whether the manufacturer exposed the consumer or user to a greater risk of danger than it should have. See *id.* at 221. This approach, therefore, implicitly reintroduces negligence principles because as Dean Prosser has suggested "[t]he almost universal use of the phrase 'due care' to describe conduct which if not negligent, should not be permitted to obscure the fact that the real basis of negligence is not carelessness, but behavior which should be recognized as involving unreasonable danger to others." W. PROSSER, *LAW OF TORTS* § 31 (4th ed. 1971).

²⁸² 20 Cal. 3d at 432, 434, 573 P.2d at 454, 456, 143 Cal. Rptr. at 238, 239.

²⁸³ *Id.* at 430, 434, 573 P. 2d at 454, 457, 143 Cal. Rptr. at 236, 239.

²⁸⁴ and rejected by many courts,²⁸⁵ the approach provides a novel alternative test that can be applied in aircraft crashworthiness cases.

(b). The *Azzarello* approach

The 1978 Pennsylvania Supreme Court decision of *Azzarello v. Black Brothers Co.*,²⁸⁶ expanded on the *Cronin* precedent and developed an innovative definition of "defect." First, the *Azzarello* court held that the trial judge was considered to have the primary screening function of determining through "risk-utility" analysis whether the particular claim of defective design was legally actionable. The court was of the opinion that only after this determination was made, should the jury have the limited function of determining "whether the facts of the case support the averments of the complaint."²⁸⁷ The jury's determination was to be based upon the standard that the manufacturer was the guarantor of the safety of his products and must at least provide a product which was safely designed for its intended use.²⁸⁸

²⁸⁴ The Alaska Supreme Court also adopted the *Barker* test. *Caterpillar Tractor Co. v. Beck*, 593 P.2d 871, 882, 885 (Alaska 1979).

²⁸⁵ The *Barker* test was specifically rejected in *Wilson v. Piper Aircraft Corp.*, 282 Or. 61, 66, 577 P.2d 1322, 1327 (1978). A similar bifurcated test was rejected in *Turner v. Gen. Motors Corp.*, 584 S.W.2d 844, 851 (Tex. 1979). *Barker* has generated many comments in various legal journals. See, e.g., Birnbaum I, *supra* note 189, at 602-10; Schwartz, *Forward: Understanding Products Liability* 67 Cal. L. Rev. 435, 438-39 (1979); Comment, *Strict Products Liability supra* note 16, at 215-62.

²⁸⁶ 480 Pa. 547, 391 A.2d 1020 (1978).

²⁸⁷ 391 A.2d at 1026.

²⁸⁸ *Id.* The *Azzarello* court recommended that a jury should apply, a test which involved possibly finding a product defective when the product left the manufacturer's control "lacking any element necessary to make it safe for its intended use or possessing any feature that renders it unsafe for the intended use." *Id.* at 1027. The *Azzarello* court stated that a judge utilizing this test would adequately charge the jury as follows:

The [supplier] of a product is the guarantor of its safety. The product must, therefore, be provided with every element necessary to make it safe for [its intended] use, and without any condition that makes it unsafe for [its intended] use. If you find that the product, at the time it left the defendant's control, lacked any element necessary to make it safe for [its intended] use or contained any condition that made it unsafe for [its intended] use, then the product was defective, and the defendant is liable for all harm caused by such defect.

Id. at 1026 n.12.

An important advantage of the *Azzarello* approach is its emphasis on the trial judge's screening role in assuring that the plaintiff has established a prima facie case. One can criticize the approach, however, for understating the competence of a properly instructed jury to perform "risk-utility" analysis.²⁸⁹ Furthermore, the test that the jury is to apply, that the manufacturer provide a product which is designed safe for its intended use, is excessively onerous on manufacturers because the test virtually insists that designers of the products include every precaution and safety device possible, irrespective of technical feasibility and prohibitive costs.²⁹⁰ The *Azzarello* approach would be particularly unjust and unworkable in cases of complicated aircraft design in which certain back-up safety devices may involve exorbitant technical trade-offs and financial costs.

5. *The Return to the Negligence Standard; The Proposed Statutory Alternative of the Model Uniform Product Liability Act*

Another approach to defining "defect" in conscious design defect cases was proposed by the Model Uniform Product Liability Act (UPLA).²⁹¹ The drafters of the UPLA were concerned with remedying certain key problems. These problems included the dissatisfaction of manufacturers with the increased insurance rates and the decreased availability of product liability insurance. The drafters also were concerned with the uncertainties in the tort-litigation system created by the product liability rules continually changing in the courts of

²⁸⁹ A small minority of scholars agree with the *Azzarello* court's lack of confidence in a jury's intellectual capacity to perform such a function. See, e.g., Henderson, *Renewed Judicial Controversy Over Defective Product Design: Toward the Preservation of an Emerging Consensus*, 63 Minn. L. Rev. 773, 779-80 (1979). Most commentators and courts would disagree with *Azzarello*, having confidence in the ability of a properly instructed jury. *Bowman v. Gen. Motors Corp.*, 427 F. Supp. 234 (E.D. Pa. 1977). See, e.g. *Birnbaum I*, *supra* note 189, at 637, 639.

²⁹⁰ Henderson, *Products Liability*, 2 Corp. L. Rev. 246, 248. (1979).

²⁹¹ MODEL UNIFORM PRODUCT LIABILITY ACT, § § 100-22, 44 Fed. Reg. 62,714 (1979) [hereinafter cited as UPLA]. The UPLA was originally issued by the United States Department of Commerce on October 31, 1979.

various jurisdictions.²⁹² Thus, the UPLA provides a uniform and single cause of action to help stabilize insurance rates not only by insuring that the injured plaintiff received reasonable compensation for his injuries,²⁹³ but also by reducing the plaintiff's protection.²⁹⁴

The UPLA provides that a product may be proven defective only if the product was "unreasonably unsafe" either (i) in terms of construction or breach of express warranty as judged by a strict liability standard or (ii) in terms of its design or in terms of inadequate warnings as evaluated by a negligence or fault standard.²⁹⁵ Specifically, the determination of whether a product is "unreasonably unsafe" in design involves a two-step process. First, the plaintiff must "show that his injury was proximately caused by the defective design of the product."²⁹⁶ Second, the jury must determine whether a defective design exists on the basis of a negligence type of "risk-utility" analysis.²⁹⁷ Accordingly, the jury will weigh the following two factors: (1) the likelihood that the product caused the plaintiff's harm or similar harms, and the seriousness of those harms; and (2) the manufacturer's burden of producing a product with an alternative design that would have prevented those harms, and any adverse effect that an alternative design might have had on the usefulness of the product.²⁹⁸ These two

²⁹² Ribstein, *The Model Uniform Product Liability Act: Pinning Down Products Law*, 46 J. Air L. & Com. 349, 351 (1981) [hereinafter cited as Ribstein]. See 44 Fed. Reg. 62,714 (1979).

²⁹³ Jobe, *The Model Uniform Product Liability Act—Basic Standards of Responsibility for Manufacturers*, 46 J. Air L. & Com. 389 (1981) [hereinafter cited as Jobe].

²⁹⁴ Ribstein, *supra* note 292, at 351.

²⁹⁵ UPLA §104,44 Fed. Reg. 62,721 (1979).

²⁹⁶ Jobe, *supra* note 293, at 40-05.

²⁹⁷ *Id.* at 405.

²⁹⁸ UPLA § 104(B), 44 Fed. Reg. at 62,723. The UPLA provides specific examples of probative evidence that the jury may consider in evaluating whether a product is unreasonably unsafe in design. This evidence includes the following:

(a) Any warnings and instructions provided with the product; (b) The technological and practical feasibility of a product designed and manufactured so as to have prevented claimant's harm while substantially serving the likely user's expected need; (c) The effect of any proposed alternative design on the usefulness of the product; (d) The comparative costs of producing, distributing, selling, using, and maintaining the product as designed and as alternatively designed; and (e) The

factors should be viewed as of the time of manufacture, not as of the time of trial.²⁹⁹

An important consequence of the UPLA approach is the abandonment of strict products liability principles developed at common law. Instead, the UPLA mandates returning to the negligence standard which places on the plaintiff the entire burden of proving that the risks at the time of manufacture outweighed the utility of the product. This burden creates an insurmountable obstacle in cases of technologically sophisticated products like aircraft because the factors³⁰⁰ involved in making this analysis are generally more within the knowledge and the skill of the manufacturer than within the knowledge of the injured plaintiff.³⁰¹ Another effect of the UPLA approach is the rejection of any "consumer expectations" test in an attempt to avoid its pitfalls.³⁰²

The UPLA has not achieved its intended uniformity and predictability in products liability law for two reasons. First, although the United States Congress (Congress) could enact most effectively and economically such a law, Congress has not done so because the UPLA drafters recognized that most tort litigation is non-federal and intended that the UPLA be enacted separately by state legislatures.³⁰³ Second, the few states that have enacted the UPLA have tended to change its substance significantly.³⁰⁴

new or additional harms that might have resulted if the product had been so alternatively designed.

UPLA § 204, 44 Fed. Reg. 62,721 (1979).

²⁹⁹ UPLA § 104(C), 44 Fed. Reg. 62, 724 (1979).

³⁰⁰ See *supra* note 298 for a list of some of the factors to be considered.

³⁰¹ See *Escola v. Coca-Cola Bottling Co.*, 24 Cal. 2d 453, 461, 150 P.2d 436, 440-41 (1944); *Jobe*, *supra* note 293 at 404-05.

³⁰² UPLA § 104(B), 44 Fed. Reg. 62,724.(1979).

³⁰³ Dubuc & Jones, *Significant Legislative Developments in the Field of Aviation Law*, 45 J. AIR L. & COM. 921, 921-22 (1980). The ULPA drafters intended that it be enacted by state legislatures in the same manner in which the Uniform Commercial Code became law in forty-nine states. *Id.*

³⁰⁴ Ribstein, *supra* note 292, at 350, 355. For example, Connecticut and Idaho have used the UPLA as the basis of some legislation. See 1979 CONN. PUBL. ACT 79-483 (App. Pamph.); IDAHO CODE § 6-1401-09 (1980).

6. *The Nature of the Action*

In respect to the aircraft manufacturer's tort liability, it is clearly advantageous for the plaintiff to launch an action based on principles of both negligence and strict liability for four reasons. First, similar proof requirements exist for both strict products liability and negligence actions in those jurisdictions in which proof of an "unreasonably dangerous" product is required before the manufacturer can be held strictly liable for a design defect. Whatever proof of an "unreasonably dangerous" product is required to establish that a defendant is strictly liable, is proof usually sufficient to establish that the defendant was also negligent.³⁰⁵ Second, evidence may be admissible and relevant under one theory of liability and not the other. For example, evidence of prior failures of a product would be admissible and relevant to prove notice in a negligence action but may not be relevant in a strict products liability case.³⁰⁶ Third, strict liability is an advantageous basis of action for the plaintiff insofar as intermediate suppliers of the product who were not negligent in the design of the product,³⁰⁷ can be held strictly liable in cases in which a negligent manufacturer is insolvent, uninsured, or beyond the court's jurisdiction.³⁰⁸ Fourth, while contributory negligence is generally a defense in negligence actions, it is not an acceptable defense to strict liability actions in many jurisdictions.³⁰⁹

C. *The Advantages and Disadvantages of the Judicial Litigation of Aircraft Crashworthiness Claims*

Certain advantages exist when a plaintiff sues a manufacturer for producing an aircraft that was not crashworthy. First, an individual plaintiff benefits from the recovery of damages in a personal injury and wrongful death action. Second, the community benefits because the costs of accident-re-

³⁰⁵ Wade I, *supra* note 138, at 836-37.

³⁰⁶ Abramson, *supra* note 15, at 170.

³⁰⁷ Wade I, *supra* note 218, at 836-37 n.40.

³⁰⁸ Abramson, *supra* note 15, at 170.

³⁰⁹ Montgomery & Owen, *Reflections on the Theory and Administration of Strict Liability for Defective Products*, 27 S.C.L. Rev. 803, 829 (1976).

lated injuries are borne by the manufacturers, who best can transmit the losses to consumers and users of the product. Third, the community also benefits from safety and crashworthiness improvements in aircraft that manufacturers are encouraged to make and the FAA are encouraged to regulate after adverse judgments are entered against the manufacturer.

The plaintiff's claim that a manufacturer is liable under the crashworthiness doctrine also has drawbacks. First, the relatively unknowledgeable court and jury are ill-prepared to digest technical data and to use the data to examine the complex technical and economic trade-offs which enter into an aircraft designer's decision. This problem is emphasized because the court's attention is unrealistically concentrated on one or two aspects of the aircraft's design when all aspects of the design should be considered.³¹⁰ Second, existing theories of recovery generate much litigation and tremendous costs. Litigants must hire expensive specialized lawyers and expert witnesses³¹¹ and the community must incur the administrative costs of prolonged litigation.³¹² Third, plaintiffs often find it difficult to prove that death or injury was proximately caused by the defective design of the airplane.³¹³ The defendant manufacturer may assert the defense of contributory negligence as a proximate cause of the plaintiff's injuries. Furthermore, problems exist in distinguishing deaths or injuries caused by the initial crash impact, from injuries enhanced by deficient crashworthiness.³¹⁴ Fourth, the interest of the community in safety is jeopardized by the adversary process. As manufacturers and carriers try to shift responsibility to the other, they may withhold important aircraft crashworthiness informa-

³¹⁰ Galerstein, *supra* note 14, at 188.

³¹¹ See Kreindler, *supra* note 10, at 20-25.

³¹² Marcy, *supra* note 67, at 1600-01.

³¹³ Marcy, *supra* note 67, at 1599. An example of this problem is an injured plaintiff opening an exit door, contrary to the flight attendant's instructions, when an exterior fire exists.

³¹⁴ Marcy, *supra* note 67, at 1599. This problem of proof may be complicated by the removal of the bodies from the aircraft before the crash investigators' arrival.

tion.³¹⁵ One of the most important consequences of the judiciary's failure to develop a single objective definition and test for determining design defects and uniform design standards is that aircraft crashworthiness decisions are not predictable. Indeed, past decisions which have decided liability generally, do not inform the manufacturer of what is expected of its designs. Therefore, the manufacturer may be unable to avoid future liability.³¹⁶ One commentator has illustrated the dilemma as follows:

For example, assume a manufacturer is held liable on the basis that injuries were caused or aggravated by a seat not of sufficient crashworthiness. That doesn't [sic] tell the manufacturer how crashworthy he ought to make the next seat, for the circumstances of the next accident will be different and may well be experienced under more severe conditions than the accident in question. Unless one takes the position that a seat should be designed so that it should adequately protect the occupant under the circumstances of every possible accident, regardless of severity, the manufacturer's dilemma is obvious.³¹⁷

The absence of a single objective test and standard has resulted in two conflicting viewpoints as to the competence of the judicial process in the determination of defectiveness. Some courts are of the opinion that it is acceptable that the courts develop and apply tests and standards case-by-case, so long as the jury is properly instructed.³¹⁸ Other commentators suggest, however, that the subjectivity of the judicial process

³¹⁵ Kennedy, *Accidents in Commercial Air Transportation—A Proposed Reform of the Liability and Compensation System*, 41 J. AIR L. & COM. 247, 248 (1975).

Other alleged disadvantages of the judicial litigation of crashworthiness claims include: the manufacturer is unfairly treated insofar as design defect liability involves a retrospective determination of the safety and reasonableness of design of the product long after the original design decisions were made; and the liability for conscious design choices is an unwarranted extension of strict liability since it does not take into consideration that the design process requires compromises.

Haskell, *supra* note 186, at 601-07. For these and other disadvantages, see Marcy, *supra* note 67, at 1567-1602.

³¹⁶ Galerstein, *Aircraft Crashworthiness: Who Sets the Standard?*, 28 Fed'n Ins. Counsel Q. 258, 258-60 (1978).

³¹⁷ *Id.* at 259.

³¹⁸ *Bowman v. Gen. Motors Corp.*, 427 F. Supp. 234, 242-45 (E.D. Pa. 1977).

in determining priorities among various goals of safety, performance, and cost makes it preferable for Congress and government administrative agencies to establish tests and design standards.³¹⁹

V. PROPOSALS

This article has attempted to demonstrate the complex intermingling of technical factors and legal issues which are involved in aircraft crashworthiness cases. In many ways, this complex intermingling renders the judicial process deficient in the determination of aircraft and parts manufacturers' tort liability. In line with this reasoning, this study proposes certain basic procedural and substantive changes.

First, Congress and the FAA should be given a greater role and the courts in turn a lesser role in the determination of tests, definitions, and standards respecting a manufacturer's liability, generally, and the crashworthiness of an aircraft, particularly. Indeed, the present process of congressional committee and subcommittee hearings³²⁰ in respect to aircraft safety might be reinforced by more hearings with a broader scope of investigation. Furthermore, recommendations resulting from these hearings should be more seriously acted upon by Congress and the FAA. The FAA should more extensively and effectively use its congressionally granted power of promulgating various FARs. The advantages of such an approach are that the FAA and Congress's specialized committees could generally provide fairer, more objective, more expert, and less expensive hearings than the courts.

Second, Congress should enact some form of a Uniform Products Liability Act. If Congress, as opposed to state legislatures, enacts a Uniform Products Liability Act a certain uniformity, consistency, and predictability in regard to

³¹⁹ Henderson, *supra* note 16, at 1542-50, 1555-56.

³²⁰ In the past, witnesses have testified before the House Subcommittee on Aviation respecting aircraft crashworthiness and the subcommittee has proposed recommendations to the FAA. See, e.g., *Aviation Safety: Hearings on Aircraft Cabin Environment Before the Subcomm. on Investigations and Review of the House Comm. on Public Works and Transportation*, 94th Cong., 2d Sess. 3-4 (1976).

crashworthiness could be attained throughout the United States. This statute not only should recognize the doctrine of automobile and aircraft crashworthiness developing at common law, but should also provide a single uniform definition and test of "defect" in conscious design choice cases, replacing the maze of definitions and tests at common law. Thus, the courts would assume the more limited function of applying and interpreting a definition and test already established by Congress.

Third, the FAA and Congress should establish compulsory and uniform minimum crashworthiness design standards. These crashworthiness design standards should reasonably accommodate the recommended standards of such organizations as the Society of Automotive Engineers³²¹ and the military.³²² Furthermore, the standards should be sufficiently clear and precise to give manufacturers adequate guidelines on crashworthy designs. The standards, however, should not be so clear and precise as to impede manufacturers from accommodating unforeseen design difficulties. Lastly, it is recommended that an aircraft manufacturer who proves compliance with such standards should be conclusively considered legally to have designed a crashworthy aircraft.

The adoption of these recommendations would result in numerous benefits over the existing system for the following reasons. First, the FAA and the specialized committees and subcommittees of Congress are more likely than the courts to acquire the technical expertise necessary for understanding the numerous and complex interrelated tradeoffs entering into an aircraft designer's decisions. Unlike the courts which generally only focus on one or two design aspects, the FAA and Congress can focus on the overall design of the aircraft. As a result, aircraft manufacturers can more systematically and consistently design their aircraft to avoid future liability.³²³

³²¹ See generally Society of Automotive Engineers, Inc., Aerospace Recommended Practices (cited in Comment, *Uncrashworthy Aircraft*, *supra* note 60, at 563 n. 67).

³²² See U.S. ARMY, CRASH SURVIVAL DESIGN GUIDE (Tech. Report No. 71-22 1971)(cited in Comment, *Uncrashworthy Aircraft*, *supra* note 60, at 564 n.68).

³²³ Marcy, *supra* note 67, at 1603. Marcy develops this argument on the basis of an analogy in the automotive field found in O'Connell, *Taming the Automobile*, 58 NW. U.L. Rev. 299, 375 (1963).

Second, most of the direct and indirect costs caused by the tremendous amount of aircraft crashworthiness litigation can be avoided. Third, minimum objective design standards are more likely to be formulated toward public safety when manufacturers, airlines, and other interested parties provide crashworthiness information in relatively detached congressional or administrative forums rather than the adversarial environment of the courtroom. Fourth, such an approach gives an aircraft manufacturer knowledge of more clearly defined guidelines regulating his prospective design behavior. These guidelines are more equitable than the present system in which the courts often make decisions respecting the safety of the design long after the manufacturers made the original design decisions. Fifth, insofar as the courts are no longer vital to the process of formulating minimum design standards, the criticism is avoided that liability for conscious design choices is an unwarranted extension of strict liability.

In the short-run, it is improbable that the present Reagan Administration will adopt such an approach given its preference for deregulation, free-market forces, and generally less government involvement in the economy. In the long-run, however, if some future administration is more favorably disposed to follow these recommendations, everyone will benefit including aircraft manufacturers, airlines, crews, passengers, and crash victims. Legislative and administrative tests and standards will establish clearcut crashworthiness guidelines that aircraft manufacturers will know, thereby pressuring them to design safer aircraft. Judicial application and interpretation of those standards will in supplementary fashion ensure that aircraft crash victims are properly compensated in design defect cases.