REGULATION OF AND LIABILITY FOR RISKS OF PHYSICAL INJURY FROM "SOPHISTICATED ROBOTS"

F. Patrick Hubbard
Ronald L. Motley Distinguished Professor of Law
University of South Carolina

Paper for presentation as a work-in-progress at
We Robot Conference
University of Miami School of Law
April 21–22, 2012

Table of Contents

I. INTRODUCTION

This paper addresses the legal treatment of physical (bodily) injury caused by "sophisticated robots," which are robots that: (1) have relatively high degrees of autonomy in terms of learning, decisionmaking, and action; and (2) are designed for interactive use with humans in public spaces like parks and highways and in private places like homes, offices, and care facilities rather than controlled industrial settings like factories. In particular, it discusses the current system for addressing robots and possible changes to provide a better balance between two competing concerns: (1) fostering innovation and choice in robotic products, particularly self-driving vehicles and mobile general-purpose personal robots, and (2) providing a fair, efficient allocation of the risk of injuries from robots. Achieving this balance will be particularly challenging in situations where an autonomous robot injures a person because of a mistake caused by something the robot has "learned on its own."

The paper analyzes this balance in terms of innovators and of persons who bear the initial risks of injury. The category of *innovators* includes not only robot manufacturers but also designers and sellers, lessors, and other distributors of physical and software components, all of whom must balance the possible economic benefits of success in innovation against the possible costs, including costs of liability for injuries. Initially, the risk of injuries from robots will be borne primarily by three types of potential victims: (1) *purchasers* (owners or lessees), (2) *users* other than purchasers, and (3) *other parties*. The important differences among these three types of potential victims are: (1) only purchasers have the opportunity to bargain with innovators for contract rights at the time of sale, lease, or other distribution; and (2) purchasers and users will

enjoy benefits as well as risks from the use of a particular robot; other parties will incur only risks.

Because this is a work-in-progress, many footnotes have either not been written or not been completed. In addition, parts of the text have not been written. Instead, such things as a short summary of what will be written, the phrase "To be written," or simply a blank line have been placed at that point.

II. "SOPHISTICATED ROBOTS"

A. Robot autonomy

There is no generally accepted definition of robot.[1] This paper adopts a broad view and defines robots as machines with some ability to respond to outside input by engaging in physical motions that are subject to the machine's control.[2] Obvious examples of such robots are home

---

[1] The term "robots" originated in a science fiction play, *R.U.R. (Rossum's Universal Robots)*, by Karel Čapek, which premiered in 1921. Karel Čapek, *R.U.R. (Rossum's Universal Robots), reprinted in* TOWARD THE RADICAL CENTER: A KAREL ČAPEK READER 34 (Peter Kussi ed., 1990); *Chronology*, *in* TOWARD THE RADICAL CENTER, *supra*. In its original Czech version, the play used the term "robota," which means "heavy labor." ČAPEK, *supra* at 33. The movie *Metropolis* also featured a robot, which was referred to in the movie as a "machine man," though it was actually a female humanoid robot. METROPOLIS ((Universum Film AG (UFA) 1927). The artificial entities in Čapek's play are more aptly viewed as organic artifacts. *See* Čapek, *supra* at 38–42 (depicting artificial entities grown from organic living matter, engineered, and redesigned for mass production). The term "robot" has come to refer to machines. THE VISUAL ENCYCLOPEDIA OF SCIENCE FICTION 172 (Brian Ash ed., 1972) (explaining that robots may be defined as entities, often made of metal, whose minds are mechanical devices). Robots can take many forms, but humanoid robots are the most popular form in science fiction. *Id.* at 175–80. Such robots are sometimes termed "androids," but some writers restrict the term android to humanoid robots with synthetic biological or chemical components that are grown rather than a humanoid mechanical entity that is manufactured. Id. at 161, 180. As indicated above, the robots in Čapek's play were such synthesized androids. For further discussion of the development of the term "robot," see Jana Horáková & Josef Kelemen, *The Robot Story: Why Robots Were Born and How They Grew Up*, *in* THE MECHANICAL MIND IN HISTORY 283–306 (Philip Husbands et al. eds., 2008). For historical examination of robot myth and technology, see LISA NOCKS, THE ROBOT: THE LIFE STORY OF A TECHNOLOGY (2007); SIDNEY PERKOWITZ, DIGITAL PEOPLE: FROM BIONIC HUMANS TO ANDROIDS 17–84 (2004).

2

robots like the Roomba "vacuuming robots" produced by the iRobot Corporation.[3] This definition is sufficiently broad to include things like a cruise control system in an automobile, an autopilot system in an airplane, and perhaps even a "programmable" electronic thermostat that operates "autonomously" in turning heating and air conditioning on and off in response to temperature changes. At the other end of the spectrum, the artificial intelligence system (named "HAL" for **H**euristically programmed **AL**gorithmic computer) in the science fiction movie *2001: A Space Odyssey* would also satisfy the definition because HAL had the ability to control physical objects within the spaceship.[4] All these robots have autonomy—i.e., the ability to act independently in response to changes in input. However, there is a vast difference in the nature and degree of autonomy exercised by a thermostat operating independently after its temperature setting is entered and an advanced system like HAL. There is also a considerable difference in the potential harm that results when these robots fail to perform as intended.

In terms of legal doctrines addressing liability for personal injuries, simple robotic machines like basic cruise control systems, thermostats, and Roombas are products or product components. Because they are not very smart, these machines present no unique legal challenges.[5] Of course, robot intelligence will increase and drop in price just as computer intelligence has increased and

---

[3] The iRobot Corporation's website indicates that over six million of its home robots had been sold as of 2011. *Our History*, iRobot, http://www.irobot.com/sp.cfm?pageid=203 (last visited May 8, 2011). For further discussions of robots in the home, see, *e.g.*, GREGORY BENFORD & ELISABETH MALARTRE, BEYOND HUMAN: LIVING WITH ROBOTS AND CYBORGS 136 (2007) (discussing robotic household helpers) and DAVID LEVY, LOVE AND SEX WITH ROBOTS 99–104 (2007) (discussing virtual and robotic "pets").

[4] 2001: A SPACE ODYSSEY (MGM et al. 1968).

[5] **[CROSS REF?]**

become cheaper.[6] For example, even though "Watson" may be similar to an idiot savant with considerable skill at playing *Jeopardy*, its ability to succeed at the game is impressive.[7] Consequently, it is likely that as computer intelligence increases, robots will be able to perform an expanding range of tasks in varied environments as they develop a meaningful ability to learn from the environment and make decisions on the basis of that knowledge. Because robots with such capabilities will be capable of a high degree of autonomy in terms of mobility and choice of actions, the legal system may have to adopt new approaches for addressing liability issues.

Like many technological changes, the development of such smarter, more autonomous robots will proceed incrementally. Because of the incremental nature of this development and because autonomy varies in terms of degree of independent actions, it will be hard to identify a point where robots become sophisticated. Nevertheless, just as a white can of paint becomes gray and then black as tint is added, there will be a point where changes in degree become a change in kind—i.e., when today's robots become sophisticated robots. Cellular telephones provide an example of such a process: The latest iPhones are, in many ways, different in kind from the capabilities of the primitive cell phones used for the first time thirty-five years ago.[8]

The incremental nature of changes in robots will present challenges because the legal system will have to address not only the sophisticated robots at the end but also the steps along the way. Like the white can of paint slowly becoming black, there will be shades of gray. Unfortunately,

---

[6] *See, e.g.*, RAY KURZWEIL, THE SINGULARITY IS NEAR: WHEN HUMANS TRANSCEND BIOLOGY 56–77 (2005).

[7] **[CITE]**

[8] The first cellular network began operation in Chicago in 1978 with about 2000 users. Federal Communications Commission, *The history of . . . Cell Phones*, *available at* http://transition.fcc.gov/cgb/kidszone/history_cellphone.html (last visited Mar. 27, 2012).

some of the issues will require black/white solutions. For example, at some point in the future, driving on portions of major highways may be automated by the use of self-driven cars, specialized electronic highway infrastructure, or a combination of both. At that point, it may be too dangerous to allow human-driven cars on the same part of the highway.

Part IV of this paper focuses on two types of sophisticated robots: motor vehicles and general purpose "personal" robots like that in the recent movie *Robot and Frank*, which depicts a caretaker robot able to provide in-home support for an elderly man.[9] Various types of robotic automobile features have been developed and are available for purchase in production line models.[10] In addition, experimental and prototype vehicles have been developed, including the DARPA Grand Challenge vehicles,[11] the Google cars,[12] farming equipment,[13] truck convoy systems,[14] _____. Sophisticated personal robots appear to be less likely to be available in the near future.[15] However, specific-purpose, mobile robots are now available for

---

[9] (Park Pictures 2012).

[10]

[11]

[12]

[13]

[14]

[15] The challenges involved in developing such robots are daunting because the robot would have to have the following characteristics: (1) mobility in space and of manipulative "arms" and "hands," (2) communication in terms of actions and words, (3) sensory perception in terms of at least sight, sound, and touch, and (4) sufficient intelligence to "understand" humans and avoid grossly wrong decisions. *See, e.g.*, PERKOWITZ, supra note 1, at 105–97; WENDELL WALLACH & COLIN ALLEN, MORAL MACHINES: TEACHING ROBOTS RIGHT FROM WRONG (2009). An indicator of where we are today is a state-of-the-art mobile robot on wheels, operating in a controlled environment on the basis of a task-specific program, can act, though very slowly, on a voice order to fetch a beer by

home use and for commercial uses—for example, Roombas and more complex robots that can retrieve inventory to be shipped from a large warehouse.[16]

B. Design and Safety

Because robotic machines can be very dangerous, robots that might cause bodily injury are currently designed in a way that is analogous to strict versions of the three "laws" of robotics developed by Isaac Asimov:

1. A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.[17]

Though these laws were designed to serve as plot devices involving robots, rather than as a detailed protocol for robot design,[18] and are not actually used in designing robots, crude forms of Asimov's laws are reflected in current practice. More specifically, the first law is reflected in design features that isolate dangerous robots from humans or cause a robot to stop activity if a

---

going to a refrigerator, getting the appropriate bottle from a very well organized refrigerator, delivering it to the person who ordered it, and opening the bottle. This is an awesome achievement for a machine but not for a four-year-old child. Moreover, at a base price of $400,000, it will not compete in cost with a general-purpose, self-programming human child. [**CITE—PR2 Video**] On the other hand, the robot is not likely to sample the beer the way my son did when he got beer from the refrigerator for me when he was four.

[16] Nick Bilton, *Disruptions: At Amazon, the Robot World Comes a Little Closer*, N.Y. TIMES, Mar. 25, 2012, at B5 (Amazon/Kiva); _____.

[17] A. ASIMOV, ROBOT VISIONS 8 (1990); *see* A. ASIMOV, THE NAKED SUN (Fawcett Crest 1972) (1957).

[18] *See* F. Patrick Hubbard, *"Do Androids Dream?": Personhood and Intelligent Artifacts*, 83 TEMPLE L. REV. 405, 464–66 (2011) (discussing Asimov's robot novels and short stories, noting role of laws as plot device, and noting that the laws cannot be used to program robots).

human comes within a danger zone.[19] In terms of design, a combination of the first and second laws parallels the wide use of the human-in-the-loop approach in such things as cruise control in cars, autopilot systems in airplanes,[20] an auto-drive system in a land vehicle on highways,[21] and missile firing decisions in drone aircraft.[22] Finally, the third law is reflected in features that alert users to the need for recharging a battery or that enable the machine to find a power source and recharge the battery on its own.[23]

The safety achieved by these design features comes at a high price because their severe limits on autonomy drastically reduce potential usefulness. The first Asimovian-like approach—isolation from humans by barriers or automatic stop features—prevents the ability of humans to engage in collaborative efforts with potentially dangerous robotic machines, with far greater size and capabilities than a Roomba, in a wide variety of settings.[24] The second approach reduces the ability of robots to replace humans, rather than provide only assistance, in many tasks. As a

---

[19] *See infra* notes 104–110, 123 and accompanying text (discussing safety standards for industrial robots).

[20] *See, e.g.*, Brouse v. United States, 83 F. Supp. 373 (N.D. Oh. 1949) (holding that operator of plane "under robot control" was negligent in failing to "keep a proper and constant lookout" for other planes).

[21] **[Google car; Nevada scheme—requirements (1) presence of human in vehicle; and (2) for equipment enabling human to take immediate control]** *See infra* notes 193–194.

[22] **[Cite] [Note: Robot does not harm humans; human does]**

[23] **[Warehouse robots—*see supra* note 16]**

[24] *See, e.g.*, National Institute of Standards & Technology (NIST), *Safety of Human-Robot Collaboration Systems Project*, *available at* http://www.nist.gov/el/isd/ps/safhumrobcollsys.cfm. NIST notes:

> Safe human-robot collaboration is widely seen as key to the future of robotics. When humans and robots can work together in the same space, a whole class of tasks becomes amenable to automation, ranging from collaborative assembly to parts and material handling and delivery.

Id.

result, the design approaches currently used inhibit the development and use of sophisticated robots with the autonomy of physical movement that will enable them to be integrated into daily life and perform physical tasks in the same ubiquitous way that computers have come to handle information.

In terms of comparison, because of the enormous benefits of automobiles, there is no debate about whether to use them despite their high costs in terms of injuries and deaths, urban sprawl, pollution, and dependency on foreign oil supplies. We do, of course, try to reduce costs; but we are not seriously considering abandoning automobiles. Similarly, a central challenge in the design and use of sophisticated robots will be a search for ways to achieve the benefit of autonomous robots with sufficient size and mobility to cause serious injury in interacting with humans in a cost-effective manner. As robots get smarter, it will be possible to relax the current rigid limitations on robots. For example, increased abilities to identify humans and predict their behavior will reduce the scale of the danger zone where a robot must cease activity. Similarly, fewer tasks will require a human in the loop. Robots with such capabilities "are under development throughout the world . . . [and] will revolutionize manufacturing by allowing humans and robots to operate in close proximity while performing a variety of tasks."[25]

III. THE CURRENT LEGAL SYSTEM

For over two centuries, the United States has addressed the legal regulation of, and liability for, risks of physical injury from new technologies with a complex hierarchical system of federal, state, and local governmental entities, each of which: (1) is relatively autonomous, and

---

[25] *Id.*

(2) uses both judicial and legislative/regulatory mechanisms to address injuries. The system has changed enormously in response to problems resulting from developments like mass production of goods, mechanized transportation systems, and electronic communications systems. Before addressing possible developments in this system in response to sophisticated robots, this paper will discuss the present scheme for dealing with unsophisticated robotic machines.

A. Judicial approaches

Judicially administered legal schemes impose liability, based primarily on "fault," for injuries caused by machines, and this liability provides an incentive to make products safer. As the development and use of sophisticated robots proceeds, the risk of injuries from the *sale*, *lease*, or other *distribution* of robots will likely be governed by products liability law, including both contract and tort doctrines, and injuries from the *use* of products will be governed primarily by the general negligence principles of tort law.

Contract and tort are examples of judicially administered "corrective justice" schemes for allocating the risk of loss because both schemes operate on the following principle: Where Plaintiff (*P*) can show that Defendant's (*D*'s) wrongful act—i.e., a breach of a legal duty to *P*—caused injury to *P*, *D* must correct that wrong by placing *P* in the position *P* would have been in (usually by paying compensation) but for the wrong by *D*.[26] Thus, in both contract and tort, the plaintiff bears the burden of proving a right to compensation from the defendant. The primary

---

[26] *See* F. Patrick Hubbard, *The Nature and Impact of the "Tort Reform" Movement*, 35 HOFSTRA L. REV. 437, 446–48 (2006) (discussing nature and purposes of tort law).

difference between contract and tort is that legal duties are generally imposed by agreement of the parties in contract and by operation of the law in tort.

As indicated more fully at Parts III.A.1. and III.A.2. below, efficiency in terms of requiring only cost-effective expenditures on safety plays a central role in defining the duties to potential victims owed by product sellers, lessors, and users. As a result, corrective justice and the efficient reduction of accidental injury costs are *not* in conflict with each other. Instead, because efficiency defines duties, the corrective justice systems of contract and tort are intended to promote efficiency.[27]

Contract law and tort law are largely a matter of state law. In order to deal with the complexity of disagreements among the states concerning the details of legal doctrine, this discussion adopts two approaches to simplify the complexity resulting from the doctrinal variations among the states. Contract law will be addressed primarily in terms of Article 2 of the Uniform Commercial Code (UCC), which governs sales and other forms of distribution in terms of "transactions in goods,"[28] and Article 2A of the UCC, which governs leases.[29] Both articles apply to robots. Though the UCC is the product of state legislation, it is applied by the courts

---

[27] Even though tort law incentivizes efficiency by only imposing liability for inefficiency in making decisions about safety, it does not function in the same way as a regulatory system. For example, if a person acts in a negligently dangerous manner by driving twenty miles per hour over the speed limit and no one is harmed as a result, there is no wrong to correct and thus no liability. In contrast, under regulatory schemes addressing driving, a fine for that speeding could be imposed regardless of outcome.

[28] U.C.C. § 2-102; *see id.* § 2-105 (defining "goods"); *id.* § 2-106(1) (defining "sale"). Licensors can, under many circumstances, be subject to the same liability as the seller of a product. *See, e.g.*, DAVID G. OWEN, PRODUCTS LIABILITY LAW § 16.2, at 1070–77 (2d ed. 2008). Software is likely to be viewed as a product, particularly if it is sold as a general purpose package. OWEN, *supra* § 16.8, at 1114–15 **[ADD ADDITIONAL CITATIONS—LEGAL NOTEBOOK 1]**. On the other hand, software prepared for a specific purpose might be treated as a service rather than a product. Regardless of the treatment involved, defectiveness in design or warning in cases of software is likely to be measured by a cost:benefit test similar to that applicable to products.

[29] U.C.C. § 2A-102.

and is, therefore, addressed in this discussion of judicial approaches to allocating liability for personal injuries. Second, the discussions of tort law will use the *Restatements of the Law of Torts*,[30] particularly the *Restatement (Third) of Torts: Products Liability* (referred to hereinafter as *Products Liability Restatement*).[31]

These simplifying approaches do not substantially restrict the utility of the discussion herein for several reasons. First, persons considering whether to sell, buy, or develop robotic products will evaluate risk ex ante—i.e., before any injuries have occurred. From this perspective, they cannot know which state's law will control and, therefore, will be concerned with the *risk* of liability for injury in *any* state where the injury *might* occur. The U.C.C. and the *Restatements* provide a useful basis for such broad ex ante considerations of risk.[32]

Second, the content of the legal rules in each state will always be indeterminate to some extent.[33] This indeterminacy cannot be avoided party because the limits of verbal communication make it impossible to devise rules precise enough to decide cases outside of a

---

[30] **[Describe Restatements and ALI]**

[31] The *Product Liability Restatement* was adopted by the ALI on May 20, 1997.

[32] Unfortunately, it is not possible to simplify other important areas of doctrine relevant to allocating the risk of liability for injuries caused by sophisticated robots, including the following: (1) remedies, particularly damages rules; (2) defenses, particularly those based on conduct by the victim; and (3) allocation of liability among innovators (and to a lesser extent, among innovators, purchasers, and users). Though the conduct of users and victims is addressed in the discussion of design and warnings at Part IV.A.2.a. below and the allocation involved in the third area is addressed to some extent in the discussion of indemnity at Part I.A. below, the other aspects of these doctrinal areas will not be addressed herein. Covering these other areas is simply too complicated to be addressed in a paper of this length. Hopefully, the ex ante nature of risk assessment will restrict the impact of this necessary limitation on coverage.

[33] *See* H.L.A. HART, THE CONCEPT OF LAW 124–36, 144–45, 272–73 (2d ed. 1994).

"core of undisputed meaning" containing a limited class of clear cases.[34] In addition, because of the dynamism and complexity of the world, rule-makers are limited in their ability to determine present and future facts. As a result, they are handicapped by a "relative indeterminacy of aim" concerning the subject of the rule, and this indeterminacy presents difficulties in interpreting and applying the rule.[35] (Analogous problems arise in programming autonomous robots to perform complex tasks in unanticipated, changing environments.)[36] Finally, even relatively precise rules can be changed, and these changes can apply even if they are enacted *after* the sale of the product.[37]

Third, doctrinal uncertainties are far less important than the wide variation in the types and amount of harms that might result when a product is designed or used wrongfully. For example, where a failure of an automatic braking system causes an automobile collision, the injuries caused by the collision could range from minor bruises to spinal injury that renders the victim quadriplegic. Though rare, serious injuries like quadriplegia involve millions of dollars in economic damages for a life care plan, as well as potentially large awards for psychic harm.

---

[34] *Id.* at 12; *see, e.g.*, *id.* at 123 ("core of certainty"), 129 ("paradigm, clear classes").

[35] *Id.* at 128.

[36] **[CITE]** Though programs are not ambiguous, it is not possible to provide rules for all possible cases because of problems involved in providing a complete model of the robot's environment. In addition, difficulties can arise as a result of emergent behavior where a robot is given some autonomy. *See infra* note 128 and accompanying text.

[37] Statutory changes in law often apply to causes of actions [claims] "arising after" the effective date of the statute. **[CITE]** Typically, a cause of action arises after the event in which a product caused the injury regardless of whether the sale of the product occurred before the statutory change. Judicial changes often follow a similar pattern. **[CITE]**

Given all these uncertainties, the rational ex ante approach for innovators is to find the best mix of basic product liability insurance,[38] excess insurance,[39] and self-insurance for their particular robotic product. Though the yearly premium cost of the policy may vary some from year to year,[40] the cost of this insurance package will provide a relatively certain figure as to the liability cost for innovation.

1. Contract

In terms of policy, rights based on "fair" contracts are viewed as both fair and efficient because their allocation of risk is the result of rational choices by autonomous agents.[41] Two kinds of contracts are important to the allocation of risk: (1) UCC rules governing sales, leases, and other distributions[42]; and (2) contracts of indemnification, which explicitly allocate a risk of liability for loss by agreeing to shift the liability from one party (the indemnitee) to the other party (the indemnitor).

38

39

[40] The variation in cost can result from factors like increased (or decreased) competition, reduced investment opportunities for the fund established to pay claims, changes in administrative costs, and increased payouts for claims.

[41] The underlying goals of contract law are the subject of dispute, primarily in terms of whether the goal is the promotion of efficiency or the protection of promise-based or expectation-based rights. *Compare* RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW § 4.9 (6th ed. 2003) (arguing for efficiency), *with* CHARLES FRIED, CONTRACT AS PROMISE: A THEORY OF CONTRACTUAL OBLIGATION 8 (1981) (discussing promise-based rights), HENRY MATHER, CONTRACT LAW AND MORALITY 1, 3–6 (1999) (asserting that facilitation of reliance and beneficial coordination is the goal), *and* STEPHEN A. SMITH, CONTRACT THEORY 3 (2004). Under both approaches, however, the result is the same—i.e., the wishes of the parties as expressed in the contract are generally enforced.

[42] *See supra* notes 28–29 and accompanying text.

a. The UCC

The UCC has a number of default rules to structure the contracting process. One of the most important default rules in terms of product-caused injuries to persons is: Products sold or leased by "a merchant with respect to goods of that kind" must be "merchantable," which means, among other things, "fit for the ordinary purpose for which goods of that kind are used."[43] Generally, this "fit for ordinary purposes" standard requires that the product be reasonably safe for such purposes. This is basically the same standard as the tort standard used for sales of products.[44] Therefore, the discussion below at Part III.A.2.a. of the tort scheme for determining defectiveness is applicable to UCC claims.

Two other UCC rules are important in considering the warranty of merchantability. First, a seller/lessor can avoid being subject to this implied warranty of merchantability by excluding or modifying the warranty.[45] Second, if the merchant does not exclude or modify the warranty, the merchant: (1) will almost certainly be liable for physical injuries caused by breach of the

---

[43] U.C.C. § 2-312(2)(c); U.C.C. § 2A-212 (2)(c). A manufacturer is treated as a merchant under these provisions because the manufacturer sells or leases the product.

[44] Denny v. Ford Motor Co., 662 N.E.2d 730, 738 (N.Y. 1995) ("As a practical matter, the distinction between the defect concepts in tort law and in implied warranty theory may have little or no effect in most cases."); *see* PRODUCTS LIABILITY RESTATEMENT § 2, cmt. n ("Regardless of the doctrinal label attached for a particular claim, design and warning claims rest on a risk-utility assessment."); *id.* at cmt. r ("[I]n cases involving defect-caused harm to persons or property, a well-coordinated body of law dealing with such harm would adopt the tort definition of product defect.").

[45] U.C.C. § 2-316(2); U.C.C. § 2A-214(2).

warranty, even though he is entitled to limit or exclude liability for economic losses caused by the breach,[46] and (2) will likely be liable to third parties who are injured.[47]

b. Indemnity

The right to indemnity can be based on law or contract. An example of a legal right to indemnity is the right of an employer to recover from its employee, who has committed a tortious act for which he would be personally liable, where the employer has been held to be vicariously liable for that tortious act of the employee.[48] Contractual claims to indemnity are more likely to be successful where liability involving robots is involved.[49]

---

[46] *See* U.C.C. § 2-302 ("If a court . . . finds the contract or any clause of the contract to have been unconscionable . . . the court may refuse to enforce it."); U.C.C. § 2-719(3) ("Limitation of consequential damages for injury to the person I case of consumer goods is prima facie unconscionable . . . ."); U.C.C. § 2A-108 (establishing scheme for addressing unconscionability and authorizing the court to grant appropriate relief); U.C.C. § 2A-503(3) ("Limitation, alteration, or exclusion of consequential damages to the person in the case of consumer goods is prima facie unconscionable."); U.C.C. § 2A-520(2)(b) ("Consequential damages . . . include . . . injury to person or property proximately resulting from any breach of warranty."). The definitions sections of Articles 2 and 2A refer to U.C.C. § 9-109 for the definition of consumer goods. Section 9-109 defines consumer goods as goods "used or bought primarily for personal, family, or household use."

[47] *See* U.C.C. § 2-318; § 2A-216.

[48] **[CITE]**

[49] *Compare, e.g.*, Hudson v. Siemens Logistics & Assembly Syss., Inc., 353 F. App'x 717 (3d Cir. 2009) (claim of contractual right to indemnity successful), *with, e.g.*, Williams v. Unit Handling Syss. Div. of Litton Syss., Inc., 449 N.W.2d 669 (Mich. 1969) (rejecting claim of right to implied indemnity against employer for manufacturer's costs of settling suit for defect in a robotic machine with employee of employer).

2. Tort

a. Sales, leases, and other distributions

(1) Doctrine

In cases of commercial sellers, lessors, and other distributors, liability for physical injury arising from products is governed by tort law,[50] regardless of whether contract law applies.[51]

---

[50] *See* PRODUCTS LIABILITY RESTATEMENT § 1 (applying scheme to commercial sellers and lessors); § 19 (defining "product" as "tangible property distributed commercially for use or consumption"); § 20 (defining "seller" and "distributor"). The concept of "selling or otherwise distributing" includes sellers of components if:

> (a) The component is defective in itself, as defined in this Chapter, and the defect causes the harm; or
> (b)(1) the seller or distributor of the component substantially participates in the integration of the component into the design of the product; and
> (2) the integration of the component causes the product to be defective, as defined in this Chapter; and
> (3) the defect in the product causes the harm.

PRODUCTS LIABILITY RESTATEMENT § 5. Special rules are established for particular types of "sellers." *See id.* § 6 (prescription drugs and medical devices); § 7 (food products); § 8 (used products); §§ 12–13 (purchasers of assets of business entity that sold a defective product); § 14 (seller of products sold as if it manufactured the product even though it was manufactured by another). *See supra* note 28 and accompanying text for discussion of licensors' liability and of treatment of software. **[Insert discussion of reason all sellers etc. in chain of distribution are liable]**

[51] Because contracts are viewed as a more efficient method of allocation of economic losses arising from a product defect, the tort system generally uses the "economic loss rule," which provides that, where there is no physical injury or injury to property other than the product, only contract doctrine applies. Section 21 of the *Products Liability Restatement* provides:

> § 21. Definition of "Harm to Persons or Property": Recovery for Economic Loss
>
> For purposes of the Restatement, harm to persons or property includes economic loss if caused by harm to:
> (a) the plaintiff's person
> (b) The person of another when harm to the other interferes with an interest of the plaintiff protected by tort law; or
> (c) the plaintiff's property other than the defective product itself.

Comment a to this section notes as follows:

> Two major constraints on tort recovery give content to this Section. First, products liability law lies at the boundary between tort and contract. Some categories of loss, including those often referred to as "pure economic loss," are more appropriately assigned to contract law and the remedies set forth in Articles 2 and 2A of the Uniform Commercial Code. When the Code governs a claim, its provisions regarding such issues as statutes of limitation, privity, notice of claim, and disclaimer ordinarily govern the litigation.

Tort generally relies on the concept of efficiency to impose responsibility based on "fault," which is defined in terms of efficiency and exists where it was "feasible"—i.e., technologically and commercially (or practically) possible[52]—to utilize a safety measure (either in terms of design or warning) that would have been less costly than the probable injuries that would occur without the safety measure—i.e., where the "safety costs" are less than the "accident costs."[53] For example, if adding a shoulder harness to a seatbelt system costs less than the costs of accidents prevented by the shoulder belt, the shoulder belt should be included in the system.[54]

> Second, some forms of economic loss have traditionally been excluded from the realm of tort law even when the plaintiff has no contractual remedy for a claim.

The economic loss doctrine has been used to bar tort claims in numerous cases involving computers and software. *See, e.g.*, Transport Corp. of Am. v. Int'l Bus. Machs. Corp., 30 F.2d 953 (8th Cir. 1994) (holding that suit in tort for failure of disk drive was barred by economic loss doctrine and that because seller had disclaimed all contract remedies, buyer had no contract claim).

[52] *See, e.g.*, OWEN, *supra* note 28, at 527–29. Owen notes:

> Feasibility requires at least technological capability, but it normally is viewed more broadly to include cost, commercial practicability (including practicable availability of materials and components), and even the likelihood of consumer acceptance. Viewed in this expanded fashion, "feasibility" really means "reasonableness," as reflected in the Products liability Restatement definition of a design defect in terms of the availability of a "reasonable alternative design."

Id. at 527–28 (citations omitted). "Reasonable alternative design" is discussed *infra* at notes 56–57 and accompanying text.

[53] The statement in the text is valid for nearly all tort-based products liability schemes. Where the facts support it, a plaintiff might also file a claim for some form of misrepresentation. *See* PRODUCTS LIABILITY RESTATEMENT § 9; OWEN, *supra* note 28, §§ 3.1–3.4. However, such claims are relatively rare and always require representations of fact by the defendant and, subject to a narrow exception, fault on the part of defendant. Though a few jurisdictions have some degree of strict liability for design and warning defects, these aspects are limited. **[CITE]** Moreover, the vast majority of jurisdictions follow the approach set forth in the *Products Liability Restatement*. **[CITE—Owen?]**

[54] *See, e.g.*, Williamson v. Mazda Motor of Am., Inc., 131 S. Ct. 1131 (2011) (holding that claim based on lack of shoulder belt not preempted). The cost:benefit analysis is more complicated than the text might indicate because the safety costs include not only the cost of the belt but also other possible costs, such as loss in utility of the product and increases in risks of different harms. *See infra* note 57 and accompanying text. The costs of the harnesses per vehicle must be multiplied by the number of vehicles manufactured to get the total safety costs. The total injury

Because injurers are not liable for efficient injuries, one effect of this rule is to impose the costs of efficient injuries on innocent victims. Because of this effect, this fault-based scheme is replaced, on *very rare* occasions, with a "strict liability" nonfault approach in order to be "fair" to victims. Perhaps the most important example of such strict liability in terms of products is where injury is caused by a "manufacturing defect"—i.e., a failure to manufacture the product in accordance with the manufacturer's own specifications. For example, a particular cruise control system that was not manufactured in accordance with the manufacturer's specifications will be held to be "defective" even if the manufacturer used a cost-effective method to achieve quality control in the manufacturing process.[55]

The other two types of product defect involve either: (1) design or (2) warnings or instructions. A product "is defective in design when the foreseeable risks of harm posed by the product could have been reduced or avoided by the adoption of a reasonable alternative design. . . ."[56] A "reasonable alternative design" is defined in terms of risk-utility or cost-benefit—i.e., the safer alternative design's costs (in terms of such things as manufacturing costs, loss in utility of the product, and increase in risks of different harms) must be less than the foreseeable injuries prevented by incurring the costs of the safer, alternative design.[57]

---

costs includes all foreseeable injuries, each of which must be discounted by the probability that the injury will actually occur.

[55] PRODUCTS LIABILITY RESTATEMENT § 2(a) ("[A] manufacturing defect [exists] when the product departs from its intended design even though all possible care was exercised in the preparation and marketing of the product. . . ."); OWEN, *supra* note 28, §§ 7.1–7.4; *see, e.g.*, Jurls v. Ford Motor Co., 752 So. 2d 260 (La. Ct. App. 2000) (holding that plaintiff had presented sufficient circumstantial evidence of manufacturing defect to withstand motion to dismiss).

[56] PRODUCTS LIABILITY RESTATEMENT § 2(b).

[57] *See id.* at cmts. d, f, and g; OWEN, *supra* note 28, §§ 8.4–8.5, 8.8.

A product "is defective because of inadequate instructions or warnings when the foreseeable risks of harm posed by the product could have been reduced or avoided by the provision of reasonable instructions or warnings by the seller or other distributor. . . ."[58] These claims raise two types of issues: (1) was a warning or instruction needed,[59] and (2) if a warning or instruction was provided, was the warning or instruction reasonable. As a general rule, a warning or instruction concerning a risk is required if: (1) the risk is foreseeable to the seller; and (2) it is foreseeable a significant number of users will not be aware of the risk.[60] Determining whether "reasonable instructions or warnings" were used involves a contextual consideration of "various factors, such as content and comprehensibility, intensity of expression, and the characteristics of expected user groups."[61] There is no "easy guideline" and "the ability of a plaintiff to imagine a hypothetical better warning in the aftermath of an accident does not establish that the warning actually accompanying the product was inadequate."[62]

Two types of problems concerning product use have been particularly troublesome in terms of both design and warning: "misuse" and "obvious" risks. Both have been addressed by the broad concept of foreseeable use. Thus, if it is foreseeable that a product will not be used in a

---

[58] PRODUCTS LIABILITY RESTATEMENT § 2(c).

[59] An ordinary paring knife does not need a warning that it is sharp.

[60] F. PATRICK HUBBARD & ROBERT L. FELIX, SOUTH CAROLINA LAW OF TORTS 329 (4th ed. 2011). There are "exceptions" to this rule. *See, e.g.*, PRODUCTS LIABILITY RESTATEMENT § 6 (prescription drugs and medical devices); OWEN, *supra* note 28, § 9.5, at 620–24 ("sophisticated users" and "bulk suppliers").

[61] PRODUCTS LIABILITY RESTATEMENT § 2(c) cmt. i; *see* OWEN, *supra* note 28, §§ 9.3–9.4 (addressing reasonableness in terms of "Adequacy" and "Persons to be Warned").

[62] PRODUCTS LIABILITY RESTATEMENT § 2(c) cmt. i.

manner other than its intended use, design and warning decisions must be based on that foreseeability.[63] Thus, for example, automobiles must be reasonably "crashworthy,"[64] which means they must have reasonable safety measures like shoulder harnesses as well as lap belts.[65] Similarly, even though a dangerous risk may be "obvious," warnings or a design approach must address that risk if it is foreseeable that the risk will not be noticed or appreciated or that the user will not use due care to avoid the risk.[66]

(2) Examples

Because of the widespread use of industrial robots in factories and other work settings,[67] a number of cases have involved claims against manufacturers by workers injured on the job.[68] Another group of cases have involved suits against manufacturers of surgical robots.[69]

---

[63] PRODUCTS LIABILITY RESTATEMENT § 2 cmts. f, m, p; OWEN, *supra* note 28, § 8.8 at 524. Where a seller is liable as a result of foreseeable misuse or other misconduct, the person engaging in the misuse or other misconduct (including the victim if the victim has engaged in such conduct) may also be liable to some extent as well. *See* PRODUCTS LIABILITY RESTATEMENT § 2 cmt. p; § 17

[64] PRODUCTS LIABILITY RESTATEMENT § 16 cmt. a; OWEN, *supra* note 28, § 17.3.

[65] *See* Williamson v. Mazda Motor of Am. Inc., 131 S. Ct. 1131 (2011) (holding that claim based on lack of shoulder belt not preempted by federal law).

[66] PRODUCTS LIABILITY RESTATEMENT § 2 cmts. j, *l*; OWEN, *supra* note 28, § 10.2. Where it is not foreseeable that an obvious danger will not be noticed, there is not duty to warn. *See, e.g.*, Jones v. W+M Automation, Inc., 818 N.Y.S.2d 396 (App. Div. 2006).

[67] The International Federation of Robotics (IFR) estimates:

> In terms of units, . . . the worldwide stock of operational industrial robots will increase from about 1,035,000 units at the end of 2010 to 1,308,000 at the end of 2014, representing an average annual growth rate of less than 6% between 2012 and 2014. In 2011, the stock will increase by 6% to almost 1.1 million units.

IFR, *Industrial Robot Statistics*, *available at* http://www.ifr.org/industrial-robots/statistics/. The IFR also estimates that 150,000 units were sold in 2011. IFR, IFR Press Release, available at http://www.ifr.org/news/ifr-press-release/robot-sales-in-2011-exceeded-all-expectations-361/. The IFR used the definition of "industrial robot" adopted by the International Organization for Standardization (ISO):

A number of cases involving allegations of negligent design of or warning concerning automatic elevators, an early form of a partially robotic machine used widely in consumer settings, have been brought, but most appear to have been unsuccessful.[70]

A number of design/warning cases involve a relatively primitive form of robot—vending machines. Though some suits involve contract claims,[71] others involve tort claims for personal

---

> An automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications.
>
> **Reprogrammable**: whose programmed motions or auxiliary functions may be changed without physical alterations;
>
> **Multipurpose**: capable of being adapted to a different application with physical alterations;
>
> **Physical alterations**: alteration of the mechanical structure or control system except for changes of programming cassettes, ROMs, etc.
>
> **Axis**: direction used to specify the robot motion in a linear or rotary mode

IFR, *Industrial Robots*, *available at* http://www.ifr.org/industrial-robots/.

[68] *See, e.g.*, Payne v. ABB Flexible Automation, Inc., 116 F.3d 480 (8th Cir. 1997) (affirming summary judgment in favor of defendant on claim of design defect); Hills v. Fanuc Robotics Am., Inc., 2010 WL 890223 (E.D. La.) (suit by employee against manufacturers/sellers of robot used to stack crates on wooden pallets); **[add more authorities]**; *infra* notes 87–92 and accompanying text.

[69] *See, e.g.*, O'Brien v. Intuitive Surgical, Inc., 2011 WL 3040479 (N.D. Ill.) (granting summary judgment to manufacturer of "da Vinci" surgical robot); Mracek v. Bryn Mawr Hosp., 610 F.Supp.2d 401 (E.D. Pa. 2009) (granting summary judgment to manufacturer of "da Vinci" surgical robot), *aff'd*, 363 F. App'x 925, 2010 U.S. App. LEXIS 2015 (3d Cir. 2010); Meghan Hamilton-Piercy, *Cybersurgery: Why the United States Should Embrace this Emerging Technology*, 7 J. HIGH TECH. L. 203 (2007); *cf.* Mohler v. St. Luke's Med. Ctr., 2008 WL 5384214 (Ariz. App. Div.) (finding that issue of proper credentialing of surgeon to use robot existed and reversing grant of summary judgment to defendant hospital); Silvestrini v. Intuitive Surgical, Inc., 2012 U.S. Dist. LEXIS 13801 (E.D. La. Feb. 6, 2012).

[70] *See, e.g.*, _____; *see infra* note 97 and accompanying text for discussion of claims against owners-operators of automatic elevators.

[71] Lachs v. Fid. & Cas. Co. of N.Y., 306 N.Y. 357 (1954) (interpreting life insurance contract sold at vending machine in airport).

injury from, for example, caused by excessively hot soup[72] or hot chocolate[73] from a vending machine or by soft drink vending machines that tip over too easily[74] or "invite" users to engage in dangerous measures to get a cola that was purchased but was not provided by the machine.[75]

(3) Practice

Specialization. To a considerable extent, products liability law is a specialty in terms of practice for both defendants' and plaintiffs' attorneys because it involves a distinct set of doctrinal rules. This doctrinal distinctiveness is reflected in the ALI's choice to adopt the *Products Liability Restatement* as a separate publication.

Plaintiffs' attorneys. For attorneys who represent plaintiffs, another reason products liability is a specialty is that allegations of product defectiveness generally require an expert qualified to testify about reasonable alternative design,[76] and the plaintiff's attorney pays for the

---

[72] Abruzzo v. Campbell Soup Co., 1984 WL 320898 (Pa. Com. Pl. 1984) (holding plaintiff had shown sufficient evidence to support a jury verdict).

[73] Valencia v. Crane Co., 132 F. App'x 171 (9th Cir. 2005) (affirming grant of summary judgment for defendant on claims of defective design and warning).

[74] Oden v. Pepsi Cola Bottling Co. of Decatur, Inc., 621 So. 2d 953 (Al. 1993) (no liability); Morgan v. Cavalier Acquisition Corp., 111 N.C. App. 520 (1993) (holding that plaintiff had shown sufficient evidence of design defect).

[75] Smith v. Alexandria Coca Cola Bottling Co., Ltd., 918 So. 2d 522 (La. Ct. App. 2005).

[76] An expert is not required where the feasibility of a reasonable alternative design is obvious and understandable by lay persons. The *Products Liability Restatement* notes:

> [W]hen a manufacturer sells a soft stuffed toy with hard plastic buttons that are easily removable and likely to choke and suffocate a small child who foreseeably attempts to swallow them, the plaintiff should be able to reach the trier of fact with a claim that buttons on such a toy should be an integral part of the toy's fabric itself (or otherwise be unremovable by an infant) without hiring an expert to demonstrate the feasibility of an alternative safer design. Furthermore, other products already available on the market may serve the same or very similar function at lower risk and at comparable cost. Such products may serve as reasonable alternatives to the product in question.

expert's service as the case is being prepared and, if necessary, tried. Under the contingency fee system, the attorney will not get any return on this investment unless the case is resolved by trial or settlement in plaintiff's favor. Moreover, this process can take years. Thus, these attorneys must, to some extent, have "deep pockets."

In addition, if the plaintiff wins the case, the expert's fee must come out of the verdict or settlement amount. Moreover, as indicated more fully below, products liability suits demand a considerable investment of the attorney's time as well as money. The net effect of these economic considerations is that a plaintiff's attorney will not accept or bring a suit unless the amount of damages to the plaintiff is sufficient to make the suit worthwhile—i.e., unless the injuries are severe.

As a result, product sellers and lessors are not likely to be held liable for defects that do not cause substantial personal injuries; such suits are not worth bringing. On the other hand, if the plaintiff's injuries are so severe that a very substantial amount of damages is involved, a plaintiff's attorney may take a case even if the odds in favor of success are less than 50 percent. Like any entrepreneur, it is rational for a plaintiff's attorney to invest in a project with a less than 50 percent chance of success if the costs of the project are less than the likely percentage of return multiplied by the likely amount of return.

Defendants' attorneys. Defense attorneys are usually hired and paid on a fee basis by an insurance company. In most cases, decisions on important issues like whether to make or accept

---

PRODUCTS LIABILITY RESTATEMENT § 2 cmt. f, at 23–24.

a particular settlement offer will be made by the insurance company.[77] Where substantial sums are involved, these decisions will be made by a committee.

Experts. The experts required in a particular products case depend on the circumstances. For robotic products, the experts would be required to have sufficient engineering expertise to provide a reliable opinion on, for example, the existence of a reasonable alternative design.[78] In terms of both design and warning, a "human factors expert," who might have expertise in a field like psychology, would testify.[79]

Process: discovery, summary judgment, settlement, trial, and appeal. The resolution of a products liability case generally takes a considerable amount of time. Well before trial, each side will engage in "discovery" of the other side's experts by requesting the production of documents and reports and by deposing—i.e., taking sworn testimony from—one another's experts as well as other potential witnesses. This part of the process can easily take a year or more. Typically, after most discovery is completed, a defendant will file a pretrial motion, often termed a "Motion for Summary Judgment," for a determination of whether plaintiff has produced sufficient evidence to show the product was defective and that the defect caused the injury.[80] This motion will be granted if, for example, the plaintiff's expert is found to lack sufficient

---

[77] The defendant client has rights in this process; however, partly because of typical contract terms, the insurer has considerable power.

[78] *See, e.g.*, Hills v. Fanuc Robotics Am., Inc., 2010 WL 890223 (E.D. La.) (holding that licensed mechanical engineer qualified to testify about defect in robot used to stack crates on wooden pallets even though he was not a specialist in robotics); **[ADD MORE CASES]**

[79]

[80]

expertise[81] or if the facts that can be proven do not support the expert's opinion.[82] If the motion is granted, judgment is entered in favor of the defendant.

If the motion is denied, it is likely that the case will be settled rather than tried because: (1) the results of a jury trial are hard for either side to predict; and (2) the amount of money at issue is likely to be large because, as indicated above, plaintiffs' attorneys are incentivized to bring only those claims that have sufficient damages to justify their time and expense. As a result, the plaintiff's attorney is concerned about the possibility of no recovery or a totally inadequate recovery and the defendant's attorney is worried about the potential liability for full recovery.

If the motion is granted, the plaintiff is likely to appeal unless the defendant immediately makes a reasonably high offer to settle. Such an offer, however, is unlikely. Consequently, an appeal is likely because the marginal cost of an appeal (in addition to the costs already expended) is relatively low compared to the possible gain by a reversal on appeal or a settlement pending appeal, given the likelihood that the case would not have been brought unless a substantial amount of damages are involved.

b. Control, use, and maintenance

Liability for physical injury arising from service to and use of machines is governed largely by tort law. However, tort doctrine in this context is sometimes articulated in terms of negligence based on the conduct of a "reasonable person" rather than in explicit cost:benefit

---

81

82

terms. Under this alternative phrasing, a person is generally not negligent, and thus not liable, for injuries caused by the efficient (or reasonable): (1) service to a machine; (2) use, supervision, or authorization of a machine's use; or (3) prevention of others from using a "dangerous machine."[83] In theory, both the cost:benefit and the reasonable person test are intended to achieve an efficient level of reduction in injury costs. The primary difference is that explicit costs:benefit language is better at capturing the complex, expertise-driven tasks of designing products and articulating warnings.[84] Reasonable person phrasing is more easily applied by juries where a lay person can understand the activity involved.[85] Where lay persons lack such understanding concerning an activity—for example, in evaluating the conduct of a professional like a doctor—experts would be required in the determination of reasonable conduct.[86]

This paper will focus on the liability of persons who use or control the use of a robotic product, and will address this liability in terms of two types of defendants: employers and persons who control premises where robots are used.

(1) Employment

Because so many dangerous robots are used in factories and other employment settings,[87] injuries to workers by robotic machines have given rise to a number of claims by employees

---

[83]

[84] HUBBARD & FELIX, *supra* note 60, at 64–65.

[85] *Id.* at 65.

[86] *Id.* at 146–48.

[87] *See supra* note 67 and accompanying text.

against their employers.[88] Generally, these injuries are covered by workers' compensation. In most states, a worker who is injured while working for his employer cannot sue his employer in tort; workers' compensation is his exclusive remedy.[89] This rule is based on a principle of fairness: The worker receives a guaranteed no-fault compensation scheme for injuries while working; in exchange, he gives up his right to sue in tort, where recovery is far less certain though the amount of recovery can be higher.[90] Exceptions to the bar to suit exist. For example, where the employer acted with a "deliberate intention" of exposing the worker to a specific unsafe working condition.[91] In addition, an employee injured on the job is not barred for suing a third party—for example, the manufacturer of a workplace machine. Workers have relied on this rule to sue manufacturers of robotic machines, and workers have made claims against their employers for injuries from robots based on such exceptions.[92]

---

[88] *See, e.g.*, Delawder v. Am. Woodmark Corp., 178 F. App'x 197 (2006) (holding that suit against employer for injury from robotic paint machine barred by exclusivity doctrine); Owens v. Water Gremlin Co., 605 N.W.2d 733 (Minn. 2000) (holding that family of worker (who suffered permanent partial disability and eventually died from being pinned against wall by robot arm) could recover worker's compensation benefits).

[89] **[Larson]**; *Delawder*, 178 F. App'x at ___.

[90] **[Larson]**

[91] *See, e.g., Delawder*, 178 F. App'x 197 (holding that exception not proved and that, therefore, exclusivity doctrine barred suit); State ex rel. Scott Fetzer Co., Halex Div. v. Indus. Comm'n of Ohio, 692 N.E.2d 195 (Oh. 1998) (violation by employer); Miller v. Rubbermaid, Inc., 2007 WL 1695109 (Oh. Ct. App.) (insufficient evidence of international conduct by employer); Behurst v. Crown Cork & Seal USA, Inc., 2007 U.S. Dist. Ct. Lexis 24922 (D. Or.) (evidence sufficient to support finding of intent); Edens v. Belini, S.p.a., 597 S.E.2d 863 (S.C. Ct. App. 2004) (no intentional tort shown).

[92] *See supra* note 68 and accompanying text.

(2) Premises liability

As a general rule, a person with control over premises owes a duty to make the premises reasonably safe to persons coming on the premises to transact business.[93] Under this rule, for example, the owner of the premises will be liable for failure to use reasonable care in inspecting and operating robotic machines if this failure results in injury to persons coming to a factory to perform maintenance[94] or install new equipment.[95]

As indicated above, automated elevators have been the subject of products liability claims.[96] These elevators have been involved in even more premises liability claims, and many plaintiffs have succeeded in showing a lack of reasonable care in the operation and maintenance of an automated elevator.[97]

One of the obligations of a landlord to a tenant is to use reasonable care in providing security from violent crime in a common area like a lobby or a hallway.[98] Some cases have held that where a landlord had humans to provide security functions, eliminating these humans[99] or

---

[93]

[94] *See* Budris v. Robotic Res., R2, Inc., 1997 WL 408717 (Conn. Super. Ct.).

[95] *See* Rodriguez v. Brooks Pari-Automation, Inc., 2003 WL 21517851 (N.D. Tex.)

[96] *See supra* note 70 and accompanying text.

[97] *See* Philip White, Jr., Annotation, *Liability of Building Owner, Lessee, or Manager for Injury or Death Resulting from Use of Automatic Passenger Elevator*, 99 A.L.R.5th 141 (2002).

[98] The landmark case on this point is *Kline v. 1500 Massachusetts Ave. Apt. Corp.*, 439 F.2d 477 (D.C. Cir. 1970).

[99] *Kline*, 439 F.2d at 486 (holding that where an apartment complex removed humans performing security functions, "the same relative degree of security should have been maintained" and noting that it was not deciding

replacing them with an interlock and buzzer system[100] was not sufficient to satisfy the landlord's duty because these were less effective than the humans that were replaced. Cases like these arguably provide a framework for considering whether robots should be measured by the capabilities of robots in terms of what is currently feasible or in terms of the capabilities of humans.

However, though cases like these may suggest that the robotic security systems should be measured by the capabilities of humans, two points indicate that the holdings of the case are narrower. First, they involve the *replacement* of humans rather than a situation where human security was not provided. Second, the standard of reasonable care is still based on the cost:benefit test.[101] Under this test, humans would *not* be required for security *at all* if their cost as a safety measure exceeded the foreseeable injuries from lack of human security. Consequently, the only issues would be: (1) whether some security measures were necessary; and (2) whether the particular security measures—whether human, robotic, or otherwise—that were used (or the failure to use any security measures) were reasonable.[102]

---

whether a "tenant-controlled intercom-automatic latch system . . . in the common entryways" would have been sufficient").

[100] Green Cos. v. Divincenzo, 432 So. 2d 86 (Fla. Dist. Ct. App. 1983).

[101] *See supra* notes 53, 84–86 and accompanying text.

[102]

c. The role of standards

Where mass-produced goods like automobiles are manufactured by diverse companies, some degree of standardization is necessary so that, for example, drivers can drive many different cars with a minimal learning curve, other drivers and pedestrians will know how the vehicles around them respond, and parking lots and garages can be designed efficiently. Where safety standards are involved, standardization is sometimes achieved informally by custom. However, because of the advantages in terms of safety and predictability of carefully prepared written standards, this formal approach has become increasingly common. Such standards, including standards for industrial robots,[103] are often developed by independent private entities like the Society of Automotive Engineers (SAE),[104] Underwriters Laboratories (UL),[105] the American National Standards Institute (ANSI),[106] the International Organization for Standardization (ISO),[107] and the

---

[103] For discussion of definition and number of industrial robots, see *supra* note 67.

[104]

[105]

[106] **[Discuss ANSI and ANSI Standards]**. For examples of cases that use ANSI Standards in addressing liability for injury involving robots, see Payne v. ABB Flexible Automation, Inc., 116 F.3d 480 (8th Cir. 1997) (holding that plaintiff had not shown that failure to meet ANSI standard was cause of injury); Provenzano v. Pearlman, Apat, & Futterman, LLP, 2008 U.S. Dist. Ct. LEXIS 86098 (E.D.N.Y.) (holding in malpractice claim against law firm that represented plaintiff in unsuccessful suit against manufacturer of robot that, despite showing evidence of ANSI violations concerning robot, there was insufficient evidence to support malpractice claim). The ANSI Standards must apply to the robotic system at issue. *See, e.g.*, Jones v. W+M Automation, Inc., 818 N.Y.S.2d 396 (App. Div. 2006).

[107] The ISO website describes the organization as follows:

> ISO (International Organization for Standardization) is the world's largest developer and publisher of International Standards.
>
> ISO is a network of the national standards institutes of 163 countries, one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system.

Robotic Industries Association (RIA).[108] Written standards can also be adopted by the government—for example, standards adopted by the National Institute of Standards and Technology (NIST)[109] or by the National Highway and Safety Administration (NHTSA), which promulgates the Federal Motor Vehicle Safety Standards (FMVSS).[110]

The role of nongovernmental standards in tort litigation involving products can be summarized in terms of two rules. First, *breach* of or *compliance* with *industry custom* or *private standards* adopted by an independent entity is generally *admissible* at trial because they are relevant to the issues of reasonable conduct, reasonable design, and reasonable warning.[111] The reasons for this treatment include the following: (1) custom shows what safety measures are feasible and cost-effective; and (2) requiring a more expensive measure than customarily used

---

> ISO is a non-governmental organization that forms a bridge between the public and private sectors. On the one hand, many of its member institutes are part of the governmental structure of their countries, or are mandated by their government. On the other hand, other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations.
>
> Therefore, ISO enables a consensus to be reached on solutions that meet both the requirements of business and the broader needs of society.

http://www.iso.org/iso/about.htm. A list of ISO standards for industrial robots is available at http://www.iso.org/iso/search.htm?qt=robot&sort=rel&type=simple&published=on.

[108] The RIA was founded in 1974. It "is the only trade group in North America organized specifically to serve the robotics industry . . . [and its] [m]ember companies include leading robot manufacturers, users, system integrators, component suppliers, research groups, and consulting firms." RIA, *Company Description*, *available at* http://www.robotics.org/company-profile-detail.cfm/Internal/Robotic-Industries-Association/company/319. A list of its standards can be found at RIA, *Industrial Robot Standards*, *available at* http:/www.robotics.org/bookstore-cat.cfm?category_id=118.

[109] The Institute is part of the U.S. Department of Commerce and is currently engaged in a collaborative effort to develop standards for robots working in close proximity to humans in industrial settings. *See* NIST, *Safety of Human-Robot Collaboration Systems Project*, *available at* http://www.nist.gov/el/isd/ps/safhumrobcollsys.cfm. See *supra* notes 24–25 and *infra* note 195 for further discussion of this project.

[110] For discussion of preemptive effect of FMVSS, see *infra* notes 180–181 and accompanying text.

[111]

can affect an entire industry and should, therefore, not be done lightly.[112] Second, *breach* of or *compliance* with custom is *not conclusive*.[113] One reason for limiting the effect is that allowing industries or nongovernmental groups to set safety standards might result in too little concern for safety.[114] A conclusive effect might also inhibit the development of safer alternatives.

Because the government is presumed to act in the public interest, legal standards are treated differently in that *breach* of a *legal standard* is often treated as, in itself, wrongful.[115] Thus, for example, if breach of a government standard in the design of a product caused a physical injury, the product would almost certainly be found defective.[116] *Compliance* with *government standards* is treated like custom and private standards in that compliance is relevant and admissible at trial but not conclusive.[117] One reason for this approach is that legal standards are frequently a minimum requirement that might not always be satisfactory. For example, driving on the highway at the legal speed limit is a minimum level of safety that is sufficient under normal conditions but not in a thick fog. An exception to this rule concerning compliance arises where the legislature has indicated its intent to preempt the field. Preemption will be addressed in Part IV.B.1.b. below.

112

113

114

115

116 *See* PRODUCTS LIABILITY RESTATEMENT § 4.

117

As a practical matter, a plaintiff has an extremely substantial proof problem where a product's design and warnings comply with industry custom, with a private standard adopted by an independent entity, or with a government regulation. Because of the adversarial nature of trial, juries will assume that expert witnesses for either side have been selected with a desire to win the case. In this context, the plaintiff has problems if a defendant follows a standard concerning design or warning endorsed by industry custom or by an independent or governmental entity. Similarly, a defendant's breach of an industry standard or of a standard adopted by an independent entity assists the plaintiff.

B. Legislative/regulatory approaches

The only broad-based legislative or administrative scheme currently available for addressing the risk of physical injury from consumer-oriented robots is the Consumer Products Safety Commission.[118] For workers, the Occupational Safety and Health Administration (OSHA) provides regulatory oversight.[119] At the state level, various regulatory workplace schemes exist,

---

[118] *See, e.g.*, United States v. Athlone Indus., Inc., 746 F.2d 977 (3d Cir. 1984) (discussing two different actions by Commission concerning automatic baseball pitching machines).

[119] *See, e.g.*, Payne v. ABB Flexible Automation, Inc., 116 F.3d 480 (8th Cir. 1997) (discussing citation of employer by OSHA for employer's removal of safety devices on robot); Behurst v. Crown Cork & Seal USA, Inc., 2007 U.S. Dist. Ct. Lexis 24922 (D. Or.) (OSHA investigation report relevant and admissible as business record); OSHA, OSHA TECHNICAL MANUAL § 4, ch. 4 (Industrial Robots and Robot System Safety (9/22/95)), *available at* http://www.osha.gov/dts/osta/otm/otm_iv/otm_iv_4.html; OSHA, *Guidelines for Robotics Safety* (9/21/87)), *available at* http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&P_id=1703.

and workers' compensation schemes address most of the economic impacts of injuries on the job.[120]

Because the "sophisticated robots" addressed in this paper do not yet exist, it is understandable that no system exists to focus on sophisticated robots in the workplace or in the context of daily living. However, possible approaches are indicated by current practices: (1) schemes like OSHA regulations[121] and workers' compensation for addressing injuries from robotic devices in the workplace,[122] (2) Federal Food and Drug Administration (FDA) regulation in the medical context,[123] (3) federal regulation of automobiles, which are becoming increasingly robotic in terms of devices like cruise control and automatic braking systems, by the National Highway and Traffic Safety Administration (NHTSA).[124] These agencies can impose sanctions for breach of their rules.[125] Moreover, as indicated above, compliance or noncompliance with these regulatory schemes can play a role in tort litigation.[126] In addition, Congress can provide for the preemption of state schemes by federal regulatory schemes as it has done to some extent

---

[120] *See supra* notes 88–92 and accompanying text.

[121] *See supra* note 119 and accompanying text.

[122] *See supra* note 119 and accompanying text.

[123]

[124] *See supra* note 110 and *infra* notes 180–181 and accompanying text.

[125] *See supra* notes 118–119.

[126] *See supra* notes 115–117 and accompanying text.

for motor vehicle design.[127] The possible application of approaches like these to address sophisticated robots will be discussed more fully in Part IV.B.1.b. below.

IV. CHANGES IN CURRENT SYSTEM IN ORDER TO ADDRESS SOPHISTICATED ROBOTS

In order to provide focus for the discussion of proposed changes, this paper will address proposals in terms of two specific types of sophisticated robots—cars capable of driving themselves and mobile general-purpose personal robots—that will be used in settings of daily life rather than confined to controlled work environments.

Because of the autonomy and intelligence of sophisticated robots, two scenarios may complicate the determination of responsibility for conduct by a robot that causes injury. First, the injury may have been caused by "emergent" behavior—i.e., by unpredictable behavior that the robot, in effect, "learned" on its own as a way to achieve a goal.[128] Second, because the utility of these robots will be improved if they can communicate with and coordinate behavior with other sophisticated robots,[129] it may be hard to determine which robot did something in error to cause the injury. Both scenarios raise virtually insurmountable proof problems concerning such issues as defectiveness of design and causation. For example, proof problems like this would arise if someone is injured in a collision where automated cars have been designed to "learn" and to interact with each other and with electronic aspects of the highway.

---

[127] *See infra* notes 180–181 and accompanying text.

[128] *See, e.g.*, RODNEY A. BROOKS, FLESH AND MACHINES: HOW ROBOTS WILL CHANGE US 19–21 (2002).

[129]

A. Judicial Approaches

1. Contract

It is likely that contract doctrine is sufficiently flexible to address sophisticated robot technology in the same manner as it has responded to new technologies in transportation and telecommunications. Some may argue that too many consumers will, as a result of irrationality or "coercive" marketing, agree to contract terms that should not be enforced. Such arguments have been made on behalf of buyers in the context of software licensing contracts that severely restrict buyer's rights—for example, by warranty disclaimers or compulsory arbitration clauses.[130] These arguments have not had much success where no physical injuries are involved.[131] However, if physical injuries are involved, it is more likely that such terms may be held unenforceable. Moreover, even if the terms were enforceable, tort doctrine would apply to physical injuries.[132]

2. Tort

a. Sales, leases, and other distributions

It is not likely that the tort doctrines governing sellers and distributors of products will be changed by the development of sophisticated robots. Plaintiffs would still have to show a defect in terms of manufacturing, design, or warning. For example, a plaintiff claiming that an

---

130

131

132 *See supra* note 51 (discussing economic loss rule).

automatic braking system[133] was defective would have to show: (1) that a reasonable alternative design existed; and (2) that had this design been used, the accident would not have happened.

The facts of and issues in the cases may be different in important ways—for example, expert witnesses might be required to have higher amounts of expertise. As a result, simply being a licensed mechanical engineer might not be sufficient; an expert might be required to have expertise in robotic design or in a specific aspect of robotics.[134]

Where software is concerned, defining manufacturing defect may present problems because it is possible to distinguish between the design in the form of a flow chart or algorithm vis à vis the specific coding that runs a computer.[135] If there is an error in coding, is that a part of the design or is it a manufacturing error? The answer to this question is important because, as indicated above, strict liability is imposed in cases of manufacturing defect[136] while issues of design are addressed in terms of the cost:benefit test.[137] One reason for this difference in treatment is that, in contrast to a manufacturing defect (which involves only the unit or units with such a defect), a finding of a design defect affects the entire product line using that design. Because the specific coding that implements the algorithm is used in the entire product line, it

---

[133] **[Cite to authorities on such systems?—indicate role in self-driven cars]**

[134] *Compare* Hills v. Fanuc Robotics Am., Inc., 2010 WL 890223 (E.D. La.) (holding that mechanical engineer qualified to testify about defect in robot even though not a specialist in robotics), *with* Provenzano v. Pearlman, Apat, & Futterman, LLP, 2008 U.S. Dist. LEXIS 86098 (E.D.N.Y.) (Plaintiff used an "expert in the design of robotic systems.").

[135] *See, e.g.*, David. B. Garrie, *The Legal Status of Software*, 23 J. MARSHALL J. COMP. & INFO. L. 711, 714–20 (2005).

[136] *See supra* notes 55–55 and accompanying text.

[137] *See supra* notes __–__ and accompanying text.

would likely be best to treat the coding in terms of design defect, rather than manufacturing defect.

Increasing sophistication is likely to present challenges in terms of design and of warnings and instructions. The robots will be complex machines that must be relatively easy for humans to use if they are to be used widely. To the extent that ease of use cannot be achieved or can be misleading, effective warnings and instructions will become essential.

Another area affected by an increase in sophistication is the complexity of fact issues in allocating "fault" among multiple component suppliers of hardware and software in terms of product defect and causation. The current rules concerning this situation are clear. First, as a general rule, the seller or distributor of a completely assembled product will be liable for design or warning defects in the assembled product.[138] Second, the seller or distributor of a component part is not liable unless the component is defective or the component seller or distributor of the component participated in integrating the component into the design and the integration causes the defect.[139]

Unless the seller of the assembled product is judgment proof, no longer exists, or cannot be sued for some reason like lack of jurisdiction, the plaintiff will not care about any component part sellers or distributors. However, if these problems do exist, it may be hard to prove that a component was defective or that the component seller or distributor participated in a defective integration of the component. These problems will be especially complicated where a sophisticated robot injures someone as a result of emergent behavior on the robot's part or

---

[138] *See supra* note 50 and accompanying text.

[139] *Id.*

because of interaction with other sophisticated robots.[140] Victims may address these problems by urging courts and legislatures to change burden of proof rules in ways that would make it easier for plaintiffs to recover. Such changes could expand the liability of sellers and designers of such robots.[141]

Sellers of assembled products and sellers of components may want to consider addressing issues of allocation among themselves through the use of a contract requiring one or more parties to indemnify others.[142] However, unless the contract is drawn very carefully, difficult fact issues may remain.

(1) Sophisticated robotic automobiles

As indicated above, automobiles are becoming increasingly sophisticated.[143] It has been suggested that, as this process continues, accidents will be caused more and more by the car itself and less and less by drivers.[144] One result of the increased role of robotic cars could be a shift of liability from owners and drivers to sellers and distributors.[145] Such a shift might result in higher liability costs for sellers and distributors and thus in higher costs for cars. However, more

---

[140] *See supra* notes 36, 128 and accompanying text.

[141] **[California approach to burden of proof on defendant of cost:benefit in *Barker*—*see* OWEN at p. 536]**

[142] *See supra* notes 48–49 and accompanying text (discussing indemnity).

[143] *See supra* notes 9–14 and accompanying text.

[144] NIDHI KALRA, JAMES ANDERSON, & MARTIN WACHS, LIABILITY AND REGULATION OF AUTONOMOUS VEHICLE TECHNOLOGIES 19–22 (2009).

[145] *Id.* at 22.

expensive cars would not necessarily reduce demand for increasingly autonomous vehicles[146] because the cost of owning a car includes the cost of liability insurance, which will be less if the liability costs are shifted from automobile owners to sellers. As a result, a shift to more use of products liability schemes and less use of automobile driver liability schemes may have virtually no effect on incentives for manufacturers to continue to pursue innovation in autonomous features.

Some victims of automobile accidents would be worse off if there is an increase in the use of products liability as the basis for recovery. As indicated above, products liability cases are expensive to bring and are, therefore, only brought where the damages are high.[147] In contrast, automobile claims are relatively inexpensive.[148] As a result, victims with lesser injuries might have trouble bringing a claim that could have been brought otherwise. This distributional impact would exist even if, on the whole, the number of automobile accidents is reduced by autonomous drive features.

This problem might be addressed by a no-fault scheme of automobile insurance.[149] However, there are several problems with this approach. First, automobile insurance has traditionally been regulated by the state. As a result, a national scheme is not likely. In addition, no-fault schemes require legislation, and there is likely to be opposition to such proposals, particularly from

---

[146] *See id.* at 22 (arguing that effect of liability shift might cause manufacturers to be reluctant to introduce technology that will increase their liability).

[147] *See supra* Part III.A.2.a.(3) (discussing plaintiffs' attorneys).

[148]

[149] *See, e.g.*, KALRA, ANDERSON, & WACHS, *supra* note 144, at 20 (suggesting that no-fault schemes may be more attractive if the shift occurs).

plaintiffs' attorneys.[150] Moreover, unless benefits are very low and administrative savings are very high, no-fault insurance may cost more than liability insurance.[151] Manufacturers should also keep in mind that no-fault schemes like workers' compensation and no-fault automobile insurance generally allow products liability suits against manufacturers.[152]

(2) Sophisticated mobile general-purpose robots

As indicated above, sophisticated general-purpose mobile robots are not likely to be available in the near future.[153] However, it is likely that such robots will be similar to automated cars because both will be mobile, autonomous, and capable of causing injury. As a result, the discussion above of automobiles should provide a sense of the problems to be addressed with general-purpose robots.

b. Control and use

Though doctrines are not likely to change in the near future, changes may be adopted as robots become increasingly sophisticated. For example, sophisticated general-purpose mobile robots may be so similar to human workers in terms of learning and autonomy that there may be

---

[150] *See, e.g.*, THOMAS F. BURKE, LAWYERS, LAWSUITS, AND LEGAL RIGHTS 103–41 (2002) (discussing failure to adopt automobile no-fault schemes in California and role of plaintiffs' attorney in fighting no-fault).

[151]

[152] *See, e.g.*, *supra* note 92 and accompanying text (discussing right of workers covered by workers' compensation to sue manufacturers); N.Y. CODE ch. 28, art. 51, § 5104(b) (McKinney's Insurance Law § 5104(b)) (allowing suit against a "non-covered person," which is a category that would include product sellers).

[153] *See supra* notes 15–16 and accompanying text.

a push to expand liability by treating these robots as servants under the respondeat superior doctrine (which imposes vicarious nonfault liability on owners or users),[154] as children,[155] or as animals (which could also result in nonfault liability of owners or users).[156] Another proposal may be to impose nonfault liability by treating the use of robots in some settings as an "abnormally dangerous activity."[157] These nonfault doctrines, which are discussed more fully below, could affect innovation because owners and users may view their increased liability costs as an additional cost of having a sophisticated robot and thus reduce the demand for these robots.

Even if the tort system continues to use only fault approaches to address the control, use, and service of robots, the application of concepts like reasonable care will change where increasingly sophisticated robots are involved because the legal system measures the level of skill reasonably required by the nature of the activity undertaken. For example, a person who undertakes to drive an automobile on the highway or drive a large bulldozer on the site of a construction project would be negligent if he failed to perform at the level of a reasonably skilled operator of either machine.

Similarly, using a sophisticated, general-purpose robot may require considerable skill—for example, in giving it orders or knowing when it has misunderstood an order or is malfunctioning. In this respect, these robots may be like children or like domestic animals like a dog or cat. The

---

[154] *See* SAMIR CHOPRA & LAURENCE F. WHITE, A LEGAL THEORY FOR AUTONOMOUS ARTIFICIAL AGENTS 128–30 (2011).

[155] *Id.* at 120.

[156] *Id.* at 130–31.

[157] *Id.* at 131–32; KALRA, ANDERSON, & WACHS, *supra* note 144, at 21 (discussing possibility of treating sophisticated vehicles as "ultra hazardous").

custodian of a child or animal has a duty of reasonable care in supervising the child or animal to prevent the foreseeable risk of harm from either.[158] Similarly, the person controlling a sophisticated general-purpose robot would be expected to know its characteristics and use reasonable care to prevent harm to others.[159] By the same reasoning, special skills may be required in the case of automated cars. As the very least, some level of supervision would be required for any sophisticated robot that could cause serious injury.

Respondeat superior. Literally translated, the Latin phrase respondeat superior means "let the superior make answer."[160] Roughly translated, the phrase can be viewed as a Latin equivalent of "Let's speak to the boss; he is the one who is responsible because his employees are just the hired help." This rough translation captures the rule's effect: An employer is liable in tort for the injuries committed by his employee within the scope of the employee's employment.

Though multiple policy grounds have been given to justify the doctrine,[161] it is based in large part on the view that fairness requires that the employer, who benefits from being able to control an employee's conduct in the pursuit of the employer's business, be liable for the torts

---

158

159 *See, e.g.*, Mohler v. St. Luke's Med. Ctr., 2008 WL 5384214 (Ariz. App. Div.) (finding that issue of proper credentialing of surgeon to use robot existed and reversing grant of summary judgment to hospital).

160 BLACK'S LAW DICTIONARY 1338 (8th ed. 2004); *see, e.g.*, PROSSER § 69, at 500.

161 **[CITE. Discuss other policies, including efficient accident reduction and spreading; critique spreading rationale.]**

committed by the employee.[162] From a more practical point of view, artificial persons like corporations can only act through human employees and thus can only be liable vicariously.

Both these policy reasons are based on the unique nature of human employees—i.e., the benefit of a human to do your business and the unique ability of humans to act as responsible agents for an artificial person. Thus, their application to a robot is questionable unless the robot's capacities approach those that humans possess, particularly the ability to engage in complex, intellectual interaction as a self-conscious member of a community.[163] If a sophisticated robot does not possess these characteristics, the argument that respondeat superior should apply loses force. On the other hand, if the robot did possess these characteristics (which appears unlikely in the near future), then the doctrine might be applicable. However, the legal system would also have to decide whether a robot with these characteristics could be owned.[164] If the answer to this question is "no," then a robot with self-ownership should also be liable in tort in the same way that an employee is liable for his torts regardless of whether the employer is vicariously liable under respondeat superior.[165]

Animals. Because the intellectual capacity of sophisticated general purpose robots will likely be less than that of humans, animals might be a better analogy for nonfault liability than respondeat superior. Generally, a person controlling an animal is not strictly liable for harm

---

[162] **[CITE. Define employee vis à vis independent contractor.]**

[163] *See* CHOPRA & WHITE, *supra* note 154, at 153–91 (discussing personhood for "artificial agents"); Hubbard, *supra* note 18, at 418–33, 441–50 (discussing test of capacity for personhood and applying test to machines).

[164] *See* Hubbard, *supra* note 18, at 428–33, 441–55, 473–74 (arguing for consideration of personhood in terms of self-ownership for highly intelligent, self-conscious machines).

[165] *See id.* at 423–24 (arguing that an entity with self-ownership is required to recognize responsibility for violations of rights of others); **CITE for employee liability**.

from the animal, unless: (1) the animal (other than a dog or cat) causes physical harm by trespassing on the land of another; (2) the animal is wild; or (3) the person knows or should known that the animal has dangerous tendencies abnormal for the animal's category.[166]

It is difficult, if not impossible, to apply any of these three exceptions to general purpose robots without knowing more about the characteristics that these robots are likely to have. For example, the following are not clear: Do they have a tendency to trespass? Are they sufficiently dangerous and unpredictable to be viewed as wild or abnormally dangerous?

Abnormally Dangerous Activities. The "rule" concerning abnormally dangerous is easy to state, but very difficult to apply. Section 20 of the *Third Restatement* states:

> (a) An actor who carries on an abnormally dangerous activity is subject to strict liability for physical harm resulting from the activity.
> (b) An activity is abnormally dangerous if:
> (1) the activity creates a foreseeable and highly significant risk of physical harm even when reasonable care is exercised by all actors; and
> (2) the activity is not one of common usage.

Determining whether a risk of physical harm is "foreseeable" and "significant" even "when reasonable care is exercised" and whether an activity is "one of common usage" has challenged courts for decades.[167] Given this problem and our current lack of knowledge about the specific characteristics of sophisticated general purpose robots, it is virtually impossible to do more than guess how a court might treat a claim that using a robot in a particular way constituted an abnormally dangerous activity.

---

[166] RESTATEMENT (THIRD) OF TORTS § 21 (trespassing animals); § 22 (wild animals); § 23 (abnormally dangerous activities); *see id.* §§ 24–25 (defenses); § 29 (limitation to harms that result from the risk that made actor strictly liable).

[167]

c. Maintenance

Because of the complexity of sophisticated robots, maintaining them would require a high level of skill. A person who represented himself as capable of such maintenance, could be held to the standard of a reasonably skilled, sophisticated robot maintenance "expert."[168] As a result, expert testimony might be required to show negligence and causation.[169] Claims of improper maintenance would also be affected by governmental adoption of regulatory standards for persons who maintain sophisticated robots.[170] If this is done, evidence of compliance or noncompliance with those regulations would be admissible to show negligence.[171]

B. Legislative/Regulatory Approaches

1. Motor vehicles

Sophisticated autonomous vehicles will present challenges to innovators because of uncertainty concerning how the existing legal system will apply the existing liability scheme to such a new, evolving technology. In order to reduce this uncertainty and thus foster innovation while also addressing accident costs, the legal system should do the following at the federal level: (1) follow the European model and facilitate the development of national standards; (2) as the technology emerges, develop federal regulatory standards for sophisticated autonomous

---

168

[169] *See supra* notes 78–79, 81–82 and accompanying text (discussing role of expert testimony in products liability suits).

[170] *See infra* Part IV.B.1.c. and Part IV.B.2.a.

[171] *See supra* notes 115–117 and accompanying text. Surprisingly, however, failure to have a required license to do such maintenance might not be admissible. **[CITE]**

vehicles like the current scheme of Federal Motor Vehicle Safety Standards (FMVSS); and (3) *where appropriate*, preempt state law that conflicts with the federal regulatory standards. As increasingly sophisticated vehicles become more common, the states should adopt new requirements for licensing drivers, for regulating certification and maintenance facilities, and for insurance for owners, certifiers, and maintainers.

a. Standards

As indicated above, standards have a significant role in regulating design and warnings and in tort claims based on claims of defective design or warnings.[172] Written standards for the *design of standards* for increasingly autonomous vehicles have already been adopted in Europe. RESPONSE 3, a code of practice for "advanced driver assistance systems" (ADAS), "summarises best practices and proposes methods for risk assessment and controllability evaluation." It was "produced by a group of experts within the RESPONSE 3 project, a subproject of the integrated project PReVENT, a European automotive industry activity, co-funded by the European Commission, to contribute to road safety by developing and demonstrating preventive safety applications and technologies."[173] Even though developed in Europe, RESPONSE 3 could serve as a standard for the automobile industry in an American

---

[172] *See supra* notes 104–117 and accompanying text.

[173] RESPONSE 3 ii (2009).

court, particularly since it has been endorsed by the European Automobile Manufacturers Association, whose members include American companies like Ford and GM.[174]

Because ADAS technology is still emerging, RESPONSE 3 does not contain specific substantive standards.[175] Instead, it serves as "a support tool for the engineer engaged in the development of ADAS."[176] This code of practice is intended "to provide the vehicle industry with the tools and common understanding to overcome and to help managing the problems about safety concerns and liability of Advanced Driver Assistance Systems."[177]

Given the existence of RESPONSE 3 and the developing nature of ADAS technology, it is not clear whether an American version of RESPONSE 3 is needed at present. However, at some point the federal government should be involved in developing research-oriented standards like RESPONSE 3. For example, the driving environments in the Untied States may be sufficiently unique in some respects that an American set of standards is needed. In addition, the federal government could foster research by providing assistance in testing and market development. For example, by providing states with financial incentives to set up special lanes along portions of the interstate high system where only vehicles with very sophisticated ADAS technology could be driven.

174

[175] *See id.* at 1 ("The current status of development makes it very difficult to describe the state-of-the-art knowledge of ADAS, because there are so many systems with different technology addressing even more different assisting functions.").

[176] *Id.* at 2.

[177] *Id.* at 1.

b. Preemption

Preemption can take two forms. First, a state legislature can preempt a field and thus deny courts the power of using common law tort as a way of addressing liability for particular conduct within that field. Second, Congress can preempt the field and thus deny states, whether acting through the state legislature or through the state courts as they apply common law, from addressing a field. Given the national nature of the market for automobiles, the second form of preemption is often urged as a way to address uncertainty about the law of the various states.[178] However, as indicated above, the extent and importance of this uncertainty is often overemphasized.[179]

Moreover, in practice, preemption can become very complicated and thus very uncertain. For example, the preemption scheme for the FMVSS scheme has resulted in considerable litigation over the issue of when a particular FMVSS is preemptive. In one case, the Supreme Court held that a version of the FMVSS for air bags preempted state tort law;[180] a later case held that the FMVSS giving manufacturers a choice of lap belts or lap and shoulder belts on inner rear seats did not preempt state claims.[181]

---

[178]

[179] *See supra* notes 32–40 and accompanying text.

[180] Grier v. Am. Honda Motor Co., 529 U.S. 861 (2000).

[181] Williamson v. Mazda Motor of Am., Inc., 131 S. Ct. 1131 (2011). The FMVSS standard involved in this case and in *Geier* were "promulgated pursuant to the National Traffic and Motor Safety Act of 1966 (Act), 80 Stat. 718, 15 U.S.C. § 1381 *et seq.* (1988 ed.) (recodified without substantive change at 49 U.S.C. § 30101 *et seq.* (2006 ed.))." *Id.* at 1134.

This uncertainty could have been addressed by more explicit language in the statutory scheme of preemption. However, explicit language preempting all state tort claims for all regulatory standards would probably face tremendous political opposition in Congress. Part of this opposition would be motivated by a concern for "agency capture" by the regulated industry.[182] This concern results from the asymmetry in power between the industry, which consists of focused, well-funded repeat players in the regulatory process, and consumer interests, which are made up of loose ad hoc coalitions that are primarily composed of poorly funded nonprofits. Given this inequality, there is arguably a strong possibility that safety concerns will not be adequately addressed.

c. Licensing

Licensing of motor vehicles and of drivers is now largely a matter of state law. If the states do not respond to problems that arise with increased use of automated cars, the federal government may have to either adopt a scheme for getting states to respond or, as a last resort, impose a federal scheme.

Regardless of how regulation through the states is achieved, the recently adopted scheme in Nevada provides a useful example of a state regulatory approach to "autonomous vehicles." In 2011, the Nevada Legislature adopted a bill defining "autonomous vehicle" and directing the Department of Motor Vehicles (DMV) to establish regulations addressing: (1) licensing operators of autonomous vehicles; (2) operation of these vehicles on highways in the state; (3)

---

[182] *See, e.g.*, Hubbard, *supra* note 26, at 455–56 (comparing institutional characteristics of courts and administrative agencies and discussing agency "capture").

requirements and safety standards for the vehicles; (4) testing of the vehicles; (5) insurance for testers or operators of the vehicles; and (6) other requirements the department determines to be necessary.[183]

The regulations adopted by the DMV[184] address autonomous vehicles in terms of three categories of licensees: operators,[185] testers,[186] and certifiers.[187] The regulations also address the registration of autonomous vehicles,[188] insurance and bond requirements,[189] operation and testing requirements,[190] sale requirements,[191] and vehicle requirements.[192] At least two persons must be present in an autonomous vehicle being tested and one of these must be able to take control of

---

[183] Nev. Assembly Bill 511 §§ 2, 8 (2011) (effective Mar. 1, 2012).

[184] Nev. DMV, LCB File No. R084-11 (effective Mar. 1, 2012).

[185] *Id.* §§ 5, 27.

[186] *Id.* §§ 7–15.

[187] *Id.* §§ 17–26.

[188] *Id.* §§ 6, 11.

[189] *Id.* §§ 6.3–6.4, 8.3–8.4, 18.3.

[190] *Id.* §§ 4, 7–16.

[191] *Id.* § 16.

[192] *Id.* §§ 6.2, 16.2.

the vehicle.[193] The vehicle is required to have the equipment to make such a shift to human control possible.[194]

When sophisticated robot vehicles develop beyond the experimental stage, licensing of maintenance and repair facilities might be necessary. Without such regulation, the performance of these complex vehicles could become unreliable. In the event that such a licensing scheme is adopted, the Nevada scheme for licensing certifiers could provide a useful guide.

2. General purpose robots

a. Standards

[Early stages of consumer-oriented development—therefore, standards premature? Approach of RESPONSE 3? Of NIST?[195]]

[Possible approaches: (1) design and warning features; (2) licensing schemes like for self-driven cars—*See Mohler, supra* note 69 (credentialing of surgeon to use surgical robot)]

---

[193] *Id.* § 10. These persons must have a driver's license and be trained to operate an autonomous vehicle. *Id.* However, they are not necessarily the same persons as the licensed "operator" and "testers." *See id.* §§ 4, 10.

[194] *Id.* § 16.2

[195] In order to facilitate innovation in manufacturing robots, NIST has undertaken a project to:

1. Develop the safety standards and performance measures to enable humans and robots to work together in the same space.

2. Develop performance measures for sensors used to monitor the work area and ensure safety of robots, vehicles, and people.

NIST, *supra* note 24. The goal of the project is to "develop and deploy the measurement science needed by industry (manufacturers, integrators and end-users) and robot safety standards organizations to enable safety and effectiveness of human robot collaborative activities by 2014." *Id.*

b. Subsidies

Because sophisticated general purpose robots have such potential, it might be argued that the government should subsidize both basic and applied research in this area in order to facilitate the process of innovation so it will occur sooner and so that the United States will be a "player" in the robot industry if these robots have the effects they could. These subsidies could take the form of grants of funds or special tax deductions or credits. To some extent, such subsidies currently exist. For example, **[DARPA?; funding of university research; National Robotics Initiative?]**

One objection to subsidies is that the government is not able to make better decisions about areas of promising research than the market.[196] A response to this objection is that the government is more able to take the long view that is required for a return on technology that could take twenty to thirty years to bear fruition.

One could also use changes in tort law to foster the development of sophisticated robots. Such a proposal would be similar to "tort reform" proposals to limit liability for medical malpractice in order to reduce the costs of healthcare and thus provide greater access to care.[197] For example, because of the transformative benefits of sophisticated robots, the legal system

---

196

197 *See, e.g.*, Hubbard, *supra* note 26, at 476.

might foster innovation (or a particular approach to innovation)[198] in robot development by adopting a limited immunity from liability under the current fault-based system. This could be combined with a system of liability insurance for owners or users to provide a fund to pay for those physical injuries for which they are held liable under the current legal system.[199]

There are several objections to using the liability system in this way as a means to foster innovation in robot development. First, limited liability for sellers is not likely to foster innovation unless the liability of buyers for defective robots is also limited. Otherwise, buyers will view their additional liability costs (or their additional insurance costs) for product defects as part of the cost of owning a robot. As a result, demand will drop. If both buyers and sellers are immune, a second objection arises: Why should victims of defective robots be forced to bear the costs of injuries from the defects rather than the sellers and owners, who are enjoying the benefits of improved robots? Finally, any immunity scheme, as well as any compulsory insurance scheme, would require legislation, which would be hard to achieve because it would be subject to both policy objections and political resistance. Competing economic interests would object that immunizing manufacturers of general purpose robots (or of a particular type of general purpose robot) provides an unfair advantage. Moreover, to the extent that sophisticated general purpose robots can replace workers in service industries, unions might object. If only a particular approach to development of these robots is favored, those pursuing other approaches

---

[198] *See* M. Ryan Calo, *Open Robotics*, 70 MD. L. REV. 571 (2011) (proposing scheme to immunize manufacturers of "open robotic platforms" from tort liability and to, perhaps, require robot owners to carry liability insurance).

[199] *See id.*

would object. Finally, consumer advocate groups (and perhaps plaintiffs' attorneys) would object on behalf of owners and victims.[200]

V. CONCLUSION

[200] *See, e.g.*, Hubbard, *supra* note 26, at 480–83 (discussing opposition to "tort reform" proposals to limit liability to victims).