Democratic Experiments

Problematizing Nanotechnology and Democracy in Europe and the United States

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Citation:

Democratic Experiments: Problematizing Nanotechnology and Democracy in Europe and the United States
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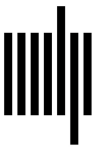
DOI: 10.7551/mitpress/10580.001.0001
ISBN (electronic): 9780262344487
Publisher: The MIT Press
Published: 2017

OA Funding Provided By:

OA Funding from Knowledge Unlatched



The MIT Press

7 Democratizing Nanotechnology?

Sites of Problematization

In chapter 6, we encountered various initiatives meant to sustain social mobilization within or against nanotechnology. These initiatives directly echo the main concerns of this book: how to critically describe large-scale technological programs associating objects, futures, concerns, and publics? How to identify the questions they raise for democracy and envision perspectives for democratization? These questions articulate the practice of social scientific research with the issues of research ethics and critical engagement. This chapter builds on the empirical inquiries of the previous chapters in order to question what the democratization of nanotechnology could and should mean. It connects the sites examined in the previous chapters in order to identify contrasting problematizations of nanotechnology and democracy. While these problematizations do not claim to be exhaustive, they do offer insights into current evolutions of contemporary democracies. And, perhaps more importantly, they will help me reflect on a nonevaluative yet normative perspective that I eventually characterize as a critical constitutionalism.

In the previous chapters, I have conducted the analysis in the sites where nanotechnology was problematized. These sites of problematization were science policy offices, science exhibits, participatory mechanisms, standardization and regulatory bodies, expert organizations in science or social science, and places of social mobilization. They are the places where nanotechnology is defined as a problem deserving a range of acceptable solutions, and consequently, where democracy itself is problematized. This has led us to explore places not always associated with democratic practices (such as standardization organizations and science museums) or usually situated at its fringes (such as public expert bodies). But it is precisely in these margins that the rules governing institutions such as the European

Commission, national governments, and international organizations have to be questioned when dealing with nanotechnology's objects, futures, concerns, and publics. It is in these sites that questions of citizenship, legitimacy, and national or European sovereignty were explicitly raised. These sites are not passive scenes, on which problematization of nanotechnology would be stabilized or destabilized. Consider, for instance, the public meetings of the French national debate on nanotechnology. The separation that the organizers maintained between the invited speakers and the public in two different rooms and the eventual closure of the debate were part of the problematization of nanotechnology they propose. Hence, sites are not a priori distinct from the agencements that problematize, and their natures and rules can be contested. They are part and parcel of the processes of problematization. Their variety displays the extent of places where democracy is at stake in contemporary societies. How to make these sites the location of a critical reflection on democratization?

Throughout the sites I examined in the previous chapters, we encountered agencements that define the "nano-ness" of objects, produce anticipations about the future, identify public concerns, and shape the agency of the political subject. Speaking of agencements was an approach to studying the problematizations of nanotechnology through the instruments that problematize, in ways that did not separate "reality" from its "representations." For instance, when I explored diverse definitions of "nano-ness" in chapter 4, I described various ways of granting regulatory existences to nanomaterials. Analyzing the replication of technologies of democracy in chapter 3 was an investigation into the making of political subjects, whether "deliberating" or "debating" citizens. By highlighting processes of problematization, the analysis was inserted in the making of the objects, futures, concerns, and publics of nanotechnology.

STS thinkers such as Annemarie Mol or John Law would speak of the "ontological politics" at stake here, in that "reality does not precede the mundane practices in which we interact with it but is rather shaped within these practices" (Mol 1999, 75). The expression points to the contingency of choices related to the shaping of objects and subjects, and concurrently, to the possibility of conceiving these realities differently. It is an invitation to consider the forms of scholarly engagement as "interferences," an expression used by John Law to point to the many connections between the description work and the activities of the actors themselves, and the performativity of social science (Law 2010, 278–279). For Law, focusing on "interferences" directs the attention to the contingency and particularities of the

situations at stake. It prevents one from taking for granted the dichotomy between "description" and "intervention." One can indeed understand as "interferences" the analysis of nanotechnology that I conducted and presented in the previous chapters, intervening in sites of problematization alongside the actors involved (as in the OECD or in Vivagora's public initiatives) or contributing to their publicity by describing them. Thinking in terms of interferences pays close attention to the local situations of uncertainty for the analyst's engagement. It adds another dimension to the ontological politics at stake within sites of problematization, namely that of the politics of scholarly engagement.

The next research steps could then consist in delving further into the exploration of the multiplicity of problematizations. There could be two ways of doing that. One would be to concentrate on some of the sites I studied, and describe at further length the microprocesses that led to the expression of the variety of problematizations in each of the sites. A second would be to multiply the forms of interferences.[1] Choosing one approach or the other, the natural conclusion could well be that "reality is multiple," that various problematizations of nanotechnology are proposed, and that, consequently, "decisions" and "choices" are all situated, and distributed in heterogeneous processes. This is not a position that I find satisfactory, for both analytical and political reasons.[2] What would be gained in terms of the quality of fine-grained descriptions would prevent an analysis of nanotechnology and democracy as categories extending over wide institutional spaces. It would limit ontological politics to the local sites of trials, while there is indeed ontological politics at stake in the making/stabilization of such entities as "states" or "international organizations." It would prevent such crucial questions as: how do democratic experiments acquire value? For whom are they valuable?

Answering such questions requires an examination of the spaces within which such initiatives as the French national public debate on nanotechnology, the nanotechnology exhibits in American and European museums, the regulatory attempts at governing nanomaterials or mechanisms based on "real-time technology assessment" are valued and for and by whom: who are the audiences in front of whom these initiatives are conducted? In whose name and for whose interests? What public spaces are then crafted?[3] These questions are directly dealt with in the sites of problematization of nanotechnology encountered in the previous chapters. By considering that reconstruction is part of both the analytical and engagement work of the social scientist, as he or she circulates across sites and draws connections among them, this chapter builds on the empirical explorations of sites in

order to reconstruct spaces characterized by common problematizations of both nanotechnology and democracy.

Four Problematizations of Nanotechnology

Mobilizing Expertise to Realize the Potential of American Nanotechnology

When the National Nanotechnology Initiative (NNI) was created in the late 1990s, its integration in the making of American science was manifest. Nanotechnology was "the next frontier," as announced as early as 1959 by physicist and Nobel Prize winner Richard Feynman, the "next industrial revolution," for which society had to be prepared. The value of the new technology was to be demonstrated in order for members of the U.S. Congress to fund the initiative, for students, workers, and consumers to participate in its development, and for the "general public" to accept it. One could identify the connection with past science policy programs in the United States, from the Apollo project to Vannevar Bush's vision of science as an "endless frontier."[4] But nanotechnology is a particular case. It is not meant to be a government-driven program aimed toward the realization of a single objective (like the Apollo or the Human Genome Project). Nor does it follow a linear, science-based model that would contend that funding basic science is a sufficient condition for the development of applied research, and, eventually, social progress. The NNI is best described as a program that operationalizes in research management instruments long-term objectives, research organization plans, and understandings of the historical development of science and technology. It associates numerous federal agencies, and brings together fundamental and applied science for the development of nanotechnology. Nanotechnology objects and futures have caused vivid controversies between industrialists and proponents of visions of nanotechnology based on the anticipation of self-replicating molecular machines (see chapter 1). Eventually, the instruments of the NNI were able to connect both, while making nanotechnology a vast program gathering a large number of projects. For instance, Roco's four generations of nanomaterials connected current practices, industrial applications, and long-term developments. It allowed the NNI to avoid the long-term and scary visions of Drexler while also situating nanotechnology in the continuation of Feynman's prophecies, within the history of scientific discoveries.

Yet nanotechnology also caused public actors to deal with concerns. The proponents of nanotechnology in the American science policy landscape

soon advocated the management of risks and ethical issues through specific expert work, and the integration of "public input" in nanotechnology programs. As the example of nanosilver illustrates (see chapter 4), the way of dealing with these issues is, in many respects, defined within the American expertise system in federal agencies. Legal conflicts occur on the qualification of substances (as "new pesticide" or "known material" in the case of nanosilver), and the legal arena is the terrain on which arguments are presented and opposed to each other, and administrative choices are challenged.

Nanotechnology is problematized, in the American sites we encountered, as an issue of scientific development for the sake of collective progress, and for which the American society has to be prepared, and externalities are to be taken care of. Doing so implies the use of appropriate expertise, and this requires demonstrating the quality of the expertise being mobilized and the scientific value of the stakeholders' positions. This process was described in chapter 4 about silver nanoparticles, and in chapter 6 about expertise in ethics. It enacts boundaries between expertise and the stakeholders' interests, and between the expertise in ethics and toxicology and the technical development of substances. It makes the relevance of the expertise to mobilize a matter of public discussion. Hence, numerous organizations called for the integration of more federal funding for environmental, health, and safety (EHS) research during the discussions that led to the reauthorization of the National Nanotechnology Initiative by Congress in 2009.[5] But mobilizing the "good expertise" to answer nanotechnology concerns is not only a problem of research funding. It also requires that the expertise be identified. Thus, successive congressional reports interrogated the quality of the reporting of EHS activities in nanotechnology programs, and, by 2008, called for a better monitoring, identification, and quantification of EHS research.[6] A specific area of expertise was needed, and it was to be visible enough for policymakers to mobilize, evaluate, and control it.

Through her exploration of biotechnology policies, Sheila Jasanoff has identified the components of an American contentious civic epistemology (Jasanoff 2005). She demonstrates that the processes through which public decisions gain scientific objectivity and democratic legitimacy are based on a combination of an adversarial style of policymaking, mobilization of expertise as a way of escaping politics, and calls for transparent decision-making processes. One can see these dynamics at play within the problematization of nanotechnology in the United States, which thereby appears as an empirical lens for scholars interested in the description of the American

civic epistemology. Yet the problem of identifying nanotechnology objects and dealing with strong connections to future prospects introduced some displacements in the known processes of objectivity and legitimacy building. We encountered several of them, when proponents of nanotechnology suggested a "safety by design" approach to considering toxicological properties at the design phase of substances; at the Boston Museum of Science, where science communication specialists make "deliberation" an important part of the public communication of nanotechnology; and at Arizona State University's Center for Nanotechnology in Society, where "real-time technology assessment" is conceived as an intervention in the construction of science and society meant to "democratize science" (Guston 2004). The last two experiences explicitly envision democratization as their objective, while the first is conceived as an innovative way of anticipating social concerns from the core of technological research.

These attempts could question the boundaries between expertise and politics, and indeed the very definition of the relevant expertise to mobilize on technological issues. Their impacts are not given, and require adaptations so that innovative interventions can be integrated in the space of expert knowledge production, and, eventually, democratization be reached through the development of additional technical competencies in the public management of technology. Making safety by design a new area of expertise for dealing with nanotechnology risks would require scientometrics methods able to render measurable safety-by-design projects, which, by definition, are not understood by the distinction between material sciences and toxicology.[7] The uncertainty surrounding the objectives of deliberation as introduced in the American science museums is dealt with through the transformation of deliberation into an expertise managed by museum staff, and addressed to individual citizens expected to learn about a new scientific field. The construction of a small-scale experiment at the Center for Nanotechnology in Society (CNS) described in chapter 5 can be seen as a demonstration of the scientific quality of an approach that does not separate science from society, but can nonetheless differentiate its expert work from public decision making.

A French State Experiment with Nanotechnology

As French public institutions attempted to make nanotechnology both a program of technological development and a governable domain, they also made it a problem of engaging the French democracy, at local, national and European levels. The importance of centralized technology policy and research initiatives for the development of the French state has been

described in other domains than nanotechnology (see Hecht 1998). But the situation is complex for the centralized expertise of the French state, as the interests of the concerned publics are not well identified and the objects at stake not defined, while radical activists question the role of public bodies. At local levels, the involvement of local public bodies in nanotechnology has to cope with protests, and the science communication specialists, as in the Grenoble science center, are at pains to transform the relationships with science and its publics. How to deal with the social and technical uncertainties of nanotechnology? How to define a national position in European and international arenas? These are the questions that the French state is expected to answer.

In chapter 3, I described the national public debate on nanotechnology organized in 2009 as a state experiment. The replication of the CNDP public debate procedure on nanotechnology engages the modes of intervention of the French state and indeed its very nature. Similarly, the introduction of the *substances à l'état nanoparticulaire* ("substances in a nanoparticulate state") category, the nano-responsible project, and the science exhibits turning visitors into debating citizens transform the roles of public bodies and are signs of the attempted extension of their competences to new areas—poorly defined chemicals, uncertain industrial processes, and unknown publics. As it struggles with nanotechnology's objects, futures, concerns, and publics, the French state experiments with the ways and means of its public action. In replicating technologies of democracy or introducing innovative techno-legal instruments, the French state is also experimented with. This state experiment manifests itself in the integration of new components in French state expertise, with the objective of governing social and technical uncertainties, be they unknown concerned publics or uncertainly defined *substances à l'état nanoparticulaire*.

This makes nanotechnology a component of a wider evolution. Thus, the director of ANSES, the public health agency in charge of the mandatory declaration of substances in a nanoparticulate state wrote in the national newspaper *Le Monde* that "experts are not researcher monks" (*moine chercheurs*). He meant that expertise could not remain in the secluded place of research, but needed to answer social problems, be aware of controversial situations, and make sure that the involved actors are heard. He argued, "this is precisely by enlarging the space of controversy, as a place for well-argued discussion, that we will avoid polemic."[8] The opposition he drew between "controversy" and "polemic" is significant. While the latter was characterized by irrational exchanges of opinion, the former could be organized as a collective process of political and technical rationality. This was, for him, precisely the role of the public agency—illustrated by its

intervention in the field of nanotechnology, through its role in the development and management of the *substances à l'état nanoparticulaire* initiative.

This proposition has a particular resonance in France, where centralized public expertise is a basis of the democratic state.[9] It is inscribed in, as much as it contributes to shape the trajectory of a powerful state, expected to guarantee the neutrality of administrative expertise, and prone to integrate new concerns in this very expertise. Political scientists have described how the French state managed to integrate environmental issues related to industrial activities into the centralized public administration of industry (Lascoumes 1994). Others have analyzed the response to health crisis in the 1990s and showed that the French state created health agencies meant to ensure the neutrality of its technical expertise while also taking demands for a greater public participation into account (Benamouzig and Besançon 2003). The creation of CNDP in 1995 and the extension of its missions to general policy options in 2002 are steps in the development of "the French experiment with public participation," by which the state relies on expertise about participatory matters (Revel et al. 2007). These evolutions display a state constantly attempting to integrate new components in a centralized expertise that grounds the legitimacy of its intervention. This powerful state is able to act through an expertise owned by various government components, public agencies, and research organizations, brought together for the sake of the development and control of technology. It attempts to govern technical objects uncertainly defined, and to constitute new political subjects by turning poorly identified publics of science into debating and participating citizens.

The outcome of the French state experiment with nanotechnology is still uncertain, and what will appear out of it unsure. This is particularly clear when considering that the civil servants involved in nanotechnology-related issues are permanently raising questions about their positions, and the objectives and modalities of public policy actions regarding nanotechnology. They gather in informal working groups across ministries, participate in public meetings, intervene in European and international arenas where they represent France and argue for specific "nano" regulation in Europe and (unsuccessfully) for international initiatives able to take the technical and social uncertainties of nanotechnology into account. Over the past few years, many of the French civil servants involved in nanotechnology I interviewed were keen on making this domain a new area of intervention for the French state. But they were also anxious how so much uncertainty could be made governable and were wondering about the

overall perspective of their works. The uncertainty about the outcome of the state experiment with nanotechnology also impacts the intervention of civil society organizations such as Vivagora (see chapter 6). While the organization intervened in various ways in the democratization of nanotechnology, the absence of a known and consensual procedure for collective discussions about technological development was both a condition for its experimental interventions and a source of permanent uncertainty about the roles of social mobilization.

That the outcome of the state experiment with nanotechnology is uncertain is a sign of the incomplete transition of the French state, which is imperfectly equipped to deal with the new entities it attempts to make governable. It makes it easy for proponents of nanotechnology to ignore the attempts at governing social and technical uncertainties. Consider, for instance, an initiative undertaken by CEA, unironically called "Nanosmile." Developed as part of a European project, Nanosmile was an online training device meant to describe the approach to be taken in order to "apprehend potential risks and benefits of nanomaterials in order to contribute to Science & Society dialogue" (Laurent 2010, 85). It separated the "subjective perceptions" from the "objective risks" to be mastered by "good practices." For the proponents of Nanosmile, what mattered was the production of adequate representations of science, for the benefits of known publics, namely ignorant crowds prone to irrational concerns. In Nanosmile, social and technical uncertainties were not in the picture.

The incomplete evolution of the French state makes it particularly vulnerable to criticisms, and the anti-technology activists were particularly vocal about nanotechnology. For them also, uncertainty is not an issue. They consider that the attempts at governing uncertain chemicals and unruly publics are only signs of the blurring of boundaries among scientific research, state intervention, and citizen involvement. For them, the rationality of the French citizen is situated outside of technology development, as he or she ought to perform critical inquiry from a distant position. Their interventions are forceful reminders that a stream of political philosophy, whereby the equality of simple citizens accepting the primacy of the general interest is the basis of social order, may be threatened by the current transformations of the French state.

A Problem of European Integration

Speaking of the harmonization project as crafted in the early 1990s by the European Commission, Andrew Barry describes it "both as a way of imagining and of reordering European space, as well as a technical process directed

at establishing this space as a governable entity" (Barry 1993, 316). Harmonization points to a set of operations meant to ensure the integration of the European political, economic, and moral space. It is based on such instruments as the standardization of products circulating on the European market, the coordination of policy choices of member states, or the identification of common values for European societies, such as "sustainability" or "competitiveness." We encountered some of these instruments in the previous chapters, as European public bodies proposed definitions for nanomaterials, introduced codes of conduct for nanotechnology research, or set up "networks of excellence" to coordinate the initiatives of member states. In the sites where these instruments are crafted, the problem of nanotechnology is that of the composition of the European harmonized space. In that sense, it is a problem of integration. This integration is political, economic, and moral. It is political in that it relates to the way European institutions can define long-term objectives (such as the development of new technological domains or the promotion of values deemed European) and exercise control over scientific and technical activities that, according to the subsidiarity principle, are governed at member state level. Integration is economic in that technological development is expected to make Europe a place where laboratory research is transmuted into market developments and technological innovation meets the needs and expectations of the European consumer. Eventually, integration is also moral in that European values are expected to be integrated at the core of technological research. Defining these values also defines what it means to qualify objects, people, and practices as "European."

Problematizing nanotechnology as a matter of integration makes nanotechnology a step in the transformation of the European research policy. Commenting on the report about converging technologies he edited, philosopher Alfred Nordmann spoke of a "European experiment" (see chapter 5). The expression is accurate, as it points to instrumented interventions in the making of Europe itself, for still-uncertain results. These interventions are much wider than Nordmann's report, or indeed nanotechnology. There are situated within long-term reflections pertaining to the nature of Science–Society relationships in Europe (see Felt and Wynne 2007), and more generally to the appropriate way of making science and technology engines of European integration (Laurent 2016a).

As seen in chapter 5, nanotechnology paved the way for the development of "responsible research and innovation" (RRI), itself a component of the post-Lisbon strategy recompositions of the European research policy. The 2000 Lisbon strategy, which hoped to make Europe a knowledge-based

economy, defined target levels of public and private investment in R&D (3 percent of GDP) for member states. Evaluated in the early 2010s, it was considered a failure since the majority of member states never reached this target share. By contrast, the new forms of the European research policy after 2010, notably within the Europe 2020 strategy, did not attempt to define minimal thresholds of investment, but instead target a limited number of objectives considered to be priorities (Lundvall and Lorenz 2011). This evolution had a dual objective, which directly resonates with the problematization of nanotechnology described in the previous chapters.

First, it is situated within the same line of argument as the RRI: European science has to adapt to what the European public could consider meaningful. Targeting "challenges" such as global warming or aging is a way of doing so. In chapter 2, I described the "scientific understanding of the public" that the Directorate-General for Research and Innovation of the European Commission defined as an objective in the wake of initiatives in nanotechnology and public communications. Knowing European publics "scientifically" was an answer to a perceived trust issue—a concern that is regularly expressed in European policy documents. Thus, the presentation of the Europe 2020 strategy relates the definitions of "challenges" supposedly meaningful to the European public to the fact that "the percentage of European citizens [who] trust science and technology to improve their quality of life decreased over the last five years from 78 percent to 66 percent." The report thus considered that there was "a genuine expectation for science to reorient its efforts to contribute to addressing the societal challenges of our time."[10]

Second, the reorientation of the European research policy also offered a way of dealing with a constrained budgetary situation. Thus, Maire Geoghegan-Quinn, commissioner in charge of science and technology, said in 2011 that "at a time when most Member States are confronted with strong budgetary constraints," it was necessary to target public investments toward "growth-enhancing policies that get excellent value from the money invested, prioritizing the most cost-effective reforms that help develop new markets for innovative products and services." In this declaration, the evolution of the relationships between European science and the European publics appeared as a part of a broader recomposition of the European economic policy.

Thus, the European sites of problematization of nanotechnology are steps toward the redefinition of the European research policy, and more generally, participants in the construction of Europe as a consistent space. They make the integration objective less a matter of uniformity of levels of

research investment across member states (as in the Lisbon strategy) than a problem of political, economic, and moral harmonization across the European Union. Integration is expected to answer many concerns, whether they are related to the much-discussed European democratic deficit, to the EU's economic strength, or its problematic common identity. It is, then, the vehicle for making Europe a common space, within which member states, private companies, and European publics are closer with each other and with the European institutions.

Realizing integration relies on a mode of reasoning whereby the European public action needs to ensure a balance between constraining legal interventions and delegations to market mechanisms. Coordination devices such as codes of conduct and ethics review (see chapter 5), and the regulatory precaution approach in the treatment of nanomaterials (see chapter 4) are instruments expected to ensure this balance. They can be described using the works of political scientists who characterize a European style of policymaking as "experimental governance." Commenting on instruments such as the Open Method of Coordination, through which the European institutions determine broad policy objectives and implement a set of instruments (guidelines, benchmarks, etc.) for member states to reach these objectives on a voluntary basis, these scholars argue that experimental governance aims not to legally constraint but to coordinate actions in reversible ways.[11] The experimental governance literature often considers that experimentalism can unproblematically be equated with greater efficiency of policymaking, and better democratic practices. Yet the European experimentalism encountered in this book is also a terrain of oppositions, about how to craft interventions that would achieve an appropriate balance between constraining legal actions and the delegation of collective organizing power to markets. One can read the opposition between the European Commission and the European Parliament in those terms (see chapter 4). The explicit analogy between "scientific understanding of the public" and market studies is at odds with more sophisticated approaches that attempt, for instance, to craft a "lay ethics" that would leave social expectations open (Davies, Macnaghten, and Kearnes 2009; see chapter 5). Therefore, if nanotechnology can indeed be considered a "European experiment," it is not because Europe would be the place where science and society would finally come together and produce, at last, a democratic technology policy. Nanotechnology is a European experiment in that it entails explorations of the channels of democratic legitimacy in Europe, and, more generally, of defining and governing Europe itself.

International Nanotechnology for a Global Market

In June 2009 in Braga, Portugal, the OECD Working Party on Nanotechnology (WPN) organized a roundtable on international cooperation in nanotechnology.[12] The chair of WPN at that time was physicist Robert Rudnitsky, who was also chairing the Global Issues in Nanotechnology working group at the NNI. Rudnitsky gave the opening talk, in which he equated international cooperation primarily with an operation protecting the development of nanotechnology from foreign threats. "Previous technologies have seen public acceptance of rejection begin in one country and migrate to others," he said, and "international regulatory regimes affect U.S. industry." Developing "a healthy global marketplace for U.S. nanotechnology goods and products" required international cooperation in order to avoid these troubles. The example he had in mind then was that of biotechnology, and particularly the controversies about GMOs. In the reading of these episodes by policymakers involved in nanotechnology programs, the biotechnology experience is that of a failed harmonization. Opposition over GMOs in Europe resulted in differences in regulatory choices, people like Rudnitsky claimed, which hindered market developments and resulted in disputes in front of the WTO.

This understanding of the biotechnology case can be criticized. It ignores the embeddedness of regulatory choices and public reception of technology in stabilized institutional constructs (Jasanoff 2005), the variations in the construction of science as a basis for decision making (Winickoff and al. 2005), and the subtlety of the anti-GMO critiques on both sides of the Atlantic (Marris 2001; Joly and Marris 2001). Consequently, it oversimplifies the trajectory of technology acceptance and tends to make it an issue of public fad followed by irrational rejection (Rip 2006). But however inaccurate this narrative of the GMO case might be, it is crucial in the problematization of nanotechnology as an issue of international cooperation. It is used as a counterexample demonstrating the need to anticipate potential threats to the extension of a global market, be they differences in regulatory choices or variations in public acceptance—both potential sources of trade barriers.

As Rudnitsky was speaking in Braga, he identified an objective of "harmonized policies and constructive interactions between nations." But "harmonization" was different in his speech than in the European case, where it is an operation expected to craft a common European identity. Here, it refers to the objective of "developing an international marketplace for nanotechnology products and ideas." The 2011 U.S. strategic plan for nanotechnology similarly referred to the need to "increase international

engagement to facilitate the responsible and sustainable commercialization, technology transfer, innovation, and trade related to nanotechnology-enabled products and processes" (National Science and Technology Council 2011, 27).

In this document, international collaboration was seen as a condition for the "development of a vibrant and safe global marketplace for nanomaterials and nanotechnology-enabled products." International cooperation for the construction of a global market requires common terminologies and standards, which are crafted at the International Standardization Organization (see chapter 4). International cooperation also has to be conducted at policy levels. Within the global objective of the development of a market for nanotechnology, international cooperation about public engagement can be seen as a way of preventing differences in public acceptance (see chapter 3).

Matthew Kearnes and Arie Rip cited as an aspect of the responsible development discourse "the way it operates internationally as a tool for the development of global consensus and strategy" (Kearnes and Rip 2009). The objective of "responsible development" is indeed shared, and serves as a common reference. Yet as the American, French, and European cases show, "responsibility" may point to different problematizations of nanotechnology. And as the intervention of Rudnitsky at the OECD made clear, national interests are central in the development of international markets. Thus, "international cooperation" in the responsible development of nanotechnology is not just a matter of peaceful agreements among countries interested in the safety and acceptability of technological innovation. It is also a strategic matter of governments and private companies eager to ensure their market share in the developing nanotechnology market.

In France and the United States, as well as within the European institutions, problematizing nanotechnology is also problematizing democracy. We saw that these problematizations engage the forms and conduct of American public expertise, the nature of the French state, and the identity of a European Union in the making. That nanotechnology is a matter of market making at the international level does not mean that democracy is not at stake. First, international organizations develop reflections and expertise about democracy. At the OECD, the WPN makes "public engagement in nanotechnology" a matter of democratic practices. It did so by crafting an expertise on technologies of democracy, separated from the content of nanotechnology issues. A "policy expertise" could then be proposed in ways that would not cross the boundary between the international work and national policy choices. Second, the projects conducted

within international organizations are expected to be based on collective negotiations, in which public and private interests are represented. This results in a particular political format, which relies on science to produce international consensus. The "science" on which the international expertise and standards are supposed to be based is made of heterogeneous considerations. Recall, for instance, the mixture of science policy logic, communication imperatives, and technical considerations that had to be mobilized so that the 100 nm size limit for the definition of nanomaterials could hold at ISO TC229 (chapter 4). Eventually, it prevented an association between the fact of being "nano" and the eventuality of increased risks.

The particularities of the international problematization of nanotechnology appear clearly when one considers the purification devices it requires in order to eliminate propositions that do not fit with it. Thus, attempts at defining nanomaterials using properties related to size rather than size itself were not acceptable within ISO. Initiatives that would have connected public engagement with public intervention in the government of nanotechnology objects could not succeed at the OECD WPN. Eventually, the international consensus on the construction of a global market for nanotechnology requires a constant purification of international interventions expected to be untainted with policy choices reserved for the sovereign decisions of participating countries. This is not a neutral process, as it makes it impossible to define nano-ness in ways that could lead to the regulation of potential hazards, and conceives "public engagement" as no more than exercises with no effect on technological development.

Identifying Problematizations

Starting the analysis from agencements located in sites of problematization was a way of accounting for spaces characterized by common problematizations. The four problematizations of nanotechnology described previously extend over spaces that reproduce national territories, or transnational political organizations. As a global program associating objects, futures, concerns, and publics, nanotechnology is a lens for the study of what these democratic spaces are. Thus, it offered empirical entry points in the study of contemporary democracies. We encountered the importance of technological progress as a collective project in U.S. democracy—a collective project relying on trained individuals expected to become consumers, supporters of policy choices, students, or workers, and on public regulation through adversarial procedures. I described the concerns for the rationality of the French citizen, and the transformation of the powerful French state

as it attempts to deal with issues of technical and social uncertainties. The description of nanotechnology as a European experiment helped characterize Europe as a political entity in the making whose democratic legitimacy and indeed its very identity are permanently questioned. Later I analyzed international organizations as sites of reflection about democratic practices and collective negotiations for the sake of the global market, where it is crucial to ground expert interventions outside of sovereign policy choices.

The problems that are discussed in these sites are different. They concern the transformation of technology assessment in the United States, the extension of state action to new social and technical entities in France, the growing European integration, and improved adjustment of a global market offer to public demands. These differences relate to variations in modalities of democratic ordering, and directly impact the construction of objects, futures, concerns, and publics that constitute technological development programs.

Identifying these differences requires two joint movements. First, one needs to avoid the apparent dichotomy between the localization of the empirical site and the macroscopic scale of democratic spaces. The previous chapters have shown that the study of sites of problematization make visible the conditions under which particular democratic experiments are valued, and the ways in which they matter for the actors involved. For instance, one cannot understand the state experiment that is the French national debate on nanotechnology (see chapter 3) without considering the redefinition of the technocratic expertise on both public participation and risk management. The identification of problematization requires that one is sufficiently close to the empirical phenomena being described in order to account for the ways local initiatives matter and to whom, and, thereby, how they participate in the making and remaking of wider spaces. Second, one needs to use the circulations across sites undertaken by actors and analysts alike in order to draw what Michel Callon has called a "political geography of sites" (Callon 2012, 151). As policymakers circulate from their national offices to international arenas, social scientists and science communication experts meet in academic and professional conferences, and market products flow across political boundaries—so the analyst needs to connect sites belonging to regulatory organizations, science museums, and public debates in order to make problematizations visible.

Stabilizing Problematizations

Foucault considered one of the main benefits of the notion of problematization to be the attention it draws toward the public restabilization processes through which problems are constantly made explicit, and solutions crafted. Within these very processes lies the possibility for displacements. In studying, in the previous chapters, the agencements that problematize nanotechnology, I examined the processes through which problematizations are constantly restabilized, and consistent spaces characterized by common problematizations are built.

One can identify three of these processes. A first one is the *extension* of known agencements. Thus, I showed how the American adversarial regulatory system included public debates about the novelty of nanoparticles such as nanosilver. I described the extension of state expertise to new domains in France, through the replication of technologies of democracy such as the CNDP procedure or the introduction of new regulatory categories. I showed how in Europe, nanotechnology is an opportunity to extend the reflection about European values to the entire research policy.

A second stabilization process is based on the *purification* of agencements. Thus, I analyzed the elimination of alternatives, be they related to definitions of nanomaterials or understanding of the objectives and formats of public engagement, at ISO and the OECD. The experts mastering technologies of democracy encountered in chapter 3 have to purify the issues expected to be discussed and the participating publics in order to eliminate anonymous activists or non-neutral panel members of consensus conferences. When an initiative such as the French nano-responsible standard enters the space of European standardization (see chapter 4), it needs to be transformed so that it becomes acceptable as a proposition based on risk–benefit evaluation.

Eventually, one can identify in *comparison* a third process of stabilization, particularly visible as European actors defined their perspectives on nanotechnology and converging technologies in opposition to the American programs. But comparison is also at stake when French civil servants compare their initiatives with those of other European member states more reluctant to act to regulate the uncertain risks of nanomaterials, or when Grenoble-based museum experts judged European projects disappointing because they do not make nanotechnology a topic of experiment in the display and practice of public debate, as French science museums attempt to do. Comparison, eventually, is constantly undertaken in international organizations such as the OECD, where national initiatives are

benchmarked against one another, in the hope of constructing a global expertise.

Extension, purification, and comparison are not mutually exclusive. For instance, I describe in chapter 2 how a network of American museums extended its expertise on informal science education to new topics and methods. The comparison with the European science museums was used to call for new methods based on "two-way communication." In the meantime, the network purified innovative deliberation exercises such as the forum developed at the Boston Museum of Science in order to include them within its expertise distributed across the country. The three operations certainly do not cover the entire range of processes that stabilize problematizations. But they help point to the importance of accounting for problematizations not as given entities, but as outcomes of stabilization processes. They direct the attention to the contingency of dominant formations, as well as to the struggle and tensions among them. They also make potential alternatives and variations visible. Thus, the extension of the French state expertise to participatory mechanisms and uncertain risks is strongly resisted by anti-technology activists, who use the attempts at extension as opportunities for proposing to turn the French public into "simple citizens" engaged in critical inquiry. The purification processes needed to write international standards make eliminated choices visible for the analyst, who can then locate, for instance, property-based definitions of nanomaterials as alternatives to simpler, size-based definitions. Eventually, the comparisons undertaken in international arenas also make it possible to envision the broader range of problematizations of nanotechnology and democracy, such as the British upstream engagement discussed at the OECD WPN (see chapter 3), which would base the legitimacy of collective decisions on a public intervention at an early stage of a technological development understood in a linear way.

Extension, purification, and comparison locate the analysis in the midst of the operations that problematize, and directly raise the questions of counter-problematizations. How then to envision the critique of democracy, or, symmetrically, the possibility of political intervention in the democratization of nanotechnology in particular, and technology in general?

What Critique?

Democratic Ideals?

After having identified various problematizations of nanotechnology, various democratic constructs, and located the sites where counter-problematizations are proposed, how should one envision the critical strength of the analysis?

Claiming that the analysis can merely stand outside of the described realities, possibly for others to take sides, is not satisfactory. For the conduct of research, and indeed the very nature of sites of problematization, makes such distinction between description and intervention not relevant. Another option would be to evaluate the democratic construct according to external criteria. This would replicate the position of political theorists developing a critique of "actually existing democracy" (as philosopher Nancy Fraser [1990] would say), or an evaluation of participatory procedure according to known criteria of "good deliberation." Scholars have proposed to grade the "social robustness" of governance and participatory initiatives about nanotechnology. They consider that participatory initiatives in nanotechnology "only partially meet aspects of social robustness, and that the governance and deliberative turn in science and technology policy has not led, so far, to greater democracy and responsibility in nanoscience and nanotechnology development."[13]

Yet criteria such as "deliberation" or "robustness" are explicit parts of the problematization of nanotechnology. They are advocated by social scientists invited to give their opinions, and inscribed in controversial and diverse agencements. They enact different democratic constructions. Being "not responsible enough" is thus a weak critique, since it is entirely part of the problematization one would want to critique.

"Merely describing" problematizations or evaluating them according to known criteria are two operations based on an understanding of scholarly work and political engagement that distinguishes epistemological from normative tasks. This distinction is precisely what the analysis of problematization seeks to avoid—and had to do, given the variations of scholarly engagement in sites of problematization. This means that any critical perspective able to question the world as it is and as it should be needs to associate both the practice of research (examining questions such as: how to select sites of problematization? How to circulate across them?) and the mode of political engagement (providing guidance into the ways of democratizing nanotechnology, and indeed any other entity subjected to this kind of analysis). STS scholars and political theorists have proposed

approaches that may contribute to our interrogation here. I will discuss two of them before turning to "critical constitutionalism" that, as I argue, the analysis of the problematization of nanotechnology suggests adopting.

Novelty

Describing the joint problematizations of nanotechnology and democracy, one could identify a special interest in situations where new entities are being constituted. This is a distinctive trope in STS, as some of the original works of the discipline originated from the sociology of technological innovation (Callon 1986; Latour 1992). These works considered innovation as a particular interesting domain of scholarly investigation and political intervention, since it potentially redefines the ontological quality of the human and nonhuman entities composing a given situation. In doing so, they also identified a political value in innovation, as the provider of situations where democracy might be reinvented (Callon, Lascoumes, and Barthe 2009). The dynamics here owes much to a Deweyan perspective identifying the mechanisms constituting new publics as issues that are not dealt with by existing institutions.[14] Michel Callon's analysis of market in terms of framing/overflowing can be understood in these terms. As Callon explained, the proliferation of markets create "overflows," which results in the formation of new concerned groups, and, potentially, new forms of political organization (Callon 2007).

The joint analytical and political interest for situations characterized by novelty is much more complex to take at face value in the case of nanotechnology—and, indeed, for any domain described in the vocabulary of "emerging technologies." The "novelty" of nanotechnology is perpetually negotiated, used as a resource by its proponents, or questioned. In the United States as well as in Europe, novelty was at the heart of nanotechnology policy. It was contested when the U.S. National Nanotechnology Initiative was created (chapter 1), during discussions about the nature of nano products such as nanosilver (in the United States, chapter 4), or throughout the discussions about the definitions of nanomaterials (in Europe, chapter 5). Constructing "new standards" for a new market, and rethinking the categorization of chemicals so that existing substances become "nano" or not were permanent concerns in the standardization organizations we encountered. Consequently, the language of the "new" entity facing existing modes of problematization cannot account for the constitution of nanotechnology.

For our concern for the democratization possibilities, this means that "novelty" cannot be considered an independent criterion according to

which the social scientist could isolate the interesting situations—both at analytical and political levels. This point is made by Michel Callon himself in a 2012 paper, where he argued that "intensive innovation," linking technological and social exploration with renewed democratic constructs, is a particular problematization, and certainly not the only one, or the more valuable (Callon 2012). Callon then suggested that the social scientist ought to multiply the possibilities for alternate problematizations to develop. This leads to a second perspective, which makes pluralism a central objective.

Pluralism

Accounting for various problematizations of nanotechnology and deciphering the variety of articulation between its objects, futures, concerns and publics, one could see pluralism as a guiding principle for both the conduct of analytical work and political engagement. Pluralism is a concept in political theory, and a category of thought originating from pragmatism. William James's "pluralistic universe" points to the philosopher's interest in reality in the making, for variations in the making of things themselves (James 1977). James's pluralism is ontological, in that it seeks to account for the variety of experiences. This resonates well with our use of problematization—a way to account for the construction of objects, futures, concerns, and publics at the same time that they are made collective problems to deal with.

At this stage, one should distinguish between two versions of pluralism, a weak and a strong one. The weak version of pluralism contends that pragmatism invites us to identify various "perspectives" of reality. This stems from a reading of classical pragmatism that focuses on variety across values. For example, discussing the "politics of the pluriverse," a political theorist developed an understanding of William James's political theory based on the pluralism of various orders of worth (Ferguson 2007). Framed this way, pluralism inevitably raises the question of relativism. Hilary Putnam, for instance, refers to Dewey in order to point to the situated objectivity of ethics, "as opposed to an 'absolute' answer to 'perspective-independent' questions" (Putnam 1989, 25). Putnam's pluralist argument leads him to argue for an ethics "without ontology," that is, an ethics that would not refer to a stable and unquestionable Being (Putnam 2004). He is then caught in the problem of relativism, since he wants to retain the objectivity of moral judgment, and the "fundamental values of liberty, autonomy and respects for persons" (Alexander 1993, 376). Putnam solves this problem by considering that objectivity, as in mathematics, is obtained within systems

of language. One can thus be "objective without object," and there is no need for a reference to an outside world to sustain ethics' objectivity.[15] Then objectivity is that of the situation within particular language games (in mathematics), or in "practical reasoning" (in ethics) (Putnam 2004, 72). The equivalent of "language games" are thus "frames" or "habits" that define values and acceptable reasoning. A recent book entitled *Pragmatist Ethics* suggests a similar reading of Dewey: the varieties of "frames" and "habits" would determine moral reasoning (Fesmire 2003). A pragmatist ethicist would recognize this variety and locate his own habits.

The political theorists interested in pluralism are concerned with the kind of world we should live in. They attempt to work on the tension between the plurality of values and the need for making a common collective.[16] But in their reflections, they do not discuss what is certainly one of the most interesting outcomes of STS research, namely the interest for ontologies, be they material objects, prospective futures, or political subjects. By contrast, the strong version of pluralism is concerned with "multiple ontologies," as Annemarie Mol would put it (Mol 2002). Pluralism then, is not about focusing the analytical work on variety across values or stable cultural frames, but rather ontological entities. Pluralism is about local answers to situated problems.[17] As such, the analysis of the problematization of nanotechnology that I have been developing could be described as a strong pluralist endeavor. But pluralism itself, even in its strong version, is not enough to account for differences across problematizations. They are not equally stabilized, or equally extended. They are not equally heard, for instance in the international arenas where countries confront each other. At ISO and the OECD, the concern for "science" separating international work separated sovereign policy decisions that make the initiatives of French delegates particularly difficult to hear, as these initiatives attempting to make the social and technical uncertainties of nanotechnology governable are still poorly equipped. The risk of pluralism is to value multiplicity without differentiating among the variety of technical and political formations.

Critical Constitutionalism

Pursuing her inquiry into the mutual production of technical and social order, Sheila Jasanoff has proposed to develop an analysis focusing on "constitutional moments." The expression, borrowed from legal scholar Bruce Ackerman, is defined as follows by Jasanoff:

These are brief periods in which, through the unending contestation over democracy, basic rules of political practice are rewritten, whether explicitly or implicitly, thus fundamentally altering the relations between citizens and the state. To this definition of constitutional change, STS scholars have added an important further dimension: namely, that constitutional moments may encompass the relationship between experts, who underwrite almost all contemporary state action, and citizens, who are collectively subject to the decisions of states. (Jasanoff 2011, 623–624)

From there, one can develop a constitutional analysis—"constitutional" in that it pertains to the allocation of roles and capacity for action within political institutions, and also to the constitutions of governable entities, be they political subjects, future prospects, or poorly identified material objects. Eventually, constitutional analysis proposes to make states, or state-like entities such as the European Union, a topic of empirical study.

Jasanoff's description of "constitutional moments" resonates with what has been the focus of the analysis in this book. The sites of problematization I looked at are windows into constitutional ordering, and those I studied could well be qualified as "constitutional moments." The French national public debate, the experimental form of real-time technology assessment in the United States, the making of "responsible research and innovation" a key component of the European research policy, or the definition of "nanomaterials" in international organizations are situations where the allocation of power within political institutions, the definition of social identities, and the crafting of ontological categories are at stake. They are sites where the nature of the democratic state, or democratic organizations, is questioned, restabilized, or displaced.

The perspective opened by Jasanoff is useful to characterize the type of engagement that this book proposes. The interest for constitutional analysis is both a guiding principle for research work and political engagement. It suggests locating sites of problematization that have constitutional amplitude, and developing their constitutional strength. Indeed, the analytical engagement in the sites of problematization of nanotechnology that I considered made it possible to account for processes that make nanotechnology a constitutional problem, whether related to the transition of the French state, the restabilization of American expertise, the legitimacy of international decision making, or the modalities of European integration.

The approach I adopted is thus a "constitutionalism," in that it is attentive to constitutional problems rather than others. It focuses on sites where both the constitution of social and technical entities and the institutional organization of democratic life are at stake. This constitutionalism is "critical," in a dual sense. It focuses on sites that are situations of trial, and where

processes such as extension, purification, or comparison may reproduce or displace constitutional order. These moments are critical in that they display explicit questions raised by the actors involved about the description of the world as it is and as it should be. They may be turning points in the redefinition of accepted problematizations, as they connect the particularities of the issues at stake (such as the engagement of nanotechnology's publics, the definition of its objects, or the government of its anticipated developments) and problems of political philosophy, raising concerns related to the public objectivity of American expertise, the conditions under which the French state can act for the general interest, the sources of democratic legitimacy of European institutions, or the nature of an international negotiation acceptable for all participating countries.

The constitutionalism I propose is also critical in that it displays the normative charge of problematizations, examining how questions about the desirability of constitutional arrangements and the possibility for alternative propositions are voiced and managed to get heard. In doing so, it is necessarily based on the political engagement of the social scientist, who chooses sites and circulates across them, thereby participating in problematization processes. Extension, purification, and comparison are also operations performed by the social scientist, as she inscribes empirical descriptions in longer genealogies, purifies messy empirical fieldwork to display regularities, and uses comparison as an instrument shedding lights on local specificities. This requires that the social scientist adapt her research methodologies so that she can navigate across different constitutional settings, adding reality to certain problems, while also inserting its analysis within the processes that might destabilize dominant problematizations. Critical constitutionalism, then, is critical in that it deploys a wide array of interventions meant to permanently question the world as it is and as it should be.

As he calls for the multiplication of "interferences" between the social scientist and his field of study, STS scholar John Law criticizes the assumption that "there is indeed a common world or collective within which we live and need to live well in together," which grounds a "constitutionalist" approach he argues against. Instead, Law contends that "in practice the world is irredeemably messy" and that "ordering is partial, incomplete, always more or less local, more or less implicit, and therefore more or less disconcerting" (Law 2010, 273, 279). Law sees an irremediable opposition between the multiplication of interferences meant to account for the messiness of the world, and attempts that presuppose the existence of macro order, possibly by introducing procedural criteria to propose

desirable democratic paths. By contrast, critical constitutionalism does not presuppose the existence (or the need for) a unique "common world," but offers a direction for the analysis of the constitution of different worlds. It does not use ready-made criteria to evaluate what is democratic and what is not, but neither is it satisfied with the mere multiplication of interferences. It is guided, when conducting research and engaging politically, by the need for accounting for processes of constitutional ordering.

Not all sites of problematization are equally interesting then. It is a matter of research work and political engagement to choose them, and make them relevant for constitutional analysis. Thus, this book has focused on sites where nanotechnology was problematized in such a way that problems for democracy were explicitly raised. By contrast, it did not make laboratories primary sites of investigation. While laboratory studies in the field of nanotechnology are helpful to describe reconfigurations of practices between disciplines, the use of technical instruments and organizational format as coordinating devices, and new concerns for "responsibility" (Hubert 2007; McCarthy and Kelty 2010; Merz and Biniok 2010), the sites I had to focus on connected nanotechnology with constitutional issues, and as such, were all related to the functioning, reproduction, or displacement of political institutions. They were entry points for the study of problematizations of nanotechnology more or less stabilized, more or less open to alternative formations, and interesting in that they were also problematizations of democracy.

Situated Democratization

Critical constitutionalism is a research program that proposes to rethink the study of democracy. It extends the set of sites where the critical study of democracy should be undertaken. It grounds a democratic theory in that it offers a pathway for the empirical description of the sites where democracy is at stake, and for the normative commitments adopted by the researcher. This theory is empirical, in that it does not seek to provide evaluative criteria independently from the particularities of problematic situations. It claims that the core of democratic life deals with the constitution of objects and subjects, and the making and stabilization of public problems. This forces expanding the kinds of sites to reflect upon when considering democratic problems, from political parties and national assemblies to more secluded places such as standardization organizations and science museums. One can then rethink the problem of external democratic criteria introduced earlier in this chapter. Rather than using categories such as

"responsibility," "anticipation," or "participation" as external resources for the evaluation of the democratic quality of collective processes, one is thus bound to make them integral components of contemporary democratic life. As such these categories now belong to what is to be analyzed, and, simultaneously, to what can and should be open for contestation.

The approach undertaken here can be read as a proposition for democratization that suggests turning more places into sites of problematization, and draws more connections among them. It calls for an examination of the sites where the possibilities for disagreement occur, and suggests exploring in what ways oppositions are eliminated, or would have the possibility to be heard. As such, the approach developed here does not make any outcome of problematization a democratic construct, but proposes to turn as many sites as possible into places where democracy is at stake. This is the reason why one can conduct that kind of analysis in international organizations and could do so in nondemocratic states. As sociologists Isabelle Thireau and Hua Linshan have shown in their study of Chinese institutions meant to respond to individual or collective protests, the official places where issues are turned into public problems are sites where democratic life might emerge in China, and where, simultaneously, demands are carefully governed so that oppositions remain limited (Thireau and Linshan 2013). As such, these places are crucial sites for potential democratization, and, simultaneously, for the repression of democratic activities.

The analysis of problematization is both modest and ambitious. It is modest in that it is not separated from the social scientist's conduct of research work, from the detailed analysis of problematization processes, and from the circulation of the analyst as she circulates across sites. Yet it is also ambitious in its objective since it proposes, rather than a never-ending examination of local sites, an approach meant to make constitutional constructs apparent. Its critical strength lies in its ability to rethink democratic ordering from its margins, where the basic tenets of democratic life are contested, restabilized, and, in some cases, displaced.

This book was set in Stone Sans and Stone Serif by Toppan Best-set Premedia Limited.
Printed and bound in the United States of America.

Library of Congress Cataloging-in-Publication Data

Names: Laurent, Brice, author.
Title: Democratic experiments : problematizing nanotechnology and democracy in Europe and the United States / Brice Laurent.
Description: Cambridge, MA : MIT Press, [2017] | Series: Inside technology | Includes bibliographical references and index.
Identifiers: LCCN 2016028724 | ISBN 9780262035767 (hardcover : alk. paper)
Subjects: LCSH: Nanotechnology--Political aspects--European Union countries. | Nanotechnology--Political aspects--United States. | Nanotechnology--Government policy--European Union countries. | Nanotechnology--Government policy--United States. | Science and state--European Union countries. | Science and state--United States. | Democracy--European Union countries. | Democracy--United States.
Classification: LCC T174.7 .L379 2017 | DDC 338.94/06—dc23 LC record available at https://lccn.loc.gov/2016028724

10 9 8 7 6 5 4 3 2 1