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A taxonomy for descriptive research in law and technology

Bert-Jaap Koops

1. INTRODUCTION

Law and technology is a field in which many scholars work. Given the number of journals and conferences devoted to studying this field, one could speak of an emerging new discipline, similar to law & economics or law & literature that are now established areas of scholarship. Although the field is often called 'law and technology' (or technology law), it is actually broader than law, since many scholars have a broader focus. The field encompasses different forms of regulation,[1] not only law, but also self-regulation, ethics, social norms, and technology itself as a regulatory instrument. Moreover, it encompasses different types of technologies[2] – ICT, industrial and chemical technologies, biotechnologies, nanotechnologies, neurotechnologies, and the combination of these in so-called 'converging technologies'. Thus, the field of law and technology, or technology regulation (which I am using as a synonym in this paper), is very broad indeed.

As an emerging discipline, law and technology is rather under-theorised. This is not surprising, as the broad range of studies published with different perspectives and using diverse methodologies makes it challenging to develop overarching insights on what technology regulation is and does. To help developing theoretical perspectives on technology regulation, a good starting point is to create a conceptual framework that can serve as common ground.

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[1] In this paper, I use 'regulation' in the sense of the intentional influencing of the behaviour of people; see *infra*, section 2.1.

[2] In this paper, I use 'technology' in the sense of the broad range of tools and crafts that people use to change or adapt to their environment.

Building on earlier work in which I described ten dimensions of technology regulation,[3] my aim in this paper is to sketch a taxonomy of law and technology that can be used for descriptive research into new developments in technology from a regulatory perspective. In a sense, the taxonomy can be used as a method of research, to the extent that it helps identifying, describing, and classifying relevant regulation for a specific technology. It is not a full-blown methodology, but rather a metamethodology or a protomethodology: it provides a way to structure and sketch the existing regulatory field. This can subsequently be used for additional legal or regulatory research, both descriptive and normative. Depending on the type of follow-up research questions that are relevant to ask on the basis of the description of the regulatory field, additional methods can be applied, such as the comparative legal method, normative-doctrinal research, or social-science methods.

Since a taxonomy needs to be fleshed out to show what its concepts entail, I will illustrate the various steps and concepts by applying the taxonomy to a specific technology. I have chosen the field of robotics, in a wide sense of the term: technological applications that perform tasks with a certain level of autonomy. It is a useful field to illustrate the taxonomy, as it comprises many different types, materials, and functions, and covers both the material (mechanical robots), computer (software bots), and life sciences (bio-robotics, brain-computer interfaces).

The paper is structured as follows. After a summary of the ten dimension of technology regulation that are the taxonomy's building blocks (section 1), I describe four steps that can be followed when embarking on technology regulation research. The first step consists of aspects that are potentially relevant for identifying applicable norms (section 2). Once norms have been identified and selected, they can be described, first by looking at the norms themselves in terms of their type and status, which is the second step (section 3). In the third step, to put the norms more in perspective, they can be described in terms of their context and purpose (section 4). Finally, in the fourth step, the norms can be classified according to various distinctions that may be relevant (section 5). Following the consecutive steps of the taxonomy thus al-

[3] B.J. Koops, 'Ten dimensions of technology regulation. Finding your bearings in the research space of an emerging discipline', in M.E.A. Goodwin et al. (eds), *Dimensions of Technology Regulation*, Nijmegen, WLP 2010, pp. 309-324.

lows researchers to identify relevant norms and to make thick descriptions of the norms and regulatory context that (may) apply to a certain technology. This is actually only the starting point for much research, as the description can be used for asking and answering questions, such as whether existing regulation is incomplete or inadequate or why certain norms do or do not apply. As indicated, the taxonomy does not provide an overall methodology for technology regulation research, but only a protomethodology.

2. TEN DIMENSIONS OF TECHNOLOGY REGULATION

In order to get a certain grip on the broad field of law and technology, we can use a conceptualisation in the form of a ten-dimensional space, which I developed in an attempt to create a comprehensive mapping of the field.[4] This provides a bird's eye view of technology regulation.

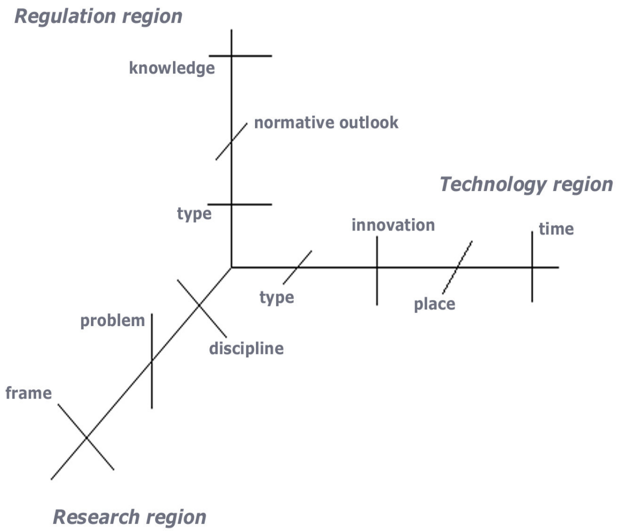

Figure 1. Ten dimensions of technology regulation[5]

[4] *Ibidem*.
[5] Source: *ibidem*.

The ten dimensions consist, briefly put, of the following:[6]

1. **Technology type**: the character (e.g., material, immaterial, life-related, converging) and level of abstraction (the spectrum from concrete application to 'technology'.
2. **Innovation**: the 'newness' of the technology, from 'more-of-the-same', everyday applications to radical innovations that create step changes in social or human practices, qualitatively or quantitatively.
3. **Place**: where the technology is developed, marketed, or used.
4. **Time**: the temporal development cycle of technology, from fundamental to applied science, and from research & development via product development to product marketing and product use.
5. **Regulation type**: the character (e.g., which regulatory modality, actor, manifestation) and level of regulation.
6. **Normative outlook**: the normative assumptions underlying or implicitly feeding technology regulation, e.g., ethical paradigms, fundamental values, or risk attitudes.
7. **Knowledge**: what and how much (or how little) is known about a technology and its effects, about regulatory aspects, or about an instance of technology regulation.
8. **Discipline**: the academic discipline(s) that can, should, or will be used to study an issue in technology regulation.
9. **Problem**: what problem is addressed, what kind of problem is this, what is a suitable approach to addressing this problem, and which methods can or should be used for that?
10. **Frame**: (usually implicit) frames of reference that define the 'window' through which an issue in technology regulation is perceived or studied, which function as constraints on the room for study or action.

Each of these dimensions entails its own concepts, distinctions, and issues. For the purposes of this paper, I have used this multi-dimensional map of technology regulation research to select and order the concepts and distinctions into a taxonomy for identifying and describing norms that are relevant for researching a specific technology regulation issue.

[6] See *ibidem*, pp. 312-320.

3. FIRST-ORDER ASPECTS: IDENTIFYING NORMS

3.1. *The regulatory tool-box*

Regulation is 'the sustained and focused attempt to alter the behaviour of others according to standards or goals with the intention of producing a broadly identified outcome or outcomes, which may involve mechanisms of standard-setting, information-gathering and behaviour-modification'.[7] Put more succinctly, regulation is the intentional influencing of the behaviour of people (or other entities with a legal status). Law is the most obvious example of this, but behaviour is also influenced by other intentionally used mechanisms. The regulatory tool-box thus consists of several tools. Lessig identifies:

- law;
- social norms;
- market;
- architecture (i.e., technology as a regulatory tool).[8]

Other classifications of the tool-box are broadly similar but have different nuances. Christopher Hood identifies four tools of government: nodality (the property of being in the middle of an information or social network), authority (the possession of legal or official power), treasure (the possession of a stock of moneys or 'fungible chattels'); and organisation (the possession of a stock of people with whatever skills they may have (soldiers, workers, bureaucrats), land, buildings, materials, computers and equipment, somehow arranged).[9] Morgan and Yeung distinguish five classes of regulatory instruments: command, competition, communication, consensus, and code (i.e., technology as a regulatory tool).[10]

As with Lessig, law can play a role in each of these instruments either in a direct way (as in command-based tools) or as a facilitator (as in creating a basis or framework for competition or consensus).

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[7] J. Black, 'What is Regulatory Innovation?', in J. Black, M. Lodge and M. Thatcher (eds), *Regulatory Innovation*, Cheltenham, Edward Elgar., 2005, pp. 1-15 at p. 11.

[8] L. Lessig, 'The Law of the Horse: What Cyberlaw Might Teach', *Harvard Law Review* Vol. 113, 1999, pp. 501-546.

[9] As formulated in Ch. Hood and H. Margetts (2007), *The Tools of Government in the Digital Age*, 2nd edition, Palgrave Macmillan, pp. 5-6.

[10] B. Morgan and K. Yeung, *An Introduction to Law and Regulation – Text and Materials*, Cambridge, Cambridge University Press, 2007, pp. 80-105.

Within the deployment of these regulatory tools, regulatory theory in the past decades has stressed the importance of new or innovative approaches to regulation, termed for example 'smart regulation' or 'responsive regulation' or 'passive regulation', which rely more on 'soft law' or self- and co-regulation and participatory governance, as opposed to traditional approaches (often deemed 'old' or 'unsmart') that rely on 'hard law' or command-and-control legislation and enforcement.[11] This element will be developed further in section 3 on the type and status of norms.

For robotics regulation, law is obviously a relevant regulatory instrument, but norms can also be found in the combination of law, social norms, and market in the form of self-regulation or soft-law, such as codes of conduct or technical standards. Besides legal and self-regulatory rules and standards, it should not be overlooked that social norms, which develop gradually over time together with technologies in a process of mutual shaping,[12] are relevant for robotics regulation, particularly for emerging robotics applications such as in biorobotics and brain/computer interfaces. These developments may affect our collective imagination and trigger the need to reconsider whether a clear distinction between ('natural') humans, other biological organisms, artificially enhanced humans, and 'non-humans' (artefacts, robotic devices, synthetic substances, etc.) can be maintained. Borders between human beings ('natural persons'), extended bodies, synthetic bodies, and non-human but 'intelligent' entities may gradually blur, which will affect the perception and interpretation of existing (legal or soft) norms based on old categories and distinctions.

3.2. *Level of regulation and selection of jurisdictions*

In a world of multi-level governance,[13] regulation can be initiated at different levels, often in combination:

- international, e.g., United Nations, OECD, WTO, ISO;

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[11] Cf. R. Brownsword, *Rights, regulation, and the technological revolution*, Oxford/ New York, Oxford University Press, 2008, pp. 12-13; A. Freiberg, 'Re-Stocking the Regulatory Tool-Kit', *Jerusalem Papers in Regulation & Governance,* 2010, Working Paper No. 15.

[12] W.E. Bijker and J. Law, *Shaping technology/building society: studies in sociotechnical change*, Cambridge, MA, MIT Press, 1992.

[13] L. Hooghe and G. Marks, 'Unraveling the Central State, but How? Types of Multi-level Governance', *American Political Science Review,* Vol. 97 No. 2, 2003, pp. 233-43.

- supranational, e.g., European Union, ASEAN;
- national, e.g., Germany, Canada, Japan;
- sub-national (in a federated state), e.g., Vlaanderen, Bayern, Ontario, California.

All of these levels are relevant when studying robotics regulation, although for the more innovative type of robotics, it is unlikely that specific norms will be found at the sub-national level. At the inter/supranational level, possibly relevant organisations for robotics regulation are the United Nations, the World Health Organisation, the World Intellectual Property Organisation, ISO, OECD, and the European Union. Particularly in multi-level regulatory regimes such as the EU, an important question is which legal grounds exist for intervention at the supranational level and for harmonizing national legislation (or for providing common patterns of interpretation). At the national level, it could be most interesting to look at countries that are frontrunners or early adapters in (different types of) robotics, such as Japan, China, the United States, the United Kingdom, Germany, and Italy. At the sub-national level, some US states are starting to regulate new robotics applications, such as autonomous vehicles, which can be interesting, for example for comparative legal research.

3.3. *Legal areas and application sectors*

Law is divided in many sub-fields, each of which has its own traditions, structure, and concepts. Which legal areas are relevant will depend to a large extent on the technology, the application area, and the perspective from which the technology is being studied.

Almost all legal fields may have a bearing on robotics. Potentially relevant legal areas include the following:

- constitutional law;
- public international law (including international humanitarian law);
- public law;
- criminal law;
- administrative law;
- environmental law;
- traffic law;
- contract law;
- tort law;

– intellectual-property law;
– private international law;
– labour law;
– disability law;
– health law.

Most of these areas, at least the broad, standard areas of law (public, criminal, administrative, private law) have two sub-fields:

– substantive law (containing substantive rules);
– procedural law (containing rules on how law-making and legal disputes are dealt with).

Some legal areas are relevant for almost all spheres of social life.[14] Other legal areas are associated more specifically with certain spheres or sectors of society. For the robotics field, several application sectors can be distinguished and relate to areas of the law:

– defence, military ~ public international law (especially humanitarian law);
– intelligence, national security ~ public law;
– police, surveillance ~ criminal law;
– consumer, business ~ contract law, consumer protection law;
– workplace ~ labour law;
– healthcare ~ health law.

The legal area and the sector in which technological applications are used will often be strongly connected, but it should be borne in mind that this is not an exact 1-to-1 relationship.

3.4. *Types of the technology being regulated*

The legal areas and the sectors listed in the previous section are probably also linked to the types of the technology in question. A first aspect is what material the technology is made of. Robots, for example, can consist of one or more of the following materials:

– physical matter (e.g., steel, plastic);
– chemicals (e.g., polymer husks with chemical loads ("chobots"));
– human tissue (e.g., tissue-engineered organs);

[14] Cf. M. Walzer, *Spheres of justice : a defense of pluralism and equality*, New York, Basic Books, 1983.

- synthetic biology (e.g., synthetically grown implants);
- computer hardware and/or software (e.g., software robots or softbots).

The material used impacts on the regulation that applies. For example, chemicals are regulated in Europe by REACH,[15] and human tissue is regulated by health-sector directives, such as the Directives on medical devices[16]. In contrast, softbots are not regulated as such in terms of the material they are made of.

Another relevant characteristic is the scale of the matter, since matter may have different properties depending on whether it exists in nano form or on a larger scale. For example, surveillance robots may fall under different regimes depending on whether or not they are visible to the human eye. Thus, relevant scale categories are:

- nano scale (i.e., on a scale of up to 100 nanometers);
- larger than nano scale but not visible to the human eye;
- large enough to be visible to human eye.

The material also relates to the resulting object. In robotics, we can basically distinguish three types that may generally trigger quite different legal regimes:

- thing (a 'classic' robot);
- human being (e.g., a woman with a neuro implant or bionic prosthesis);
- software (an intelligent agent).

Another relevant aspect of technology is the sector they are applied in and, related to this, their function (purpose) and consequent functionalities (capacities). In this respect, a possible classification of robots is:

- industrial robots (manufacture; assist automated procedure);
- agricultural robots (harvesting);
- house robots (cleaning; lawn-mowing);
- vehicle robots (self-guiding cars, boats, vehicles);
- street robots (observation; traffic management);

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[15] Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals).

[16] Directive 90/385/EEC on active implantable medical devices, *Official Journal* L189/17, 20.7.1990; Directive 93/42/EEC on medical devices, *Official Journal* L169/1, 12.7.1993; see also Proposal for a Regulation on medical devices, COM(2012) 542 final.

- care robots or ‘carebots’ (care; cure);
- prosthesis (cure; human enhancement);
- companionship robots (pets);
- sex robots (sex);
- drones (surveillance; warfare);
- electronic agent (information management; contract negotiation).

As the function of robots is often closely linked with the sector they are applied in, these categories are also often associated with specific legal areas (see s. 2.3 above). For example, vehicle and street robots may be regulated primarily by traffic law, while cure robots are regulated by health law. It should be borne in mind, however, that robots with a particular function in a particular sector will also usually be regulated by some cross-sector areas of law, such as health & safety regulations and liability law.

4. SECOND-ORDER ASPECTS: THE TYPE AND STATUS OF NORMS

While the first-order aspects enable us to know where to look in order to find rules that regulate robotics, second-order aspects help in identifying the type and status of the rules thus found. Generally speaking, regulatory systems know a hierarchy of norms, ranging from fundamental, inalienable rights to non-binding self-regulatory rules. The type/status of norms can be subdivided in three, inter-related characteristics: bindingness (the legal status of the norm), appearance (the legal form of the norm), and the actor promulgating the norm. Since the status of a norm depends on the legal tradition (e.g., a statutory rule being more important in civil-law countries, while precedent is more important in common-law countries), this is also a relevant aspect to include. Together, these aspects lead to a grouping of norms in roughly the following hierarchical order.

Hier-archy	**Bindingness**	**Appearance**	**Legal tradi-tion**	**Actor**
1a	fundamental rights	constitutional rule		constitutional legislator; treaty organisation
1b	(interpretation)	case-law		(international or consti-tutional) court
2a	interna-tional/supranational rule	treaty provision		inter/supranational body
2b	(interpretation)	case-law		international court, arbi-tration body
3a1	Act of Parliament	statutory rule	*civil law*	(formal national) legisla-tor
3a2	precedent	case-law	*common law*	national court
3a3	(interpretation)	case-law		national or lower court
3b1	lower-order legisla-tive rule	Ministerial De-cree, Regulation		Administration; public executive body; quasi-NGO or 'quango'
3b2	(interpretation)	case-law		national or lower court
4a	contract	contractual term		business (B2B; B2C), health practitioner; con-sumer, patient
4b	General Terms and Conditions	standard clause		(branch organisation; consumer organisation)
4c	(interpretation)	case-law, outcome of al-ternative dispute resolution		national or lower court, arbitration or mediation body
5a	normalisation, standard-setting	standard, guide-line		standard-setting bodies; supervisory authorities
5b	self-regulation	code of conduct, code of practice, compliance seals		industry; NGOs; public-private partnerships

Table 1.Type and status of norms

In an analysis of regulatory provisions, the hierarchy of norms is very important, but it should be borne in mind that rules at different levels interact. In practice, combinations of levels often occur, for example in co-regulation where private actors set standards or codes of conduct, within limits set by framework legislation.

Moreover, the actor promulgating the norm cannot always be simply equated with the formal status of the norm. With the rise of 'smart' and other forms of innovative regulation (*supra*, section 2.1), the extent to which regulatees have been engaged in the regulatory process can be more or less prominent at each level. Although one-way promulgation of rules usually takes the form of statutory rules or precedent, while interactive rule-making is exemplified in self-regulation or soft law, this is not always the case. Statutory rules (e.g., rather technical or technocratic rules on minor issues) can be promulgated in a top-down manner with little parliamentary debate, but they can also result from extensive public consultations, participatory technology assessment, and fundamental parliamentary debates in a representative democracy. Many forms of 'participatory governance'[17] and 'responsive regulation'[18] have been developed to improve the quality, legitimacy, and effectiveness of legal rules by various ways of connecting regulator and regulatees. At the same time, self-regulatory rules or soft law can be developed through much interaction with regulatees, but they can also result from procedures that are rather closed or technocratic without room for stakeholder participation, as may be (but not always is) the case with codes of conduct developed by oligopolistic enterprises, technical norms developed in highly technocratic committees of standard-setting bodies, or rules developed by ethical committees in highly institutionalised political-scientific settings. Therefore, besides identifying the type and status of norms by placing then somewhere in the hierarchy of Table 1, it is also important to identify the extent of interaction between regulator and regulatees that took place in the rule-making process.

[17] See, e.g., A. Fung and E.O. Wright (eds), *Deepening Democracy: Institutional innovations in empowered participatory governance*, New York, Verso, 2003.

[18] I. Ayres and J. Braithwaite, *Responsive Regulation: Transcending the deregulation debate*, Oxford, Oxford University Press, 1995.

5. THIRD-ORDER ASPECTS: THE CONTEXT AND PURPOSE OF NORMS

Besides the status of a norm, its context and purpose are also very relevant to describe in order to be able to understand the norm. A key contextual aspect for regulation is the stage in which the technology exists. In roughly chronological order (one of the aspects of the dimension of time), technology goes through the following stages:

- fundamental research;
- prototyping, proof of concept;
- testing;
- marketing;
- in use with early adapters (state-of-the-art, 'hi-tech');
- well-established use (mainstream technology).

Particularly in the early stages of technology (but for some technologies, this applies to all stages), regulation consists of some form of risk governance. This will not be a major issue for the more standard types of robots (although some materials used in manufacture might be hazardous, in which case risk governance is relevant), but it will be for robotics applied to the human body, such as neural implants. Risk governance typically consists of two stages:

- risk assessment, in which risks are identified and, as far as possible, calculated;
- risk management, in which measures are taken to deal with the identified risks.

In the stage of risk assessment, emerging technologies may present different kinds of difficulties for estimating the likelihood that a hazard will materialise (see, e.g., Hood, Rothstein and Baldwin 2001). In rising order of difficulty, hazards relating to technology development or use may be:

- calculable;
- uncertain:
    - the (type of) hazard is known, but there is no metric to estimate its likelihood ('known unknown');
    - the (type of) hazard is unknown ('unknown unknowns').

Regulators may deal differently with risk assessment and risk management, depending on their risk attitude (risk averse or risk tolerant) but also on the level that they tolerate uncertainty.[19] This contextual factor will be important to bear in mind when comparing legal regimes.

Another relevant aspect required to understand a norm, is its purpose(s). As regulation is the attempt to influence people's behaviour 'with the intention of producing a broadly identified outcome or outcomes' (*supra*), a rule should be understood in light of what it aims to achieve. On an abstract level, regulation can have the following broad types of purposes (note that these partly overlap, and regulation often serves a combination of these):

- providing legal protection, e.g., of vulnerable groups or assets;
- providing legal certainty;
- ordering socio-economic relations;
- distributing responsibilities;
- (dis)incentivising technology research or development.

When using a functional approach to legal analysis (i.e., focusing on the function of norms in the context of the legal system, which is relevant in comparative legal research), it is useful to apply a two-step analytical framework:[20]

- apply existing legal provisions to a new development in (e.g., robotics) technology to determine whether the technology impacts on interests that the law seeks to protect;
- if legal interests are threatened by the technology development, adopt a more contextual approach to determine to what extent existing law should influence the technology development and to what extent the technology development should incite adaptation of existing law.

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19 M.B.A. Van Asselt and E. Vos, 'The precautionary principle and the uncertainty paradox', *Journal of Risk Research,* Vol. 9 No. 4, 2006, pp. 313-36.

20 A. Cockfield and J. Pridmore, 'A Synthetic Theory of Law and Technology', *Minnesota Journal of Law, Science & Technology,* Vol. 8 No. 2, 2007, pp. 475-513.

6. FOURTH-ORDER ASPECTS: CLASSIFYING NORMS

Having identified and described relevant norms for a particular technology, the second step for analysing regulatory provisions is to classify the norms according to aspects that are relevant for the project, and to compare, where relevant, norms between areas and jurisdictions.

The following aspects seem prima facie interesting to study for the norms identified and described in the previous steps of the taxonomy. Most of these relate to the regulation type, which is one of the main relevant dimensions in technology regulation.

6.1. *Regulatory pitch, range, tilt, and connection*

A first broad category that can be useful for describing and classifying norms relates to the different ways in which the norm addresses its regulatees. Roger Brownsword has elucidated several distinctions that fall within this category.

First, regulators can apply different 'tones of voice' when 'speaking' to their regulatees. This is what Brownsword calls 'regulatory pitch':[21]

- moral pitch, engaging with regulatees' moral reason; this may draw upon:
    - authoritative pitch (appealing to the regulator's authority to set norms);
    - substantive pitch (appealing to a certain moral principle, as making the regulation legitimate);
    - procedural pitch (appealing the process that led to the regulation, e.g., using participatory governance, as making the result legitimate);
- practical pitch, engaging with the practical reason of regulatees, e.g., that the norm is in their own (often economic or other welfare) interests;
- behavioural pitch, which does not engage with regulatees' reason but rather simply establishes a rule and expects the regulatees to follow this without much ado.

Second, and related to the pitch, regulators can choose between different methods to make a norm achieve a regulatory purpose. Brownsword distinguishes between three types within the 'regulatory range':[22]

[21] Brownsword, *op. cit.*, pp. 16-17.
[22] Brownsword, *op. cit.*, pp. 19-20.

- negative: applying a 'stick' to prevent or stop a certain practice, e.g. prohibiting a practice ('it is forbidden to have unmanned vehicles on public roads without a human driver');
- positive: applying a 'carrot' to incentivise a certain practice, e.g. subsidising a practice ('elderly people can deduct the costs of a pet robot from their income tax');
- neutral: giving regulatees an open choice to apply or avoid a certain practice (but stipulating consequences for either choice), e.g., permitting a practice under certain conditions ('it is allowed for civilians to use a surveillance drone if it complies with the requirements of List 1; the owner is liable for any damage caused by the drone').

Third, and somewhat related to pitch and range, is the 'default setting' of a norm. Default settings are not only important in software as an instrument to steer human behaviour,[23] but also in the regulatory position. The 'regulatory tilt'[24] may be:

- permissive, which allows a certain practice unless an explicit rule unequivocally points to the contrary;
- prohibiting, which prohibits a certain practice unless an explicit rule unequivocally points to the contrary.

Fourth, norms have different levels of connectivity between the regulator and the regulatee. Part of this relates to what Brownsword terms 'regulatory connection', i.e. the extent to which the norm is (still) or can be connected to the technology it is supposed to regulate.[25] Specific norms introduced to regulate a specific technology will typically be well-connected, at least at the start; over time, however, as technology develops, the norm may become less connected and 'lose contact' with the technology. (For example, are rules regulating interception of electronic communications, introduced in the 1990s or early 2000s, still adequate to regulate communication applications of the early 2010s?) Also, and particularly relevant for emerging robotics technologies, new technologies are often not specifically regulated; in that case, the technology has to be connected to existing norms through interpretation, or through the introduction of new regulation. An important aspect of le-

[23] J.P. Kesan and R.C. Shah, 'Setting Software Defaults: Perspectives from Law, Computer Science and Behavioral Economics', *Notre Dame Law Review,* Vol. 82, 2006, pp. 583-634.

[24] See Brownsword, *op. cit.*, pp. 21.

[25] Brownsword, *op. cit.*, pp. 160-184.

gal analysis is to find ways to determine whether existing, technology-unspecific, legal rules suffice for regulatory purposes (for example, if the rules can be (re)connected to the technology through interpretation by courts, e.g., can a street-cleaning robot be considered a 'pedestrian' in traffic law?), or whether legal rules need to be adapted or new rules created (e.g., should a sui-generis category of street robots be introduced in traffic law, or should specific liability rules be introduced for street robots?).

6.2. *Fundamental legal concepts and values*

A second category that is useful for classifying norms, is whether or not they are built upon certain fundamental values or establish or change fundamental legal concepts. 'Fundamental legal concepts' in this context denotes concepts that lie at the heart of a legal (sub)system, i.e., which establish the basic foundation on which the (sub)system is built. For example, the notion of property underlies an important part of the system in both private law and criminal law, while freedom of contract is a fundamental concept in contract law.

In the context of robotics regulation, fundamental concepts that might play a role, particularly in applications involving robotic implants and neurological interfaces, include (non-exhaustively) the following:

- property;
- bodily integrity;
- legal subjectivity.

Equally important for legal research is to determine whether and to what extent fundamental values are at stake. In the case of robotics technologies, values that may potentially be affected include (non-exhaustively) the following:

- autonomy;
- liberty;
- accountability, responsibility;
- privacy;
- human dignity;
- equality.

Of course, fundamental values and fundamental legal concepts are difficult to define and delineate; their meaning and gist will differ depending on context- and culture-dependent interpretation. When analysing the impact of a technology on fundamental legal concepts and values, researchers will have to clarify (working) definitions of legal concepts and make explicit which legal tradition(s) they are applying.

6.3. *(Hidden) constraints and perspectives in regulation*

A third category of aspects that is important for classifying norms, relates to understanding the various constraints and perspectives embedded in the norm. Some of these constraints relate to the broad overall context, others relate to more invisible constraints underneath the surface of a norm.

Invisible constraints can be found in various kinds of biases that may influence, usually unintentionally and subconsciously, the form and substance of regulatory provisions. Possibly relevant constraints are:

- ethical frame of reference (the ethical paradigm of a regulator, e.g., utilitarian reasoning, Kantian reasoning, or communitarian or 'dignitarian' reasoning);[26]
- institutional bias (the organisational setting, culture, and tradition, e.g., in Parliament or a regulatory agency, favour certain types of regulation over others);
- cultural bias (e.g., a negative regulatory tilt to androids in strongly religious societies that think of creating humanoid robots as 'playing God');
- gender bias (e.g., assuming that robots (which may have a tendency for 'male' features because engineers (often male) tend to apply 'I methodology')[27] will have 'male' characteristics such as rationality and will therefore behave in predictable manners);
- language frames (e.g., vocabulary with which (new) robotic technologies can (or cannot) be described in a norm; metaphors applied in regulatory proposals that influence the debate by the connotations they summon, such as 'Frankenstein technologies' or 'intelli-

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[26] Cf. the bioethical triangle in Brownsword, *op. cit.*, pp. 35-47.

[27] Cf. N. Oudshoorn, E. Rommes and M. Stienstra, 'Configuring the User as Everybody: Gender and Design Cultures in Information and Communication Technologies', *Science, Technology & Human Values*, Vol. 29 No. 1, 2004, pp. 30-63.

gent software'; or an inadvertent use of essentially contented concepts[28]).

An important factor relating to many of the above aspects (both invisible constraints and the regulatory aspects described *supra*), is culture (in the broad sense of the term). Attitudes to robotics, both of engineers and the public and of regulators, may differ for example depending on whether the culture is:

- Western;
- non-Western (e.g., Asian, African, Latin American);
- hybrid (e.g., Japan).

Cultural differences may impact on people's attitudes towards robots (for example, to what extent the 'uncanny valley' introduces a sense of eeriness in 'all too human' robots[29]) but also on the adoption of robots in other ways, e.g., through religion, history, and the make-up of society.[30] Of course, also within these broadly indicated cultures, attitudes differ. Within Europe, there are significant cultural differences between, for example, Italy, the Netherlands, the United Kingdom, Sweden, and Poland. When describing norms in terms of their context, purpose, and aspects such as regulatory pitch or default position, it may be useful to make explicit how these aspects may be related to their cultural context.

Similarly, norms are created in a certain legal tradition. Not only are there major differences between the common-law and civil-law traditions (such as the relative weight of precedent versus statute, *supra*), but also within the civil-law tradition there are different regulatory traditions. Acknowledging the importance of the legal tradition is a central element of further legal research on identified and classified norms, for example in comparative legal analysis.

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[28] W.B. Gallie, 'Essentially Contested Concepts', *Proceedings of the Aristotelian Society*, Vol. 56, 1956, pp. 167-198.

[29] M. Mori, 'The Uncanny Valley', *Energy*, 1970, Vol. 7, No. 4, pp. 33-35, translation K.F. MacDorman and T. Minato, 2005.

[30] K.F. MacDorman, S.K. Vasudevan and C.-C. Ho, 'Does Japan really have robot mania? Comparing attitudes by implicit and explicit measures', *Artificial Intelligence and Society,* Vol. 23 No. 4, 2009, pp. 485-510.

7. Conclusion

The field of technology regulation is very broad. Technology is an umbrella term for a wide variety of applications at different levels of abstraction. Moreover, norms regulating technology can be found in a wide range of law (in different legal areas and jurisdictions) as well as in self-regulation, technical standards, market mechanisms, social norms, and in technology itself. In order to enable researchers to map this very broad field when they embark on researching a particular technology from a regulatory perspective, this paper has developed a taxonomy that can guide researchers in knowing what to map and how to structure and colour the map. It provides a comprehensive taxonomy of concepts and distinctions that are potentially relevant for describing technology regulation. The main elements of the taxonomy can be summarised in the following graph.

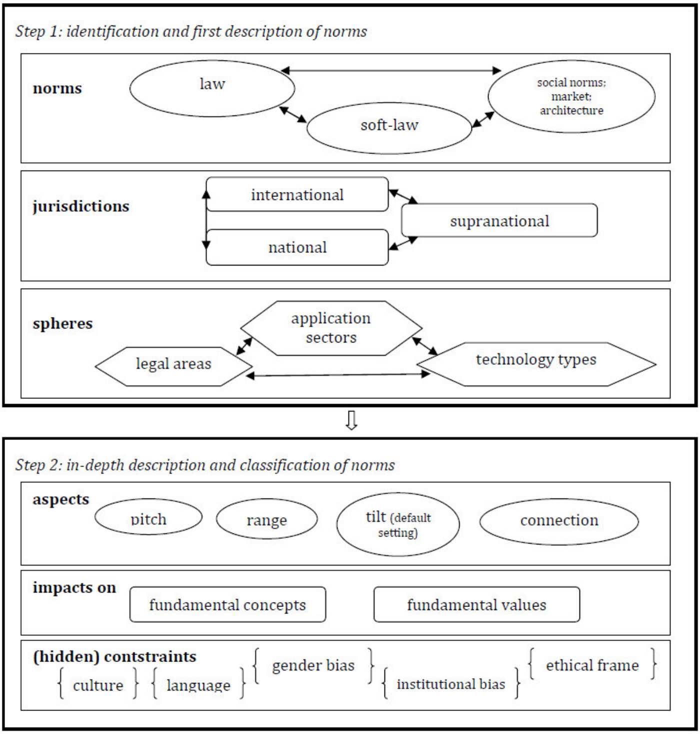

Figure 2. A taxonomy for descriptive law and technology research

This taxonomy is not intended as a manual describing exactly how existing norms can or should be inventoried, nor is it meant as a blueprint of concepts and distinctions that is set in stone. Rather, the taxonomy aims to provide a guiding document that can be used in the inventory of norms, in the form of a set of issues and questions that will often need to be addressed in research in a more or less logical order. Following the various issues and questions in the order in which they are presented in this paper may help researchers to ask meaningful questions at the right time and to make decisions on which elements to select and describe. The resulting thick description of the existing regulatory field will serve as an excellent starting point for asking additional, descriptive or normative, research questions, for example how new technologies are, could be, or should be regulated, or how technological developments impact on existing regulatory concepts or frameworks.

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