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**LIABILITY RULES IN THE INTERNET OF THINGS:  
WHY TRADITIONAL LEGAL RELATIONS ENCOURAGE MODERN  
TECHNOLOGICAL INNOVATION**

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Liability Rules in the Internet of Things:  
Why Traditional Legal Relations Encourage Modern Technological Innovation

By

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To most experts on cyberspace, 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, I think that any 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 making this general claim, I do not wish to deny the scope or importance of these technological transformations for legal liabilities. Indeed, there is ample evidence that they are important. A recent article in the Wall Street Journal proclaimed that the “Robot Vacuums Are Finally Good”<sup>1</sup> now that they can work their way around corners and into crevices—only to offer an annoying picture of eufy’s BoostIQ Robovac 30c jammed underneath a railing at the top of a stairwell. The consequences of those domestic errors are relatively small, and hence the potential for liability is low, especially if the vacuums are only used in one’s own home. But the liability issues loom larger once these vacuums are used commercially, where the robot may injure the property of someone other than its owner. Next, of course, there are drones that navigate the skies, which, at least compared to houses and highways, offer a less variegated environment. But the prospect of a crash between a

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<sup>1</sup> David Pierce, *Robot Vacuums Are Finally Good—Here’s Which One to Buy*, THE WALL STREET JOURNAL, Dec. 16, 2018, available at <https://www.wsj.com/articles/robot-vacuums-are-finally-goodheres-which-one-to-buy-11544968981>.

drone and passenger airplane remains a low frequency event—unless the locale is Gatwick Airport, the United Kingdom’s second largest, which has been shut down twice so far by the unannounced arrival of drones whose appearance disrupted the travel plans of thousands.<sup>2</sup> 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.<sup>3</sup> The sensory data fed to the car’s computer contained an uneasy amalgam of things 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. The one familiar feature about this tragedy is that accidents often 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 are 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. So 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 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

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

<sup>3</sup> Abe Kwok, *Police report in no way lessens Uber’s role in pedestrian fatality*, ARIZONA REPUBLIC, June 22, 2018, available at <https://www.azcentral.com/story/opinion/oped/abekwok/2018/06/22/uber-self-driving-car-death-pins-blame-human-driver/724542002/>.

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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, I shall begin in Part I with a simple definition of what the phrase “internet of things” means and why that new development is so important. In Part II, 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. 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 the advent of IoT work with equally well with IoT. It may be inferred from that demonstration that I think 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 Part II. I illustrate this point in part by referring to other adaptations that have been made to respond to other novel technologies, including those involving aviation and telecommunications, which in my view follow the same basic pattern: 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 liability rules.

**I. THE INTERNET OF THINGS.** The most conspicuous technical change in computation is not the adoption of this or that computer language, algorithm, or other technology. Instead it is the cumulative effect that all of these changes have had on the cost of storing, organizing and transferring information in cyberspace. Those costs have gone down so much that digital space is for sale in the private market that it is for most purposes virtually a free good for the people who want it. This is a far cry from the momentous event in the early computer life of Richard A. Epstein, who hired an outside contractor for some tidy sum in 1981 dollars to increase the 128KB capacity of his Mac computer fourfold to a new configuration with a

capacity of 512KB. It took two people more than an hour to solder all the connections into place for the increased capacity. It was only when I took the machine to a Mac dealer for repairs that I learned to my sorrow that unauthorized modifications by third parties voided whatever warranties went with the equipment.

The high cost of digital space influenced every aspect of the computer business. Microsoft Word 4.0 alone required 512 KB of random access memory, which meant at the time that the system designers had to wring every unnecessary step out of their programs so they could meet the space constraints. At the same time, it was clear that the tasks that could be undertaken by computers were sharply limited for the same reason: people did not have the space to worry about anything other than the most rudimentary transactions. Now, of course, the exact opposite is true. The advent of near-free space has both increased the number and types of tasks that one can undertake by internets and computers. And thus we saw the advent of Big Data, and in the last five or so years, the rise of the Internet of Things—a new set of tasks that exploits the vast capacities of the internet.

The simplest definition of the IoT runs roughly as follows:<sup>5</sup> the Internet of Things allows someone at one computer not only to transfer information to another site, but also to control remotely, by a series of directions, activities that are performed at the second site. The tasks in question are immaterial to the definition of the IoT, as is the spatial relationship of the two devices in question. They could be located in separate places or they could be housed in a single large facility, where the instructions go only short distances. The nature of the commands could be simple or complex. At one end of the spectrum is an instruction to turn on the thermostat to X degrees at a given time. At the other end, the IoT could seek to revolutionize the nature of human interactions by providing for such things as driverless vacuum cleaners or driverless cars. Clearly, the pattern of innovation in this area will follow some well-charted paths. The initial forays will be to achieve ministerial tasks well, without error, before entering into matters in which some degree of judgment is required because of

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<sup>5</sup> For a readable explanation, see Jacob Morgan, *A Simple Explanation of “The Internet of Things,”* FORBES, May 13, 2014, available at <https://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/>.

complex interactions between the controller, the controlled party, and the environment in which they both operate.

These permutations will exhibit the usual familiar relationship. Low risk/low return projects will be the first off the drawing board. A simple set of well-defined tasks has few opportunities for mishap, so that the choice of liability regimes in the event of an adverse event is highly unlikely. This is even more so if the only, or predominant, environment is such that the controller and the controlled party are the same person, so that the issue of liability reduces to the simple proposition that there is no liability at all when the same person is both the injurer and the injured party. A situation where A hits B, causing damage, raises serious liability issues. But A hitting A, causing the same amount of damage, poses no issues of liability, any more than the question of theft arises when A takes money from his right pocket and puts it into his left.

Yet how then do we deal with the interesting cases of liability that can arise? The obvious concern is with new IoT technologies that are capable of causing a good deal of harm, as with driverless cars run amok. In order to attack that question, I shall examine two cases, each in two stages. In the first stage of the argument, I will develop the general rules for dealing with highway accidents between strangers that have been in place for over 100 years—ever since automobiles displaced the horse and carriage. I shall develop these rules without any regard to the special problems presented by driverless cars and similar technologies. The second part of the task repeats the same exercise in connection with harms that arise out of consensual and cooperative arrangements, which could involve the use of IoT to control factory technologies or medical operations. In both areas, the same thesis will apply: *virtually no change* in approach or liability rules is needed to deal with issues of compensation for past harms in IoT.

## **II. Constructing Comprehensive Liability Regimes**

*General principles.* 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 any harms suffered by B. For ease of explication here, I shall limit this discussion to death or bodily injury on the one side, or the destruction or damage to real or personal property on the other side, ignoring for the moment harms to intangible interests, such as patents and copyrights, or relational interests, such as when the

actions of X disrupt a set of advantageous relationships between A and B with the threat of force or by false statements. The second issue is forward-looking: how should the law regulate 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 those for completed harms, discussed under the first rubric?

*Conventional liability.*

Basic organization. The difficulty in organizing liability rules is best stated by looking 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 prima facie case of strict liability—an output rule that ignores all questions of care level—sets the correct standard of liability. There is no such uniform standard for harms arising out of consensual arrangements, where both output rules and input rules have their place. The optimal solution could rest in different contexts on theories of strict liability, negligence, gross negligence or even malice.

Legal intervention before harms occur adds a huge element of uncertainty. The standard inquiry in private law asks whether any some injunctive relief is required, and if so its terms. There are no hard and fast rules in these remedial contexts, where the balance of equities in the sound discretion of the court is a standard on which no one has been able to improve in close to 2,000 years. 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 also encountered in practice. This last observation is not one of abject skepticism, for the choice of best regulatory regime makes a huge difference even in a second best world.

One characteristic of all second-best cases is that they often involve remedies not only against the individual wrongdoer, but also a second tier of liability against other persons who were connected with the harm in a somewhat remote fashion. For these purposes, I shall confine my attention to two major areas. product liability and vicarious liability. The

first 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 which deals with the liability of employers for the torts committed by their employees that arise out of and in the course of employment, and property owners and occupiers for harms caused by persons lawfully on their premises.

After harm:

**Input rules or output rules: stranger cases.** All liability 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 looks at the harm, traces it back to its source in the actions of another party, and then imposes liability for 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. This system vastly simplifies the task of determining liability because it tends to rule out of bounds a wide range of antecedent conduct. Such a system can be thought of as an outcome-based rule.

In common experience, we are all familiar with outcome rules, because they are used to organize many common forms of 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 developments.<sup>6</sup> Here the uniform verdict favors output rules that ignore inputs.

Start with some simple examples. It is often necessary to determine whether a ball is hit fair or foul, or 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 those that involve a combination of time, position and motion. Was the defensive player set, i.e. not moving, before he was hit? And, in a more

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<sup>6</sup> Richard A. Epstein, *Positive and Negative Externalities in Real Estate Development*, 102 MINN. L. REV. 1493 (2018).



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. 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 change the odds, but not the rules. But 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*, i.e. between two individuals who have no special duties or connection between them such as arise in connection with 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 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 rules of the road are put in place 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 is universally put into place. It is a political decision 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. 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 administrative processes have to deal with those matters.

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 transaction costs barriers 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 the ground extend to the top of the heavens. But that rule would convert every airplane flight into multiple trespasses, all of which could be enjoined. 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, 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 from these same parties. Instead, the notion of implicit-in-kind compensation covers the case. There is, roughly speaking, a Pareto improvement in which the gains are, to the extent that anyone can measure them, equal across all persons. And if it is not, no one would know who gained more than anyone else, so that dominant solution remains utterly unquestioned.

While the reasons for instituting highways lie in the background, they are no longer in evidence for day-to-day operation. Once those 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 affairs. 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, and 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 is perforce a danger because others will dart and maneuver

to get around that party. To have the autonomous vehicles obey the speed limit is to increase the danger. But to have it obey 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 disparate—which is more easily said than done. There is no easy way to do this, but no matter how this is resolved, it is critical to note that neither statutory or customary speed limits are input measures. They are two output measures in obvious tension with each other.

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, (4) noncompliance by both. In the first case, if the rules of the road are internally consistent (i.e. so 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, in which both parties are responsible, 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.<sup>7</sup> More ambitious rules can adopt some form of comparative responsibility which could seek to measure the percentage of responsibility for the various lapses in question. Alternatively,

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<sup>7</sup> See *United States v. Reliable Transfer Co.*, 421 U.S. 397 (1975).

each party could be required to bear 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 now has to take some steps to prevent the impending loss to himself and anyone else in the vicinity. Here there tends to be a duty of reasonable care, because the two corner solutions—from above, 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 not governed by strict rule that penalizes a party who makes a decision that is seen with the benefit of hindsight to be incorrect. Accordingly, the intermediate position adopts a 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. That two-tier system is in use under one guise or another—"last clear chance" is a common formulation—in every legal system. Fortunately, most accidents tend to fall into cases two or three, which in common settings reduces the pressure on the apportionment rules.

The analysis thus far uses a compound of strict liability and reasonable care rules. There are, however, many modern cases that formally reject the strict liability rule in favor of a universal rule of negligence, which is said to rely on the quintessential cost benefit rule, commonly called the Hand formula,<sup>8</sup> which compares three elements under the inequality  $B < PL$ , and asks whether the burden of precaution exceeds the expected losses measured by the probability of the harm, multiplied by the anticipated severity. 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 situation could exceed the amount in controversy, so that it is easily questioned whether this rule can be or ever has been applied. Indeed, it 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.<sup>9</sup> Thus highway cases frequently invoke this

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<sup>8</sup> See *United States v. Carroll Towing*, 159 F.2d 169 (2nd 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).

<sup>9</sup> See, e.g., *Martin v. Herzog*, 126 N.E. 814 (N.Y. 1920).

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, it 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.<sup>10</sup>

It is importance to appreciate the significance of this transformation. The answer is it is enormous, even after the law admits some “excuses” into these disputes. Here is a brief catalog. First, one deviation is allowed when someone violates a rule of the road because of an effort to avoid harm when he knows that some other party has previously and independently violated the rule of the road. But that exception for dealing with cases of last clear chance is well known in the system. When someone forces you into defensive mode, they cannot claim if the uncertainty that you created leads them to make a mistake why acting in good faith. Only a small set of accident cases are governed by this theoretical exception. The second pair of excuses that is tendered goes to the capacity of the party to conform its conduct to the rules of the road. On this score, 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.<sup>11</sup> But these cases are rare as hen’s teeth. The truly important claim is that 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. It is no wonder that this rule has been stoutly rejected.<sup>12</sup> The effective regime is for all intents and purposes an output regime, properly qualified as such in certain interactive cases.

*Remote 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 to the person whose injury they cause, but, as noted above, a robust theory of

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<sup>10</sup> For discussion, see Richard A. Epstein, *The Irrelevance of the Hand Formula: How Institutional Arrangements Structure Tort Liability* in Jef De Mot (ed.), LIBER AMICORUM BOUDEWIJN BOUCKAERT (2012).

<sup>11</sup> See, e.g., *Breunig v. American Family Insurance Co.*, 173 N.W.2d 619 (Wis. 1970).

<sup>12</sup> See, e.g., *Daniels v. Evans*, 224 A.2d 63 (N.H. 1962).

liability 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 the IoT, 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.

*After harm: Responsibility of Third-Parties.*

Product liability. Thus far the arguments stated above assumed that the sole error involved was attributable to 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 could not be detected in ordinary use. With much doubt over the situation, the rule essentially was established that the driver could sue the manufacturer if the defect in the vehicle caused the driver to lose control. 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. 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 IoT.

Vicarious liability. The second major inroad on the principle of individual responsibility is far more important than the product liability exception, because the rule does not require proof of any defect in the product or negligence of the employer who is held responsible for the wrongs of another. The rule here is so ubiquitous, especially in corporate contexts, that people rarely notice when it is invoked. But every time an employee causes an

accident, the employer is responsible for that harm so long as it arises out of, and in the course of, employment. The rule, as with primary liability, does not turn on negligence in the selection or instruction of the employee, which would make matters turn on an input measure that yields no 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 a company shipping, say, explosive products on the road entrusted them to an impecunious driver in a rental car. Once again, this system is entirely 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.

#### Before harm.

In most situations, there is little that any 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 there is something to be gained if ways can be found to enjoin the completion of the actions from which 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 when harm does occur, and intervening too soon when no harm would have occurred at all. Balancing these two kinds of errors is a massive 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,<sup>13</sup> one often talks about injunctive relief—which they call a property rule—as if it were solely 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 legal approaches, which is why it should come as no surprise that the stark opposition pointed out by Calabresi 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*. 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 for 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 a clear error minimization problem for which there is no unique solution.

Private suit injunctions are useless in connection with road accidents, because no one knows in advance who 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. 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

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<sup>13</sup> Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089 (1972)



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.

*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, as these situations bear scant resemblance to 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. 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. 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. 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 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 use of a product either by the injured party or some third person who used the product incorrectly. 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. 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. The object of the system is to encourage only cost-justified actions, but the mode to achieve that result depends typically on resort to the standard of customary practice within the applicable group of physicians—specialists, nurses and soon—at the time the care was offered. 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.

Similar rules have developed with respect to the liability of owners and occupiers to others on their premises. As a matter of 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.<sup>14</sup> The problem will be small when the deviation between the legally imposed and the 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.

### **III. The application to IoT.**

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 applicable rules were in no way dependent upon the level of technical sophistication that was found in the pre-IoT 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 all the 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

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<sup>14</sup> 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).

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 IoT. 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 of the buyer 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 in the IoT 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.<sup>15</sup> 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),<sup>16</sup> 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 in the IoT. 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.

**Conclusion** Some forty years ago I wrote an article entitled *The Static Conception of the Common Law* that anticipates the arguments made here.<sup>17</sup> Its central thesis was that the basic elements of the common law proved remarkably stable over time and were invariant to changes in technology, except in those cases, as with air rights and patents, where a

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<sup>15</sup> See Guido Calabresi, *THE COST OF ACCIDENTS: A LEGAL AND ECONOMIC ANALYSIS* (1970).

<sup>16</sup> 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*, 8 TEXAS A&M L. REV. \_\_\_ (2018).

<sup>17</sup> Richard A. Epstein, *The Static Conception of the Common Law*, 9 J. LEGAL STUD. 253 (1980).

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. 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. The IoT does 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.