Regulating the new

Regulation, Ethics, Acceptance and Legitimacy in the governance of technology

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to my real students
Margot and the huggies
and mothers
for everything

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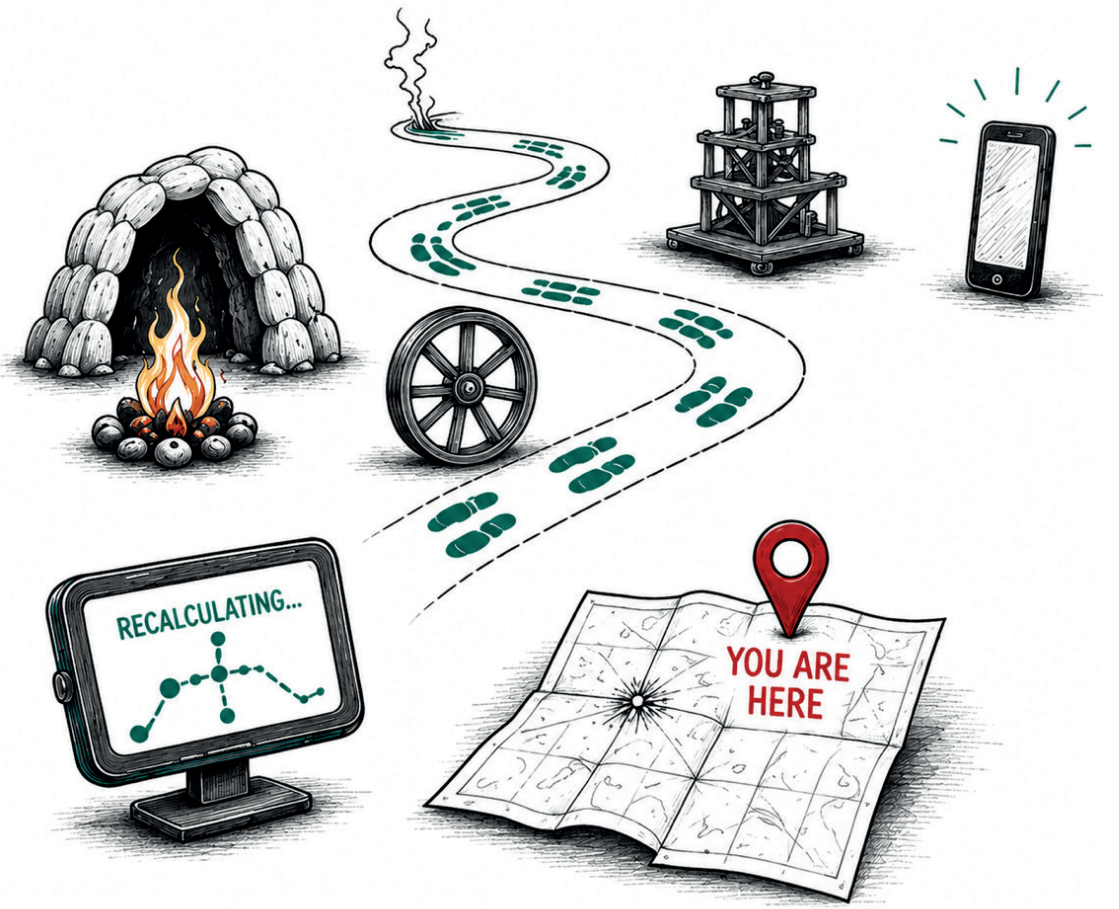
RECALCULATING...
YOU ARE HERE

Preface

How did we get here?

the origins of this book, and how to read it

The girl was never there
It's always the same
I'm running towards nothing
Again and again and again and again...

The Cure – A Forest, 1980

This book began, in a sense, as a request from students in my course on the regulation of technology. In the summer of 2022, returning from a burn-out, I took on the redesign of the course Regulation, Ethics, Acceptance, Legitimacy. I struggled with the title, but the acronym — REAL — was a gift. I collected the papers in the field that matter and rebuilt the course from the ground up. In late August, I was anxious to be back teaching in class (remember, we had just emerged from COVID and its online teaching) and looked forward to discussing the field's important scholarly work. The course worked fine and got me firmly back on my feet, but students complained about the volume and complexity of the literature. I see their point: academic papers are not exactly written with LLM students in mind.

Since I was still entitled to somewhat of a sabbatical, I decided to take the plunge and write a book for the course that addressed my students' concern. The book was to be a REALbook. And the project was a real one, too, in that it had to be done in between busy periods. So it started with me finishing a couple of chapters just before each new iteration of the course (which runs twice a year).

What was the book supposed to look like? There are few examples in the field to lean on. There is a good text-and-materials book by Bronwen Morgan and Karen Yeung (2007), 'An Introduction to Law and Regulation', but its quotations are longer than I would like and technology hardly plays a role in the book. Of course there are the various handbooks edited and written by Robert Baldwin, Martin Cave, and Martin Lodge, but these too are somewhat dated and too detached from technology. And there are numerous good textbooks on internet law and related topics, but these are too legal. The course, and my ambition, are far more multidisciplinary: the book had to be about the regulatory governance of sociotechnical change and innovation. I also wanted it to reflect my journey through the field over the past three decades. There had to be a personal touch — my quirks, my concerns, my joys.

Central to the book is a simple model of technology regulation that I had devised a couple of years earlier. The model depicts the stages a regulator has to go through to guide sociotechnical change in the right direction using regulation and governance. The chapters elaborate on these stages in turn. I also wanted the book to go beyond theory and findings and offer regulators concrete instruments.

This is where my problems began. It is easy to say that technology does not matter and that we should look at the context of use instead — but that does not clarify *what* we need to look at, or *why*. What is relevant about self-driving vehicles from a regulatory perspective? Not the brand of the car, the number of wheels, or its colour, but perhaps the fact that there is no driver in the traditional sense.

What started as a project describing my take on the existing literature increasingly turned into rethinking theory and developing new approaches and models. For every chapter, I had to search for methodologies and tools that could help students and regulators make sense of their environment and the tasks ahead. And with that I believe the book has outgrown its original student audience: legislators and regulators may find inspiration — and instruments — in it too.

While I was writing, we ourselves entered a new stage of sociotechnical change. In November 2022, OpenAI launched its revolutionary tool ChatGPT. This was not only highly relevant from the perspective of regulatory governance; it also affected education — and the writing of this book.

First, it became clear that generative AI poses significant challenges for student assessment in a hybrid programme such as the LLM Law & Technology at Tilburg Law School. This led me to shift assessment partly away from take-home exams which almost invites students to employ genAI tools in completing the assignments. The model adopted in the course, with its multitude of perspectives and tools, proved demanding for students with legal training. Fortunately the model also lends itself ideally to forming the backbone of a serious game reflecting the tasks any regulator has to perform: analysing a problem space and coming up with solutions. Thus the REALgame was born. Alongside the book, we developed a board-and-card game in which teams of five students play 'European Commission', tasked with addressing a particular innovation. The cards provide the constraints, perspectives, and tools the teams can draw on. At the end of the game the teams will have made an analysis and a concrete set of interventions to guide the innovation. The game teaches students how all the moving parts relate. The game is played under pressure and there is little room for the team to call genAI to help them. This solves part of my grading problem, I can be relatively certainwhat I am assessing is student work. The game is a central part of the REALproject.

Second, generative AI matured during the writing process, and I have used it extensively along the way. At first to create songs to accompany the book: ChatGPT wrote lyrics based on the chapter texts, and Suno set them to music. The result is the REALalbum — not essential for learning about the regulation of technology, but a fun side effect. I then used ElevenLabs to generate an audiobook version. This is a genuinely useful addition: many of our students commute to campus and can now listen to the book (in voices other than mine). Next, I used NotebookLM to create podcasts for the chapters. They are not perfect, and that too has pedagogical value — students have an extra exercise that supports learning: spotting the glitches in the REALpodcasts.

I also increasingly used AI myself as a research assistant. Early on, NotebookLM produced chapter summaries and review questions; ChatGPT and later Claude helped me brainstorm, structure, and refine and edit my writing during the production stage. This allowed me to create what I had in mind faster and at higher quality, remember that English is my second language and that I have little resources to help me produce an Open Access book. The resulting text is entirely my responsibility.

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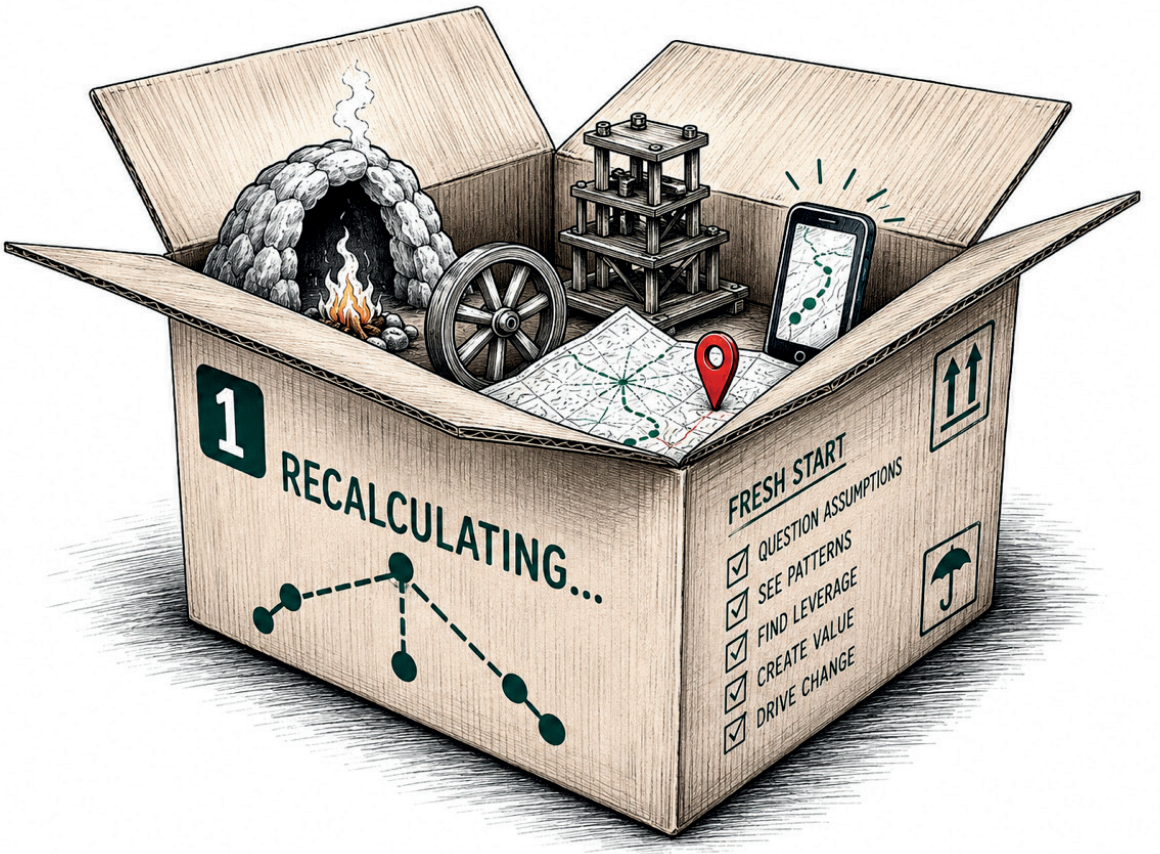
And all REAL students since September 2023 for bearing with me and pushing me to complete the book.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RECALCULATING...
FRESH START
QUESTION ASSUMPTIONS
SEE PATTERNS
FIND LEVERAGE
CREATE VALUE
DRIVE CHANGE

Chapter 1.

Setting the scene

sociotechnical change, technology, and regulation

Wir fahr'n fahr'n fahr'n auf der Autobahn
Vor uns liegt ein weites tal
Die sonne scheint mit glitzerstrahl
Die fahrbahn ist ein graues band
Weisse streifen, grüner rand

Kraftwerk – Autobahn, 1974

1.1 Introduction

From the period mankind moved away from being hunter-gatherers technology has played a defining role in getting us where we are today. In fact, without technology we would not be the present day hyperconnected city dwellers[1] most of us are. Technologies are embedded in many ways in our everyday lives, and we could even be considered Cyborgs, the combination of human and machine, even though we don't look like the typical Sci-Fi Cyborg, like Arnold Schwarzenegger as the Terminator. Attached to our bodies are glasses for improving our eyesight, we wear internet connected smartwatches and cling to our smartphones as attachments to our bodies to provide essential functionality, and as we get older we may get hearing aids to make us participate in social life.

Yet the full impact of technology largely escapes us, precisely because we are too immersed in it to see it. Technology also does not matter qua technology to most people. It is a set of tools necessary for our daily functioning, but so is breathing. And if one takes a professional interest in sociotechnical change within a law school, many even frown upon you. Legal scholars do contract law, tort law, criminal law and so on. Technology and innovation are not legal subjects. Sure, technology enters the realms of law that have existed for thousands of years, but they don't present anything worthwhile to warrant specific attention. At least that has been the attitude within my own Law School until fairly recently. The claim that we develop in this book and in the wider field of Law & Technology is that technologies do matter for law and governance and they may even be so disruptive that we have to rethink legal concepts and institutions that have been around since the days of Roman law.

New or emerging technologies have always created new opportunities, while at the same time raising concerns and discontent. And these attract lawyers and legal scholars. Whenever a new technology appears, one of the first questions that comes to the table is what happens if something goes wrong as a result of the (application) of the new technology? Who is liable for damages? But also other (legal) questions arise, such as how does the new technology relate to human rights? Is it legally permissible

1. More than 50% of the people (worldwide) live in cities. By 2030, some 5 billion people are projected to live in towns and cities. See https://www.unfpa.org/urbanization accessed 10 July 2026.

to scrape images created by artists on the internet? Do AI art tools, such as DALL-E and Stable Diffusion infringe on the copyright of the artists whose work is scraped from the internet?

Not far removed from these legal questions regarding the permissibility of conduct facilitated by new technologies and their effects are the calls to enact new regulation to govern the new technology. And despite calls for deregulation, especially during election seasons, there is a steady growth of regulation, not in the least regulation targeting technologies and their use.

What is interesting here is that somehow the newness of some invention or innovation seems to spur a call for new regulation to govern its use. This call for regulation not only comes from affected individuals or groups, such as artists in the AI art tools case, but also from developers, engineers, policymakers, and the odd scientist, who may quickly arrive at the conclusion that there is a regulatory disconnect in need of fixing. Industry may complain that the law needs to be changed. Industry typically brings forward two claims regarding the regulatory framework in their domain: one, that they are unduly constrained by it, and two, that the rules are unclear. The calls for new regulation because of some novelty seems to be the knee-jerk reaction every time a new technology emerges, rather than first exploring the actual state of the art with respect to the technology and the law.

We have clearly seen this 'call-to-regulate' reflex in the field of self-driving vehicles where Google (currently Waymo), and the car industry more generally, urged for new regulation.[2] A similar response was seen with regard to "newish" 'taxi-like' services with human drivers, such as Uber, where a strong demand from the new services to regulate the field is visible.[3] Of course, by regulating the field, they mean "in a manner that is to their advantage". Uber's concerns are different from Waymo's, but

2. The head of Google's self-driving car programme, Chris Urmson, urged Congress to establish a single national framework rather than a state-by-state patchwork: US Senate Committee on Commerce, Science and Transportation, 'Hands Off: The Future of Self-Driving Cars' (hearing, 15 March 2016) https://www.commerce.senate.gov/public/index.cfm/hearings?ID=C1BE704F-8D6B-43C6-B472-858C6B457E86 accessed 10 July 2026. See also 'Google Urging Congress To Speed Up On Self-Driving Cars', (*Fortune* 14 March 2016) https://fortune.com/2016/03/14/google-congress-self-driving-cars/ accessed 30 July 2026.

3. 'Uber, Hassan Support State Regulations on Ride-Sharing in N.H.', *New Hampshire Public Radio* (24 February 2016) https://www.nhpr.org/politics/2016-02-24/uber-hassan-support-state-regulations-on-ride-sharing-in-n-h accessed 10 July 2026.

the source of the issues is the same in both cases: there is a regulatory disconnect. That is, the existing regulation does not regulate current or emerging practice in a satisfactory way. In both cases, though, the call was eventually answered: ride-hailing is now covered by dedicated statutes in almost every US state (New Hampshire's dates from 2016)[4], and automated vehicles are gradually acquiring rules of their own, from state-level AV laws in the United States to the EU's type-approval regime for automated driving systems (Regulation (EU) 2022/1426).[5] As we will see, however, the arrival of new rules is rarely the end of the story: the harder question is whether new regulation was the right response at all, or whether the framework already in place could have coped.

The songwriter T Bone Burnett and the film producer Jonathan Taplin put the stakes for artists starkly in a letter in the Washington Post in 2023. They claim that AI companies appropriate the work of artists without permission and payment through online scraping and that genAI systems are producing content that endangers the revenue-creating possibilities for artists on a massive scale. They note the attention AI raises in other areas but warn that a 'nation's cultural life is not a minor matter, and preserving artists' rights is essential to ensuring their continued contribution'. They end with the familiar trope – new laws and regulations governing AI and safeguarding the human core of creative artistry is required.[6]

A case has since been decided. In May 2023 the Supreme Court held, 7-2, in Andy Warhol Foundation for the Visual Arts v Goldsmith that the Foundation's licensing of Warhol's image of Prince was not fair use, siding with the photographer. Tellingly, the courts reached that result through ordinary copyright doctrine rather than any new, AI-specific rule - a first hint at the question that runs through this book: does a new technology really call for new regulation, or can the framework already in place absorb it?

4. New Hampshire enacted its transportation-network-company statute in 2016 (originally NH RSA ch 376-A, since repealed and recodified as NH RSA ch 359-U); by 2018 almost every US state had adopted comparable legislation.
5. Commission Implementing Regulation (EU) 2022/1426 of 5 August 2022 laying down rules for the application of Regulation (EU) 2019/2144 as regards uniform procedures and technical specifications for the type-approval of the automated driving system (ADS) of fully automated vehicles [2022] OJ L221/1.
6. T Bone Burnett and Jonathan Taplin, 'To Protect Human Artistry from AI, New Safeguards Might Be Essential' (*The Washington Post* 14 March 2023) https://www.washingtonpost.com/opinions/2023/03/14/artificial-intelligence-threatens-creative-artists/ accessed 10 July 2026.

Pause to think about this for a second. Law has been around since at least Roman times and has a remarkable resilience. Institutions like contract, tort etc have proven very robust and capable of handling major changes in society over time. Why then should any new technology then require new regulation? This is one of the conundrums that we deal with in this book.

The field of law and technology is thriving with many journals, papers and scholars contributing to our understanding of what makes technology and innovation interesting from a legal and governance perspective. Similarly, there are many courses and even entire programs on law and technology.[7] While there is a significant body of relevant knowledge on everything Law and Tech, it is scattered over many sources. This book aims to bring together a large collection of concepts, theories, tools and examples and connect them into a coherent whole. It draws on papers from diverse fields, such as law, Science & Technology Studies (STS), philosophy of technology, and economics, to address questions such as why, when, what, how, by whom to regulate technology.

Lyria Bennett Moses nicely summarises the typical way in which technology issues are addressed in legal scholarship:

> Within legal scholarship, most such consideration is piecemeal, evaluating how best to influence or limit particular practices thought to cause harm or generate risk. This typically involves an analysis of a small range of current or potential acts associated with particular technological developments, the potential benefits or harms associated with those acts, the impact of existing law and regulation, as well as proposals for new laws or regulation. Most discussion of new technology by lawyers and regulators is specific in this sense.[8]

She then goes on to say that this type of study is relevant and necessary, but that we also need more general scholarship that seeks to understand the relationship between law, regulation, and technology across doctrinal and technological contexts:

7. Such as the REAL course within the Tilburg Law School (TILT) Law & Technology LL.M.
8. Lyria Bennett Moses, 'Regulating in the Face of Sociotechnical Change' in Roger Brownsword, Eloise Scotford and Karen Yeung (eds), *The Oxford handbook of law, regulation and technology* vol 1 (Oxford University Press 2016) 574.

> The primary question is thus not 'What regulation is justified by a particular technology?' or 'How should a particular technology be regulated?' but rather What is the appropriate legal or regulatory response to this new technological possibility?' At a broader level, we need to ask not how to 'regulate technology'[9], but rather how existing legal and regulatory frameworks ought to change as a result of rapid changes in the things being created, the activities that are possible and performed, and the sociotechnical networks that are assembled.
>
> Changing the frame from 'regulating technology' or 'regulating new technology' to '*adjusting law and regulation for sociotechnical change*' enables a better understanding of the relationship between law, regulation, and technology.[10] (italics are mine)

This book takes this broader approach of addressing sociotechnical change.

This chapter will scope the field and lay some foundations. It will introduce a model that can be used to control the regulatory knee jerk reaction. The model provides us with a way to decompose the emerging technology at hand and allows us to single out parts of the problem for further analysis. The chapters that follow zoom in on parts of the model and provide perspectives, concepts, and tools to analyse and understand parts of the problem.

1.2 Sociotechnical change

Although we tend to talk about technology and the law and regulation of technology, in most cases it is actually not the technology itself that is regulated but rather the use of the technology in question. Let us explore this claim a bit further.

One (old) technology, trains, can serve as an example here. The first railway steam locomotive was built and run in 1804 by Richard Trevithick, whose engine hauled a load along the Welsh Pen-y-Darren Tramroad. (Matthew Murray's commercially successful locomotives, such as the Salamanca, came a little later, in 1812.) And, as Braden Allenby writes in

9. As in Roger Brownsword and Karen Yeung, *Regulating Technologies: Legal Futures, Regulatory Frames and Technological Fixes* (Hart Publishing 2008).
10. Bennett Moses (n 8) 575.

his recount of the story of trains and railroads as technology systems, 'the world changed forever'[11].

After the first journey in Wales of this, from a 21st century perspective, clumsy barrel on wheels, trains also made their way abroad, such as in the US. In 1832, the *Atlantic* was able to carry 50 tons from Baltimore to Ellicott's Mills, Maryland, burning a ton of coal on the 42 km round trip. Railroads and trains then took on their role in opening up the vast space of the US to its new settlers. It changed the pace at which the country could be inhabited by a new population. Huge interests were at stake and legal conflicts abound. One of these conflicts is depicted in 'Once upon a Time in the West', the 1968 Western classic movie by Sergio Leone, which plays against the background of a piece of unassuming property in the desert bought by a guy called Brett McBain, who is killed early on in the film. McBain knew the railroad under construction would pass through his property, Sweetwater, one day and had planned to create a watering station (essential for the water hungry steam engines), subject to a reverter that McBain would forfeit Sweetwater if the station was not built by the time the railroad reached that point. The law (of contract) is involved in this story of new technology as it often does. But I digress.

Railroads became topic of specific regulation a little later when president Lincoln signed the Pacific Railway Act in 1862, authorising the construction of the first transcontinental railroad.

Meanwhile, in Europe, railroads had taken on even more significantly. Allenby gives an extensive overview of the strategic role railroads played in continental wars between Prussia and Russia, and later between Germany and the rest of Europe. Railroads allowed to carry troops and material across large distances and facilitated quick mobilisation. To this purpose, Prussia had established the Prussia Railway Fund which supported the construction of railways that were commercially non viable, but of military strategic interest. Also freight cars, even commercial ones, were constructed in such a way that they could also carry soldiers, horses and military equipment if necessary. This is a prime example of dual use technology (civil and military).

11. Braden R Allenby, 'Governance and Technology Systems: The Challenge of Emerging Technologies', *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight* (Springer 2011) 3.

The infrastructure created by the Prussians was so advanced that it took the Austrian Empire by complete surprise when it showed capable of moving 197,000 men and 55,000 horses to the front in limited time. Prussians and later Germans took the lessons learned to create the "Schlieffen Plan" which, using the railroad infrastructure, would allow the Germans to fight on two fronts in what would become World War I. The plan was to first battle France on the Western front and then after delivering a hard blow there, quickly move the troops across Europe to fight the Russians on the Eastern front. If the French defense at the Battle of the Marne had not prevented the Germans from delivering the first blow, the Schlieffen Plan might have worked. Instead, the Western front became one of the (if not the) bloodiest battles in history.

This little historic detour shows one of the obvious features of a (by now) common technology: trains are mobile. But it takes a bit more effort to realise what effects trains had on society. At times when most people travelled on foot, if at all, being able to undertake journeys over significant distances crossing inhospitable landscapes while at it, must already have opened up opportunities otherwise unavailable. But in doing so it has changed much more. Production and consumption could more readily be spread geographically. Goods could easily be shipped, relatively cheaply, and reach distances far beyond the reach of horse-drawn carriages carrying perishable goods. This in turn went hand in hand with industrialisation (at least in the US). Local and small regional business concentrations were replaced and complemented with entities that operated on the scale of the country as a whole. "Big Sugar, the Tobacco Trust, Standard Oil ... industrial monopolies of unprecedented scale rode in on rails of steel"[12].

But the effects go well beyond these. Allenby points out that the railroad system required a uniform, precise system of time that was compatible with the network – they required "industrial time". Although by and large people had no use for very precise times (the sun was their guide), local communities everywhere used their own local times to synchronise community affairs. Trains needed their uniform time, but even there it took quite some time before US train companies gave up their own time! Given the multiple railroads passing through bigger cities, cities could have multiple times. Buffalo at one point had three times, Pittsburgh six.

12. Ibid 5.

As the extensive railroad networks required coordination (has the 12:34 train departed Buffalo?), not only time needed to be standardised, but also a communication infrastructure was needed too. And this is where the telegraph came in.

Allenby pushes the point further, and it is worth following him. The railroad did not merely move goods; it rewrote the continent. Chicago exists, and organised the Midwest around itself, because of the railroads. Rail travel also dissolved the old sense of place and rhythm that the horse and the canal had kept intact — the space-time compression that post-modernists think they discovered was already a commuter's complaint. Most striking is the shift in imagination: in the United States the railroad moved the national dream from Jeffersonian agrarianism to what Allenby calls a "high-tech New Jerusalem", a shining city on the hill built not by a democracy of farmers but by technology overcoming human frailty. That quarrel still echoes — in the sustainability debate's yearning for Eden, and in the way the US and the EU talk past each other over GM crops, an industrial matter for one and a question of landscape for the other.[13]

The railroad/train example gives us a good impression of the power and impact of infrastructure as technology.

Take a moment to think about one of the other 'great infrastructures', the motorway (and cars/trucks). The development of combustion engines and introduction of an 'affordable' car, such as the Ford Model T (produced between 1908 and 1927) in the US lay at the roots of another revolution. Ford's Model T provided inexpensive transportation on a massive scale, but the car also signified innovation for the rising middle class and became a powerful symbol of the United States' age of modernisation.[14] In Europe, the construction of the *Reichsautobahn* in the 1930s in (Nazi) Germany and the promotion of the Volkswagen *Käfer* (Beetle) as the car for everyone in the late 1930s and 1940s have initiated a sociotechnical change in Europe of a serious magnitude. This chapter's epigraph, Kraftwerk song Autobahn, is testimony to the power of this system: although travel on the motorway may be monotonous, it will get you places, certainly given

13. Ibid 5-6.
14. Mads Nygaard Folkmann, 'Encoding Symbolism: Immateriality and Possibility in Design' (2011) 3(1) Design and Culture, 51–74.

that the Germans opted for not implementing a maximum speed on the motorway (until fairly recently).

We take a closer look at the role of technology and innovation in and on society in the next chapter(s), but the examples above already show that technology does not exist in a vacuum. Technologies must be understood as integrated cultural, economic, institutional, and built phenomena. Looking at a technology as just an artefact (man made object), like the locomotive as locomotive or the smartphone that you can pick up, would for many technologies lead to gross over-simplifications and dysfunctional analysis.

Of course it is possible to look at a technology as technology. Engineers can study artefacts from the perspective of design requirements and whether the result meets these requirements in technical terms. For instance, the Netflix series 'The Playlist', which presents the history of Spotify, contains a few segments about the team's struggle with founder Daniel Ek about the performance of the service. Ek initially hammers the team to improve the prototype (app/service) to have at most 500 msec between pressing play and the song to start playing. Later on he presses them to make the song play instantly. The main engineer at first complains that anything under 0.2 seconds is not noticed by humans at all, making their effort to reduce latency to approach 0 seconds moot. Ultimately they manage to do it and inventing a new TCP/IP transport protocol on the go.

Although superficially the above is about the Spotify technology, it is actually not. Latency, as Ek realised, is a make or break feature of his music streaming service. Spotify might not have reached the success it currently has if users would have to wait too long for their songs to play. Where the sweet spot in terms of latency is exactly (is it indeed 0.2/0.3 sec), is unclear, but it is correct to assume that people sign off if a (machine) response takes too long.[15]

We need to look at the **sociotechnical context** that incorporates the technology to understand what the technology means, what (potential) issues it raises and how we can potentially deal with these issues from a policy perspective. It is the sociotechnical change in which technology features

15. We will come across ways to manipulate our assessment of time and delays later in sections 4.1 and 9.3.7 (Fogg's captology).

that matters, not the technology itself. But before we do that, it is instructive to first get a proper understanding of what we mean by *technology*.

1.3 Technology

I doubt that many readers will be particularly interested in railroads or motorways *qua* technology. Generally, law & technology literature concerns *newer* technologies, such as robots[16], AI and somewhat longer ago nanotechnologies and Information Technology (IT). It appears as if *technology of interest* is a moving target, and indeed the adjective *new* in New Technologies suggests such.

But it is also the case that many authors talk about (new or emerging) technologies without defining what they mean by these terms. Most of the times it concerns technologies at the forefront of technology, hence Chatbots are in, Autobahn is out. While it keeps the field of law and technology dynamic, as is the underlying technological development, it requires a constant update of what is currently *Wired* instead of *Tired*, as one of the popular tech journals (Wired.com) calls it.

An interesting side-effect of this Wired/Tired distinction is that some phenomena relating to innovation and technology are within the realm of law & tech scholars, while similar, or even bigger developments or advances are not interesting to them and 'left' to the traditional legal disciplines. The focus is on hip and new, not on boring older technologies. The focus of 'technology regulation' then is on how regulators ought to deal with new technological fields.[17]

1.3.1 Defining technology

However, if we look closer at the term technology, then we will notice that novelty does not play a role at all in many definitions. In fact, the concept technology might incorporate many things that most will not immediately recognise as such.

16. See for instance Ronald Leenes and others, 'Regulatory Challenges of Robotics: Some Guidelines for Addressing Legal and Ethical Issues' (2017) 9(1) Law, Innovation and Technology; Ryan Calo, 'Robotics and the Lessons of Cyberlaw' (2015) 103 Calif. L. Rev. 513.
17. Lyria Bennett Moses, 'How to Think about Law, Regulation and Technology: Problems with "Technology" as a Regulatory Target' (2013) 5(1) Law, Innovation and Technology.

A quick scan on definitions of technology show a wide variety. Oxford's dictionary defines technology as "scientific knowledge used in practical ways in industry, for example in designing new machines". If we think a bit about this definition, we get into a bit of a rabbit hole, because scientific is meant to mean involving science. Science is probably involved in all things we currently consider new technologies, but is that universal. Is fire a technology? To me fire would qualify as a technology and an important one at that, but did its invention/discovery require science?

The Stanford Encyclopedia of Philosophy (SEP) has a lemma on philosophy of technology and after 88 occurrences of the word technology it comes up with the following "Technology can be said to have two aspects or dimensions, which can be referred to as instrumentality and productivity. **Instrumentality** covers the totality of human endeavours to control their lives and their environments by interfering with the world in an instrumental way, by using things in a purposeful and clever way.[18] **Productivity** covers the totality of human endeavours to bring into existence new things through which certain things can be realised in a controlled and clever way."[19]

What is stressed in the text is that science and technology are quite different from each other (contrary to what the Oxford Dictionary lemma suggests). SEP points at Henryk Skolimowski's argument in a special issue of the journal Technology and Culture that science concerns itself with *what is*, whereas technology concerns itself *with what is to be*[20], a view that is corroborated by Herbert Simon in 'The Sciences of the Artificial'[21]. Others, such as Mario Bunge in the same T&C special issue argues that "technology is applied science, but in a subtle way that does justice to the differences between science and technology. Bunge acknowledges that technology is about action, but an action heavily underpinned by theory—that is what distinguishes technology from the arts and crafts and puts it on a par with science."[22]

18. Maarten Franssen, Gert-Jan Lokhorst, and Ibo van de Poel, 'Philosophy of Technology', The Stanford Encyclopedia of Philosophy (Spring 2023 Edition), Edward N. Zalta & Uri Nodelman (eds.), https://plato.stanford.edu/archives/spr2023/entries/technology/ accessed 10 July 2026.
19. Ibid.
20. Henryk Skolimowski, 'The Structure of Thinking in Technology', (1966) 7(3) Technology and Culture 371–383.
21. Herbert Simon, *The Sciences of The Artificial* (1st ed, The MIT Press 1969).
22. Quoted in https://plato.stanford.edu/archives/spr2023/entries/technology/

Don Ihde, in his introduction to Philosophy of Technology also emphasises the link between science and technology.[23] Among other perspectives, he gives a historic account of technology, going back to early civilisation where pre-historical men and women picked up sticks to be used as a club, or broken gourds used as containers. He calls these examples of **found technology**. By this he means objects found in nature that are adopted (and often modified) by humans to serve a role in their coping with their environment. The way this happened is not universal. Depending on the conditions, different adaptations are made. In culinary technologies, most cultures appear to have come up with 'bowls', 'spoons' and 'knives'. The fork, according to Ihde, was a far less prominent and arrived only relatively late to the scene and even only in parts of the world. In some cultures, based on rice as the primary grain, chopsticks became the utensils of choice, rather than forks. This is an indicator that technologies not only revolve around humans relating to their *environment*, but also that they are deeply *culturally embedded*.

Next to found technologies, we have the, currently much more prominent, form of **technoscience**. Technology that derives from scientific knowledge. A very clear example of technoscience is plastics. Whereas sticks as clubs will probably be discovered by anyone alone in the woods facing (small) angry animals, and glass (from melted silica in sand) might be discovered by people living near significant heat sources (volcanos), the invention or creation of plastics follows a different trajectory. Plastics do not exist in nature. They are 'manufactured through precisely the processes made possible by technoscience'[24]. They require scientific knowledge, not mere chance.

This distinction between found technology and technoscience technology does not define technology, but it provides a backdrop to understand some aspects of technology. Ihde does provide us with a 'preliminary definition of technology' earlier in the book.

> First, we shall insist that a technology must have some concrete component, some material element, to count as a technology. And, second, a technology must enter into some set of praxes –"uses"– which humans may make of these components. And, third, we shall take as part of the definition, a *relation* between the technologies

23. Don Ihde, *Philosophy of Technology: An Introduction* (1st ed, Paragon House 1993), 47.
24. Ibid 49.

> and the humans who use, design, make, or modify the technologies in question.[25]

This definition covers the technologies mentioned in the previous paragraph, but doesn't that 'material element' create issues? What about the non-material tools people use to adapt to their environment? Many of the contemporary — I would say completely indispensable — technologies are (online) services. Granted, the Internet does not exist without cables, routers, switches and other hardware, so in a strict sense a material element is always present. But we rarely see that hardware as *the* technology when we talk about social networks, market platforms, or search engines; what we mean by 'the technology' is the service, and the service feels immaterial. And here, I think, is the rub — and a trap for lawyers in particular. When Ihde says 'material' he does not mean what we mean by a *material fact* or a *material breach*, where material is a synonym for relevant or significant. He means it in the literal, physical sense: matter, something with a body. His is a philosophy of embodied, tangible artefacts that you can pick up and handle, and that physicality is built into the definition. It is precisely this materiality requirement that begins to strain once we reach software and services. His book dates back to 1993, the very early days of the internet and of the shift from atoms to bits (which we discuss in chapter 2), which may explain why the immaterial sits so awkwardly in his account. To be fair to Ihde, he does allow that language can be a technology, which already loosens the materiality requirement he sets himself — so the tension is partly his own, and not merely ours.

A definition of technology by one of the prominent law & tech scholars, Bert-Jaap Koops adopts a very broad understanding of technology.[26] He understand technology as 'the broad range of tools and crafts that people use to change or adapt to their environment'. Gone is the necessity of science, in come tools and crafts. Also different is the focus on the use of technology as a way for everyone to adapt to their environment, and not confined to industrial processes. The focus on people and their tools/crafts is important. It aligns with the earlier remark that technology need to be understood in context (culturally embedded as Ihde called it).

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25. Ibid 47.
26. Bert-Jaap Koops, 'Ten Dimensions of Technology Regulation. Finding Your Bearings in the Research Space of an Emerging Discipline' in Morag Goodwin, Bert-Jaap Koops and Ronald Leenes (eds), *Dimensions of Technology Regulation* (Wolf Legal Publishers 2010).

Another interesting angle on technology can be found in science fiction. As technology features in much Sci-Fi literature, it should not come as a surprise that Sci-Fi authors have ideas about what technology means. Ursula Le Guin, who was critiqued for not having enough technology in her writings, countered the critique by pointing out that

> Technology is the active human interface with the material world.

A short definition, and one I like — though, characteristically for the field, it anchors technology in the *material* world, and so does not obviously stretch to intangibles such as language and law. (Le Guin, of all people, would surely resist that limit: for a novelist, language is the active human interface.) She continues to explain that

> [But] the word is consistently misused to mean only the enormously complex and specialised technologies of the past few decades, supported by massive exploitation both of natural and human resources.
>
> This is not an acceptable use of the word. "Technology" and "hi tech" are not synonymous, and a technology that isn't "hi," isn't necessarily "low" in any meaningful sense.
>
> We have been so desensitized by a hundred and fifty years of ceaselessly expanding technical prowess that we think nothing less complex and showy than a computer or a jet bomber deserves to be called "technology " at all. As if linen were the same thing as flax – as if paper, ink, wheels, knives, clocks, chairs, aspirin pills, were natural objects, born with us like our teeth and fingers – as if steel saucepans with copper bottoms and fleece vests spun from recycled glass grew on trees, and we just picked them when they were ripe...
>
> One way to illustrate that most technologies are, in fact, pretty "hi," is to ask yourself of any manmade object, Do I know how to make one?
>
> Anybody who ever lighted a fire without matches has probably gained some proper respect for "low" or "primitive" or "simple" technologies; anybody who ever lighted a fire with matches should have the wits to respect that notable hi-tech invention.[27]

27. Ursula K. Le Guin, 'A Rant About "Technology"', 2004, https://www.ursulakleguin.com/a-rant-about-technology accessed 22 July 2026. This is mentioned in James Bridle, *Ways of Being - Animals, Plants, Machines: The Search for a Planetary Intelligence* (Allen Lane 2022).

Moving on, we come across another distinction that can help us understand technologies better. Peter Kroes in his article on Philosophy of Technology in Routledge's encyclopedia of philosophy states that Philosophers of technology worry away at several such distinctions — is an artefact categorically different from a natural object, is technology merely applied science? — but the one that earns its place here is the question of technology's autonomy: does technology follow its own inevitable course, regardless of the social, political and economic setting it lands in? If it does, regulating it is largely futile. If it does not, that setting is precisely where regulation gets its grip. It is a question worth holding onto.[28]

The distinction between natural objects and artefacts is notable. This raises the question where we should place the 'stick as club' that Don Ihde talks about? Is that a natural object (it is when it is still on the ground), or an artefact (if our inventive warrior breaks of unnecessary branches and repurposes the branch to a (stick)weapon). Probably we need not worry too much about this question in view of the purposes of this book as we are almost definitely (only) interested in the technoscience kind of artefacts. Nevertheless, it is useful to keep the distinction natural object and artefact in mind to determine whether some phenomenon is (a) technology.

A final topic related to trying to define technologies that I want to bring to the table is that of direction or purpose. Above we have seen that technologies as tools to adapt to our environments is present in some treatises about technology. Klang goes a bit further. He considers technology as "both the purposeful activity and results of the transformation or manipulation of natural resources and environments in order to satisfy human needs or goals". This is interesting because human needs and goals seem to be ever shifting, and hence technologies will move with them. If we call the needs and goals moving forward (towards a better world), then this implies technologies progress as well. Whether that is the case will be questioned throughout the book as the regulatory knee jerk typically signifies that the technology at stake may not be seen as something good by definition. But in any case, I think we can subscribe to Langdon Winner's remark that 'technology goes where it has never

28. Peter Kroes, 'Philosophy of Technology', Routledge's Encyclopedia of Philosophy. Doi:10.4324/9780415249126-Q103-1

been'. It proceeds steadily from what it has already transformed and used up towards that which is still untouched.[29]

What we can take from this detailed exploration of technology is that **technology** relates to artefacts (created usually incorporating scientific knowledge and) used by people to adapt to or change their environment and that it may pertain to things usually not seen as technology, such as language and law.

1.3.2 Disruptive Technologies

Winner teaches us that technologies move into the new. Does that make technologies disruptive per se? No, it does not. We can distinguish between '**sustaining innovations**' and '**disruptive innovations**'.[30] The former are innovations that improve the performance of established products on dimensions that mainstream customers in the main markets have historically valued. It marks gradual improvement. Disruptive technologies follow another path. They generally do poorly at their introduction because they bring something entirely new. They offer a very different value proposition and people need to get used to the new features/functions. In some cases they have never seen such things before. Oftentimes, disruptive technologies are brought into the market in an immature form to try and quickly win the market or in any case obtain a competitive lead on competitors. Disruptive technologies only gain market power after some time (and iterations). The iPad (and later other tablets) is an example of such a disruptive innovation.

What further distinguishes **disruptive technologies**, or better yet, socially disruptive technologies, those that affects the social arrangements around which we build our lives, as they are increasingly called. A disruptive technology rarely just swaps one device for another. What it really unseats is the whole social world built around the thing it replaces. The printing press displaced the scriptorium — and with it the scribe. Railways finished the canals, and not merely the barge pilot: the bargeman, the lock keeper, the canal owner, the canal-side innkeeper, the barge builder, the waterway engineer and the horse trade that towed the barges all went under with them. Unseat a technology and you unseat an entire ecosystem.

29. Langdon Winner, *The Whale and the Reactor* (University of Chicago Press 1986) 174.
30. Christensen C, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Harvard Business Review Press 1997).

None of this is only of historical interest; the process never stops. Digital cameras killed film, flash drives retired the floppy disk, DVDs buried the video cassette — and have since been buried themselves (when did you last see a DVD player, never mind a VHS recorder?). Every such shift opens new possibilities for communication and control as well as bringing disruption, and each time people rebuild their routines and their unwritten codes of conduct around whatever has just moved in.[31]

It is not difficult to spot examples of these technologies in our everyday lives. Think of generative artificial intelligence (genAI), robotics, synthetic biology, nanomedicine, next-generation genomics, neurotechnology and geo-engineering. As Brey et al write:

> These are **socially disruptive technologies** (SDTs) that have the potential to radically alter everyday life, cultural practices and social and economic institutions. Societal disruption may well be necessary and desirable for responding to pressing global problems such as climate change and depletion of natural resources. But the technologies also raise tough moral questions that are in need of ethical evaluation. A complication is they may affect the basic concepts and values that we normally appeal to in our ethical thinking, such as the distinction between nature and artifact or our conceptions of freedom and responsibility. A reflective turn in the ethics of technology is therefore necessary.[32]

It should not come as a surprise that these disruptive technologies are (therefore) the ones that cause regulators (not only the state, but any entity with power) to react and hence they are totally within the realm of this book.

Something that disruptive technologies have in common is that their development and hence effects are to a large extent unknown when they really appear on the radar. This is a reason why they are commonly grouped under the heading emerging technologies.

1.3.3 Emerging technologies

Rotolo et al. delineate **emerging technologies** as having five key attributes that are important to remember:

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31. Mathias Klang, *Disruptive Technology Effects of Technology Regulation on Democracy* (2006 Gothenburg Studies in Informatics, Report 36) 8.
32. Quote stems from a grant application by Philip Brey and others.

> These are: (i) radical novelty, (ii) relatively fast growth, (iii) coherence, (iv) prominent impact, and (v) uncertainty and ambiguity. Specifically, we conceive of an emerging technology as a radically novel and relatively fast growing technology characterised by a certain degree of coherence persisting over time and with the potential to exert a considerable impact on the socio-economic domain(s) which is observed in terms of the composition of actors, institutions and patterns of interactions among those, along with the associated knowledge production processes. Its most prominent impact, however, lies in the future and so in the emergence phase is still somewhat uncertain and ambiguous.[33]

This means that a technology that is *emerging* at one point may stop to be emerging (and become established) later in time. This also means that any list of emerging technologies will change over time.

For a while, a set of 5 technologies were considered emerging: Nanotechnology, biotechnology, robotics, information and communication technology (ICTs), and applied cognitive science (**NBRIC**[34]). And indeed, when nanotechnologies surfaced in the early 2000s, a lot of academic attention went into this novel field of research and application that was marred with uncertainties. Products were marketed as including nanoparticles and a serious hype was created. Nowadays, although nano-particles are probably (still) prominently present in the same products (sunscreens for instance), they are no longer marketed as nano-products, although in the EU the suffix (nano) has to be affixed to substance on the label if it is present in nano form.[35]

Nanotechnology is a merger of a multitude of sciences that have in common that they all study phenomena on the nanometre scale (the scale of 1 to 100 billionth of a metre). This is the scale of individual atoms. A human hair, to make things a little bit more tangible, is about 80,000 nanometres thick.

33. Daniele Rotolo, Diana Hicks and Ben R Martin, 'What Is an Emerging Technology?' (2015) 44 Research Policy 1827.
34. See for instance Allenby (n 11) 8–11.
35. My toothpaste at the time of writing contains titanium dioxide, while our sunscreen (SPF 30) contains titanium dioxide (nano). In the former it functions as a whitener of the paste, in the latter as a transparent UV blocker.

Koops and colleagues explained, back in 2008, why this particular scale is worth building a science around.[36] Below roughly 50 nanometres the rules change: classical physics gives way to quantum effects, and materials stop behaving like their bulkier selves. Titanium dioxide, white in the bottle, turns translucent at nanoscale while keeping its knack for blocking UV — which is precisely why it ends up in your sunscreen. Shrink a material and its surface area balloons relative to its mass, so nanoparticles are also far more reactive, and far less of them is needed to set a reaction going. From here the story runs quickly into science fiction: *assemblers*, or nanorobots, that build objects atom by atom from a program, and self-replicating factories feeding on carbon and oxygen — the stuff of Michael Crichton's *Prey* and the "grey goo" nightmare in which the machines consume the planet. We are not there, and won't be for decades, if ever. But nature has been running nano-assemblers all along: DNA, RNA and enzymes are exactly that — and, as we are about to see, it is on the RNA front that the science fiction came closest to catching up.

More than a decade later much of what was written here is still science fiction, although we should acknowledge that large strides have been made on the RNA front. The COVID-19 vaccines were designed (and partially manufactured) on the nano scale. When introduced into human tissue, the vaccine contains either self-replicating RNA or messenger RNA (mRNA), which both cause cells to express the SARS-CoV-2 spike protein. This teaches the body how to identify and destroy the corresponding pathogen (SARS-CoV-2 in this case).

The COVID vaccine example shows not only strong advances in nanotechnology, but also how this technology is intertwined with biotechnology and information and communication technologies.

Biotechnology builds on the natural sciences (biology in particular) and the engineering sciences to achieve the application of organisms, cells, parts thereof and molecular analogues for products and services. Farmers have relied on breeding programs using artificial selection and hybridization (combining the qualities of two organisms of different breeds, varieties etc, through sexual reproduction) to achieve offspring with better

36. Bert-Jaap Koops, Ronald Leenes, Rachel Marbus, Kees Stuurman and Jonathan Verschuuren, *On Small Particles and Old Articles - An Exploration of Legal and Regulatory Issues of Nanotechnologies* (November 13, 2008). TILT Law & Technology Working Paper No. 009/2008, https://ssrn.com/abstract=1300925 accessed 23 July 2026.

qualities than the source material for ages. The results of these efforts have given us tulips like the *Black tulip*, created by cross-breeding Queen of the Night and Wienerwald tulips, a process that took Gert Hageman seven years.[37] Modern biotechnology works directly on the molecular level and uses techniques such as genetic engineering and cell and tissue culture technologies. Increasingly, the design of the desired genes is done using bioinformatics to explore, extract, exploit and produce material from any living organism for any kind of (organic) product. AI and data science are used to understand biological systems and relationships and simulate and predict the functioning and effects of (artificially) produced biological material[38] in the subdomain called computational biotechnology.

The vaccines (in any case those of Pfizer and Moderna) are developed not in the wet-lab (with chemicals and test-tubes), but rather behind a computer screen. As Bert Hubert writes on his fascinating story about reverse-engineering the source code of the BioNTech/Pfizer SARS-CoV-2 vaccine:

> The BNT162b2 mRNA vaccine has this digital code at its heart. It is 4284 characters long, so it would fit in a bunch of tweets. At the very beginning of the vaccine production process, someone uploaded this code to a DNA printer (yes), which then converted the bytes on disk to actual DNA molecules. Out of such a machine come tiny amounts of DNA, which after a lot of biological and chemical processing end up as RNA (more about which later) in the vaccine vial. A 30 microgram dose turns out to actually contain 30 micrograms of RNA. In addition, there is a clever lipid (fatty) packaging system that gets the mRNA into our cells.[39]

37. https://www.upi.com/Archives/1986/02/20/Worlds-first-black-tulip-grown-in-Holland/4964509259600/ accessed 10 July 2026.
38. One of the big challenges in biotechnology is to predict how proteins will fold. The folding of proteins to a large extent determines their function in the cell. The proteins requires a specific three-dimensional structure to function. As proteins can be thousands of molecules long, predicting how it will fold is non-trivial. DeepMind's AlphaFold is one of the promising projects in this space. See https://alphafoldserver.com/welcome accessed 23 July 2026.
39. Bert Hubert, 'Reverse Engineering the Source Code of the BioNTech/Pfizer SARS-CoV-2 Vaccine' (Berthub.eu, 25 December 2020) https://berthub.eu/articles/posts/reverse-engineering-source-code-of-the-biontech-pfizer-vaccine/ accessed 23 July 2026. A copy of the original WHO document (the source of the sequence quoted) can be found here https://www.coursehero.com/file/131651782/WHO-pfizer-sequence-11889pdf/ accessed 23 July 2026.

The digital code that he mentions looks like this (the first 500 base pairs)

Sequence / Séquence / Secuencia

GAGAAΨAAAC ΨAGΨAΨΨCΨΨ CΨGGΨCCCCA CAGACΨCAGA GAGAACCCGC 50
CACCAΨGΨΨC GΨGΨΨCCΨGG ΨGCΨGCΨGCC ΨCΨGGΨGΨCC AGCCAGΨGΨG 100
ΨGAACCΨGAC CACCAGAACA CAGCΨGCCΨC CAGCCΨACAC CAACAGCΨΨΨ 150
ACCAGAGGCG ΨGΨACΨACCC CGACAAGGΨG ΨΨCAGAΨCCA GCGΨGCΨGCA 200
CΨCΨACCCAG GACCΨGΨΨCC ΨGCCΨΨΨCΨΨ CAGCAACGΨG ACCΨGGΨΨCC 250
ACGCCAΨCCA CGΨGΨCCGGC ACCAAΨGGCA CCAAGAGAΨΨ CGACAACCCC 300
GΨGCΨGCCCΨ ΨCAACGACGG GGΨGΨACΨΨΨ GCCAGCACCG AGAAGΨCCAA 350
CAΨCAΨCAGA GGCΨGGAΨCΨ ΨCGGCACCAC ACΨGGACAGC AAGACCCAGA 400
GCCΨGCΨGAΨ CGΨGAACAAC GCCACCAACG ΨGGΨCAΨCAA AGΨGΨGCGAG 450
ΨΨCCAGΨΨCΨ GCAACGACCC CΨΨCCΨGGGC GΨCΨACΨACC ACAAGAACAA 500

First 500 characters of the BNT162b2 mRNA. Source: WHO

Information and Communication Technologies (**ICT**s) hardly require an introduction. Since the late 1980s we have seen a rapid move from the world of tangible goods to the world of the digital. This move has been termed the transition from *atoms* to *bits* by Nicholas Negroponte.[40] Banks are no longer buildings were we go to store our surplus money (saving) and get money (money withdrawals, loans). Instead they seem to be virtual entities without buildings. By and large we do our banking online. Music is no longer (prominently) distributed on carriers such as Vinyl disks, but we have moved from these to CDs and CD Roms, and later to music on our hard drives and increasingly to audio streaming services.[41] The analog sound represented in the grooves of the Vinyl disk have been replaced by a stream of ones and zeros in digital files.

Since the early 2000s, the internet has become the backbone of our lives and has changed and shaped society in radical ways. We will explore this in much more detail in the next chapter, but I do want to point out at this point that without the internet and ICTs more generally, the COVID pandemic would have been an entirely different thing for many of us. At university (and elsewhere) we had to make the switch from classroom education to online teaching in a matter of days. We managed (quite successfully actually) thanks to applications such as Zoom, Canvas,

40. Nicholas Negroponte, *Being Digital* (Vintage Books 1996).
41. Such as Spotify, Apple Music, Amazon Music and Tidal.

Teams, email, etc. In teaching, and in the working life of many, we quickly experienced that being in the same room is not a necessity for much of what we had thought it essential for. Yes, it came at the detriment of real social interaction, but on the other hand it allowed (working) life to continue without having to commute.

In older lists of emerging technologies, robotics featured as a separate entity. Although (talk of) robots can be traced back to ancient mythologies, the term robot originated from Karel Čapek's play R.U.R. (Rossum's Universal Robots). Since then, robots have inspired many (dystopian) stories and expectations about machines entering society with some form of agency and embodiment. Important to note is that robots are met with different receptions in different cultures. European and American culture by and large envision a sort of dystopian relationship with robots (especially humanoids or androids that look and behave like humans), whereas Japanese, Korean, and Chinese culture seem to take on a more harmonious approach where robots integrate with humans.

For a long time the most prominent robots around were the familiar (yellow) industrial assembly robots, but nowadays, robot 'dogs' (e.g., Boston Dynamics' Spot) and humanoids (e.g., Atlas) are near or even production ready and can we consider autonomous vehicles, surgical robots, and a plethora of other incarnations to the family of robots as well. Defining robots is very difficult. The different types seem to have more of a Wittgensteinian family resemblance (like game, which encompasses activities like card games, board games, ball games, games like ring-a-ring-a-roses.[42] A useful definition of "a robot is a constructed system that displays both physical and mental agency, but is not alive in the biological sense"[43], but as said, it does not cover everything generally considered to be a robot as they exclude softbots, (quasi) autonomous systems in software only.

Autonomous vehicles absorb an enormous amount of attention in science and engineering. Hyped in the mid-2010s, they went through a sobering few years — costs, incidents and one high-profile collapse (GM's Cruise) punctured the earlier optimism. Yet the technology did not stall so much as split: while robotaxis remain nowhere near ubiquitous, operators such

42. Wittgenstein, Philosophical Investigations para 66.
43. Neil Richards & William Smart, (2013). How Should the Law Think About Robots?. SSRN Electronic Journal. 10.2139/ssrn.2263363. accessed 23 July 2026.

as Waymo have crossed from demonstration to genuine commercial service, carrying hundreds of thousands of paying passengers a week across a growing list of (mostly American, mostly grid-planned) cities.[44] Their performance in many situations is extraordinary. But one look at busy traffic in a city like Utrecht or Amsterdam — cyclists and pedestrians appearing from nowhere and vanishing again — shows that cruising the Arizona desert and threading a European cityscape are very different problems.

The final technology in the NBRIC field are **cognitive technologies**. The brain has long been considered impenetrable and hence freedom of thought, although one of the old fundamental human rights, has not been considered a right under siege. That has changed. Human behaviour can be influenced fairly directly with alcohol and drugs (including caffeine), but more recently advances in medicine have brought cognitive enhancers such as Methylphenidate (sold under the brand name of Ritalin) (on label for treating ADHD, off-label for improving concentration), Modafinil for alertness. But also 'reading' brains (or is it minds) is no longer entirely science fiction. fMRI scanners allow showing regions of the brain that are active. This shows, for instance, where and how people respond to auditory cues. Having to solve a math puzzle activates different regions of the brain, than being told to think of something nice (not suggesting that solving math puzzles are not nice). This imaging can also be used to probe whether people tell the truth.[45] And finally, cognitive technologies are used by advertisers to try and influence our behaviour (online and offline (onlife)) through 'dark patterns' and even manipulation (discussed in chapter 9).

Although robots were on the list of emerging technologies around 2010, Artificial Intelligence was not. Skip a decade, and AI is clearly **the** emerging technology. It not only powers the robots mentioned above, but enter all aspects of ICT at the moment. After having conquered what was long considered the pinnacle of human intelligence, chess and Go, we now have entered the era where Chatbots and general purpose AI systems cause both amazement and frowns. As mentioned in the introduction,

44. https://www.forbes.com/sites/alanohnsman/2025/12/10/waymo-targets-1-million-robotaxi-rides-a-week/ accessed 10 July 2026.
45. See Martha J Farah and others, 'Functional MRI-Based Lie Detection: Scientific and Societal Challenges' (2014) 15 Nature Reviews Neuroscience 123.

systems like ChatGPT, Claude, Gemini, are causing radical changes in society to which we will return in the next chapter.

The list of emerging technologies is not stable. Over time new types of technologies are being developed and once they reach a certain scale or capability, calls to classify them as something new arise. One example of such a relatively novel class of technologies is that of the **immersive technologies**. Immersive technologies split into two camps that tell you a good deal about the field as a whole. On one side sit the consumer "worlds", the most conspicuous being Meta's Metaverse — the bet Mark Zuckerberg rated highly enough to rename the company around in 2021.[46] It has been a spectacularly expensive disappointment: Meta's Reality Labs division has burned through tens of billions of dollars, and its flagship social space, Horizon Worlds, stayed so sparsely populated that in early 2026 Meta announced it would pull the app out of VR altogether — only to reverse the decision a day later, after the remaining enthusiasts protested. On the other side are the unglamorous applications that are quietly proving their worth: surgeons rehearsing a difficult operation on a patient-specific 3D reconstruction, pilots and welders training without risk, clinicians delivering exposure therapy for phobias and PTSD. Same underlying technology, wildly different fortunes — turning less on the hardware than on whether anyone actually needed it.

1.3.4 Are technologies neutral?

A final stop in our exploration of technology concerns the question whether technologies are value-neutral or value-laden. This question is one of the central themes in ethics of technology. On one hand of the debate are those that claim that technology is just a neutral means to an end. It is the user of the technology that decides to use the 'tool'

46. Facebook renamed itself Meta in October 2021 to signal its commitment to the metaverse. The consumer payoff never arrived: Reality Labs has posted cumulative operating losses well past USD 70 billion (USD 6.02 billion in the final quarter of 2025 alone), and in March 2026 Meta announced it would remove Horizon Worlds from Quest headsets, only to backtrack within a day after user protest. The idea was not new in any case: the Metaverse strongly recalls Second Life, the virtual world briefly ubiquitous around 2006 https://secondlife.com. On the shutdown-and-reversal, see CNBC, "Meta is shutting down VR social platform Horizon Worlds" (18 March 2026) https://www.cnbc.com/2026/03/18/meta-horizon-worlds-metaverse-vr.html and https://www.cnbc.com/2026/03/19/meta-backtracks-on-decision-to-end-horizon-worlds-vr-ans-spoke-up.html accessed 10 July 2026 and TechCrunch, "Meta decides not to shut down Horizon Worlds on VR after all" (19 March 2026) https://techcrunch.com/2026/03/19/meta-decides-not-to-shut-down-horizon-worlds-on-vr-after-all/ accessed 10 July 2026.

to good or bad use. If technology is approached as just the artefact, ignoring the context of use altogether, this might seem a plausible understanding of the neutrality of technology. However, as we have pointed out a above, technology is being (co)shaped by environment and culture and hence, looking at technology as an artefact in isolation does not seem very realistic. Objects are rarely assessed as just mere objects. Even in a museum that displays artefacts from distant lands, one would approach these in terms of their embedded function and use. Technological artefacts, (almost) by definition have certain functions.[47] They can be used for these functions and not, or much harder, for other functions. There is a close connection between technological artefacts, functions and goals which makes it difficult to maintain that technology is value-neutral.[48] Goals in their turn have (less/more) good and bad moral valuations. We value saving people, whereas killing people is seen as morally bad. Hence, the claim that 'guns don't kill, people do', seems untenable in view of the analysis in this section. The negative functions of guns outweigh the positive ones, at least in my humble opinion.

1.4 Regulation

Central to this chapter is the call to regulate some new technology. But what do we mean by regulation? We probably all have an intuitive sense of it, yet defining it turns out to be far from trivial: as with many concepts, different disciplines use the word in different ways, and the literature offers a wide range of readings of its scope, source and means. Let us explore those differences and settle on a definition for this book.

Dutch constitutional-law scholars De Jong and Dorbeck define regulation as "the influencing of society through the promulgation of rules".[49] The focus here is on 'official' rules as instruments for changing the behaviour of the populace at large. The definition is indifferent to the source of those rules, though 'promulgation' hints at some authority — and hence the state. Selznick is more explicit about source and process: regulation is

47. Although technologies have intended functions, they also have side-effects or unintended uses that may have significant effects for the topic of this book. We will return to this topic in section 3.4 when we take a look at SMS messages and at affordances.
48. Stanford Encyclopedia of Philosophy 3.3.1
49. "het beïnvloeden van de samenleving door het stellen van regels", HM de Jong and BR Dorbeck-Jung, Juridische Staatsleer, 1997.

the "sustained and focused control exercised by a public agency, on the basis of a legislative mandate, over activities that are generally regarded as desirable to society".[50] He leaves out the how (rules) but is specific about the *who* (a public agency).

Baldwin and Cave go broader, dropping both the requirement of public control and the alignment with social goals: regulation is "all forms of social control, state and non-state, intended and unintended".[51] Their focus is on the what (social control). The word 'unintended' is intriguing, because it severs regulation from conscious action: on this view any impact on society counts — about as broad as it gets. Koops likewise treats regulation as an activity, setting the actor aside and stressing the *what* and *how*: "[r]egulation is controlling human or social behaviour by rules or restrictions".[52]

Clearly, scholars vary widely in what they count as regulation. To bring some order, let us group these theories. Andrew Murray offers a convenient division into three types that between them cover all the definitions above. Regulation is:

- the presentation of rules and their subsequent enforcement, usually by the state;
- any form of state intervention in the economic activity of social actors; or
- any form of social control, whether or not initiated by a central actor such as the state, and whether or not the acts are intended to be regulatory.[53]

Regulation can be seen as a process (an activity) or as a product. Seen as a product, it may even be the result of unintended effects — as when a pothole ends up limiting the average speed on a stretch of road and so, inadvertently, regulates traffic.

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50. P. Selznick, 'Focusing Organizational Research on Regulation' in RG Noll (ed), *Regulatory Policy and the Social Sciences* (University of California Press 1985).
51. Robert Baldwin, Martin Cave and Martin Lodge, *Understanding Regulation: Theory, Strategy, and Practice* (Oxford University Press 1999) 91.
52. BJ Koops and others, *Starting Points for ICT Regulations; Deconstructing Prevalent Policy One-Liners*, (TMC Asser 2006) 81.
53. Andrew Murray, *The Regulation of Cyberspace: Control in the Online Environment* (Routledge-Cavendish 2007) 22, n 2.

A second notable difference between the definitions concerns the nature of the regulator. Some scholars confine regulation to state intervention; others count any actor or institution capable of steering human behaviour. On the first view, measures introduced by the market, such as the region codes built into DVD players[54], are by definition not regulation; on the second, they are.

Selznick's state-centric view (regulation by a public agency) drew the attention of regulation scholars,[55] partly because the privatisation of utilities in the 1970s and 1980s, and their subsequent oversight by independent regulatory agencies,[56] brought a significant share of social activity under the control of non-state actors. Julia Black is among the leading scholars of these non-state, '**decentred**' approaches. In her 2001 Decentring Regulation she defines it as "a process involving the sustained and focused attempt to alter the behavior of others according to defined standards or purposes with the intention of producing a broadly defined outcome or outcomes".[57]

Karen Yeung reads two things into Black's move. It broadens Selznick by pulling non-state actors into the frame — but it also, quietly, narrows him. Selznick fixed on the *subject* of regulation ("activities valued by the community"); Black fixes instead on the regulator's *purpose*, the attempt to change how others behave.[58] The shift matters. It lets in any design that nudges behaviour — a speed hump, or, at the darker end, the chemical castration of sex offenders — while leaving out measures that merely reduce harm without trying to change anyone: the airbag, shatter-proof glass, fluoride in the water.[59]

Yeung then worries that even this is too generous. Taken at its word, Black's definition would count a parent coaxing a child to eat more vegetables, or a company's marketing department, as regulation — power exercised over others, certainly, but not what anyone in the field means by

54. A topic that we will treat in chapter 9 (section 9.3.7).
55. Another name of the field one may come across is regulatory governance studies.
56. Such as Ofwat (the Water Services Regulation Authority) in the UK.
57. Julia Black, 'Decentring Regulation: Understanding the Role of Regulation and Self-Regulation in a "Post- Regulatory" World' (2001) 54(1) Current Legal Problems 103.
58. See section 9.3.7.
59. Karen Yeung, 'Are Human Biomedical Interventions Legitimate Regulatory Policy Instruments?, in Roger Brownsword, Eloise Scotford, and Karen Yeung (eds), *The Oxford Handbook of Law, Regulation and Technology*, (Oxford University Press 2016) 828.

the term. Black herself later tightened it, adding that regulation addresses a collective problem, usually through rules plus some means of enforcement.[60] Pin regulation to deliberate attempts to change behaviour in order to settle a collective concern, and you capture what the accountability-and-legitimacy debates are actually about.

Because regulation, so defined, reaches many people at once, its legitimacy is a serious question — one we return to at length in chapter 10. For now the upshot is simple enough: regulatory activities are those intentionally undertaken by state and non-state actors to address a collective problem, directed at a sphere of social activity, according to standards or purposes that affect others. That gives us our working definition:

> **Regulation** is the "sustained and focused attempts intended to produce a broadly defined outcome or outcomes directed at a sphere of social activity according to defined standards or purposes that affects others in order to address a collective concern or problem."[61]

Note that this definition specifies neither who regulates nor how. It lets both state and non-state actors count as regulators, which opens the floor to a host of non-traditional ones — and, as we will see, the big technology companies (Google, Meta, and the like) are among the most influential regulators of all, with all the questions that raises about the legitimacy of what they do.

This analysis stems from Karen Yeung's work on design-based regulatory instruments, which implies there is more under the regulatory sun than text — that is, than law. In the Law & Technology tradition, law is only one regulatory instrument among several. Lawyers have long recognised that social norms and the market also shape behaviour; more recently, so do architecture, design and code[62] (software and hardware). Social norms are shared opinions about appropriate behaviour that people act on. Smoking, for instance, was relatively unproblematic in the 1950s and 60s (and still is in parts of the world), but has since acquired a stigma as unhealthy and antisocial, so that people now refrain not only in regulated spaces (shops, bars, restaurants, stations) but in private ones too. The market regulates through price: for many goods, a rise

60. Ibid 835.
61. Ibid 836.
62. Lawrence Lessig, *Code and Other Laws of Cyberspace* (Basic Books 1999).

in price lowers the propensity to consume and pushes people towards alternatives (price elasticity). Code regulates through the design of the environment: in physical space, parking bollards keep cars off the pavement and ticket gates keep the ticketless out of the metro (as in some Brussels stations); online, content-moderation systems filter out offensive or illegal material. These are all purposive design choices that shape behaviour. Architecture, as we will see in chapter 9, is a powerful regulator indeed. Chapter 9 will take us even further and not stop at 4 modalities of regulation, but rather bring it up to 8.

Note, finally, that 'law' and 'regulation' mean different things in different contexts. Law & Technology scholars think in terms of this toolbox — law, social norms, market and architecture — in which law is one instrument among four, often underpinning the other three and working in tandem with them. Many 'traditional' legal scholars, by contrast, treat regulation as a product within law, a type of law — an understanding that fits the EU instruments neatly, where Regulations sit alongside Directives and Communications. So be aware: in conversation, your interlocutor may mean something quite different by 'regulation' than you do. Neither is right or wrong; they are simply different perspectives.

There is as much disagreement about the meaning of 'law' as about 'regulation' (and 'technology'). For this book we adopt the working definition from the Oxford Handbook of Regulation: "For 'law', we suggested a fairly conventional, state-centric understanding, that is, law as authoritative rules backed by coercive force, exercised at the national level by a legitimately constituted (democratic) nation-state, and constituted in the supranational context by binding commitments voluntarily entered into between sovereign states (typified by public international law)."[63]

1.5 A model of sociotechnical change

In the introduction, I referred to Bennett Moses' observation about how legal scholars address technology inspired issues.[64] She, on the one hand acknowledged the usefulness of the limited focus in these writings, as well as pointed out that a broader more general perspective has a lot

63. Brownsword and others (n 59) 6.
64. Bennett Moses (n 8) 574.

to offer to addressing the challenges of designing regulatory regimes in the face of ongoing sociotechnical[65] change.

Given that we are dealing with a complex field, combining the complex topics of law, regulation and technology, some guidance in the form of an analytical model might help us navigate this space. I have named this model, the TechReg model. It will serve as a backbone to our exploration of technology regulation in all its facets in the remainder of the book. We will drill down into parts of the model in the various chapters (as depicted by the numbers) to deepen our understanding, while maintaining the overall model as our beacon.

The core of the model is depicted in figure 1.1.

The basic tenet of the model is that we have some trigger that starts us on the quest whether regulatory intervention is required, and if so, how, when, by whom etc. '[T]echnology qua technology is unimportant in justifying regulation, the tendency of technology to evolve is crucial in justifying legal and regulatory change'.[66] The appearance of a new technology, or (disruptive) technological innovation thus will usually be a trigger for our journey. We have seen a number of examples of this already, autonomous vehicles leave the lab and people start seeing (legal) issues (e.g., aren't cars supposed to have a (human) driver on the basis of art 8 Vienna Convention? What about accidents, who is liable for a computer on wheels crashing into people?). Or, Stable Diffusion produces great 'art', but what about the scraping of images as input to these works? It may also be that harm or risk is at the forefront, although that seems rarer (there has to be some change in the sociotechnical context prior to the harm or risk).

It is easy to see why technology gets cast as the villain. The headline harms — nuclear detonations, the unravelling of the Earth's ecological balance, tampering with human nature itself — all wear technology's fingerprints. And because some of that damage is irreversible, and not only physical, we do reach for regulation to head it off: the ban on human reproductive cloning, the treaty regimes that police particular classes of weapon. Technology does harm on a humbler scale too — the factory that fouls the local air, the plant that fills a street with noise — and there

65. A note on spelling. Socio-technical and sociotechnical refer to the same thing and both are accepted spelling.
66. Bennett Moses (n 8) 577.

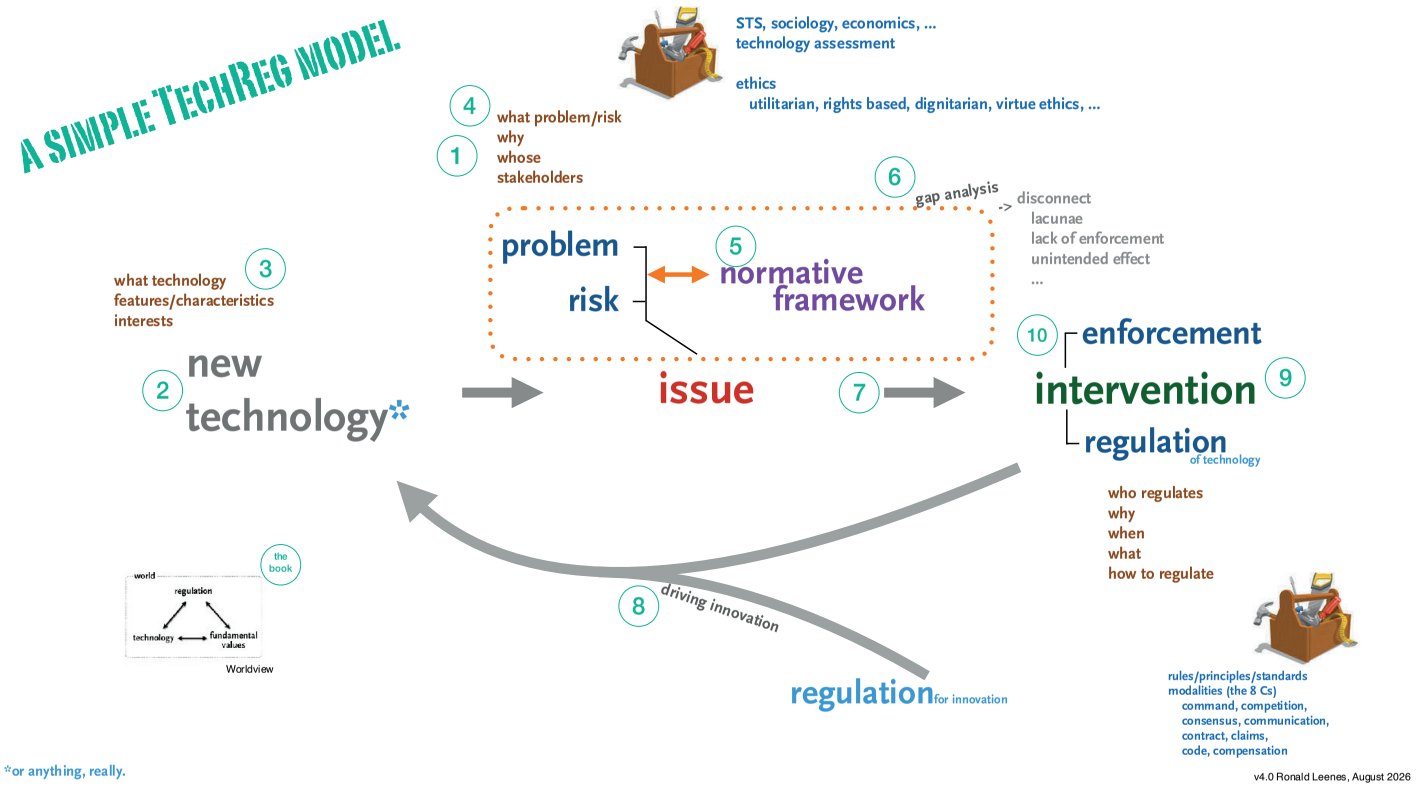

Figure 1.1. The TechReg model of regulating emerging technologies

we regulate as well, restricting what may be made, where, in what quantity and by whom. So yes: technology's capacity to cause harm, or to trample rights, can be a perfectly good reason to regulate.

But notice what is actually doing the work. The point is not that we cannot regulate when technology threatens rights — plainly we can. It is that we would want to regulate harmful behaviour just the same when no technology is involved at all. Individual violence, a spreading virus, the methane rising off the world's cattle herds and warming the planet: none of these is "technology", and every one invites a regulatory response. The test is the potential for harm, not the presence of a machine. And since technology is not the only source of harm, does not always cause it, and can even reduce it — think of vaccination — "there is technology here" is the wrong trigger to reach for. Technological and non-technological harms alike can ground a case for regulation: harm is the rationale, not the technology.[67]

There are thus two important things to keep in mind. One, not all harm is technological, and two understanding the role of technology in a particular context might be important to understand how to cope with the harm (or similarly to risk). The first implies, that although our model contains (new) technology as an element, this might be replaced by other terms, like social-change, sociotechnical change, (new) phenomenon or others. The essence is that the status quo is affected by some change in society that gives rise to an 'issue'. Hence, the model is much more generic than just a TechReg model. The second (implicit) inference implies that we need to understand the sociotechnical *context i*n order to understand the sociotechnical *change* and the effects it creates, such as risk or harm.

Analytically, it thus makes sense to start our exploration at gaining understanding of the sociotechnical context featuring our 'new technology'. This does not mean that we fully need to understand the details of the technology, but we need to be able to describe the relevant characteristics of the technology and its context of use. We need to answer questions such as: what is the (intended) function of the technology? Who are its intended users? Who is driving the technology? What are their interests/what is their business model? We will address the analysis of the technology in chapter 3, although we will discover there that determining what is relevant of a particular technology in part depends

67. Ibid 580.

on the issues we already have in mind caused by the technology. This will be explored in chapters 2 and 3.

We will then focus on the purported issue(s). This exploration was started already in chapter 3, but will continue in chapters 4 and 5. Typically these issues concern harm, either directly or indirectly, or risks to rights or freedoms of individuals. These latter should be taken very broadly, and may include health, social care, privacy, the environment and others. An example of direct harm would be local noise or air pollution as a result of a new type of combustion-engine-powered skateboard. An example of indirect harm could be the long term detrimental effects of behavioral advertising and content presentation on autonomy and identity construction. With risks — to rights or freedoms — as a category of potential effects, we enter the domain of risk governance: in the International Risk Governance Council's phrase, the way societies make collective decisions about technologies and activities whose consequences are uncertain.[68]

Risk, though, behaves much as harm did a moment ago: it is not the private property of technology. Natural activities carry risks to health and safety too, and most of the time it is simply unhelpful to sort risks by whether their origin is technological, social or natural — climate change being the case in point.[69] And, as Bennett Moses notes, risk and harm both arrive trailing a demand for objective measures[70] — which is exactly the crack climate deniers wedge open: "Sure, humans emit CO_2, but how much of the rise is really us? Temperatures have always fluctuated." Objective measures turn out to be less objective than the demand pretends.

One way out is to stop chasing objective harm and look at subjective states instead — anxiety, say. But even there the target moves: it is rarely "technology" as such that people fear, but the uncertainty around a new and untested technology's impact, which inflates our sense of its risk. Either way, a good many questions must be answered before we can say what the "issue" really is.

68. https://irgc.org/risk-governance/what-is-risk-governance/ accessed 10 July 2026.
69. Bennett Moses (n 8) 580.
70. Ibid 580.

This is where framing comes in, in chapter 4: how a problem is drawn largely decides how it gets solved. So the task is to bring every relevant stakeholder into view and to attend to their interests, and to how they actually experience the change. Because the problem, once again, is not that technology always increases risk. It is that technology opens new activities, with new and sometimes unmeasured risks, and reshapes the risk profiles we already had. The problem of technology reduces, as ever, to the problem of sociotechnical change.

The next step involves exploring the relevant regulatory landscape, which we will look at in chapter 6. Technology never develops in a regulatory vacuum. The existing regulation is not always correctly appreciated. Sometimes this is the result of (unconscious) bad framing. If one sticks too much to the current naming of a particular technology, such as e-commerce, one will fail to notice that regulation of old (distance selling) is or might be covering the novelty already. Sometimes an apparent regulatory gap is the result of careful misconstruction of facts in order to influence the regulatory debate (a form of regulatory capture). We have seen some forms of this already (the Uber example). Newcomers and incumbents both have an interest in changing (or maintaining) the regulatory landscape. We need to properly scope out the regulatory landscape before we can decide whether regulatory intervention is needed. Chapter 6 is devoted to this legal gap analysis. The intervention, if there is a regulatory gap or whether the law produces undesirable effects in view of the emerging technology, is usually not dependent on the technology qua technology. It is the sociotechnical change it brings that may warrant intervention. Whether it is justified to intervene will be the focus of chapter 7.

Figure 1.2. Framing the issues and responses

So where does that leave us? Particular technologies, and what they do, certainly bear on whether we regulate. But the bare fact that "technology" is involved justifies nothing. Regulation earns its justification elsewhere — from market failure, from harm to collectively desired rights, from risk, justice, social solidarity, or a wish for democratic control. "There is technology here" is not on the list.

What technology does is provoke the conversation. When something new makes new things or new practices possible, that newness can be a reason to reach for new rules: the new practice may carry new or heightened risks, or open a fresh context in which harm can occur, and its benefits may hinge on how it is used or coordinated. And precisely because it is new, the existing rulebook may require serious interpretation in view of the new technology or has little or nothing to say. Whether to step in — weighing, honestly, the harms and risks of stepping in — is then a question to be argued case by case.

Which is the nub of it. What is really at stake is never technology, nor human ingenuity. It is newness, and the choices that newness forces into the open: to permit, enable, encourage, discourage or prohibit.[71]

Once we have established that intervention in the changing socio-technical landscape is warranted, the question becomes what kind of intervention — and here the book slows down considerably, because this is where most of the real work of technology regulation lies. Before reaching for any particular instrument, it helps to step back and ask what posture a society should take towards innovation in the first place. Do we hold back until a technology has proven itself safe, or let it run and clean up afterwards? Chapter 8 takes this bigger-picture view, laying out the main stances on offer — from the Precautionary Principle at one end to Permissionless Innovation at the other, with Responsible Innovation and the Innovation Principle in between — and weighing what each of them buys us and what it costs. It is, at bottom, the difference between starting from 'may we?' and starting from 'why not?', and a great deal follows from which question a regulator asks first.

With that posture in view, chapter 9 gets practical and asks how one actually regulates. It is tempting to assume that regulating means passing a law, but we have already seen that law is only one instrument in a larger toolbox. Chapter 9 lays that toolbox out: the choice between rules, principles and standards, and the full range of regulatory modalities — command, competition, contract, consensus, communication, code, claims and compensation — each with its own strengths, blind spots and side-effects. Choosing among them, and combining them, is where regulatory design is won or lost. And, as we have noted, the target is rarely the technology itself; more often it is the practice of its designers or the context of its use.

Deciding that we *may* intervene, and how, is still not the whole story. An intervention can be perfectly lawful and neatly designed and still fail — ignored, resented, or quietly worked around. Chapter 10 closes the loop by asking whether an intervention is not only legal but legitimate and, in the end, accepted: whether it was made in the right way, by the right body, with proper accountability, and whether those it binds regard it as worth obeying. This is where the questions of legality, legitimacy and

71. Ibid 584.

acceptance that have hovered over earlier chapters finally come home to roost — and where we take stock of the fact that regulation fails at least as instructively as it succeeds.

Throughout, we can draw on the general regulatory-governance literature, on the large stock of case studies in Law & Technology, and on the growing body of work on 'addressing the challenges of designing regulatory regimes in the face of recent or ongoing sociotechnical change' — Lyria Bennett Moses, Ryan Calo, Roger Brownsword and others. We should also keep in view the option that technology developers least like to hear: that sometimes the regulatory status quo is fine, and it is the world, not the law, that needs to adapt. A significant part of this book is given over to these questions of intervention.

In the sections and chapters that follow, we zoom in on each part of the model in turn, providing foundations, cases, critical questions and tools to help you navigate the space of sociotechnical change.

1.6 Conclusion

We set out to scope the field and lay some foundations, and we did it by way of a few detours — a peninsula, a couple of railroads, a German motorway. If there is one thing to carry away from the trip, it is this: technology is never just technology. It is woven so tightly into how we live that we mostly stop noticing it — the glasses on my nose, the phone in my hand, the AirPods in my ears functioning as hearing aid that keeps me in the conversation. We are, in a modest way, already cyborgs. And precisely because technology disappears into the background, it is easy for lawyers to wave it away as someone else's problem, a mere backdrop to the real business of contract, tort and crime. I have argued the opposite: often enough, a new technology does not merely brush against our legal concepts but forces us to rethink them.

Much of the chapter circled one reflex in particular — the almost automatic call to regulate that greets every new technology. We saw it with self-driving cars, with Uber, with the generative-AI tools now unsettling artists and copyright lawyers alike. The reflex is understandable, but it is worth resisting, or at least slowing down: before reaching for a new rule we ought to understand both the technology and the law we already have,

which is more often up to the job than the newness of the thing suggests. This is the task of the law & technology scholar.

To make sense of any of this we cannot look at the artefact alone. The locomotive mattered not as a barrel on wheels but as the thing that rewired trade, standardised time, redrew the map and moved armies; the Model T and the Autobahn did comparable work on the twentieth century. This is what I have called sociotechnical change — technology and society remaking each other — and it is the real subject of this book, not the gadgets as such. Along the way we tried to pin down what we even mean by 'technology' (broader than the shiny and the new: found technologies and technoscience both count), and we noted the field's weakness for whatever is currently Wired over whatever has quietly become indispensable. Disruption, too, is rarely just technical: the printing press did not only replace the scriptorium, it displaced the scribe — and every disruptive technology since has rearranged the social world around it as much as the technical one.

The instrument we reach for to steer that change is regulation — and we spent some time discovering how slippery a word it is. I will settle for treating it as both a product (a set of rules or norms) and an activity (any sustained, focused attempt to change others' behaviour towards some end). On that view regulation is genuinely multidimensional: different regulators (the state, but also industry, NGOs, platforms, even individuals), different modalities (law, the market, social norms, code and others), and different targets (behaviour, design, and more). Crucially, none of this is set off by technology as such. Technology is not the only thing that causes harm or risk — cattle and viruses manage it without any help from engineers — so the presence of 'technology' is never, by itself, a reason to regulate. What earns our attention is the sociotechnical change, and the harms, risks and opportunities it brings.

That is the thread the rest of the book follows, guided by the TechReg model introduced here. Think of it as the backbone of everything that comes next: it sets out the stages of analysis that take us from 'here is a new technology' to a responsible decision about whether, when, how and by whom to intervene. Each chapter ahead drops anchor at one part of the model, and each opens with a map — an island in the technology-regulation archipelago — showing its main concepts and how they connect. Keep those maps to hand; they are there to help you hold your bearings as the water gets deeper.