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"Liability Rules for Autonomous Vehicles: How Traditional Legal Relations Encourage Modern Technological Innovation"

by

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Note: It is expected that you will have reviewed the speaker's paper before the seminar.

Liability Rules for Autonomous Vehicles:
How Traditional Legal Relations Encourage Modern Technological Innovation

Richard A. Epstein*

Abstract

The coming use of autonomous vehicles has kindled an extensive debate over the proper liability regime. This article contributes to that debate by explaining the need for rules of the road in addition to a liability regime, and how those systems interact. One salient point is that the rules of the road should change in response to technical innovation, but liability rules should not. The sound approach for dealing with damages for *past* incidents ought to be constructed to deal first with stranger (including highway) cases in which there is a dichotomous decision on compliance or not. That *regime* based on events as they unfold is applicable carries over without a hitch to autonomous vehicles. For dealing with the prevention of *future* harms from violation of these rules, by contrast, there are no fixed rules for deciding how to mix damages with injunction, and the substitution of a system of direct state enforcement faces the same difficulties of implementation In both settings, the rules of the road should be held constant, after which the ideal remedial mix follows the traditional approach of trying to minimize the sum of Type I and Type II errors, relating to over and underenforcement

The basic rules of tort liability stand in contrast to the different standard of liability that arise in consensual situations, and in all cases, they must necessarily be supplemented by rules of vicarious and product liability.

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I. INTRODUCTION: OF RULES AND STRATEGIES.

In most studies of entrepreneurship, legal rules tend to fall into the background. The dominant effort is to devise optimal strategies for innovation within some given set of exogenous constraints. On this view, the design of operative constraints is a task that is best left to others, including lawyers who concern themselves primarily with the choice of legal framework and reserve the private strategies of the players as a second-order consideration. Ideally, however, there should be some useful convergence between the business and the legal approaches, so that sound legal rules set a useful framework to support innovation. These issues can arise in a variety of contexts, such as the liability of owners and occupiers for injuries that occur on their premises; the liability for health care professionals for various kinds of medical injuries; or the liability of the manufacturers, distributors and retailers for product related injuries.

All of these schemes to some extent overlap, but in this paper devoted to the legal regime that governs the use of autonomous vehicles (AV), the key issue will be with the rules of the road, with a secondary emphasis of the liability rules associated with the manufacture and use of defective products, most notably AVs. The applicable set of rules that govern AVs are of two different sorts: those of system design, and those governing liability for accidents resulting in bodily injury or property damages.

The first set of rules includes the many statutes and regulations that set the rules of the road under which AVs—like other vehicles—operate. These issues are properly the domain of public planners who design highways systems so that, at a minimum, when all parties obey the rules of the road, no crashes will result from driver error. It also involves the ability of these government agencies to decide who gets access to the public road system, so that AVs—like other vehicles—have to meet minimum safety standards, pass annual safety inspections, and are operated by drivers who carry insurance. Taken together, the central challenge is to design a complete system, the function of which is to optimize the flow of traffic over the system when all parties comply with the rules in question.

No lawyer can answer those critical questions of system design. But what lawyers can do is deal with the second issue, namely to help design a set of sanctions to deal with situations where parties deviate from the rules previously established. This effort includes

establishing a set of liability rules that indicate just how losses should be allocated to private parties once the rules in question of have been broken. These sanctions can take various forms. First, they can specify the payment of damages between private parties when the operation of AVs lead to harm. Second, they can specify the fines that should be paid for actions that violate the rules, whether or not any harm occurs. And third, the sanctions can limit the access that drivers and other parties have to the highway system when they have violated these rules. As in all cases, the legal rules have two functions. The first is to minimize the expected losses from the general application of the rules by reducing the cost and severity of accidents at an acceptable economic cost. The second is to allow for the prompt and accurate resolution of disputes once they occur. The two elements are heavily interdependent, because the resolution of the second aids in the implementation of the first.

One question that arises is whether breakthroughs in technology—most notably the rapid development of the Internet of Things (IoT)—is an arena in which novel legal solutions are likely to prove dominant. I take the opposite position, even though—or perhaps precisely because—I have never done much specific work in this area. Contrary to the conventional wisdom, the lack of specialized knowledge offers hidden advantages in working through the basic problems at a high enough level of generality to facilitate setting up a comprehensive liability regime even—perhaps especially—in an area undergoing rapid technological change. In a historical perspective, we have had massive transformations in previous ages, from stagecoaches, to railroads, and motorized vehicles, which have inaugurated vast improvements in the speed, reliability and safety of transportation systems. But to my knowledge the basic legal regime used to deal with these innovations have proved remarkably stable over time,[1] which provides a huge advantage in the dynamic situation of technological change because the more robust the liability rules, the fewer the social losses from the uncertain discontinuities that always take place when there is some shift in a basic liability regime.

Yet at the same time, the rules of the road, which can be conceived as a system of property rights, do have to change to meet the demands of modern technology. As motor

[1] Richard A. Epstein, *The Static Conception of the Common Law*, 9 J. LEGAL STUD. 253 (1980).

vehicles replaced the horse and carriage, a modern highway requires an elaborate network of lanes, stoplights, overpasses, and ramps to reduce the likelihood of impact between two vehicles moving at high rates of speed. Further technological innovation raises the need to establish rules of the road to prevent the harmful interaction, for example, between drones and airplanes, which could prove critical in areas of intensive use. Thus Gatwick Airport, the United Kingdom's second largest, has been shut down twice so far by the unannounced arrival of drones whose appearance disrupted the travel plans of thousands.[2] And finally, there is the grim case of Uber's driverless car that crashed into and killed an innocent woman who was walking her bicycle across a public street.[3] The sensory data fed to the car's computer contained an uneasy amalgam of physical features that machines might identify separately, but not in combination. In this instance, the fatality resulted from an interplay between machine failure and human error, given that the backup driver was supposedly watching a TV show on a phone situated in her lap.[4]

One familiar feature of many modern accidents is that they frequently occur when redundant systems fail. But the challenge for driverless cars is making sense in real time of hundreds of different unexpected images that do not fall into any recognizable pattern. Surely, a sensible liability regime, and—as will become clear—a sensible regulatory system is needed to deal with these cases. Whatever the difficulties in these technologies, their potential to do good is enormous. Elderly persons, disabled persons, and sick persons stand to benefit from technologies that can allow them to receive vital medical supplies or move freely place to place even if they are no longer able to drive. The simplest way to avoid the risks of these new technologies—banning them—is far too costly to contemplate.

Once committed to new innovations, the challenge is to develop a set of rules that can deal with these and countless other similar situations. The task is not easy, but the bottom

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[2] Laura Smith-Spark et al., *More flight delays at Gatwick after new drone sighting*, CNN (Dec. 21, 2018), https://www.cnn.com/2018/12/21/uk/gatwick-airport-drone-shutdown-intl-gbr/index.html.

[3] Abe Kwok, *Police report in no way lessens Uber's role in pedestrian fatality*, ARIZONA REPUBLIC (June 22, 2018), https://www.azcentral.com/story/opinion/op-ed/abekwok/2018/06/22/uber-self-driving-car-death-pins-blame-human-driver/724542002/.

[4]

line is this: innovation is relevant to designing regulation for future and uncertain harms, but irrelevant to liability for past harms. A single, uniform set of liability rules is sufficient to cover all cases in which the harm has occurred, but many different regulatory regimes will have to be put into place to decide which of these technologies should be licensed and under what conditions. That inquiry is not novel, for every advanced society today has multiple licensing systems for both automobile drivers and nuclear power plants. Yet no one thinks that the same licensing rules should apply to both.

To put these overlapping problems into perspective, In Part I, I shall explain why the appropriate liability rules for this area are already familiar to anyone who understands the basic principles of tort liability. There are many problems with implementation of the program once these essentials are grasped, but creating a new set of liability rules to deal with these novel issues of technology is not one of them. In Part II, I then offer a general explanation of how old liability rules should be adapted to new technologies—first with cases involving interactions among strangers, then with harms that arise out of consensual arrangements. In both of these cases I argue that the liability regimes that worked before autonomous vehicles work well with autonomous vehicles.

It should not be inferred from this discussion that technological changes never require a transformation of any system of property rights or liability rules. That is false. It is possible to identify cases where technological changes require major legal transformations. But in Part III I shall show that when these cases are fully understood, they do not require the alteration of the particular conclusions reached in Parts III. I illustrate this point in part by referring to other adaptations of legal rules to novel technologies, including those involving aviation and telecommunications. The consistent pattern features small adaptations from existing formats, so long as they create, to the extent that human institutions can do it, Pareto improvements over the existing set of property rules. Many of these changes are driven by the rapid movement of our activities from physical space to cyberspace. Indeed, the arrival of 5G technology promises to expand the number and types of tasks that one can undertake by computers over the internet, which allows not only for the transfer of information to distant places, but also the control of operations at distance, whether it be temperature changes on a thermostat or, with marked increase in difficulty, the control of AV in multiple environments.

These permutations will follow the familiar relationship. Low risk/low return projects will be the first ones off the drawing board. A simple set of well-defined tasks has few opportunities for mishap, so that the choice of liability regimes to deal with adverse events is not likely to be of great moment. This is even more in a closed environment, where the controller and the controlled party are the same person, so that the issue of liability disappears given that no person can sue himself. When A hits B, causing damage, liability matters. But A hitting A, causing the same amount of damage, poses no issues of liability, any more than theft can occur when A takes money from his right pocket and puts it into his left.

Yet it is imperative to address liability issues when AVs run amok. In order to attack that question, I shall examine two cases, each in two stages. First, I will develop the general rules for dealing with highway accidents between strangers that have been in place for hundreds of years—even before automobiles displaced the horse and carriage—wholly without any regard to the special problems presented by driverless cars. Second, I shall repeat the same exercise in connection with harms that arise out of consensual and cooperative arrangements, when, for example, IoT is used to control factory technologies or medical operations. In both areas, the same thesis will apply: the rules of the road will change, but at the same time *virtually no change* is needed in the rules governing liability when the rules of the road are violated.

As befits this overall problem, the discussion of any system of liability rules normally has to address two different issues. The first is the question of whether and to what extent is A liable for *past* harms suffered by B—here limited to death or bodily injury on the one side, or the destruction or damage to real or personal property on the other. The second issue is forward-looking: how should the law regulate *future* activities that may or may not result in harm? Is there any remedy, typically by way of injunction, that should be granted to a person (or persons) who stands in the potential path of harm, or are the only remedies available for those completed harms, discussed under the first rubric?

To structure this inquiry, it is necessary to look first at the rules of liability and thereafter those for remedies. These remedial rules first address harms that have already been consummated, so that the only remedial question left is the level of compensation owing. These cases in turn are divided into two classes. First are harms that occur between strangers and second are harms that arise out of consensual arrangements. In the former

case, a uniform rule that governs the conduct of all parties should rest on an *output* rule that consciously ignores all questions relating to the level of care. Unfortunately, no such uniform standard can be developed for harms arising out of consensual relationships, where some mix of output and input rules is needed, such that liability can be strict, based on negligence, or even malice.

In the alternative, any legal intervention before the occurrence of harm adds a huge element of uncertainty. The standard inquiry in private law asks whether some injunctive relief is required, and if so, what are its terms. There are no hard and fast rules that the govern the choice of remedy; injunctions are crafted according to "the balance of equities,"—a baffling standard upon which no court has been able to improve in close to 2,000 years—whose measure rests on the sound discretion of the court. That uncertainty in remedies carries over to cases where private injunctions are inadequate to deal with widespread potential harms of different types and intensities. In these cases, it falls to public entities to create regulations to deal with the endless remedial variations routinely encountered in practice. In these instances, the same trade-offs have to be made, and it perhaps one of the most serious weaknesses of modern environmental law that it overweighs under the National Environmental Policy Act the risk of new construction of various facilities, especially pipelines, against the usually greater danger of keeping to the status quo ante.[5] This last observation is not one of abject skepticism, for choosing the best regulatory regime makes a huge difference even in a second-best world.

One characteristic of all second-best systems of liability rules is that they often impose remedies not only against the individual wrongdoer, but also against a second tier of actors who are connected to the harm. For these purposes, I shall confine my attention to two major areas: product liability and vicarious liability. The former concerns the liability of upstream parties—manufacturers, distributors, component part manufacturers—for harms that occur from their *defective* products *after* they come into possession of another person. The second is vicarious liability of employers for the torts committed by their

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5 *Calvert Cliffs, Inc. v. United States*, 449 F.2d 1109 (D.C. Cir. 1971)(allowing private judicial challenges under NEPA). For an account of some of the risks, see Richard A. Epstein The Many Sins of NEPA, 6 Texas A & M L. Rev. 1 (2018). .

employees for harms arise out of and in the course of employment, and property owners and occupiers for harms caused by persons lawfully on their premises.

II. CONSTRUCTING A COMPREHENSIVE LIABILITY REGIME FOR PAST HARMS.

a. Who is a proper defendant?

The first question in any tort case is, who is the defendant? With AVs, that question is tricky to solve in the abstract,[6] but in practice the problem should not cause too much difficulty. Any sensible legal system will require that all AVs have an identifier that indicates the financially able party who is responsible for all of the losses attributable to that vehicle. To simplify litigation, such a system should identify only a *single* party that answers to the outsider for the loss, which then can obtain whatever insurance is needed to cover the risk. Once that party is found liable, it can then move by contract or otherwise to seek potential contribution or indemnity with parties further up the supply chain, or bring actions for contribution by joint tortfeasors (e.g. other vehicles or highway operators) to recover the loss.[7] Those general rules need not change because of the novelties involved here.

b. Negligence versus strict liability: input versus output rules.

All legal systems have to make a fundamental choice about the basis of liability for harms caused to one person by the activities of another. The strict liability system operates as an output rule. It looks at the harm, traces it back to its source in the actions of another party, and then imposes liability for that harm based on the causal connection, without inquiring into the level of care that one person exercised in order to avoid potential harm to another.[8] This system can be thought of as an output rule because it tends to rule out of bounds a wide range of antecedent conduct, which vastly simplifies the task of determining liability. The only time that such a system is displaced is in the case of deliberate harms—generally absent in cases of highway collisions—in which antecedent conduct becomes highly relevant by definition.

In traditional tort law analysis, it is commonly said that the strict liability system comes out in a distinct second-best position to a negligence formula that operates under an

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6 For some of the difficulties, *see* Mark Lemley & Bryan Casey, *Remedies for Robots*, 86 U. CHI. L. REV. 1311 (2019).

7 For a general discussion, *see* RICHARD A. EPSTEIN, TORTS ch. 9 (1999).

8 Richard A. Epstein, *A Theory of Strict Liability*, 2 J. LEGAL STUD. 151 (1973).

input rule. In contrast, a system of liability based on negligence looks to the actions taken and those omitted by the various parties to see if they conform with some socially predetermined standard of care, which in the abstract case requires that individuals take precautions until the marginal benefit of any given precaution precisely equals in probabilistic terms the marginal cost of the additional precautions. That negligence rule is said to rely on the quintessential cost/benefit rule, commonly called the Hand Formula,[9] which compares three elements under the inequality B > < PL, and asks whether the burden of precaution (B) exceeds the expected losses measured by the probability of the harm (P), multiplied by the anticipated severity (L). The tension between negligence and strict liability regimes has long historical roots,[10] and it is generally regarded by most that the negligence system has, with exceptions, emerged as dominant.

There is at this point an emerging literature that examines this choice. On one side of the debate is Ezra Friedman and Eric Talley, writing about Automatorts.[11] On the other side, Steve Shavell has argued that it is best to carry over the scheme for strict liability that he had developed in his earlier article on the choice between strict liability and negligence.[12] A third view is that even though negligence is the basic rule of liability, variations on this theme are in the words of Brian Casey, "essentially nonstarters," on the grounds that where "robots of 'confounding' complexity roam, how could we possibly find the needle of fault in a haystack composed of millions of lines of software?"[13] Casey himself takes the position that a

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9 *See United States v. Carroll Towing*, 159 F.2d 169 (2d Cir. 1947). For the leading defense of this formula, much prized by economists, *see* Richard A. Posner, *A Theory of Negligence*, 1 J. LEGAL STUD. 29 (1972).

10 For the relevant case law, *see* RICHARD A. EPSTEIN & CATHERINE M. SHARKEY, CASES MATERIALS ON TORTS ch. 2 (12 ed. 2020).

11 Ezra Friedman & Eric Talley, *Automatorts: How Should Accident Law Adapt to Autonomous Vehicles? Lessons from Laws and Economics* (2019), available at https://hooverip2.org/working-paper/wp19002.

12 Steven Shavell, *Strict Liability versus Negligence*, 9 J. LEGAL STUD. 1 (1980).

13 Brian Casey, *Robot Ipsa Loq*uitur at 5 (forthcoming Geo. L. J. 2019), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3327673

For other representative articles, *see* Kenneth Abraham & Robert Rabin, *Automated Vehicles and Manufacturer Responsibility for Accidents: A New Legal Regime for a New Era*, 105 VA. L. REV. 127; Mark A. Geistfeld, *A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation*, 105 CALIF. L. REV. 1611 (2017), and works cited in Casey, *Robot Ipsa Loquitur*, at note 25.

negligence regime can work so long as it rests on the well-established rule of *res ipsa loquitur*—the thing speaks for itself—in which it is said that in those cases where the defendant is in exclusive control of some dangerous instrumentality, the occurrence of a particular action will be presumed to stem from negligence unless some alternative explanation is given to explain the source of the accident.[14]

Before commenting briefly on each of these articles, it is critical to stress a deep ambiguity in how any negligence rule plays itself out—one that responds to the basic distinction between harms to strangers and harms that arise out of some consensual relationship, such as medical practice. Thus it is widely understood that in medical malpractice cases a strict liability rule is wholly unworkable because it forces on the physician or other health care provider all the untoward—but often unavoidable—consequences of various forms of medical or surgical intervention. In its place, a standard of customary care governs,[15] and *res ipsa loquitur* is applied sparingly, if at all.[16] If physicians, hospitals and other health care providers are forced to bear these losses, they will have to charge their patients fees sufficient to cover the future cost of their various liabilities in question plus the cost of defending the case. That total cost will often exceed the capacity of ordinary individuals, with or without health care insurance, to pay the premiums needed to cover the potential cost of all future adverse events.

To overcome this obstacle, the law switches to an *input* standard—typically one based on the exercise of the standard of care that is customary within the particular portion of the profession in which the defendant works. Two main consequences flow from this decision. First, there is a huge reduction in the number of cases that fall within the tort

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14 *See* RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL HARM § 17 RES IPSA LOQUITUR (Am. Law Institute 2005) ("The factfinder may infer that the defendant has been negligent when the accident causing the plaintiff's physical harm is a type of accident that ordinarily happens as a result of negligence of a class of actors of which the defendant is the relevant member.")

15 *See, e.g.*, *Lama v. Borras*, 16 F.3d 473 (1st Cir. 1994); *Hood v. Phillips*, 554 S.W.2d 160 (Tex. 1977); for classical academic defense of the customary rule, *see* Clarence Morris, *Custom and Negligence*, 42 Colum. L. Rev. 1147, 1164-1165 (1942).

16 *See, e.g., Salgo v. Leland Stanford Jr. University Board of Trustees,* 317 P.2d 170 (Cal. Ct. App. 1957).

system. Second, the use of a customary standard changes the nature of inquiry into whether the defendant has complied with the basic rules. Now the trier of fact is not required to make a direct application of the standard Hand Formula, but can rely instead on the repeated social interactions that has generated that result. That standard understands that there is more than one way to approach any complex procedure, so the customary standard does not insist on one dominant solution, by allowing any health care provider to defend itself by looking to alternative schools of thought for setting the applicable standard of care.[17] The huge reduction in the potential liabilities allows for a reduction of fees, which in turn allows an insurance market to function without having meet the evidentiary demands of the Hand formula.

In stranger cases, *res ipsa loquitur* has a very different function. In these cases, no plaintiff is asking a defendant to supply him with care. The only requirement is that the defendant keep off the plaintiff (to avoid liability for trespass), or not block his right of way (to avoid liability for indirect harms). Although harmful interactions in stranger cases are infrequent, in those cases where harm does arise, it is uniformly costly to examine all the antecedent behaviors to decide which accidents stem from negligent behavior and which are not. A traditional negligence rule, therefore, does *not* stabilize these markets, and in these cases, *res ipsa loquitur* takes on a very different function. It is now used to make a de facto shift back towards the strict liability system mentioned above. In dealing with this issue, Casey takes the view that *res ipsa loquitur* is one way to avoid the endless effort to find negligence by wading through computer code. But so long as the *res ipsa loquitur* creates only a *rebuttable* presumption, the revised rule still allows the defendant to go through the lines of code to alleviate himself of the charge of negligence by establishing that each of these was correct. Shifting the burden of proof therefore does not work any movement to output measures, unless the presumption becomes well-nigh irrebuttable—at which point, there is a move to a strict liability rule in all but name. In fact, the better doctrinal handle for these cases is yet another refinement: the so-called rules of negligence per se, which I shall discuss presently.[18]

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17 *See, e.g., Jones v. Chidester*, 610 A.2d 964 (Pa. 1992).

18 *See infra* p. 19.

The alternative solutions of both Talley and Shavell do not even attempt to deal with the antecedent level of care. Instead they simply apply the same apparatus that they would use to deal with liability for highway transactions under the standard Hand Formula. But it is extraordinarily difficult to figure out in the context of a broad range of highway accidents whether the various parties have reached the point at which the marginal benefit from additional precautions is now less than the gain from the precautions so taken. The theoretical model is beyond application without the use of some simple proxies, such as compliance with the rules of the road, which then turn out to back into a strict liability output system.

The Shavell article seeks to capture the useful distinction between activity levels and care levels, in order to make sure that the former is taken into account in determining liability.[19] But the traditional strict liability standard based on outputs does just that without having to make some tricky assumptions on whether additional miles driven are more or less safe than previous miles. The difficulty here is that drivers with more experience are often better drivers with lower rates of accidents per mile. The standard that looks at outputs only does not have to speculate which way these curves move for various individuals. The constant pressure of a strict liability regime for responsibility will induce drivers of both classes to take optimal levels of care, without the legal system having to make direct judgments of those inputs. In addition, the use of an output system avoids one of the constant difficulties dealing with any liability formula—namely, how to deal with the accidents that are the result of both parties. Shavell makes the right point that with the ordinary tort rules, the incentives are less than ideal because any payments between the two parties necessarily reduce the incentives of the recipient to take care to avoid his own contribution to the harm.[20]

Shavell's solution— "*strict liability with damages paid to the state*," — hardly meets that problem. The first difficulty is that it removes any concern with compensation for economic losses from the equation, and therefore means that no individual victim will bring a tort action, and that state enforcement becomes the exclusive means of control. This

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19 Shavell, *supra* note 11, at 2.

20 *Id*.

exposes everyone to the risk of massive incompetence of state officials. There is, moreover, no need to take that step within the tort system, because the tort law operates side by side with a state system of enforcement, the latter allowing for the imposition of fines for various violations, coupled with the ability to suspend licenses and impose where necessary criminal sanctions.

Second, even if we ignore these direct public controls, Shavell's solution wildly overstates the frequency of joint responsibility accidents, given that in most accidents only one party is at fault no matter what system is used. It is most unwise to treat the inability to solve perfectly one-percent of the cases as a reason to jettison all systems of private enforcement. In addition, the use of output measures, as developed below, obviates the need to make judgments regarding levels of care for each individual case. Instead, it is only necessary to develop some allocation formula to deal with the few cases in which both (or all) parties are not in compliance with the rules of the road. Such rules will not be perfect, but neither are any of the more exotic alternatives put forward above capable of meeting that exacting standard.

III. THE THEORETICAL MIXED SOLUTION: STARTING WITH THE SINGLE OWNER.

a. General principles.

At this juncture, the global inquiry is whether there is any way to demonstrate the superiority of strict liability in these cases in which rights of way (but not personal obligations of care) are established. In common experience, we are all familiar with outcome rules, because they are used to organize many common forms of voluntary relationships. Some suggestive examples arise out of sporting events, where the entire game collapses if the rules regulating outcomes or conduct make it impossible to play the game. These games are, moreover, organized by private parties who have every incentive to make sure that they pick rules that maximize the expected value of the enterprise they have formed—a pattern that also holds for other collective organizations like planned unit real estate developments.[21] Here, the uniform verdict favors output rules that ignore inputs.

[21] Richard A. Epstein, *Positive and Negative Externalities in Real Estate Development*, 102 MINN. L. REV. 1493 (2018).

Start with some simple examples. In baseball, it is often necessary to determine whether a ball is hit fair or foul, or, in basketball, whether the defensive player blocked the path of the offensive player to the basket, or alternatively the offensive player was guilty of a charge. In these cases, the only determinants that matter are physical determinants that involve a combination of time, position and motion; we ignore whether an athlete tried hard to stay within the rules. Instead, we simply ask: was the defensive player set, i.e., not moving, before he was hit? And, in a more modern variation, was the player outside the three foot-line to prevent defensive players from setting up too deeply? These rules often raise close cases worthy of slow-motion cameras, just as whether the baseball hit the back of the glove before the runner's foot touched the base. And to be sure, in all these settings, effort levels of the players involved may influence the chances of success, which is why coaches are so concerned about proper technique. But those managerial efforts are best understood only as attempts to improve the odds of success, but not recalibrate the rules. The legal liability regime looks at one thing, and one thing only—observable physical variables, measured by either time or space. A great save by the first baseman does not lead to an out if his foot is off the bag.

It is just this model of causation that dominates all systems of liability rules when the harm takes place *between strangers*, namely between two individuals who have no special duties or connection between them such as parent and child, physician and patient, landlord and tenant, buyer and seller, and so on. Thus, in dealing with collision, the initial rule is simple enough: The party who hits another party is responsible for the harm in question. But that initial rule, which sets out what lawyers call the prima facie case, only governs in those cases in which there are no rules of the road set up by a common authority to minimize the likelihood of collision between the two parties. In reality, first highways and then intangible rules of the road are put in place, at some considerable private or public expense, to increase the flow of traffic and reduce the risks of accident. These changes are costly because they involve the creation and enforcement of rights of way. But the gains in speed and safety more than justify these costs, which explains why some set of rules of the road is universally put into place. It is a *management* decision, either private or public, on how to design these rules, and the basic rule of thumb is the higher the volume of traffic, the greater the need for separation. Sidewalks are next to roadways, and all kinds of inconsistent uses

are allowed so long as traffic moves at a slow speed. But let the speed increase as on major thoroughfares, and traffic uses are rigidly separated so that bikes and scooters are not allowed on interstate highways. Similarly, the prospects of collision are reduced, as first stop signs, then traffic lights are replaced by total systems of separation as with the modern cloverleaf system with its on and off-ramps.

The basic design of these systems is in general a collective decision without regard to liability rules for accidents. The guiding principle behind their application runs roughly as follows: The implementation of any new system of property rights—in this instance rules that create consistent rights of ways by the use of lanes, stop signs, traffic lights and the like—adds administrative costs that can only be justified by the benefits provided both in terms of added speed and greater safety. The good news is that for broad scale operations like these, there is relatively little risk of design error that will benefit one group more than another, so at least in terms of end use, there is relatively little risk of disparate impact to the overall class of users. There are, of course, all sorts of political intrigue that could arise in the design of these systems, but other bodies of law have to deal with those administrative matters.

b. Transformations of the rules of the road.

The situation is not unique to highways, for there are many other instances in which technological transformations require a reconfiguration of property rights by government action, given the enormous barriers of transaction costs that stand in the path of voluntary reconfiguration. Here are two brief examples. Before the advent of the airplane there was no downside to having property rights in land extend to the top of the heavens--referred to as the a*d coelum* rule in the common law.[22] But that rule would convert every airplane flight into multiple aerial trespasses of private property, all of which could be enjoined if the land owner exercised his rights over the airspace. Such a system is so manifestly impossible that either by judicial action or legislation, all surface owners must be denied the right to exclude from the upper airspace. That action is most surely a taking of preexisting property rights, but the net benefits across the board are so enormous that it is idle to think that there is any reason to offer compensation in cash to all property owners—paid for out of taxes collected

[22] For a case that deals with the transition, *see Hinman v. Pacific Air Transport*, 84 F.2d 755 (9th Cir. 1936).

from these same parties. Instead, the notion of implicit-in-kind compensation covers the case.[23] There is, roughly speaking, a Pareto improvement in which the gains are, to the extent that anyone can measure them, equal across all persons. In these cases, the upper airspace is separated from the ground by a fixed rule (adjusted for landing zones and tall buildings) that divides the two regimes from each other. And in the upper airspace, the Federal Aviation Authority in the United States is charged with setting the rules of the road to avoid aircraft collisions, whereas actions for damages on the ground are governed by a strict liability rule whenever they occur.[24] The liability rule for midair collisions are, thankfully, not much litigated but it seems clear that any deviation from the rules of the road would be regarded as negligence per se, or tantamount to a strict liability regime.

A similar regime applies to highway accidents, for once the rules of the road are set, they are binding on all users of the system, even if they are in some ideal sense less than efficient. This model would be easily operational if the rules of the road were solely determined by statute. But in all too many situations, there is a customary gloss over the statute that dominates ordinary transactions. Thus, it is common to see the speed limit set at a level below that which traffic moves. On freeways, the limit may be 70 miles per hour, but often the traffic moves at 80 miles per hour. The measure of safety in these cases is in part a function of the dispersion about the speed of the median driver. If that speed is 80 and the safe band is plus or minus 10 miles, anyone who drives under the speed limit becomes perforce a danger because others will dart and maneuver to get around that party. Thus, to have the autonomous vehicles obey the speed limit, which sits at the bottom of the customary range, is to increase the danger. But to have the AV set its speed according to the customary rule is to make the calculations far more difficult—as it is difficult ascertain what that rule is, when it is a function of not only place, but also of time of day and week.

The ideal solution in these cases is to take conscious decision to close the gap by making the speed limit respond to those customary variations in order to eliminate the disparity—which is more easily said that done. There is no easy way to do this, but no matter

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[23] For systematic development, see RICHARD A. EPSTEIN, TAKINGS: PRIVATE PROPERTY AND THE POWER OF EMINENT DOMAIN 195-215 (1985).

[24] RESTATEMENT (SECOND) OF TORTS § 520(a) GROUND DAMAGE FROM AIRCRAFT (Am. Law Institute 1966).

how this is resolved, it is critical to recognize that neither statutory nor customary speed limits are input measures. Instead, they are two output measures in obvious tension with each other.

c. Output measures in two-party accidents.

For the moment, it is best to bracket this difficulty in order to work through the permutations in the simplest two-party accident in which either or both of the parties is (or is not) in conformity with the rules of the road. It is easy enough to sort them into four cases: (1) compliance by both, (2) compliance by A, but not B, (3) compliance by B, but not A, and (4) noncompliance by both. In the first case, if the rules of the road are internally consistent (such that it is clear which of the two parties has the right of way in an intersection) then no liability attaches to either party. The only source of the collision has to be some external force, most commonly an Act of God for which the general rule is that the losses lie where they fall. Alternatively, if the harm is the action of a third person who forces one vehicle to hit another, the third party is then responsible for the harm that is caused to either or both of the other parties, who are not responsible to each other.

In the second and third cases, the answers are clearly binary, or win/lose, events, so that the party who deviates from the rules of the road has to bear the costs of his own injuries and must pay the other side damages for the harm sustained. In the fourth case, which is the least likely, both parties are out of compliance so that some rule of loss allocation is required. The simplest rule is that each party bears 50 percent of the total losses in question, with payments required only to offset the fortuity of unequal losses, which was the traditional admiralty rule.[25] More ambitious legal regimes adopt some form of comparative responsibility, which could either seek to measure the percentage of responsibility for the various lapses in question, or impose upon each party the burden of its own losses unless it can show that the majority of the harm was caused by others.

The situation gets more complex where one party is aware of the error of another and knows that it can take steps to prevent or minimize the impending losses to both and to any third party in the vicinity. Here the law shifts to a regime of reasonable care, because the

[25] *See United States v. Reliable Transfer Co.,* 421 U.S. 397, 406 (1975).

two corner solutions—as in cases two and three—are no longer acceptable. It cannot be the case that a person with full knowledge of the peril can do nothing, and thus risk the life of limb of him or the other party. Hence, the innocent party is placed under a duty to mitigate damages. Yet in light of the complexity of the situation, the duty to mitigate is strict in that the innocent party has to make the decision that looks optimal in retrospect.[26] Accordingly, the intermediate position adopts a modified formula of reasonable care, where the presumption is set in favor of the innocent party so long as he or she acts in good faith to avoid the harm. This last rule is *not* the Hand Formula because of the cross between good faith and reasonable care. This two-tier system is in use under one guise or another—"last clear chance" is a common formulation—in every legal system.[27] Fortunately, most accidents tend to fall into cases two or three, which in common settings reduces the pressure on the apportionment rules.

This analysis thus far uses a compound of strict liability and reasonable care rules, as under the Hand Formula.[28] Accordingly, it should take just a moment's reflection to note that the costs of estimating all of the relevant inputs even in the simplest of situations could exceed the amount in controversy, so that it is easily questioned whether this rule can be or ever has been applied. Indeed, in practice that formula tends to be a giant *suggestio falsi* whose apparent universality is wholly undercut by a critical subrule dealing with negligence per se for statutory violations.[29] Thus, highway cases frequently invoke this doctrine, which holds that noncompliance with a statutory requirement is negligence in and of itself, thereby obviating the need for any cost-benefit analysis. The per se rule is not some small curlicue on negligence liability. Rather, unlike *res ipsa loquitur*, which operates as a burden-shifting device in a negligence system, negligence per se marks a huge switch from the input (or ex ante) nature of negligence law to the output (or ex post) rules-of-the-road of strict liability,[30] which, as noted, does not govern in the last clear chance cases.

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26 One early case on this point is *The City of Lincoln*, 15 P.D. 15 (1889).

27 RESTATEMENT (SECOND) OF TORTS §§ 479, 480 (Am. Law Institute 1966).

28 *See, supra* note 8.

29 *See, e.g.*, *Martin v. Herzog*, 126 N.E. 814 (N.Y. 1920).

30 For discussion, *see* Richard A. Epstein, *The Irrelevance of the Hand Formula: How Institutional Arrangements Structure Tort Liability*, in LIBER AMICORUM BOUDEWIJN BOUCKAERT 65-76 (Jef De Mot ed., Brugge, Die Keure 2012).

A second pair of excuses often proposed for accidents goes to the capacity of the party to conform its conduct to the rules of the road. On this score, some version of the insanity defense is cautiously allowed, but only in those cases where it can be shown that the insane person had no premonition of the harm.[31] But these cases are rare as hen's teeth. The truly important claim covers cases thousands of times more frequent: younger drivers should be given the benefit of the doubt and be judged by lower standards. But allowing this deviation would make it impossible for drivers to coordinate interactions on the road because they have no idea of what to expect from other drivers whose age they cannot determine from a distance. It is no wonder that this rule has been stoutly rejected.[32] The effective regime is for all intents and purposes an output regime, properly qualified as such in certain interactive cases. With AV, the infancy and insanity issues both drop out, but otherwise the technological changes do nothing to alter the liability traditional liability rules

IV. OTHER LEGAL RELATIONSHIPS.

a. Product and vicarious liability.

The discussion thus far has only dealt with the responsibility of the drivers of automobiles or, more generally, the persons in direct control of an instrumentality that causes harm. In any legal system, these parties are always responsible for the injuries they cause, but, as noted above, a robust theory of liability also has to deal with cases in which compensation is not available from these primary actors. Virtually all legal systems therefore contain two additional types of liability rules, both of which are fully applicable to AVs, to pin liability on a second tier of responsible parties. There are two such situations. The first deals with the manufacturers and suppliers of products. The second deals with employers of the individuals who caused the harm in question. Each of these points requires some brief discussion.

Thus far, the arguments stated above assumed that the sole error involved was attributable to a driver's failure to follow the rules of the road. But the situation is often more complicated than this. Suppose that the responsible driver had purchased the car from a manufacturer, and he received that car when it contained a latent, i.e. hidden, defect, that

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31 *See, e.g.*, *Breunig v. American Family Insurance Co.,* 173 N.W.2d 619 (Wis. 1970).

32 *See, e.g.*, *Daniels v. Evans,* 224 A.2d 63, 411 (N.H. 1966).

could not be detected in ordinary use. With much doubt over the situation, the rule was established that the driver could sue the product manufacturer if the defect in the vehicle caused the driver to lose control.[33] Easy cases involved a break in the steering wheel, or the failure of the braking system to work because of a missing part or a broken component that was not built up to standards. In these cases, at least, the driver in question may normally receive compensation from the manufacturer if the original defect remained operative—e.g. was not repaired or replaced—to bring about the harm. And if the driver is insolvent, it is generally the case that the injured party can jump over that middle party in order to recover damages from that manufacturer—in the older cases, called a remote supplier.[34] In modern product liability laws, the scope of liability has been extended far beyond these simple cases, often to include situations where the defect was either known, or open and obvious to the driver at the time he took to the road. I think that these cases are usually a mistake, but for these purposes it does not matter. All that has to be established is that outsiders can be held responsible for the defective products that they supply—a rule that can carry over to AVs.

The second major inroad on the principle of individual responsibility—vicarious liability—is far more important than the product liability exception, because the rule does not require proof of any defect in the product; nor does it require proof by negligence of the responsible employer in either the hiring or supervision of the worker.[35] The rule here is so ubiquitous, especially in corporate contexts, that people rarely notice when it is invoked. But every time an assembly-line employee causes an accident, the employer is responsible for that harm so long as it arises out of, and in the course of, employment. Vicarious liability thus avoids looking to any input measure, which, as in other contexts, could not yield a bright line rule. Instead, it is enough that the harm arises out of the employment, even from actions that were expressly forbidden by the employer. The case for this system rests on the sensible consequentialist argument that only this system will prevent the systematic escape from liability that could result if, for example, a company shipping explosive products on public

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33 *See* RESTATEMENT (SECOND) OF TORTS § 402A SPECIAL LIABILITY OF SELLER OF PRODUCT FOR PHYSICAL HARM TO USER OR CONSUMER (Am. Law Institute 1966) (Note that in all cases some defect is necessary for product liability, contrary to Shavell, *supra* note 11, at 2-5.

34 For an early application, *see MacPherson v. Buick*, 111 N.E. 1050 (N.Y. 1916).

35 *See generally*, Alan Sykes, *The Economics of Vicarious Liability*, 93 YALE L.J. 1231 (1984).

roads contracted with an impecunious driver in a rental car. Once again, this system is basically output-driven, even though there are occasional doctrinal anomalies that might complicate the situation. And note that the third-party system of liability can be seamlessly added to the basic rules, because the effort to introduce third parties does not eliminate the responsibility of the immediate actors unless that third party is ready, willing, and able to assume any and all financial responsibility.

b. *Harms arising out of consensual arrangements.*

In the settings thus far examined, output rules dominate input rules. But that simple relationship does not hold in the many cases where harms arise out of some specific consensual arrangements between two parties, for these situations bear scant resemblance to either nuisances or highway accidents. In these instances, the correct way to think about the tort law is not as a body of rules that keeps people apart, but as a *default* set of contract rules that allows them to come together on terms that are mutually advantageous.[36] One central issue that these parties have to resolve is allocating the risk of loss from such activities, which should be assigned in ways that maximize the expected value of the venture from the ex ante perspective. At this point, the wide variety in these relationships will tend to preclude a uniform solution. Just think of the range of activities that have to be covered: simple slip-and-fall activities in homes and shops; liability for medical mishaps; liability for badly made products and for the side effects of dangerous drugs properly made; liability of schools and universities for injuries to persons entrusted to their care. How should the contracting parties allocate these losses?

The first point to note is that there are still some situations in which the strict liability regime works well. Thus, if the question is whether a product is fabricated in accordance with its own design standards, or whether the design standard allows the product to be used for the very purposes for which it is intended, the usual preference is for strict liability.[37]

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[36] PATRICIA DANZON, MEDICAL MALPRACTICE: THEORY, EVIDENCE, PUBLIC POLICY (1985); For my early defense of this position, see Richard A. Epstein, *Medical Malpractice: The Case for Contract,* 1 AM. BAR. FOUNDATION RES. J. 87 (1976).

[37] RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 2(a) (Am. Law Institute 1998) ("A product is defective [when it](a) contains a manufacturing defect when the product departs from its intended design even though all possible care was exercised in the preparation and marketing of the product").

The point here is that any party that has sufficient control over the preparation and inspection of a given product should make sure that its products are safe before they reach the market. This suggests the appropriateness of a strict liability rule. But in these cases that rule is qualified by a requirement that the product only be safe at the time it left the hands of the manufacturer; the manufacturer should not be held liable for downstream misuse or modification of a product either by the injured party or some third person. In those cases, the risk of loss properly falls on that downstream party. Needless to say, in complex chains of distribution, all the parties can enter into unique complex arrangements for indemnity, contribution and insurance.

As applied to dangerous drugs, that strict liability regime works well with product fabrication, but badly when the question concerns the necessary or common adverse side effects of properly made drugs. In these cases, the appropriate response is an adequate warning of the potential side effects, which allows downstream parties—typically hospitals, physicians, health care plans, and patients—to make informed decisions about its use in individual cases.[38] And in medical practice, a strict liability regime for diagnosis and surgery will cast liability on the physician for all the harms that occur to a patient who already suffers from major diseases or disabilities, as well as those which come from the inherent risks in any standard procedure. In general, therefore, the shift to an input regime is designed to ease financial burden, but for the most part that ideal could *not* be achieved by applying the Hand cost-benefit formula at a retail level. To ask the manufacturer or physician to assume liability for all adverse events will close down the market, for the defendant will require some payment in advance to cover those losses—a payment that could easily exceed the ability of potential product users or patients to pay the freight. Hence, it follows that the liability rules switch to a reasonably well-defined input measure to reduce the number of adverse events for which liability is possible. And in principle, if the situation required further refinement, individualized contracts could be put together to deal with discrete situations, using rules that could both define the standards of liability and the damages, if required in a particular situation. Worker's compensation law works in that general form.

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38 RESTATEMENT (SECOND) OF TORTS § 402A cmt. k (Am. Law Institute 1966).

Similar rules have developed with respect to the liability of owners and occupiers to others on their premises.[39] As a matter of joint expectations, it is usually said that in the default position the operator of a commercial property should take steps to inspect premises for potential hazards. But that duty is normally not imposed on homeowners, where the rule is that the guest has to take the same risks as the owner, such that the owner must either repair latent defects of which he has knowledge, or warn the guest of the dangers so that he can take precautions himself. And as elsewhere, parties should be able to alter these default terms at will, which in routine cases is not likely because it turns out that the default rules closely track the joint expectations of the parties. The key legal question, then, is whether the legal system will allow for these voluntary adjustments, and a strong case be made that crises in both product liability and medical malpractice arose because decisions in these areas prevented any contracting out.[40] The problem will be small when the deviation between the legally-imposed solutions and the voluntarily-adopted (i.e. contractual) solutions are small. But the problem will become large when those gaps increase. It should be noted that with the increases in technological sophistication, the ratio between harms to strangers and harms to contracting parties tends to shift toward the latter. Yet at the same time, the good news is that in such areas as medical malpractice, the pressure on the liability rules has been much reduced not because of any legal developments, but because technology has reduced the number of adverse events in standard practice. At this point, however, newer high-risk ventures are undertaken and tend to drive litigation upward. But lest one look only at the new set of possible adverse events, the most salient feature is the expanded number of beneficial products and treatments available.

V. LEGAL INTERVENTIONS BEFORE THE OCCURRENCE OF HARM.

In most situations, there is little that any single individual can do in order to move courts to intervene to prevent harm. Nonetheless, some form of injunctive relief in whole or in part is necessary for any system of liability to work efficiently. Too often, the only parties responsible are insolvent; and too often the harm in question is either death or serious injury, for which no amount of compensation can make the injured victim whole. Clearly

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39 *See generally*, *Robert Addie & Sons (Collieries), Ltd. v. Dumbreck* [1929] AC 358.

40 For products liability, *see Greenman v. Yuba Power Products,* 377 P.2d 897 (Cal. 1963); for medical malpractice, *see Tunkl v. Regents of Univ. of Calif.*, 383 P.2d 441 (Cal. 1963).

there is something to be gained if ways can be found to enjoin the completion of the actions from which noncompensable harm *may* result.

The use of the term "may" shows that any effort to create remedies before the occurrence of the harm is necessarily subject to two kinds of error: intervening too late after harm does occur, and intervening too soon when no harm would have occurred at all. Balancing these two kinds of errors is a daunting task. In dealing with this issue, it is critical to note that the problem is part of the private law in those cases where it is known in advance which actions by what actors threaten which persons. That happens most often in cases of nuisances between neighbors, where it is known who is likely to release filth or create noise and who is in the path of that injury. In these cases, as described long ago by Guido Calabresi and A. Douglas Melamed,[41] one often talks about injunctive relief—which they call a property rule—as if it functioned solely as an alternative to a liability rule. In their view, an injunction allows the plaintiff to stop the defendant in his tracks and demand huge payments—often far in excess of any possible loss—to dissolve the injunction. But the liability rule has its own fatal defect in that it allows the defendant to hold out for enormous sums to agree to cease the activities that might cause harm down the road, for which it cannot answer.

It should be evident that there are strong objections to both these corner solutions, which is why it should come as no surprise that the stark opposition between damages and injunctions pointed out by Calabresi and Melamed has never represented the law. The mistake in their well-known article is that it views the two remedies as though they were *substitutes* for each other when in practice they function as *complements*.[42] Typically, in the neighbor case, a court will limit the scope of an injunction to stop the most dangerous of practices, then use a damage remedy to "clean up" any residual harm that is caused. How the injunction is limited—by time, conditions, or inspections—is a huge inquiry as is the measure of damages when the injunction is issued in particular cases. But for these purposes, the central lesson is that all remedial choices involve clear error minimization strategies for which there is typically no unique solution.

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41 Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules and Inalienability: One View of the Cathedral,* 85 HARV. L. REV. 1089 (1972)

42 *See, e.g.*, *Escobar v. Continental Baking Co,* 596 N.E.2d 394 (Mass. App. 1992)(limited injunction with some damages).

Private suit injunctions are useless in connection with road accidents, because no one driver knows in advance which other driver or drivers is likely to be a threat. No private party will spend its own money to enjoin a single other party from using the roads. Yet at the same time, no one wants a legal regime in which any person can enter the highway at any time so long as he can be held strictly liable in tort for any harm he causes, regardless of whether the injuring party has any ability to pay compensation. The want of a private plaintiff therefore puts the state (as the operator of a highway system) in the unique position of having to decide which individuals will be able to drive what kind of vehicles under what circumstances. That task requires an extensive licensing system that covers not only ordinary drivers, but at a minimum also covers new drivers, disabled drivers, taxi drivers, and drivers of dangerous vehicles including trucks. The conditions in question are as varied as those for private injunctions, and the task has to continue to deal with decisions to suspend or revoke licenses as well. Indeed, the entire police force operates a kind of injunctive relief—after driving, but before any accident—which seeks to pull over, for example, speeding drivers before they can cause harm. The stark dichotomy between liability rules and property rules works no better in highway accidents than in private nuisance cases, and the system stands in marked contrast with the per se rules that can be used to determine liability ex post. Uncertainty accounts for that huge difference.

VI. THE APPLICATION TO AUTONOMOUS VEHICLES AND OTHER MODERN TECHNOLOGIES.

The bulk of this article addresses the three general problems that any comprehensive system of liability must tackle: harms to strangers, harms arising out of consensual arrangements, and the choice of remedial rules for past and future (but uncertain) harms. In all those cases, the traditional rules were in no way dependent upon the level of technical sophistication that was found in the pre-AV law. As a teacher of Roman law, I never tire of reminding students that the conceptual tangles of liability and remedy in the Roman system anticipated—often down to the use of identical phraseology—the debates that took place over 1,500 years later. The reason this happens is that the rules are built in ways that are consistent with any and all patterns of technical advances. In cases of completed harms to strangers, the levels of antecedent precautions are always irrelevant, so it need not matter how various parties behaved. They make those changes in ways that minimize liability

under the constant set of rules. The dynamic element in the system arises in the reconfiguration of the various rules of the road, not in the change in liability rules.

Similarly, the rules associated with the gains from trade lie at the root of the system of freedom of contract, which applies with full force to the modern world of AV and other 5G technologies. The key insight is that no matter how novel the technology, the voluntary markets that support them are largely invariant to the particular products sold or projects undertaken. In this context, the dynamic element comes in the variation of terms to deal with new products and the like. And through it all, certain warranties are part of the general landscape. These include warranties of title, i.e., that the seller owns the property that he purports to sell; the warranty of merchantability, i.e. that the product is of average quality for the kind of good in question; and the warranty that goods are suitable for the buyer's particular purpose if the seller is told of that particular function. All of these warranties work for all kinds of products. And clearly, when any transaction gets more complicated, these barebones warranties are supplemented by other quite detailed terms for risk allocation. So understood, complex transactions with AVs are of a piece with those kinds of particularized responses. The variation that is seen in other cases of harm that arises out of consensual arrangements can be developed through private ordering in this context.

The largest piece of the puzzle concerns systems of direct regulation that are imposed prior to the harm in question. Here the issue is identical in form to the problems associated with all preexisting licensing regimes, where the cost-justified prevention of harm (not the suppression of competition) is the object of an enterprise filled with pitfalls, which have to do with the timing and extent of the regulations in question. The common law approach for the most part set its presumption against an initial injunction of activities that had low risk of harm. The basic attitude was that the prospect of a strong system of liability provides an incentive in the absence of direct regulation, and that some form of injunctive relief could be offered down the road if matters started to go astray. The chief weakness of this system is that it does not work well with complex construction projects in which major errors can be introduced at any stage of the overall project. In these situations, the private approach, as with complex construction projects, is to have a system of routine inspections backed by liability insurance. In some cases, the insurer can provide the needed inspection, but in other cases independent public inspection can be added in as well.

The way in which this is done—to take a leaf from Judge Guido Calabresi—seeks to minimize the sum of the costs of accidents, the costs of prevention, and the costs of administrative oversight—which is always a chancy endeavor.[43] But that is exactly the same problem that arises with the construction of every dam, canal, skyscraper, pipeline, or mine. It is the reason, moreover, why law never reaches a stable resting place across all these endeavors, because the combination of shifts in technology and environment can easily push the needle in one direction or the other. It is, in general, a costly mistake of many environmental statutes, most notably the National Environmental Policy Act (NEPA),[44] whose basic error is to try to resolve every element of potential uncertainty, no matter how small, at the stage of the initial public review process before some government agency such as the Army Corps of Engineers. That leads to huge delays and extensive investments in inquiries that are likely to yield little or no benefit. Also, many new projects are put into place to replace other older and more dangerous technologies already in place. The same trap could arise with the new technologies for AVs or anything else. Imperfect machines replace imperfect drivers; imperfect drones replace alternative systems of delivery by road, plane or rail, each of which has its own dangers. No system of regulation should fixate on the harms of new technologies and blind itself to their benefits, including the elimination of current dangerous technologies. It is clearly impossible to go over all of these permutations in the abstract, but it is important to note that the lessons learned from other licensing schemes—their uses and their excesses—carries over to this particular area.

VII. CONCLUSION.

Some forty years ago I wrote an article entitled *The Static Conception of the Common Law* that anticipates many of the arguments made here.[45] Its central thesis was that the basic elements of the common law proved remarkably stable over time and were invariant to

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43 *See* GUIDO CALABRESI, THE COST OF ACCIDENTS: A LEGAL AND ECONOMIC ANALYSIS (1970).

44 National Environmental Policy Act of 1969 §§ 2 *et seq.*, 42 U.S.C.S. §§ 4321 *et seq.* (2018). The key early decision that enormously expanded the reach of this statute was *Calvert Cliffs' Coord. Comm., Inc. v. U.S. Atomic Energy Comm'n,* 449 F.2d 1109 (D.C. Cir. 1971) (Skelly Wright, J.). For an analysis of the defects in the basic statutory design, *see* Richard A. Epstein, *The Many Sins of NEPA*, 6 TEX. A&M L. REV. 1 (2018).

45 Richard A. Epstein, *The Static Conception of the Common Law*, 9 J. LEGAL STUD. 253 (1980).

changes in technology, except in those cases, as with air rights and patents, where a reconfiguration of basic property rights promised enormous across-the-board improvements. The explanation for this conclusion lies in the combination of certain essential features of human society that every system must cope with: scarcity, self-interest, and family relationships. The only rules that allow a society to function are ones that allow for the survival of the species, which means that family always comes first. Modern technologies do not address that issue, but it does respond to the central imperative to encourage cooperation and discourage aggression. For that we need the system of property, contract, and tort rules that I have outlined here. Improved technology pushes the production possibilities curve outward, but it does nothing to alter any of these priorities, which is why fundamental relationships of property and tort continue to shape all human endeavors. The want of novelty that follows should be welcomed, not disparaged. The ability to rely on prior institutional practices and forms should ease conflict and speed innovation, which is as relevant today as it has always been.