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PLACARDS, WARNING LABELS & OPERATION MANUALS: AN AIRCRAFT MANUFACTURER'S DUTY TO WARN

JAMES E. LINK, II

I. INTRODUCTION

A QUICK GLANCE into the cockpit of a private airplane reveals an extensive array of instrumentation, flight controls, safety devices, and placards. Placards warn of dangers ranging from fuel contamination to proper seat position. Others provide vital instructions for emergency situations, from de-icing to safe egress. These warning placards attempt, as any warning labels do, to insure safe operation of the aircraft where design modifications are impossible or impracticable. As the complexity of modern aircraft increases and technology advances, the human limitations of the pilot may adversely affect the safe operation of the airplane. Warnings or instructions try to anticipate potential dangers and foreseeable human shortcomings. When an aircraft manufacturer, however, anticipates too many hazards or underestimates the skill level and intelligence of the pilot, the result may be an accident due to an overload of the information processing capabilities of the pilot.

In normal operations as well as in an emergency situation, a pilot must make many decisions, making them quickly, and correctly. To help make those decisions, the pilot relies on instrumentation and control mechanisms

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1 See infra notes 152-174 and accompanying text for a discussion of human limitations and how they impact product design.
designed to allow smooth recovery from any problem situation. Placards in aviation traditionally provide critical safety information in a way immediately available to the pilot. Information on emergency de-icing or fuel problems is neither timely nor effective if it is buried in some operations manual or preflight checklist stuffed under the seat. Aircraft manufacturers, however, perhaps fearing recent litigation results, may be basing new placards on liability concerns rather than safety concerns. Indeed, some placards seem to be an attempt to avoid liability for actionable design defect claims.

2 Miller, Placards, Placards Everywhere, AOPA Pilot, Jan. 1987, at 103.
3 See, e.g., Cessna Aircraft Co. v. Fidelity & Casualty Co., 616 F. Supp. 671 (D.N.J. 1985) (The underlying state court action involved a jury verdict of $29.3 million dollars against Cessna, $25 million dollars of which constituted punitive damages, based on finding that the manufacturer knew of a defective seat design, yet failed to correct the problem or warn users. The original plaintiffs settled for $13 million, then Cessna and its insurance carriers turned on each other.).
4 Miller, supra note 2, at 103; see also Miller, What is a Mandatory Service Bulletin?, AOPA Pilot, Mar. 1986, at 121-22 (“mandatory” service bulletins from aircraft manufacturers may fulfill the duty to warn of the importance of wearing shoulder harnesses). But see Rimer v. Rockwell Int’l, 641 F.2d 450, 452 (6th Cir. 1981) (Evidence indicated the manufacturer knew of a fuel cap problem but did not issue a service bulletin requiring replacement of the fuel caps due to fear of encouraging litigation. The manufacturer, Rockwell, made available an optional custom kit designed to replace the existing fuel caps, which were prone to siphoning. A Rockwell memorandum revealed that the new antisiphoning cap “was purposely put out as a Custom Kit rather than a mandatory service bulletin in an effort to prevent operators from pressing litigation.”).
5 Miller, supra note 2, at 103. Miller notes that Cessna Aircraft Company offers two possible solutions to the problem of water collection in the fuel cells of certain Cessna single engine planes. Id. The alternatives are presented to the aircraft owner in the form of an airworthiness directive. Id. The aircraft owner can buy a new rubber fuel cell for about $1,000, or can install a 118-word placard in full view of the pilot detailing a water draining procedure. The placard reads:

PRIOR TO FLIGHT FOLLOWING EXPOSURE TO RAIN, SLEET, SNOW, OR AFTER FUELING FROM AN UNFILTERED FUEL SOURCE:
1. DRAIN AND CATCH THE CONTENTS OF THE GASCO-LATOR, WING, AND (IF EQUIPPED) RESERVOIR TANK SUMPS AND CHECK FOR WATER CONTAMINATION.
2. PLACE THE AIRPLANE ON A LEVEL SURFACE AND LOWER THE TAIL TO WITHIN FIVE INCHES OF THE GROUND (ON NOSE-GEAR AIRPLANES).
3. ROCK THE WINGS 10 INCHES UP AND 10 INCHES DOWN AT LEAST 12 TIMES.
4. DRAIN AND CATCH THE CONTENTS OF THE FUEL GAS-
Many placards result from the issuance by the FAA of airworthiness directives (AD). Once a manufacturer persuades the FAA to issue an AD addressing the danger, responsibility for the defect can shift to the operator. Recent concern about the use of warnings by airplane manufacturers to avoid products liability lawsuits prompted the Aircraft Owners and Pilots Association (AOPA) to protest the growing trend towards "placard clutter" as an attempt to abuse the products liability area. Placard clutter refers to the overuse of warning placards or instructions in place of design improvements. The AOPA complains that manufacturers are abusing the usefulness of placards by providing too many. Coupled with the problem of an increasing number of warnings and mandatory placards is a new device from aircraft man-

5. IF WATER IS FOUND IN STEP FOUR, REPEAT STEPS THREE AND FOUR UNTIL NO ADDITIONAL WATER IS DETECTED, OR DRAIN THE ENTIRE FUEL SYSTEM.

Id. at 104. The placard takes up a great deal of space, pertains to procedures which are performed outside the cockpit and which cannot be performed alone, and seems to place responsibility for a serious design defect on the pilot of the aircraft. Id. at 103-04.

6 The regulations dealing with Airworthiness Directives are found in 14 C.F.R. § 39.1 (1988). Section 39.1 provides: "This part prescribes airworthiness directives that apply to aircraft, aircraft engines, propellers, or appliances (hereinafter referred to in this part as "products") when — (a) An unsafe condition exists in a product; and (b) That condition is likely to exist or develop in other products of the same type design." Id. A complete examination of AD is beyond the scope of this Comment. For a thorough exploration of AD and their effect on aircraft products liability cases, see Boyd, Airworthiness Directives; Evidentiary Value in Aircraft Litigation, Trial, Aug. 1986 No. 8, at 59; Wilson, Airworthiness Directives: Recovering the Cost of Compliance, 49 J. AIR L. & COM. 1 (1983).

7 See 14 C.F.R. § 39.3 (1988). Section 39.3 provides: "No person may operate a product to which an airworthiness directive applies except in accordance with the requirements of that airworthiness directive." Id.; see, e.g., Crigler v. Cessna Aircraft Co., 880 F.2d 169, 171 (11th Cir. 1987) ("Airworthiness directives are mandatory regulations promulgated by the FAA and are binding on owners, operators and manufacturers.").

8 Miller, supra note 2, at 103-04; see also Yodice, Product Liability, AOPA Pilot, Feb. 1988, at 31-33.

9 Miller, supra note 2, at 103-04.

10 Id.
manufacturers called a "mandatory service bulletin." The mandatory service bulletin, unlike an AD, does not carry the force of law. Thus, the bulletins should prove a weak liability defense. For purposes of this analysis, however, the bulletins do serve a critical legal purpose. The bulletins present a strong inference that the aircraft manufacturer fulfilled its duty to warn.

Clearly, the aircraft manufacturer must exercise due care in warning pilots of dangers arising from the intended and reasonably foreseeable uses of its product. These warnings, whether required by the government, forced by the courts, or voluntarily placed by the aircraft manufacturer, provide the pilot with quick, often crucial information. As with other types of warnings, however, too many warnings and unnecessary placards may reduce instead of improve user awareness. In an attempt to remedy this danger, an approach known as "human factor

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12 Id. The mandatory service bulletin is not required as is an AD, but aircraft manufacturers use the term "mandatory" in an attempt to obligate the owners of the airplane to make the modification. Id.
13 Id. at 121-22. AOPA's attorneys examined the question of limited liability for manufacturers due to the bulletins, but "found [no] cases where an owner's failure to comply with a service bulletin ha[de] been used as a successful defense. But, the attorneys caution[ed], this does not mean it could not happen." Id.
14 Id. at 122. Miller noted the following concerning the Beech Aircraft issuance of a service bulletin about shoulder harnesses: "Plaintiffs' attorneys will not be able to sue Beech for failing to make aircraft owners aware of the importance of wearing shoulder harnesses or of failing to make the retrofit kits available. In other words, by issuing the mandatory service bulletin, Beech has fulfilled its 'duty to warn.' " Id.
16 Miller, supra note 2, at 103.
17 See Jonescue v. Jewel Home Shopping Serv., 16 Ill. App. 3d 339, 306 N.E.2d 312, 316 (1973) ("The purpose of a warning is to appraise a party of a danger of which he is not aware, and thus enable him to protect himself against it. When a danger is fully obvious and generally appreciated, nothing of value is added by a warning."); see also Plante v. Hobart Corp., 771 F.2d 617, 620 (1st Cir. 1985) ("Indeed, if the law required suppliers to warn of all obvious dangers inherent in a product, '[t]he list of foolish practices warned against would be so long, it would fill a volume.").
engineering" looks to the interaction between a person and the machine that person operates.\textsuperscript{18} To a great extent, the physical characteristics and mental capacities shared by all people dictate behavior under conditions of stress or potential danger.\textsuperscript{19} Modern technology is capable of exceeding operator capabilities and, in some instances, has already surpassed the human mind and body.\textsuperscript{20}

This Comment examines the effectiveness of aircraft warnings, actual and proposed. The first section provides an overview of warning claims and their impact on manufacturing. Next, a survey of case law in the area of aircraft warnings will examine actual and proposed safety warnings. Finally, a discussion of human factor psychology and engineering will suggest the limitations of traditional tort law in the context of warnings and instructions.

II. THE AIRCRAFT MANUFACTURER’S DUTY TO WARN IN PRODUCTS LIABILITY LITIGATION

As a general rule, a manufacturer assumes liability when his product, sold in an unreasonably dangerous condition,

\textsuperscript{18} See Ryder, Human Factors Engineering in Accident Litigation: A Primer For Nontechnologists, 10 J. PROD. LIAB. 51 (1987) (a description and discussion of "human factors engineering").

\textsuperscript{19} Id.; see also Bowman, Human Factors in the Defense of a Products Liability Case, 1982 PROC. OF THE SMU PRODUCTS LIABILITY INSTITUTE § 11.02[2] ("[H]uman factors are the characteristics or the attributes of people, their weaknesses, aptitudes, capacity to make mistakes, forgetfulness, strength, ability to see, capacity to work under stress. These human characteristics or factors are involved in the relationship of a human user with any product.").

\textsuperscript{20} Yules, Human-Factors Experts in Products Liability Litigation, 9 J. PROD. LIAB. 107, 107 (1986). In this article, Yules set forth the following analysis:

One well-publicized illustration of this problem concerns the F-16 fighter plane. Its astonishing maneuverability subjects the pilot to such great gravitational forces that loss of consciousness by the pilot with attendant loss of control of the aircraft is not uncommon. This failure to match aircraft design to the limitations of the human pilot is thought to explain the unexpectedly high number of crashes among F-16s. Technological development has led to the recognition that the safe and efficient use of a machine is limited by the capabilities of its operator.

\textit{Id.}
injures the ultimate user.\textsuperscript{21} Although the manufacturer is not an insurer for all injuries caused by his products,\textsuperscript{22} it must warn of dangers in some cases. The duty of a manufacturer to provide a warning or instruction arises when three conditions exist: (1) there must be a risk of harm inherent in the product or in its intended use,\textsuperscript{23} (2) the

\begin{quote}
\textsuperscript{21} \textit{Restatement (Second) of Torts} § 402A (1965). This section of the \textit{Restatement} reads:

Special Liability of Seller of Product for Physical Harm to User or Consumer
(1) One who sells any product in a 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.
\end{quote}

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It should be clear that the manufacturer is not an insurer for all injuries caused by his products. A bottling company is liable for the injury caused by a decomposing mouse found in its bottle. It is not liable for whatever harm results to the consumer's teeth from the sugar in its beverage. A knife manufacturer is not liable when the user cuts himself with one of its knives. When the injury is in no way attributable to a defect there is no basis for strict liability.

\textit{Id.}; see also Jones, 16 Ill. App. 3d at 399, 306 N.E.2d at 316 (holding "[t]he law does not require every product to be accident proof, incapable of causing harm or accompanied by a warning against any injury which may ensue from a mishap in the use of the product"); Baker v. Int'l Harvester Co., 660 S.W.2d 21, 23 (Mo. Ct. App. 1983) (noting that the manufacturer does not have a duty to design accident proof products); Rogers v. Toro Mfg., 522 S.W.2d 632, 637 (Mo. Ct. App. 1975) (noting that strict tort liability does not mean absolute liability); Bell Helicopter Co. v. Bradshaw, 594 S.W.2d 519, 530 (Tex. Civ. App. 1979) (emphasizing that the manufacturer is not obligated to design the safest product possible). \textit{But see} Piper Aircraft Corp. v. Evans, 424 So. 2d 586, 590 (Ala. 1982) (The trial court did not err in refusing instructions which stated that there is no duty to build the safest airplane possible, or an accident proof airplane. If error did occur, the Alabama Supreme Court held it harmless in view of the entire oral charge to the jury.).

\textsuperscript{23} W. Keeton, Prosser and Keeton on Torts 695 (5th ed. 1984). Keeton comments that "a flaw in a product is defined as an abnormality or a condition that
manufacturer must know or reasonably foresee the risk of harm, and (3) the product must possess a "defect." A defective warning may take the form of a total lack of warning, an inadequate warning, or inadequate instructions on safe use of the product. The Restatement (Second) of Torts suggests that a balancing test should determine whether a reasonable man would or would not sell the product, knowing the risk involved. In the context of a warning claim, a product is unreasonably danger-

was unintended, and makes the product more dangerous than it would have been as intended." Id.

24 Borel v. Fibreboard Paper Prods. Corp., 493 F.2d 1076, 1088 (5th Cir. 1973), cert. denied, 419 U.S. 869 (1974) (the court emphasized that "[t]he requirement that the danger be reasonably foreseeable, or scientifically discoverable, is an important limitation of the seller's liability"); see also Keeton, supra note 23, at 697. Keeton, while noting that a few courts hold otherwise, states:

[A] claimant who seeks recovery [based on failure to warn or failure to adequately warn] must, according to the generally accepted view, prove that the manufacturer-designer knew or should have known in the exercise of ordinary care the risk or hazard about which he failed to warn.

Id.

25 Keeton, supra note 23, at 694-97. Keeton sums up this element by stating: "Once it is established that a target defendant sold a product that was flawed in the kind of way that made it more dangerous than it would otherwise have been, the plaintiff has established the kind of defect that makes the product 'unreasonably dangerous' as a matter of law." Id. at 697.

26 For a discussion of these definitions of defective warnings, see Keeton, supra note 23, at 694-98.

27 RESTATEMENT (SECOND) OF TORTS § 402A comment i. The comment refers to products in the context of foodstuffs by stating:

The rule stated in this Section applies only where the defective condition of the product makes it unreasonably dangerous to the user or consumer. Many products cannot possibly be made entirely safe for all consumption, and any food or drug necessarily involves some risk of harm. That is not what is meant by "unreasonably dangerous" in this Section. The article sold must be 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 . . . .

Id. (examples omitted); see also Borel, 493 F.2d at 1088 (the court cited comment i of § 402A of the Restatement, stating "[t]he fulcrum for this balancing process is the reasonable man as consumer or as seller."); Technical Chem. Co. v. Jacobs, 480 S.W.2d 602, 605 (Tex. 1972) (A product is unreasonably dangerous and, therefore, defective if the ordinary man knowing the risks and dangers involved in its use, "would not have marketed the product without supplying warnings as to the risks and dangers involved in using the product as well as instructions as to how to avoid those risks and dangers."). Consider MODEL UNIFORM PRODUCT LIA-
ous if a reasonable man would not market the product without warning the ultimate user of the risks involved in the use of the product.\textsuperscript{28} A manufacturer's duty, however, does not end there. Should the manufacturer decide to market the product with warnings, those warnings must be reasonably calculated to reach the ultimate consumer or user,\textsuperscript{29} catch the user's attention, and convey a fair indication of the nature and extent of the danger to the mind of a reasonably prudent person.\textsuperscript{30} The manufac-

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\textsuperscript{29} Reese v. Mercury Marine Div., 793 F.2d 1416, 1422 (5th Cir. 1986) ("An adequate warning must be reasonably calculated to reach the ultimate user of a product.") The court found the manufacturer's efforts to warn consisted solely of a requirement for dealers to make sure boats were "properly equipped." No evidence indicated the manufacturer directed its dealers to warn ultimate consumers.; Griggs v. Firestone Tire & Rubber Co., 513 F.2d 851, 858 (8th Cir.) (informational literature from the manufacturer to distributors and automobile manufacturers does not satisfy the duty to warn the ultimate consumer), cert. denied, 423 U.S. 865 (1975); Borel, 493 F.2d at 1091 ("The seller's warning must be reasonably calculated to reach [the ultimate consumer] and the presence of an intermediate party will not by itself relieve the seller of this duty.") The court held reliance on insulation contractors to warn the ultimate users of asbestos was not enough, due to the nature of the problem.; Eck v. E.I. DuPont De Nemours & Co., 393 F.2d 197, 201 (7th Cir. 1968) (the court reversed the lower court and sent to the jury the issue of whether the warning was reasonably calculated to reach the ultimate user).

\textsuperscript{30} The "reasonably prudent person" in a warning context refers to an ordinary user of the product, not the knowledge of the particular person injured by the product. Prince v. Parachutes, Inc., 685 P.2d 83, 88 (Alaska 1984). The average user of a product may possess extraordinary knowledge beyond that of a person unfamiliar with the product, and the manufacturer is entitled to take this factor into account when deciding upon a warning. \textit{Id.} at 88; see also Bituminous Casualty, 581 S.W.2d at 872-73 (the sufficiency of the warning language depends on the language itself and the impression that language will make on the average user); Reese, 793 F.2d at 1422 (although not determinative in light of the total evidence presented at trial, evidence that the middleman dealer possessed knowledge of the pros and cons of kill switch use impacted the manufacturer's duty to warn).
turer's conduct is generally judged under the negligence standard, but in some cases courts do not seem to distinguish between negligence and strict liability.

The question of proximate cause analyzes the effectiveness of an actual warning or proposed warning, presumptions about warnings, and contributory defenses. A manufacturer's failure to warn is not the proximate cause of the plaintiff's injury if the proposed warning would not have prevented the accident. In the absence of a warning, however, courts often allow a rebuttable presumption that had a warning been given, the injured party would have read and heeded it. This presumption often satis-

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32 Conti v. Ford Motor Co., 743 F.2d 195 (3d Cir. 1984) (husband's inattention in starting car in reverse gear resulted in injury to his wife; there was no evidence that he would have been more attentive if additional warnings were provided), cert. denied, 470 U.S. 1028 (1985); Stevens v. Cessna Aircraft Co., 115 Cal. App. 3d 431, 170 Cal. Rptr. 925 (1981) (pilot had control of the airplane and responsibility under regulations to determine aircraft weight prior to takeoff; a simple warning for passengers as to plane's load capacity would not have been effective, as too many additional factors exist for a nonpilot to make a safe-weight calculation).

33 Restatement (Second) of Torts § 402A comment j. The comment addresses user conduct by stating:

Directions or Warning. In order to prevent the product from being unreasonably dangerous, the seller may be required to give directions or warning, on the container, as to its use. The seller may reasonably assume that those with common allergies, as for example to eggs or strawberries, will be aware of them, and he is not required to warn against them. Where, however, the product contains an ingredient to which a substantial number of the population are allergic, and the ingredient is one whose danger is not generally known, or if known is one which the consumer would reasonably not expect to find in the product, the seller is required to give warning against it, if he has knowledge, or by the application of reasonable, developed human skill and foresight should have knowledge, of the presence of the ingredient and the danger. Likewise in the case of poisonous drugs, or those unduly dangerous for other reasons, warning as to use may be required.

But a seller is not required to warn with respect to products, or ingredients in them, which are only dangerous, or potentially so, when consumed in excessive quantity, or over a long period of time,
fies the proximate cause inquiry. It is, however, important to note that in some instances a manufacturer may be held liable for failure to warn adequately, even where the plaintiff did not read the warning provided.

III. CASE LAW

Cases involving warning claims typically involve a design defect claim as well. Where possible, this Comment examines only the warning claims against the aircraft manufacturer. This section will examine holdings in which the court found no duty to warn or held the warning given was adequate, and cases where the manufacturer failed to warn or inadequately warned. The jury makes the determination of liability or no liability in al-

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when the danger, or potentiality of danger, is generally known and recognized. . . .

Where warning is given, the seller may reasonably assume that it will be read and heeded; and a product bearing such a warning, which is safe for use if it is followed, is not in defective condition, nor is it unreasonably dangerous.

Id.; see also Caplaco One, Inc. v. Amerex Corp., 435 F. Supp. 1116, 1119 (E.D. Mo. 1977) (a user must make a reasonable inspection of the package to see if a warning is present), aff'd, 572 F.2d 634 (8th Cir. 1978).

Reyes v. Wyeth Laboratories, 498 F.2d 1264 (5th Cir.) (where manufacturer fails to warn, presumption will arise that had warning been given, consumer would have read it and acted so as to have avoided the risk; in the absence of evidence rebutting the presumption, a jury may find that the failure to warn was a producing cause of the plaintiff's injury), cert. denied, 419 U.S. 1096 (1974); see also Uptain v. Huntington Lab, Inc., 723 P.2d 1322 (Colo. 1986) (en banc) (the manufacturer is entitled to rely on the presumption that the user would read the warning provided); Wolfe v. Ford Motor Co., 6 Mass. App. Ct. 346, 376 N.E.2d 143 (1978) (the failure to give a warning that would in the ordinary course have come to the user's attention "permits the inference that it would have alerted the user to the danger and forestalled the accident."). But see Potthoff v. Alms, 41 Colo. App. 51, 583 P.2d 309 (1978) (where the danger is obvious, the adequacy of the warning must be determined on the basis of evidence alone and no presumption exists).

See infra notes 116-133 and accompanying text for a discussion of Nesselrode v. Executive Beechcraft, Inc., 707 S.W.2d 371 (Mo. 1986) (en banc) in which the court held that the warning provided was insufficient, regardless of whether or not the mechanics had seen the warning.

For a discussion of design and warning claims against component part manufacturers see P. KEETON, PROSSER AND KEETON ON TORTS 705-06 and Comment, Products Liability; Component Part Manufacturer's Liability For Design and Warning Defects, 54 J. AIR L. & COM. 215 (1988).
most all cases involving warning claims. Consequently, application of the reasonable man standard does not always seem consistent. These cases are presented as illustrations of the type and result of litigation over aircraft warnings. The relative weight given certain evidence and fact findings should aid practitioners and manufacturers in more accurately predicting the reasonableness, sufficiency, and practicality of warnings provided.

A. Cases Declining to Find a Duty to Warn or Finding That Warning Provided Was Adequate

Litigation involving warning claims against manufacturers which find no duty was breached most often relies on evidence that the warning provided was sufficient. Since this determination is most often made by a jury, the court considering the appeal reviews the findings on an abuse of discretion standard. The seeming lack of any definable test for determining the sufficiency of a warning exemplifies some of the difficulties faced by manufacturers when trying to avoid liability for their products.

In Chohlis v. Cessna Aircraft Co., the United States Court of Appeals for the Eighth Circuit upheld a jury’s refusal to find that the plane was defective, instead returning a verdict for the manufacturer. The plaintiff’s husband, a passenger in the Cessna airplane, died when the airplane crashed on landing. The plaintiff alleged that the

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37 760 F.2d 901 (8th Cir. 1985).
38 Id. at 904.
39 Id. at 903. Evidence showed the engine failed due to lack of fuel, although the main tanks contained a significant quantity of fuel. Id. Due to a bypass feature in the fuel injection system, excess fuel returned to the main fuel tanks, regardless of which tank the fuel originated from. Id. Consequently, the auxiliary tanks contained less usable fuel than the main tanks as the main tanks effectively “confiscated” unused auxiliary fuel. Id. The court explained the tanks as follows:

The plane was equipped with four fuel tanks: a primary and auxiliary tank in each wing. Two fuel gauges served four tanks; the gauges normally displayed the levels in the tanks being used. By flipping a switch, however, the levels in the tanks not in use should be displayed. An amber light on each gauge indicated when the auxiliary tanks were in use.

Id.
plane's fuel system was defective, as were the warnings provided about the unusual fuel arrangement of the plane.\(^{40}\) According to the plaintiff, the fuel arrangement caused unnecessary confusion in the mind of the average pilot.\(^{41}\) Expert witnesses also testified that the instructions recommended procedures which did not comply with known, reasonable, common pilot behavior.\(^{42}\) Other experts recommended a warning light to indicate to the pilot when fuel tanks reached a certain low level.\(^{43}\) The plaintiff argued that the "unnecessarily complex fuel system" induced pilot error and Cessna's warnings were not sufficient to prevent error.\(^{44}\)

Cessna, on the other hand, offered evidence of many different warnings designed to call attention to this fuel anomaly. The plane's owner's manual, for example, recommended use of the main tanks during takeoff, landing, and all emergency operations.\(^{45}\) The manual also cautioned that because of the fuel diversion feature, the auxiliary tanks could run dry sooner than anticipated.\(^{46}\) Further warnings in the checklist for landing directed the pilot to switch to the main tanks prior to lowering the landing gear.\(^{47}\) A placard posted in the cockpit further cautioned the pilot that the switch to the main tanks was

\(^{40}\) Id.

\(^{41}\) Id.

\(^{42}\) Id. The court related the contentions of the plaintiff's experts by stating: The plaintiff's experts described the fuel system as defective and the accompanying instructions as inadequate. For example, the manual "recommended" that the pilot not operate on the auxiliary tanks under 1,000 feet altitude. One of the plaintiff's experts stated that often a pilot will be in a lower altitude, perhaps 800 feet, when the descent checklist is initiated. He testified that the manual should have stated: "Do not operate on auxiliary tanks below 1,000 feet." In addition, he criticized the cockpit placard as deficient in not advising the pilot of how many minutes of operation the auxiliary tanks would sustain.

\(^{43}\) Id. at 904.

\(^{44}\) Id.

\(^{45}\) Id. at 903.

\(^{46}\) Id.

\(^{47}\) Id.
the first step in the landing preparation process.\textsuperscript{48} After
the jury finding of no negligence, the trial court denied
the plaintiff's motion for a new trial, and the Eighth Cir-
cuit affirmed. The plaintiff's appeal rested mainly on ob-
jections to jury instructions, all of which the court of
appeals found fairly and adequately stated the substantive
law.\textsuperscript{49}

The case of Kroon v. Beech Aircraft Corp.\textsuperscript{50} turned on the
issue of proximate cause. In this case, the trial judge de-
cided the proximate cause inquiry, as the parties had stip-
ulated the facts.\textsuperscript{51} The pilot failed to remove the gust lock
from his Beech airplane, resulting in a wreck following an
aborted takeoff attempt.\textsuperscript{52} Beech moved for summary
judgment, a motion granted by the trial court and af-
firmed by the United States Court of Appeals for the Fifth
Circuit.\textsuperscript{53} The court emphasized the pilot's carelessness
rather than an inadequate warning on the gust lock sys-
tem itself.\textsuperscript{54} The pilot admitted that he did not comply
with the checklist of pretakeoff operations.\textsuperscript{55} The check-
list, with which the pilot was admittedly familiar, clearly
included an instruction to remove the gust locks.\textsuperscript{56} None-
theless, the plaintiff attempted to argue that Beech should

\textsuperscript{48} Id. at 907.
\textsuperscript{49} Id. at 903.
\textsuperscript{50} 628 F.2d 891 (5th Cir. 1980).
\textsuperscript{51} Id. at 892. Under Florida law, summary judgment is proper in cases where
reasonable jurors could only conclude that the plaintiff's conduct constituted the
sole proximate cause of the injury. Helman v. Seaboard Coast Line R.R. Co., 349
So. 2d 1187, 1190 (Fla. 1977) (The function of the jury is to determine proximate
cause by drawing inferences from the evidence presented. A summary judgment
can only be sustained where "the evidence [is] of such a nature that reasonable
men could only conclude that the behavior of [the plaintiff] was the sole proxi-
mate cause of the accident.").
\textsuperscript{52} Kroon, 628 F.2d at 892. The aileron and elevator gust lock protects the plane
from strong winds while not in use. Id. The lock pins the aileron and elevator
controls to prevent movement. The airplane will not fly with the lock still in place.
Id.
\textsuperscript{53} Id. at 894.
\textsuperscript{54} Id.
\textsuperscript{55} Id. at 893. The checklist was directly in front of Kroon from the time he
entered the cockpit of the aircraft. Id. However, he admitted he did not properly
perform the required check to insure that the controls moved freely. Id.
\textsuperscript{56} Id.
have designed the gust lock system so as to prevent the plane from operating while the locks were in place.\textsuperscript{57}

In affirming the trial judge's decision, the Fifth Circuit refused to consider the issues of negligent failure to warn and design defect.\textsuperscript{58} While admitting the design of the lock system was a cause of the accident,\textsuperscript{59} the court refused to find that the design problem rose to the level of proximate cause.\textsuperscript{60} Further, the placard in front of the pilot required a preflight check which would have revealed the problem.\textsuperscript{61} Clearly, the court considered this placard a much more reasonable alternative than a design modification which prevented operation of the plane with the gust locks still in place. Thus, pilot knowledge of an obvious danger can eliminate the need for further warnings or a design that makes the plane foolproof.\textsuperscript{62}

\textsuperscript{57} Id.

\textsuperscript{58} The court stated: "The rudder gust lock is not in issue in this case." Kroon, 628 F.2d at 892.

\textsuperscript{59} Id. at 893.

\textsuperscript{60} Id. The court found sufficient evidence on the facts that "nothing in the design of the gust lock nor Beech's failure to warn users of a potential danger proximately caused this accident." Id. (emphasis in original).

\textsuperscript{61} Id.

\textsuperscript{62} Id. at 893-94. The court of appeals cited with approval the trial court's analogy of this accident to a situation in which a pilot takes off with only a gallon of fuel in the plane's tanks. Id. The court noted:

Such accidents can and do happen; and no doubt an airplane could be designed to make such an accident impossible. It would, however, strain reason to suggest that the failure to make the aircraft foolproof in that detail proximately causes the resulting disaster if an experienced pilot familiar with the particular aircraft were to take off without checking to see if he had sufficient fuel.

Id.; cf. \textsc{Restatement (Second) of Torts} § 402A comment n. The comment states:

[C]ontributory negligence of the plaintiff is not a defense when such negligence consists merely in a failure to discover the defect in the product, or to guard against the possibility of its existence. On the other hand the form of contributory negligence which consists in voluntarily and unreasonably proceeding to encounter a known danger, and commonly passes under the name of assumption of risk, is a defense under this Section as in other cases of strict liability. If the user or consumer discovers the defect and is aware of the danger, and nevertheless proceeds unreasonably to make use of the product and is injured by it, he is barred from recovery.

Id.
In *Kay v. Cessna Aircraft Co.*, the United States Court of Appeals for the Ninth Circuit examined instructions provided by the aircraft manufacturer and unforeseeable misuse of an airplane. The court of appeals upheld the trial court's judgment notwithstanding the verdict and found that Cessna was not liable for the pilot's death. Undisputed evidence showed that the pilot completed warm-up procedures in the parking lot, then taxied to the end of the runway where the rear engine of the plane stopped. He sat at the end of the runway for several minutes, ignorant of the problem, then attempted to take off with only the front engine in operation. Early models of the plane featured a thrust warning light which informed the pilot of rear engine failure. Later models, such as Kay's, did not include the warning light due to its unreliability and tendency to give false warnings. The plaintiffs contended that Cessna's instructions, with respect to operation of the twin engined plane, did not adequately warn of the hazards of one-engine operation. In the alternative, the plaintiffs argued that the pilot's actions constituted a fore-

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548 F.2d 1370 (9th Cir. 1977).

Id. at 1371. The Cessna Skymaster Model 377 involved in the crash "is a twin engine aircraft of 'push-me/pull-me' design . . . ." *Id.* at 1372. That is, the aircraft has "one pulling engine forward of the pilot as in the traditional single engine design and the second pushing engine behind the pilot and totally obscured from his view." *Id.*

Id.

*Id.* In the Skymaster 377, "rear engine failure cannot be detected either visually or by a change in the plane's movement." *Id.* Contrast this to engine failure in a conventional twin, which is easily cognizable by a "sharp and violent turning motion." *Id.*

*Id.*

*Id.* The plaintiff offered newly discovered evidence on appeal in the form of an internal memorandum by Cessna's Manager of Flight Text and Aerodynamics. *Id.* The memorandum criticized the decision to discontinue the warning lights and called the then-existing system inadequate. *Id.* The appeals court held this evidence to be cumulative and therefore not relevant to the trial judge's decision to grant the motion for judgment notwithstanding the verdict. *Id.* at 1373. Evidence at trial convinced the court that Cessna attempted to develop a system free of the unreliability of earlier models, but could not successfully develop such a warning system. *Id.* at 1372.

*Id.* at 1372.
seeable misuse of the aircraft.\textsuperscript{70}

The court of appeals addressed each recovery theory in turn. As to the negligent failure to warn claim, the court drew heavily on the defendant's owner's manual pretakeoff procedures.\textsuperscript{71} These procedures included looking at the instrument panel for indications of a dead engine or a rough or sluggish engine.\textsuperscript{72} The checklist expressly recommended a full-throttle engine check for early indications of engine trouble.\textsuperscript{73} The owner's manual warned that any indication of engine trouble "constitute[s] good cause for discontinuing the take-off."\textsuperscript{74} The plaintiff's evidence did not refute the fact that compliance with the owner's manual procedures would have avoided the accident.\textsuperscript{75} Nor did the plaintiff offer an alternative warning or procedure that would have prevented the crash.\textsuperscript{76}

On the second claim of foreseeable misuse, the court concentrated on the pilot's inaction while waiting to take off.\textsuperscript{77} A simple visual scan of the instrument panel would have alerted the pilot to the dead engine.\textsuperscript{78} The court found it entirely reasonable for Cessna to expect pilots of Skymasters to comply with the owner's manual and basic air safety principles.\textsuperscript{79} Thus, Cessna was not reasonably expected to anticipate a pilot failing to check his instrument panel while waiting for takeoff.\textsuperscript{80} In upholding the trial judge's decision, the court held Cessna's instructions

\textsuperscript{70} Id. at 1372-73.

\textsuperscript{71} Id. at 1373. The court stated: "The Owner's Manual sets forth procedures the pilot should follow before take-off which include checks of the throttle settings and the magnetos. The instructions further provide that the pilot should check full-throttle engine operation early in the take-off run." Id.

\textsuperscript{72} Id. at 1373 n.2.

\textsuperscript{73} Id. The Owner's Manual under the heading "TAKE-OFF" stated: "It is important to check full-throttle engine operation early in the take-off run." Id.

\textsuperscript{74} Id.

\textsuperscript{75} Id. at 1373.

\textsuperscript{76} Id.

\textsuperscript{77} Id.

\textsuperscript{78} Id.

\textsuperscript{79} Id. The court stated: "Both the Skymaster manual and basic principles of aircraft safety dictate that the pilot be alert [immediately before and during takeoff] for potential problems." Id.

\textsuperscript{80} Id.
adequate to alert the pilot of engine failure before takeoff, and held that the pilot's failure to comply with the instructions constituted unforeseeable misuse.\textsuperscript{81}

In \textit{Rehler v. Beech Aircraft Corp.},\textsuperscript{82} the pilot died when his Beech Baron airplane crashed approximately one hour after takeoff.\textsuperscript{83} The plaintiff alleged that Beech defectively designed the airplane in that the Baron had a tendency to fall into a flat spin, and that Beech failed to warn of this tendency in the Baron's "Pilot Operating Handbook."\textsuperscript{84} In addition, the plaintiff contended that the spin recovery procedure in the handbook was ineffective for pulling the plane out of a flat spin.\textsuperscript{85} The jury's special verdict found the manufacturer did not defectively design the aircraft, nor did it fail to give adequate warnings.\textsuperscript{86} The jury then found the actions of the pilot the sole proximate cause of the accident.\textsuperscript{87}

On appeal, the plaintiff attempted to demonstrate that the evidence presented at trial pointed to misrepresentation by Beech as to the spin recovery of the aircraft.\textsuperscript{88} In upholding the jury findings on design defect, the court of

\begin{itemize}
\item \textsuperscript{81} \textit{Id.}
\item \textsuperscript{82} 777 F.2d 1072 (5th Cir. 1985).
\item \textsuperscript{83} \textit{Id.} at 1074. Witnesses observed the plane spinning to the left at a low altitude immediately before impact. \textit{Id.}
\item \textsuperscript{84} \textit{Id.} at 1075 n.5.
\item \textsuperscript{85} \textit{Id.}
\item \textsuperscript{86} \textit{Id.} at 1075-76.
\item \textsuperscript{87} \textit{Id.} at 1076.
\item \textsuperscript{88} \textit{Id.} The manual did not distinguish between flat spins and steep (normal) spins, detailing an emergency procedure only for correcting "spins." \textit{Id.} at 1084.
\end{itemize}

The Baron's Operating Handbook stated:

\begin{quote}
\textbf{SPINS}

\textbullet If a spin is entered inadvertently:

Immediately move the control column full forward, apply full rudder opposite to the direction of the spin and reduce power on both engines to idle. These three actions should be done as near simultaneously as possible; then continue to hold this control position until rotation stops and then neutralize all controls and execute a smooth pullout. Ailerons should be neutral during recovery.

\textbf{NOTE}

Federal Aviation Administration Regulations did not require spin demonstration of airplanes of this weight; therefore, no spin tests have been conducted. The recovery technique is based on the best available information.
\end{quote}
appeals relied heavily on Beech's compliance with Civil Air Regulations of the FAA. The plaintiff then argued that the trial judge failed to properly instruct the jury that Beech's compliance with the FAA guidelines did not constitute an absolute defense to the design defect claim. In upholding the instruction given, the court cited the plaintiff's own closing statement as evidence that the jury did not see compliance with the FAA's minimum standards as determinative of the liability issue.

In Stevens v. Cessna Aircraft Co., the plaintiff alleged Cessna was negligent in failing to provide a warning for passengers of an aircraft. Although the opinion does not factually determine the cause of the crash, the plaintiff alleged that the weight overloaded the aircraft's capabilities, and that Cessna's failure to warn passengers of the plane's load capacity made the aircraft defective. The California Court of Appeals affirmed summary judgment for the defendant. The court based its holding on the pilot's responsibilities for the operation of the aircraft.

"It is the pilot who has control of the airplane and the
responsibility under federal regulations to determine aircraft weight prior to take-off.' 97 The court found that instructions to the pilot concerning weight limitations found in the owner's manual relieved the manufacturer of any duty to provide the same information to passengers.98 The plaintiff attempted to analogize an aircraft passenger to a passenger in an elevator or golf cart,99 but the court stated, "Whether the plane can fly safely with a given total weight of passengers depends upon too many additional factors for a passenger to make an informed and intelligent judgment from [a simple warning]."100 Requiring the manufacturer to supply passengers with complex

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97 Id. The court cited 14 C.F.R. §§ 91.3, 91.5, 91.31 (1978), recodified as 14 C.F.R. §§ 91.3, 91.5, 91.31 (1988), in support of its statement that it is the pilot's duty to assume responsibility for the plane and meeting weight restrictions. Stevens, 115 Cal. App. 3d at 431, 170 Cal. Rptr. at 926. The regulations cited retain their form in the 1988 Regulations. Section 91.3 provides in pertinent part: "The pilot in command of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft." 14 C.F.R. § 91.3(a) (1988). Section 91.5 provides: "Each pilot in command shall, before beginning a flight, familiarize himself with all available information concerning that flight. This information must include: . . . reliable information appropriate to the aircraft, relating to aircraft performance under expected values of airport elevation and runway slope, aircraft gross weight, and wind and temperature." 14 C.F.R. § 91.5(b)(2) (1988) (emphasis added). Section 91.31 provides in pertinent part: "[N]o person may operate a civil aircraft without complying with the operating limitations specified in the approved Airplane or Rotorcraft Flight Manual, markings, and placards, or as otherwise prescribed by the certificating authority of the country of registry." 14 C.F.R. § 91.31(a) (1988); see also Associated Aviation Underwriters v. United States, 482 F. Supp. 674, 681 (N.D. Tex. 1979) ("The pilot is primarily responsible for the safe operation of his aircraft and has the final authority as to its operation . . . .").

98 Stevens, 115 Cal. App. 3d at 431, 170 Cal. Rptr. at 926. The court stated: "The owner's manual for this type of aircraft contained the necessary information for use by the pilot. Defendant did not have a duty to provide such information to the passengers also." Id.

99 A passenger in an elevator or golf cart possesses the knowledge needed to make an informed weight calculation for those products. For example, the elevator passenger reads the weight warning in an elevator and can make a reasonably accurate guess as to the total weight of the occupants of the elevator. Similarly, a golf cart passenger can read a warning restricting passengers to a certain number and evaluate compliance. However, weight calculation necessary for safe aircraft operation depends on variables far more complex, such as range, fuel load, and weather conditions.

weight calculation warnings so that they might "second-guess the pilot on a myriad of flying decisions" would not benefit passenger safety in the long run.\textsuperscript{101}

In cases where the courts have found that aircraft manufacturers have adequately warned users of foreseeable problems associated with the airplane, pilots are clearly held to a higher standard of knowledge than that of a layman unfamiliar with the product. Manufacturers can rely on a certain level of competence among pilots by virtue of the required level of flight training, familiarity with the product, and knowledge of basic flight safety principles. In some instances, however, the manufacturers may overestimate the capabilities or actions of the operator (or the mechanic charged with maintenance of the airplane). In these instances, courts declare the warning insufficient and hold the manufacturer liable for damages sustained by the user.

B. Cases Imposing Liability For Failure to Warn or Failure to Adequately Warn

The following cases find a breach of the duty to warn in light of the performance of the product and the actions of the manufacturer. As in the previous cases involving adequate warnings, judicial findings of inadequate warnings often intertwine with design defect claims. Again as before, the standard of a reasonable man's conduct necessarily involves a jury determination of the issue of a warning defect. It is interesting to note that in these cases, the manufacturer either failed to anticipate a foreseeable misuse or failed to take proper steps to insure safety of the average user.

In \textit{Berkebile v. Brantly Helicopter Corp.},\textsuperscript{102} a pilot died in the crash of his helicopter. Prior to the crash, a seven foot long piece of one of the three rotor blades separated from

\textsuperscript{101} Stevens, 115 Cal. App. 3d at 431, 170 Cal. Rptr. at 926.

the helicopter and flew off. Part of the controversy revolved around the issue of whether the blade failure resulted from a design defect or improper autorotation by the pilot. The plaintiff alleged both design defect and lack of adequate warnings. The trial judge submitted the case to the jury, emphasizing the defect claim and refusing to address directly, or give instruction pertaining to, the warning claim. In challenging this ruling by the trial judge, the plaintiff presented evidence that the manufacturer failed to warn the pilot of the response time necessary to successfully initiate autorotation procedures. Further evidence indicated that applicable FAA regulations imposed a statutory duty on the manufacturer to supply intelligible and complete directions and warnings dealing with the autorotation process.

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103 Id. at 349, 311 A.2d at 142.
104 Id.
105 Id. The design defect claim alleged that "in the event of emergency power failure in climbing flight the pilot had only one-third second to get into autorotation which was not enough time to enable a reasonable man to save his life." Id. Plaintiff also alleged defective manufacture of the rotor blade itself, and safety misrepresentations about the helicopter in its advertising brochure. Id.
106 Id. at 349, 311 A.2d at 143.
107 See id. at 349, 311 A.2d at 144. The court summarized the manufacturer's efforts to warn by stating:

[T]he warnings of the dangers and instructions for flying the B-2 are contained in the Rotorcraft Flight Manual and in the cockpit placard. There is no specific warning as to the time needed to get into autorotation, and there is no direction or warning with respect to "Engine Failure in Climbing Flight." There are, however, directions to the pilot to lower the collective pitch lever in case of engine failure; that autorotation should be implemented at no less than 300 rotor RPM; and, that failure to comply "may result in damage to the outer blades."

Id.
108 Id. In quoting the regulations upon which it made this finding, the court held that "the FAA standards are to be given great weight, especially where violation of the minimum requirements is evident." Id. The court quoted two particularly applicable Civil Air Regulations as stating:

§ 6.700(b). The operating limitations, together with any other information concerning the rotorcraft found necessary for safety during operation shall be included in the Rotorcraft Flight Manual (§ 6.740), shall be expressed as markings and placards, (§ 6.730) and shall be made available by such other means as will convey the information to the crew members.

§ 6.730(c). Additional information, placards and instrument
The Superior Court of Pennsylvania reversed the trial court and remanded the case for new trial and a jury determination of the defectiveness of the helicopter.\textsuperscript{109} After referring to Restatement (Second) of Torts section 402A for the general proposition of warnings and their effect on a product's defective nature,\textsuperscript{110} the court stated that "[i]t is imperative that a jury hearing a case of strict liability in tort be aware of its duty to find liability where inadequate warnings exist, even in the absence of a defect in the design, manufacture, or preparation of the product."\textsuperscript{111} In this case, there was absolutely no warning as to reaction time for autorotation,\textsuperscript{112} nor direction or warning addressing engine failure in climbing flight.\textsuperscript{113} The jury should have been instructed to determine if the warnings and instructions given sufficiently warned the pilot of delayed autorotation dangers and the urgency of instantaneous reaction.\textsuperscript{114}

In this accident, the court felt the complete lack of any warnings deprived the pilot of information crucial to the safe operation of the helicopter. The monetary cost of markings having a direct and important bearing on safe operation of the rotorcraft shall be required when unusual design, operating, or handling characteristics so warrant.\textsuperscript{Id.} (emphasis in original).

\textsuperscript{109} Id. at 349, 311 A.2d at 147.

\textsuperscript{110} Id. at 349, 311 A.2d at 143. The court held: "As a matter of law, a product that is marketed without adequate directions or warnings as to its use is unreasonably dangerous, and in a defective condition." \textsuperscript{Id.}

\textsuperscript{111} Id. The court went on to quote Third Circuit application of Pennsylvania law:

If the manufacturer owes a duty to use care in making his products, he owes also the companion duty to warn of latent limitations of even a perfectly made article, the use of which, however, is dangerous if the user is ignorant of those limitations and the manufacturer has no reason to believe that he will recognize the danger. \textsuperscript{Id.} (quoting Tomao v. A.P. DeSanno & Son, 209 F.2d 544, 546 (3d Cir. 1954)); see also Hopkins v. E.I. DuPont DeNemours & Co., 199 F.2d 930 (3d Cir. 1952) (A worker died while "packing" dynamite near another worker who was drilling a hole in rock. The court held that the issue of negligent failure to warn should have been submitted to the jury in light of evidence that no warning directly addressed the circumstance under which the accident occurred).

\textsuperscript{112} Berkebile, 255 Pa. Super. at 349, 311 A.2d at 144.

\textsuperscript{113} Id.

\textsuperscript{114} Id.
such a warning or instruction seems negligible, but arguably the aggregate cost in terms of increased danger stemming from pilot information overload adds significantly to the cost of a simple placard.\footnote{See infra notes 152-174 and accompanying text for a discussion of human factors in engineering and design and how these human limitations impact safety.}

In \textit{Nesselrode v. Executive Beechcraft, Inc.},\footnote{707 S.W.2d 371 (Mo. 1986) (en banc).} reverse installation of elevator trim tab actuators\footnote{Id. at 374. Trim tab actuators move the trim tabs of an aircraft. On a large plane such as the Beech Baron, they aid the pilot by taking most of the weight off the yoke, providing control without the necessity of a great deal of muscle power. Id.} caused the crash of a Beech Baron in which the pilot and three passengers died.\footnote{Id. at 373.} The suit was filed on behalf of one of the passengers, alleging defective design and failure to warn.\footnote{Id. at 374.} The two trim tab actuators look identical but are functionally opposite.\footnote{Id. Also joined in the suit as defendants were the mechanics who incorrectly installed the actuators. Id. The accident occurred during the first flight after the mechanics installed new trim tab actuators in the aircraft. Id. at 374. For a discussion of liability of aircraft repair companies, see \textit{Comment, Liability of Independent Servicers and Repairers of Aircraft}, 54 J. Air L. \\& Com. 181 (1988).} More importantly, the undisputed evidence showed that the parts could easily be interchanged, a situation which rendered the plane impossible to fly properly.\footnote{Nesselrode, 707 S.W.2d at 374-75.} The plaintiff, based on this evidence, prevailed on the claims that the failure to warn of this danger constituted negligence, and the absence of a warning about the possibility of reverse installation rendered the product de-

Reversing the proper placement of the elevator trim tab actuators causes the trim tabs to move in a direction opposite from the one in which they are supposed to move—thereby preventing the proper operation of the elevators. Thus, when [the pilot] attempted to make the airplane climb, he began by signaling the elevators into operation. Next, he signaled the trim tabs to move downward, to assist in the climb and to relieve the forces he felt on the control wheel. But, because the right and left actuators had been reversely installed, the trim tabs not only failed to make the correct directional movements but actually forced the nose of the airplane downward, making it virtually uncontrollable.

\textit{Id.}
fective.\textsuperscript{122} The Court of Appeals and Supreme Court of Missouri affirmed the negligence finding of the jury, but held the trial court should have granted Beech’s motion for directed verdict or later motion for a judgment notwithstanding the trial court’s decision on the damages issue.\textsuperscript{123}

After an extensive review of Missouri tort liability, the Missouri Supreme Court described the “heart and soul of a strict tort liability design defect case” as “unreasonable danger.”\textsuperscript{124} The court gave the jury finding of unreasonable bleness a great deal of weight in its decision.\textsuperscript{125} The plaintiff succeeded in showing that mechanics could not tell the actuators apart by visual inspection.\textsuperscript{126} The mechanics further testified they did not know before the crash that reverse installation of the parts was physically possible.\textsuperscript{127} The mechanics and other witnesses testified that the industry practice dictated a “go right or no go” or “murphy proof” design standard, meaning that parts design should not allow incorrect installation.\textsuperscript{128} The plaintiffs offered evidence that Beech encouraged this practice in its engineering manual.\textsuperscript{129} In addition, an FAA regula-

\textsuperscript{122} \textit{Id.} at 375.
\textsuperscript{123} \textit{Id.} at 373.
\textsuperscript{124} \textit{Id.} at 376.
\textsuperscript{125} \textit{Id.} at 378, 385.
\textsuperscript{126} \textit{Id.} at 379.
\textsuperscript{127} \textit{Id.}
\textsuperscript{128} \textit{Id.} Compliance with a “murphy proof” standard requires that critical flight parts be designed in such a way that improper installation or assembly is physically impossible. \textit{Id.} The “murphy proof” design standard attempts to overcome human carelessness or inattention with design features unique to a particular component part or assembly procedure. \textit{Id.}
\textsuperscript{129} \textit{Id.} Beech’s engineering manual stated the following design policy:

\textbf{Go Right or No Go.} The phrase, “go right or no go” has been assigned to a design criterion adopted by the Army and applicable particularly to aircraft. Essentially, it is a requirement that replaceable parts of aircraft must be so designed that they cannot be installed any way but the right way. As a design policy, it shall apply to all Beech products in applications where the consequences of wrong assembly presents any hazardous condition to the article, its occupants or users. For accomplishment of this design policy, consider such examples as drilling assembly bolts at odd angles or locations, providing a unique keyway, or making the input and output ends of
tion dealing with design characteristics of the control system called for distinctive design features or markings to minimize the possibility of incorrect assembly.\(^\text{150}\)

The court concluded based on this evidence and expert testimony, that Beech should have anticipated reverse installation of the actuators and failure to prevent the practice by design or warning constituted negligence.\(^\text{131}\) The court announced that the core concern in strict tort liability is safety.\(^\text{132}\) In this case, "safety" concerns placed the burden of designing foolproof replacement parts for airplanes on the manufacturer. The holding here suggests that warning and design decisions made with only the user in mind may fall short of adequate.\(^\text{133}\)

In *Bell Helicopter Co. v. Bradshaw*,\(^\text{134}\) the jury found against the manufacturer on the issues of design defect and failure to warn.\(^\text{135}\) Evidence at trial showed that the

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\(^{150}\) Id. at 379-80.

\(^{130}\) Id. at 380. The court noted the introduction into evidence of 14 C.F.R. § 23.685(D) (1981) (recodified as 14 C.F.R. § 23.685(d) (1988)), a FAA regulation on design characteristics. Section 23.685(d) states: "Each element of the flight control system must have design features, or must be distinctly and permanently marked, to minimize the possibility of incorrect assembly that could result in malfunctioning of the control system." 14 C.F.R. § 23.685(d) (1988).

\(^{131}\) Nesselrode, 707 S.W.2d at 385.

\(^{132}\) Id. at 375 (citation omitted).

\(^{133}\) In this situation, a warning placard for the pilot would not have prevented the accident. The "user" or "consumer" in this case was the mechanic responsible for installation of the actuators. Thus, in formulating a warning or deciding on a design modification, manufacturers must keep in mind the third parties whose actions or mistakes affect the safety of the product.

\(^{134}\) 594 S.W.2d 519 (Tex. Civ. App. 1979).

\(^{155}\) Id. at 524. The Bell helicopter crashed after one of its tail rotor blades broke off. Id. at 526. The pilot attempted the prescribed autorotation maneuver, but that failed to prevent the serious impact which followed. Id. The helicopter in question had a history of tail rotor blade failures. Id. The particular tail rotor blade was prone to fatigue fractures. Id. When these fractures failed in flight, the blade would break off, causing loss of directional control. Id. The court noted that "[m]ost of these in-flight fatigue fracture failures were chiefly attributable to failure by the respective owners and operators to comply with Bell suggested, and FAA mandated, inspection and maintenance requirements." Id.
FAA refused to require replacement of faulty tail rotor systems on the helicopter types in question. Nonetheless, the court found that Bell could have effectively removed the blades from the market had they issued a service bulletin requiring replacement of the rotor systems. Bell Helicopter knew that owners of the helicopter type in question did not comply with suggested or mandated treatment of the metal fatigue problem. The replacement cost of the defective rotor blade system apparently discouraged recommended replacement. The court stated that a consumer without knowledge of all relevant safety information could not make an informed decision about possible product modifications. Therefore, Bell should have warned helicopter owners of the specific dangers resulting from continued misuse of the rotor blade system. Thus, even where the FAA decides not to require action, knowledge of a defect in the product may require the manufacturer to adequately warn

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136 Id. at 527. The court stated:
Bell did not have the legal power to force owners of Bell helicopters to replace their 102 systems with 117 systems. Only the FAA has such power and it chose not to exercise its authority when it decided to rescind the proposed AD note which would have mandated the replacement of all 102 systems with 117 systems.

137 Id. at 527-28. The court noted that Bell's subsequent service bulletin had the practical effect of removing all remaining inadequate blade systems from the market. Id. This effect came about primarily because Bell service stations were required to comply with the Bell-issued service bulletin. Id. at 528.

138 Id. at 533-34.

139 Id. The record indicated that the helicopter owner decided not to replace the tail rotor system on his helicopter because of the high cost. The recommended replacement system cost approximately $2700. Id.

140 Id.

141 Id. The court relied on the holding in Technical Chemical Co. v. Jacob, 480 S.W.2d 602 (Tex. 1972) that "where a consumer, whose injury the manufacturer should have foreseen, is injured by a product sold without a warning, a rebuttable presumption will arise that the consumer would have the read the warning and acted to minimize the risks." Bradshaw, 594 S.W.2d at 534; see also Reyes v. Wyeth Laboratories, 498 F.2d 1264, 1281 (5th Cir. 1974) ("In the absence of evidence rebutting the presumption [stated in Technical Chemical], a jury finding that the defendant's product was the producing cause of the plaintiff's injury would be sufficient to hold him liable.").
the users. The warning provided in this case did not supply enough information to the user.

In *LaBelle v. McCauley Industrial Corp.*, a defect in the airplane's starboard propeller caused the propeller to break off and slice into the fuselage. The plaintiffs successfully brought an action against McCauley, the propeller manufacturer, for negligent failure to warn of the propeller defect. The United States Court of Appeals for the Fifth Circuit affirmed the jury's findings, holding that McCauley knew of the propeller defect, but did not directly warn the aircraft owners. McCauley argued that by revising its service manuals to warn repair stations of the danger, its duty to warn was satisfied. Although recognizing that in the context of the federal regulatory scheme an aircraft manufacturer might be entitled to presume that repair stations would follow the new service manual requirement, the Fifth Circuit declined to allow McCauley to totally rely on this indirect warning.

In examining the warning provided, the Fifth Circuit concentrated on the fact that McCauley gave no direct notice to the plaintiffs. Reliance on the repair stations proved unreasonable, as McCauley knew the stations did not perform the rounding and polishing operation re-

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142 649 F.2d 46 (1st Cir. 1981).
143 *Id.* at 47. The accident occurred as the pilot began his take-off roll, and the pilot was able to abort the takeoff without injury to any person. *Id.*
144 *Id.* The plaintiffs also sued New England Propeller Service, Inc. the company which overhauled the propeller. *Id.* at 47 n.2. A default judgment was entered in favor of the plaintiffs on May 24, 1977. *Id.*
145 *Id.* at 49. Fatigue cracks developed in the propeller in question, leading to propeller failure. *Id.* at 48. Evidence indicated that a design defect in the form of sharp corners on the propeller hub contributed to this failure. *Id.* McCauley revised its service manual to require the removal of sharp corners from inside the propeller hub during overhaul of the propeller. *Id.* Subsequently, McCauley requested and received an airworthiness directive from the FAA, because repair stations were not performing the operation. *Id.* Unfortunately, this airworthiness directive did not cover the specific type of propeller which failed on the plane in question. *Id.*
146 *Id.* at 49.
147 *Id.*
148 *Id.*
quired by the manufacturer.\textsuperscript{149} Thus, the warning did not reasonably appraise the purchaser of the danger by direct notice, or by indirect notice reasonably calculated to reach the ultimate user.\textsuperscript{150} Manufacturers must keep in mind that once a problem is identified, effective warnings must reach the pilot. The design of the propeller in this case contained defects which rendered its operation unsafe.\textsuperscript{151} Although the manufacturer warned the persons responsible for repairing the defect, the warning was ineffective due to the repairmen's noncompliance with the warning. Such a warning accomplished neither of its ultimate goals: protection of the users and liability protection for the manufacturer.

In the foregoing cases, the manufacturer failed to fore-

\textsuperscript{149} Id. The court stated:

\begin{quote}
Whether McCauley discharged its duty to warn by revising its service manual, that is, whether the revision adequately warned Plaintiffs, was a question of fact. McCauley's assertion of a right to presume that repair stations would follow the manual rings hollow, for, respecting other propeller models having the same problem, McCauley knew in 1965 that repair stations had not been performing the required rounding and polishing operation. Despite that knowledge and the availability of alternate means of warning Plaintiffs, such as the belatedly issued Service Bulletin 88, McCauley chose to rely solely on whatever indirect notice might result from its service manual revision. In such circumstances, the jury would have been warranted in finding that McCauley's indirect notice constituted an inadequate method of warning and thus a negligent failure to warn.
\end{quote}

\textsuperscript{150} Id. The court cited \textit{Restatement (Second) of Torts} § 388 comment c (1965). \textit{Id.} Section 388, entitled "Chattel Known to be Dangerous for Intended Use" provides:

\begin{quote}
One who supplies directly or through a third person a chattel for another to use is subject to liability to those whom the supplier should expect to use the chattel with the consent of the other or to be endangered by its probable use, for physical harm caused by the use of the chattel in the manner for which and by a person for whose use it is supplied, if the supplier

(a) knows or has reason to know that the chattel is or is likely to be dangerous for the use for which it is supplied, and

(b) has no reason to believe that those for whose use the chattel is supplied will realize its dangerous condition, and

(c) fails to exercise reasonable care to inform them of its dangerous condition or of the facts which make it likely to be dangerous.
\end{quote}

\textsuperscript{151} \textit{LaBelle}, 649 F.2d at 48.
see or react to a design characteristic or user characteristic that injured a consumer. Judicial findings in the products liability area, though numerous, are vague as to what can be done by a manufacturer to avoid such liability in light of consumer misuse of the product. In any case, a judgment certainly comes too late to avoid liability for that particular accident. To avoid accidental consumer injury and resulting lawsuits, manufacturers must look to preventative measures, not postaccident corrective measures. These preventive measures should not focus solely on the avoidance of liability, but should strive to provide maximum protection for the average user. The field of human factor engineering examines the interaction of people and the products they use and attempts to predict what might go wrong in the relationship.

IV. HUMAN FACTORS IN PRODUCT DESIGN

A. History of Human Factors Design

The pilot of a private aircraft is often the only person on board with the training and experience required to fly the plane. Consequently, all decisions regarding safe operation of that plane must be made by the pilot alone. It is therefore critical to the well-being of pilot, passengers, and aircraft that the human pilot interact well with the flying machine. Human factor engineering, though implicitly important since primitive man first made tools and clothing, became a national concern in World War II. The United States drafted ordinary men who, after a few short weeks of training, flew the most complicated

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152 Ryan, Human Factors Engineering for Consumer Safety: A Perspective, TRIAL, Nov. 1982, No. 11, at 86. For example, the Chicago Museum of Natural History and the Henry Ford Museum contain exhibits showing how primitive man designed tools, implements, utensils, clothing, and machines to best fit the user. Id. at 86. Ryan compares these early attempts at product design to modern efforts by stating that “[s]uch fundamental design principles as weight, balance, comfort, durability, etc., are evident in most of the early consumer products. The principle of safety, however, was more frequently ignored, or at best crudely applied.” Id.

fighter and bomber planes ever built. The complexity of these weapons strained the capabilities of even experienced flyers. For example, the government noticed that some fighter planes crashed more often than others solely due to "human error." To try and alleviate this problem, early training and personnel programs concentrated on the operator. Efforts were made to anticipate errors and correct the behavior through more thorough training and education. After these attempts failed to reduce the accidents and injuries, design engineers realized the impossibility of modifying people to fit machinery. Thus, the design of the machine itself had to consider the physiological and neurological limitations of a human being. "Human error" was redefined as "design-induced error." The "unreasonably dangerous" machine or product was redefined as one which failed to provide for normal, anticipatable human behavior.

B. Human Reactions in Emergencies

How quickly can a human react to an emergency or life-threatening situation? This question is of vital concern to aircraft manufacturers, since the air will not hold a plane aloft indefinitely while the pilot decides his course of action. The assumption of reaction time impacts design decisions perhaps more than any other factor.

154 Bliss, Human Factors Specialists: What They Can Tell Attorneys About Design Problems, TRIAL, Oct. 1984, No. 10, at 52. Women employed to replace the new soldiers, sailors, and pilots at their former jobs experienced similar difficulties with inappropriately designed industrial machines. Id.

155 Id.

156 Bliss, supra note 154, at 52.

157 Id. In the discipline of "Human Factors Specialists," the question became, "Is this machine unreasonably dangerous in design from a human factors point of view? To answer 'Yes', the machine must have design characteristics that induce human error, and the errors must cause accidents or create situations that will lead to accidents." Id.

158 Messina, supra note 153, at 39. Messina phrased the new definition as a machine or product design which "does not allow for normal, anticipatable human behavior to occur without tragic results." Id.

159 Bliss, supra note 154, at 52-53.
Reaction to danger is not instantaneous with recognition. The brain must recognize that a problem exists, identify the proper response, and command the body accordingly.\(^{162}\) Unfortunately, the time period may lengthen if the person sees the source of danger but does not recognize it as dangerous, or if the person cannot decide how to avoid the danger.\(^{163}\)

Estimates of human reaction time vary widely. One author used 0.7 seconds as a standard,\(^{164}\) but another cited the American Association of State Highway Officials' 2.5 second value as appropriate reaction time.\(^{165}\) One study which presented drivers with completely unexpected dangers recorded reaction times of 5.7 to 9.1 seconds.\(^{166}\) Clearly, extremely short reaction time assumptions as in Berkebile v. Brantly Helicopter Corp.\(^{167}\) demand too much from the limited capabilities of a user. Since machines can move, calculate, and break down much faster than a human can react, manufacturers need to be aware that some design flaws will result in disaster no matter how many warnings are provided. For example, a placard warning that the pilot only has one-fourth second to feather a propeller is useless. No human could react that quickly.

A continuing concern with the operation of an aircraft is the multitude of tasks a pilot must perform in order to

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\(^{162}\) Ryder, Human Factors Engineering in Accident Litigation: A Primer For Nontechnologists, 10 J. PROD. LIAB. 51, 52 (1987). Ryder uses the example of the driver of a car "who decides (on a conscious or subconscious level) that a given obstacle presents a threat of collision, and who reacts by stepping on the brake." \textit{Id.}

\(^{163}\) \textit{Id.} A car driver must decide whether to brake, turn left, turn right, or accelerate. \textit{Id.} Indecision may in some cases extend the reaction past the point necessary to avoid the danger. \textit{Id.}

\(^{164}\) \textit{Id.}

\(^{165}\) Bliss, \textit{supra} note 154, at 53.

\(^{166}\) \textit{Id.} The 1978 U.S. Government study required drivers to respond to unexpected situations necessitating change in speed or direction. \textit{Id.}

\(^{167}\) 225 Pa. Super. 349, 311 A.2d 140 (1973) (the plaintiff alleged the pilot had only one-third second to begin autorotation in the event of an emergency), \textit{aff'd.} 462 Pa. 83, 337 A.2d 893 (1975). For a discussion of Berkebile, see \textit{supra} notes 102-115 and accompanying text.
The pilot of a private aircraft must concern himself with the weather at his location as well as his destination and all points in between. He must decide his course, deviations from that course, and must concern himself with the airworthiness of the plane, its fuel supply, weight, center of gravity, passenger safety, airspeed, engine r.p.m., landing gear position, trim, engine temperature, and whether another plane will suddenly appear from behind a cloud bank. To aid the pilot in some of these decisions, the aircraft manufacturer supplies instrumentation, warnings, and instructions. Ideally, these items would enable the pilot to make better decisions. Unfortunately, the instruments sometimes give false readings, the warnings are subject to misinterpretation, or the placement of warning placards causes confusion. The components of an aircraft cockpit are well designed and as accurate as possible, given modern technology. Still, the primary complaint from pilots is the layout of the instrumentation and the trouble they have distinguishing certain functional instruments during emergency situations.

168 Bliss, supra note 154, at 53. The author uses the example of “car operators who drive on strange freeways during rush hour having to deal with many stimuli simultaneously. Thousands of normally competent drivers have had accidents as they watched for lane changes and speed changes by other vehicles, read road signs, and prepared for their own lane changes and turn-offs.” Id. D. Beaty, The Human Factor in Aircraft Accidents, 26-30 (1969). Id. at 29-30. Id. at 31. Referring to the problem of distinguishing certain instruments, the author stated:

Altimeters, airspeed indicators and other instruments have figures of almost identical size and shape. The rows of circuit breakers [referring here to large commercial airliners of the 1960's], laid out symmetrically and identically like a huge Halma board on the roof of some aircraft, appear almost to invite errors of identification—and so do the switches, particularly those of the pitot heaters.

It has also been noted:

Flying . . . [all but the simplest aircraft] . . . has been described as “hours of boredom interspersed with moments of sheer panic.” The panic phase, of course, is the crisis, such as engine failure on takeoff, when there is far too much to do and too little time to do it in. . . . It is possible for work overload combined with marginal sensory discrimination to cause an accident—for instance, a difficult ap-
Foreseeable misuse of a product, whether involuntary or intentional, concerns manufacturers as much as if not more than normal usage. Humans, by nature, are impatient. As a user becomes more familiar with a product, he finds ways to shortcut safety procedures in order to achieve a satisfactory level of performance from the machine while personally expending a minimal amount of effort.\footnote{See, e.g., Kroon v. Beech Aircraft Corp., 628 F.2d 891 (5th Cir. 1980) (pilot neglected to preflight his aircraft, thus failing to discover gust locks still in place on the aircraft) (discussed supra at notes 50-62 and accompanying text).} Safety features or procedures tend to slow down efficient operation and are sometimes circumvented when the operator is rushed or impatient.\footnote{See, e.g., McAdams v. Pak-Mor Mfg., 602 S.W.2d 374, 380 (Tex. Civ. App. 1980) (A sanitation worker lost his hand when he attempted to push spilling trash back into the truck's compactor. A human factors expert testified that the worker's action was instinctive. The expert described the design of the compactor as a "trap in that when the stuff falls [out] . . . you try to push it back in and you really can't help your reaction. This is possibly the key reason to guard it.").} In some instances, involuntary human reflexes may place the operator in danger of physical harm. Where design features or warnings fail to anticipate such reflex reactions, the user may suffer injury simply because his instincts caused certain behavior.\footnote{UNIFORM PRODUCTS LIABILITY ACT § 104(C)(2)(d) (1979). The other factors listed by this section are:}

Because of this human tendency to misuse a product, manufacturers find themselves more and more at risk for user injuries. The following section suggests warnings designed to provide the user with essential information without overloading his processing capacity, while at the same time discouraging misuse.

C. Warning Clarity, Intensity & Placement

Section 104(C) of the Uniform Products Liability Act lists "clarity and conspicuousness of the warnings or instructions that were provided" as one of the factors in a warning liability question.\footnote{Bliss, supra note 154, at 53.} A warning is inadequate if it

proach can distract a pilot from monitoring the aircraft glide slope, resulting in touchdown short of the runway.

Bliss, supra note 154, at 53.
is not sufficiently intense to communicate the gravity of the danger.\textsuperscript{176} Once the duty to warn arises, the manufacturer must decide what type of warning to use under the circumstances.\textsuperscript{177}

The effectiveness of a warning label depends on the product user's perception. FMC Corporation of Chicago developed guidelines for a product hazard communication system.\textsuperscript{178} This system combines symbols with recognizable meanings and normal words of warning.\textsuperscript{179} Although simplistic in nature due to the relative simplicity of the machines, the suggestions as to clarity and the straightforwardness of the communicated message indicate a clear understanding of human factor engineering. FMC recommends a warning label consisting of three elements: (1) a signal word, (2) a symbol or pictogram, and (3) descriptive words.\textsuperscript{180} The signal word indicates to the user the nature and extent of the hazard sought to be avoided by using readily recognizable words with defined meanings.\textsuperscript{181} Next, a visual message in the form of a

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\textsuperscript{176} B. Wrubel, Liability For Failure to Warn or Instruct, Product Liability of Manufacturers; Prevention and Defense 105, 170-171 (1986) (bound collection of symposium speeches, available in SMU Law School Library); see also, Reese v. Mercury Marine Div., 793 F.2d 1416, 1422 (5th Cir. 1986) ("An adequate warning must be reasonably calculated to reach the ultimate user of a product. Such a warning must also convey a fair indication of the nature and extent of the danger." (citations omitted)).

\textsuperscript{177} Ross, Legal and Practical Considerations for the Creation of Warning Labels and Instruction Books, 4 J. PROD. LIAB. 29 (1981).

\textsuperscript{178} Id. at 39.

\textsuperscript{179} Id.

\textsuperscript{180} Id. Ross describes the function by stating, "The signal word or hazard intensity level identifies the nature and extent of the hazard by using words with defined meanings." Id.

\textsuperscript{181} Id. These words and definitions are recommended by FMC Corporation: "1) DANGER — Immediate hazard which \textit{will} result in severe personal injury or death. 2) WARNING — Hazard or unsafe practices which \textit{could} result in severe
pictogram relates the hazard. Ideally, this symbol portrays the hazard and the effect on the user of that hazard. FMC research found that an interactive pictogram worked better than a display of only one element. The final part of the suggested warning label tells the user how to avoid the hazard by giving instructions or outlining procedures.

A warning design and decision criteria perhaps better suited to aircraft comes from the United States Air Force. The Air Force restricts placement of warning placards to limited circumstances. The guidelines state:

Fix only the following instructions and markings in the cockpit:
A. Instrument identification and range markings.
B. Control identification and position markings.
C. Radio call signs.
D. Emergency procedures. Restrict this category to procedures, which (if not properly followed immediately) will result in the loss of life or property.
E. Ground rescue instructions.
F. Emergency exits.

At least one commentator argues that these guidelines are far superior to the FAA’s unpredictable, often inconsistent process. Critics of the Air Force guidelines argue that military pilots know their aircraft better than civilian pilots, and therefore do not require as many warnings.

personal injury or death. 3) CAUTION — Hazard or unsafe practices which could result in minor injury or product or property damage.” Id. at 39-40 (emphasis in original).

182 Id. at 40.
183 Id. An example of a pictogram suitable for aircraft might be a picture of a box striking a person in the back of the head as part of a warning to firmly secure the load.
184 Id. (The portrayal of the hazard and the interaction of the person with it was more effective than depiction of only one).
185 Id. at 41.
186 Miller, supra note 2, at 104.
187 Id.
188 Id. Miller criticizes the FAA’s lack of guidelines for warning placards, calling for the FAA to adopt the Air Force guidelines. Id.
189 Id.
Manufacturers, however, should be able to rely on a certain degree of care on the part of the civilian pilot when determining warning placement. To overcome this civilian unfamiliarity with the airplane, pilots might face the requirement of a thorough check ride with an instructor for each model of airplane the pilot desires to fly. Airplane manufacturers themselves could make familiarization schools available to prospective users of their airplanes.

Whatever the warning used, several human factors impact its effectiveness. Factors such as user identification, normal use (expected and reasonably foreseeable), abnormal use (unexpected and not reasonably foreseeable), and foreseeable third-party interference with the aircraft's operation must enter into warning decisions. The actual placement of the warning depends on its urgency, user characteristics (height, eyesight, etc.), and the viewing angle.

V. Conclusion

Placards, instructions, warning labels and emergency procedures attempt to aid the pilot of an aircraft during flight. The form, placement and number of these aids all impact their effectiveness. The human mind and body, however, possess limitations which can hinder effective operation of an aircraft. Manufacturers must take these limitations into account not only in designing airplanes, but also in designing and placing warnings and instructions. Courts must look to the same principles in their review of a manufacturer's decision to market a product.

190 Id. Currently, a pilot need only be "checked out" in a plane based on the engine configuration. See generally 14 C.F.R. §§ 61.105-107 (1988). See infra notes 199-200 and accompanying text for a more detailed examination of private pilot licensing requirements.
191 Miller, supra note 2, at 104.
192 Ryan, supra note 152, at 88. User identification includes age, skill, intelligence, strength, memory, perception, and fatigue. Id.
193 Id.
194 Ross, supra note 177, at 41.
Without guidelines for manufacturers and courts, the ultimate loser is the consumer. Primarily due to products liability suits, Cessna ceased manufacturing its incredibly popular piston-engined airplanes in 1986.\textsuperscript{195} Light aircraft deliveries in 1987 numbered only 1,085 compared to 17,811 in 1978.\textsuperscript{196} The average insurance premium paid by aircraft manufacturers rose from $2,000 per plane in 1972 to between $60,000 and $100,000 in 1988.\textsuperscript{197} Perhaps the courts and manufacturers should look in a different direction for solutions to the safety and liability concern.

Many aircraft accidents involve pilot error as much as, if not more than, design defects. Pilots, unfamiliar with the aircraft and its unique operation characteristics, make mistakes which often result in tragedy.\textsuperscript{198} Under the current FAA regulations, certification in a particular aircraft category enables the pilot to fly a large number of very different airplanes.\textsuperscript{199} For example, a rating of “single-engine land” enables the pilot to fly aircraft ranging from fixed speed propellers and gear assembly to variable pitch prop.

\begin{itemize}
  \item [\textsuperscript{195}] Light Aircraft-Pulling Out of Nose Dive, 308 ECONOMIST 72 (June 18, 1988).
  \item [\textsuperscript{196}] Id. These statistics define light aircraft as “single engine to executive turbo-prop.” Id.
  \item [\textsuperscript{197}] Id.
  \item [\textsuperscript{198}] See, e.g., Stevens v. Cessna Aircraft Co., 634 F. Supp. 137 (E.D. Pa. 1986) (The pilot died when he engaged in a needlessly risky maneuver on a landing attempt, causing the engine to stall. The court found that the pilot had never flown that model of aircraft before, and the crash was solely due to the pilot’s inattention, carelessness or panic.).
  \item [\textsuperscript{199}] The categories of certification and ratings are found in 14 C.F.R. § 61.5 (1988). Section 61.5 provides:
    \begin{itemize}
      \item (a) The following certificates are issued under this part:
        \begin{itemize}
          \item (1) Pilot certificates; (i) Student pilot; (ii) Private pilot;
          \item (iii) Commercial pilot; (iv) Airline transport pilot.
        \end{itemize}
      \item (b) Flight instructor certificates.
      \item (b) The following ratings are placed on pilot certificates (other than student pilot) where applicable:
        \begin{itemize}
          \item (1) Aircraft category ratings: (i) Airplane; (ii) Rotorcraft;
          \item (iii) Glider; (iv) Lighter-than-air.
        \end{itemize}
      \item (2) Airplane class ratings: (i) Single-engine land; (ii) Multiengine land; (iii) Single-engine sea; (iv) Multiengine sea.
      \item (3) Rotorcraft class ratings: (i) Helicopter; (ii) Gyroplane.
      \item (3) Lighter-than-air class ratings: (i) Airship; (ii) Free balloon.
    \end{itemize}
\end{itemize}
turboprop airplanes with retractable landing gears. The sophistication difference in operating the airplanes within a category enables a pilot to fly airplanes beyond his ability. As airplanes become more and more sophisticated, the FAA and pilot associations will be forced to restructure the licensing requirements for prospective pilots. To overcome what is often simply unfamiliarity with the operation of the airplane, the FAA should mandate more training to obtain a pilot's license and narrow the ranges of certifications. For example, a requirement that a pilot make five full-stop takeoff and landings in each type aircraft with an instructor would go a long way towards eliminating pilot error. Manufacturers, however, should keep in mind that human error is only part of the equation. The most qualified pilot in the sky cannot overcome a serious design defect.

200 The regulations dealing with pilot training are found at 14 C.F.R. § 61.101-.111 (1988).