**Imagined and Invented Worlds**

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Science and technology have been involved in efforts to reimagine and reinvent human societies for close to two hundred years. Social theory, however, has yet to embrace this key dimension of modernity and to acknowledge the centrality of these two institutions in constructing the futures toward which we direct our presents. The concept of sociotechnical imaginaries aims to do just that. It takes as its starting point the resurgence of theoretical interest in the nature of collective self-understandings, but offers a more comprehensive framework for thinking critically about why societies follow the paths they do, and why some formations endure while others weaken and wither. It incorporates pervasive elements of modern life that normally are not included in the analysis of power and organization, such as expertise, intellectual property, bioethics, nuclear power, computers, the fear of pandemics, or genetically modified seeds. In this respect, the sociotechnical imaginary as laid out in this book is a voyaging concept: it facilitates theorizing across disciplinary boundaries by taking in ordinarily neglected dimensions of social thought and practice. And in so doing, it offers as much analytic mileage to traditional social sciences such as anthropology, history, sociology, legal studies, and political theory as it does to science and technology studies understood narrowly.[[1]](#endnote-1)

Just as imagination liberates the mind to rise beyond the constraints of the possible, so too the lens of sociotechnical imaginaries enables us, as analysts, to look for patterns and juxtapositions that cut across the conventional grid lines of disciplines. Imaginaries, to some extent, belong to the disciplinary common property of anthropology, but they have found their way into political theory, and thereby into new projects of analysis and explanation, through such anthropologically-minded scholars as Benedict Anderson and Charles Taylor. Imaginaries have also migrated into science and technology studies through writers concerned with the interpenetration of knowledge, materiality, and power. How, for example, do our co-produced sociotechnical formations bear on the potential for concerted action, stability, resistance or conflict (Jasanoff 1996, 2001, 2004; Mitchell 2002)? As noted in the introduction, sociotechnical imaginaries offer enlightening perspectives on questions of difference, time, space, and identity that form the classic subject matter of social thought. The introductory chapter mapped the major theoretical and methodological issues raised in working with sociotechnical imaginaries: when does it make sense to invoke the concept; with what methods can we study them; and what counts as evidence of their existence or effects? In this concluding chapter, I offer a more comprehensive narrative of social change, accounting for both lock-ins and transcendence, that emerges from empirical work on the nature and operation of sociotechnical imaginaries. This is a reflection on what we should be looking for when we study sociotechnical imaginaries, and what lessons we can glean from such undertakings about the social fabrication of power and meaning.

The essays in this collection serve at one level as case studies, illustrating how sociotechnical imaginaries take shape in varied social and cultural contexts, and how they in turn help reorient the evolution of those contexts. These studies exemplify but also elaborate on the definition offered in the introduction. Sociotechnical imaginaries, in our view, are “collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology.” Standing on their own, and marrying theory and observation, the chapters play rich variations on this definition. Taken together, however, they also provide a powerful new angle on world-making: one that rejects linear causality and excessively actor-centered histories while at the same time retaining an empirical focus on where transformative ideas come from, how they acquire mass and solidity, and how imagination, objects, and social norms—including accepted modes of public reasoning and new technological regimes—become fused in practice.

Reading across the cases, one finds a number of recurrent emphases that add up in effect to an account of collective belief-formation in scientifically and technologically engaged societies. First, work in the imaginaries framework necessarily invites us to examine the *origin* of new scientific ideas and technologies, and the social arrangements or rearrangements they help sustain. This is a fundamentally humanistic inquiry which recognizes the capacity of individuals and groups to see and think things differently from what was previously seen or thought. Second, by inquiring into imagination as a social practice, we follow the *embedding* of ideas into cultures, institutions, and materialities, whereby the merely imagined is converted into the solidity of identities and the durability of routines and things. Third, several of the cases illustrate moments of *resistance*, when new conceptions of how to change the world bump up against the old, or when powerful competing imaginations struggle to establish themselves on the same social terrain. These periods of emergence and conflict shed light not only on the components of successful imaginaries but also on the social apparatus that supports their continued potency. Resistant imaginaries function as a political force that can either enable or disable thoroughgoing social transformations. Last, in tracing sociotechnical projects from conception to realization, we explore the phenomenon of *extension*, the complex of processes by which unconventional ideas gain traction, acquire strength, and cross scales, for example, by persisting through time or by overcoming geopolitical boundaries.

These four phases in the development of sociotechnical imaginaries bridge several perennially problematic boundaries that have long troubled the social sciences: descriptive and normative, structure and agency, material and mental, local and translocal. Imaginaries reveal a dynamic interplay between binaries that are too often kept analytically distinct; they build on the world as it is, but they also project futures as they ought to be. Articulated and championed by agents of change, working within and beyond localized sites of action, imaginaries get built into the hard edifices of matter and praxis. Once situated in the specifics of time, place, and social worlds, they still have power to move minds and actions at a distance; and, as constructs in part of human thought, they remain continually open-ended and subject to revision. In analyzing how sociotechnical imaginaries have played out in varied concrete settings, we thus position the concept to do more general work within the analytic and explanatory repertoires of the social sciences.

This chapter follows sociotechnical imaginaries from origin to extension, noting how the four phases of turning imagination into social practice are exemplified in each preceding chapter. In revisiting these chapters. I roughly track the order in which they appear in the table of contents, and yet this is an imperfect organizational strategy, since to a greater or lesser extent each chapter illustrates all four phases of the dynamic described above—a point we try to make clear through cross-referencing. Nonetheless, origin stories figure more prominently in some early chapters, especially those focused on individuals, while material or institutional embeddings and resistance feature more in others, as does extension in still a third group. To repeat a metaphor borrowed from the introduction, the chapters form a braided whole in the study of sociotechnical imaginaries. Each tells its own distinct saga of an imagined and invented world, originating in dreams and ambitions but substantiated into people, objects, and practices. Yet, each chapter also relates to one or more others with respect to sites and modes of action, the mobilization of specific aspects of imagination, and of material technologies that provide instruments for drawing together a collective social or political imagination.

**Origins**

It takes daring individuals to dream up new worlds and give personal embodiment to loosely circulating cultural aspirations, and individuals figure prominently in many of the stories told in the preceding chapters. Thus, in William Storey’s account, Cecil Rhodes arrives in South Africa in 1870, a seventeen-year-old vicar’s son from Hertfordshire, to try his hand at farming. The land overwhelms him, much as the Hudson Valley painters of a slightly earlier day were overcome by the sweeping vistas of their grand new world. Later, as capitalist and industrialist, dreamer and technocrat, Rhodes learns to master the land. He exploits South Africa’s natural resources, especially its mines, as well as its native-born people. But the farming instinct remains alive and well in this transplanted Englishman, who in time develops vineyards as well as mines and railroads. His infamous political imaginary of racial segregation, precursor to the scourge of apartheid, comes to fruition in tandem with a less well documented imaginary of segmented sociotechnical development. In Rhodes’ vision, Storey argues, overlapping dichotomies of Black and White, labor and leisure, city and country map onto a nation segregated not only by race but by the parallel economies of its dirty, extractive, mining industries and its sometimes idyllic agricultural enclaves.

A continent and a century away, Vannevar Bush, President Franklin D. Roosevelt’s unofficial wartime science adviser, confronted a future in which the problem was no longer how to meld technology and politics into governing institutions but how to save science from its own instrumental successes. Bush envisioned a grave threat to science from its close partnership with the state at the end of the Second World War. This, as Michael Dennis argues, was a specter of state control so like the Soviet Union’s disastrous embrace of Lysenkoism that it figured as a “monster” in Bush’s imagination. Dennis traces the production of a Cold War U.S. imaginary of science and the state through the tension between Bush’s attempts to carve out a space of “basic science,” wholly free from politics, and the political scientist Don K. Price’s alternative plan to integrate politics with science in his 1954 book *Government and Science*. Price, who had the enviable opportunity to work his ideas into pedagogical practice at Harvard’s newly minted School of Government, in effect won that contest. He rightly foresaw that there was no turning back on the union between science and politics forged during the war, if not long before (Forman 2007). In Price’s imagination, however, the potential power imbalance could be managed by a networked state, in which universities and other independent entities would deliver wise, confidential advice on how to direct research in the public (read *military*) interest. A deep irony of Price’s sanitized vision was that it ignored the plight of J. Robert Oppenheimer, the physicist and national hero whose suspect loyalty to the state became the centerpiece of the infamous 1954 security hearings. Caught in the monstrous jaws of the Cold War imaginary that Bush so feared, Oppenheimer in his fall from grace—a symbol of science’s subservience to politics—illustrates the pathologies of the networked state that Price sought to render tractable through a professionalized science policy service.

The figure of the monster that energized Vannevar Bush’s postwar science policy surfaces, in one form or another, in any attempt to imagine worlds radically different from those that look threatening in the present. As such, the fear of monsters may be integral in some sense to imaginaries of resistance or revolution such as those discussed in the chapters by Felt, Moon, and Barker. A point worth noting here, though, is that monsters can fire up institutional as well as individual imaginations. In my comparative work on biotechnology policy, for example, I suggested that divergent national regulatory choices in the late twentieth century responded, in part, to culturally specific notions of what is morally repugnant, or monstrous, in projects to manipulate nature (Jasanoff 2005; see also Burri, Hurlbut this volume). Such potent ideas of what has to be avoided—the discordant harmonics of risk and disorder that trouble the uplifting strains of technological progress and liberation—are part and parcel of the construction of imaginaries.

Cecil Rhodes’ African nation-building, and eventually his imperial project, drew heavily on the model of the British Empire as he saw it. He imagined bringing “the whole uncivilized world under British rule” (Storey, this volume), although his efforts ultimately led to a form of rule entirely particular to South African conditions and circumstances. Similarly, late twentieth-century nation builders found models to appropriate, rhetorically if not in practice, from postcolonial states that elbowed their way into modernity during the postwar period. Rwanda’s Paul Kagame belongs to this cadre, as does to some extent Onno Purbo, the “father of the Indonesian Internet,” described by Joshua Barker. Kagame, in Warigia Bowman’s narrative, confronts problems that are almost the opposite of those faced by Rhodes: a nation already divided by blood and the backwash of genocide, a shattered economy, elites in disarray, and ruling institutions in ruins. With so much destruction on the ground, it is poetically just that this seasoned warrior seized on an aerial metaphor, the imaginary of South-East Asia’s “flying geese” (Akamatsu 1962), and of Singapore in particular, to will a new Rwanda into being. Bowman’s chapter describes the inevitable disjunctions between the envisioned model and its mundane contexts of application. Kagame’s is a dream of technology in the abstract, divorced from the institutional and cultural supports—such as English language proficiency and relative income equality—that made the Singaporean information technology revolution succeed. Kagame’s Rwanda progressed toward healing its deadly ethnic rifts, but big gaps remained between the leader’s soaring rhetoric of progress and on-the-ground social and technological realities.

**Embedding**

Ideas matter in the origin stories of imaginaries, whether they begin in the minds of single individuals, in projects of like-minded activists (Barker, Kim, Moon, this volume), in corporate boardrooms (Smith, this volume), or among professionals such as bioethicists trained to think together for the common good (Hurlbut, this volume). But ideas about scientific and technological futures need to gain assent outside such bounded communities in order to become full-fledged imaginaries. Often, they must latch onto tangible things that circulate and generate economic or social value: commodities like wine or diamonds; artifacts such as defensive weaponry or GM crops; legal instruments such as licenses allocating intellectual property rights; or, as in the cases of bottom-up innovation described by Moon and Barker in their stories about Indonesia, the relative hardness of long entrenched cultural expectations and interpersonal relations. This hybridization, or co-production (Jasanoff 2004) of ideas, materiality, values, and sociality happens through processes that we call embedding.

Sociotechnical imaginaries are similar in many respects to large technological systems, though they are made up in part of individual visions, dreams, and ambitions. The idea of inspiration still permeates much talk and thinking about the imagination. Imaginative faculties are imputed to specially gifted people who have not lost the childlike capacity for wonder and can call new worlds into being through sheer creative brilliance. The “technoscientific imaginaries” that George Marcus (1995) and other anthropologists have written of are largely the figments of individual envisioning. Reward structures in science, moreover, recognize and reinforce the idea of genius, which creates powerful role models for scientists; more recently, parallel structures have arisen to reward not only discovery but also invention. But one person’s vision does not make an imaginary any more than one swallow calls a summer into being. It may take considerable mental effort to rethink the process of creative projection not as one person’s “intellectual scheme” but rather as a collective reflection on a group’s “social existence” (Taylor 2002:23); nor as “mere contemplation” but as an “organized field of social practices” (Appadurai 2002:50). Nonetheless, historians of technology have long insisted that creating novel material objects involves more than individual insight; indeed, this may be the reason why the “charismatic inventor” is a rarer figure in popular mythology than the “genius scientist.” And work in science and technology studies has extensively documented that even Nobel Prize winning discoveries rely on social, cultural, economic, and normative structures in order to achieve their effects in the world (see, for example, Forman 1971, 2007; Rabinow 1996).

As many of the foregoing chapters illustrate, a foretaste of change, even when it originates with a sole progenitor, needs to be laid down upon economic, material, and social infrastructures in order to take hold at population-wide or nationwide levels. Cecil Rhodes had to move mountains, not merely in his mind but literally, and to harness new machines in order to get at the gems that propelled his stratospheric rise along South Africa’s economic and political axes. His early reflections were prescient: “Some day I expect to see the kopje one big basin where once there was a large hill” (Storey, this volume). His was a grounded, physical vision of progress, one that could not have come into being without skills, labor, connections, money, and machines—and the subjugation of bodies that worked to minds that planned the digging of pits, the laying of rails, and the ruling of continents.

Through deployments of labor and capital, including nature’s capital, imaginaries get embedded in the concrete artifacts of industrial civilization, be they massive in size like engineered landscapes, medium like nuclear power plants (Felt, this volume; Jasanoff and Kim 2009), or tiny and mobile like genetically modified organisms (GMOs) (Chen, Smith, this volume). Analogies and histories matter. Kagame in Rwanda buys into a model of development sanctioned by assumed success in Singapore. The Chinese government, according to Chen, draws on its own long history of state-sponsored rice cultivation when it buys into a genomic vision of plant breeding. To be sure, that move gains strength from a newer imaginary of scientific modernization; it also displaces farmers in the innovation chain, allowing genomic scientists to take the lead in solving the nation’s food security problem.

Embedding also occurs through group reflection by publics and other non-state actors on remembered pasts and desired futures. Ulrike Felt provides a fascinating account of the mobilization of citizens’ memories to produce a new imaginary of Austria as free from technologies seen as incompatible with national identity. Focus group research by Felt and her colleagues documents that, by the first decade of the twenty-first century, Austrian citizens took pride in being a small nation that had stood up against technologies deemed both harmful and non-Austrian. Ordinary Austrians congratulated themselves on having innovated policy instruments, such as warning labels, to enable a regime of nuclear and GMO-free coexistence within the European Union. This assertion of “epistemic subsidiarity” (Jasanoff 2012) rested on an assembling of factual and counterfactual events that together constituted a new narrative of Austrian autonomy. A powerfully imagined “balcony scene” in which the words “Austria is free” were allegedly spoken, though there is no record of that utterance being made there, an inconclusive anti-nuclear referendum later seen as dispositive, and a successful though possibly ineffectual referendum against agricultural biotechnology—all these were pieced together by citizens and the media into a compelling picture of a small state going its own way in choosing and rejecting technologies.

Memory work and imaginaries similarly loop together in J. Benjamin Hurlbut’s chapter on the legacy of Asilomar in U.S. deliberations on the ethics of biotechnology. Here, in contrast to the Austrian case, it is not citizens or non-governmental organizations who play upon collective memory, but rather scientists and ethicists who jointly affirm the potent myths of value-free and self-regulating science that are so central to American political culture (Jasanoff 2005b). These expert communities recollect Asilomar as a golden moment in which scientists took responsibility for the risks and rewards of their novel creations. Bearing little resemblance to the actualities of the 1975 Asilomar meeting, which was notable mainly for ratifying a reassuring discourse of containment around GMOs, Hurlbut’s “Asilomar-in-memory” shores up broader political and policy settlements consistent with the overarching American national imaginary of progress through scientific and technological innovation. Most significant here is the idea of a linear progression from innovation at the bench to technological applications to eventual release into the market and the world. That linear model remains a powerful resource for policymakers, even though it has been repeatedly, and thoroughly, discredited through empirical investigation (see, for example, Pielke 2007; Stokes 1997). Hurlbut’s analysis shows how the adoption of that convenient model by leading bioethicists in effect disciplines democracy itself, by permitting scientists to define when, where, and even in what terms debates about the value of technological advances should take place. Science’s right to self-governance, legitimated through the construct of Asilomar-in-memory, thus produces as its significant other a constrained understanding of democracy, in which scientists in effect define important parameters of political representation while purporting merely to declare the state of the world as it is.

The embedding of sociotechnical imaginaries takes place, then, through many partially overlapping pathways—from the production of things such as GM rice or nanomaterials that have hoped-for futures designed into them to the subtle, unacknowledged processes of collective “remembering” of events, which possibly never took place, in order to construct meaningful translations from pasts that were, to presents that are, to futures as people would like them to be. It is through embedding, whether material as in objects or psychosocial as in memories and habits of social interaction, that imaginaries are effectively translated into new contexts. Embedding thus performs an important part of the work of extension that allows imaginaries to spread across cultures, time, and space; but it is not friction-free.

**Resistance**

Imaginaries, as we have argued throughout this volume, occupy a hybrid zone between the mental and the material, between individual free will and group habitus (Bourdieu 1990), between the fertility of ideas and the fixity of things. Most importantly, however, sociotechnical imaginaries can become integrated into the discourses and practices of governance, and thereby structure the lifeworlds of larger groups, including entire nations and even transnational communities. That integration of imagination with rulership is perhaps easiest to discern in the early phases of a technology’s introduction, when evolving regulatory systems are grappling with alternative framings of risks and benefits. Moments of resistance, which threaten the disintegration of older settlements, offer additional insights into the underlying structures and assumptions of power.

Imaginaries move through the realm of resistance in double guise, sometimes raising impediments to the spread of new ideas, and at other times crystallizing the dissatisfactions of the present into possibilities for other futures that people would sooner inhabit. Revolutions, whether in science (Kuhn 1962) or in social order (Taylor 2004), can be seen as the overthrow of one no longer sufficient imaginary by another that looks more promising. Key to such complete and radical transformations is a widespread resistance to the status quo that makes the projected alternative appealing, believable, and worth attaining, even through immense struggle and sacrifice.

Heterodox imaginations are by no means guaranteed to succeed, especially when the dominant imaginary itself is strongly rooted in culture and history. Sang-Hyun Kim describes a situation in South Korea where repeated, forceful attempts to assert visions counter to those of state-supported, technocratic, developmental nationalism failed to win wider popular support. Kim shows that opposing imaginaries were at play in the development of nuclear power, the regulation of biotechnology, and the demonstrations against beef potentially contaminated with bovine spongiform encephalopathy (BSE) imported from the United States. It may matter that two of Kim’s cases—nuclear power and biotechnology—involve technologies through which states in the postwar period have particularly sought to affirm their high standing among nations. Given nuclearity’s wartime history and its ties to both military and energy self-sufficiency, nuclear power resonates quite differently in Korea from more recent new and emerging technologies. Nonetheless, it is worth noting that, unlike in Felt’s account of the Austrian case, the repertoires of resistance in South Korea seemed unable to coopt the discourses of nationhood and national autonomy.

In each South Korean controversy, activist efforts foundered against the national fear (a spectral monster) of losing an all-important competitive edge in relation to other countries. Put differently, the top-down sociotechnical imaginary of industrially driven development, repeatedly expressed in South Korea’s desire to be among the world’s technology leaders (Kim forthcoming), proved resistant to the countervailing demands of groups wishing to democratize the national politics and ethics of technology. There was no other equally compelling model of what the nation might stand for to provide the foundations for a radically new sociotechnical imaginary.

By contrast, the Indonesian father-son activists Hasan Poerbo and Onno Purbo relied less on physical vehicles to carry their imaginations and more on longstanding cultural notions of what connects people to people to form robust networks of concerted action. Muhammad Hatta and Hasan Poerbo, as described by Suzanne Moon, imagined Indonesian development in active opposition to the imaginary of New Order developmentalism espoused by President Suharto. Overthrowing President Sukarno, modern Indonesia’s first leader, Suharto grabbed power in a bloodbath of anti-communist violence in which half a million people died. He then enacted a vision of economic development that was patronage-dependent, dominated by large conglomerates, and preferring centralized industrial policy over decentralized agricultural production. Against this controlling imaginary, the anti-colonial activist and revolutionary thinker Hatta stood for a model of Indonesian development that centered on cooperatives rather than conglomerates.

Hatta’s vision was both communitarian and utopian: an understanding of the nation as a family, realizing its potential through participatory self-governance and initiative (“swakarya”). The contrast between Hatta and Indonesia’s first two presidents underscores a point not sufficiently obvious from Anderson’s theorization of nationalism: that the imagination which binds nations together rests in turn on normative, culturally conditioned ideals of solidarity, permitting multiple “nationalisms” to coexist within a single nation. Which nationalism governs is then itself a prime matter of contestation, as borne out in early twenty-first century electoral conflicts all over the world. While industrialization was not central to Hatta’s project, Moon suggests that his imaginary was sociotechnical in its emphasis on infrastructures that would advance social cohesiveness as well as economic production. Hatta advocated development from the bottom up, through self-help and concern for others in linked, small-scale projects.

It fell to the architect Hasan Poerbo to realize Hatta’s imaginary in a project for mass housing. Though specific connections between the two men are hard to document, Moon finds persuasive convergences in their thinking. Poerbo saw mass housing as a sociotechnical project that was also an alternative mode of building Indonesia’s future, relying, as Hatta had favored, on cooperatives and substituting communitarian “people-mindedness” for an industrialized “efficiency-mindedness.” Instead of drawing on networks of patronage radiating out from Jakarta, Poerbo’s project aimed to capitalize on widely distributed artisanal skills and traditional knowledge of residential construction throughout the nation. In the lineage from Hatta to Poerbo, then, Moon finds a resilient counter-articulation of an Indonesian imagined community, one that is both social and technological, yet one that relies on an utterly different networking of knowledge, skills, and communal values from the New Order put in place by Suharto.

Joshua Barker’s story of the founding of the Indonesian Internet likewise illustrates the force of an imaginary shaped outside the structures of state power and integrating technological capacities with a self-conscious “politics of freedom.” The originator of this vision, Onno Purbo (Hasan Poerbo’s son), conceives of the Internet, while studying in Canada, as a counterpoise to the top-down, state controlled development of satellite communications by the Suharto regime. *That* system, based on the Javanese oath of kingship (“Palapa”), after which it was named, corresponds more closely to Anderson’s analysis of nationalism as a communal bond enforced through centralized control of thought and communication by capital and the state. Key to Purbo’s thinking, by contrast, is the dispersed character of the Internet, enabling communication between one and many and uniting people across geographical space as well as across time. The network within Indonesia, Purbo wrote, should resemble the network that already connected Indonesian students living abroad, but in a community imagined as both national and anti-despotic. This oppositional vision of an emerging technological system illustrates at once the phenomena of extension, in its borrowing of experiences from other points of origin, and of resistance, in the local rearticulation of those distant visions to fight realities on the ground.

Notably, the tactics Purbo uses to bring his model of the Indonesian Internet into being are those of the political organizer rather than the engineer of physical interfaces. He and his associates see themselves (in their own terms) as guerilla warriors, building a freedom movement from within. Minds must be persuaded and hearts won over, in addition to expertise and infrastructure being built. Much effort is therefore expended on teaching and training a widening network (work never undertaken in Kagame’s Rwanda with its fractured civil society) and on speeches and rallies to form a “counter-public” that in time grows strong enough to influence state policy. On display here are the classic dynamics of co-production, with talented actors using social levers to reconfigure the technological: an ethos (freedom), a set of social identities (guerillas, liberationists), an understanding of what the Internet is (a commons), and aspects of the Internet’s design (accessibility) are produced in a single transformative process of enacting a new sociotechnical imaginary.

**Extension**

In an early article, Bruno Latour (1990) offered an influential account of how scientific knowledge becomes universal. His explanation centered on the moves by which localized observations are converted into readable representations, or inscriptions, that in turn are disseminated by centers of calculation, perhaps better conceptualized as centers of power, discipline, and control (see introduction). Many of today’s welter of portable knowledge claims, especially those rendered in graphic, quantified or cartographic forms, seem on the surface to conform well to Latour’s analysis—although, as two decades of climate change controversy illustrate, even the most carefully constructed representations may encounter unexpected friction and resistance when they travel (Jasanoff and Wynne 1996; Mahony 2014). Work on imaginaries, however, suggests a fundamentally different explanation for how scientific and technological ideas acquire dominion over time and territory. This dynamic works not through the frictionless mobility and erasures of context that black-box scientific facts or technological systems, but rather through the global circulation of already powerful sociotechnical imaginaries—such as those of the endless scientific frontier, innovation-driven progress, or global health crisis—which are then re-embedded into local constellations of production and practice. Imaginaries, unlike Latour’s notion of circulation, are symmetrical with respect to the production and reception of ideas and artifacts; scientific and technological ideas, in short, are produced together with ideas about science and technology. Sociotechnical imaginaries belong in this respect to the framework of co-production developed in *States of Knowledge* (Jasanoff 2004).

This more complex circulation depends, as many of this volume’s contributions demonstrate, on translation agents who are capable of moving imaginaries from one sociopolitical setting to another. Cecil Rhodes imports a remembrance of rural England into South Africa and couples that with ideas of British rule, eventually inscribing lines of division between industry and agriculture, and rulers and ruled, on a foreign landscape. Paul Kagame launches his information technology policies in Rwanda with an eye toward Singapore, hoping that his East African nation will take off like the flying geese of another continent. Onno Purbo, in Joshua Barker’s telling, accentuates with specifically Indonesian overtones the discourse of liberation associated with the early years of cyberspace. The imaginary constructed by Purbo and his colleagues, Barker says, “was an extension of a globalizing rhetoric about the Internet commons, but it was also inflected by the specific history of technology and nationalism in Indonesia.” Extension, in other words, calls for a situated re-embedding in order for translated imaginaries to take root and flourish in new soil.

Though individuals matter (as also in classic accounts of actor-network theory), unsurprisingly it is institutions of governance that operate as some of the most effective agents of extension. Institutions already have jurisdiction, that is, they control well-demarcated tracts of physical or virtual territory in which they exercise authority and implement the rules of the game. In the modern world, moreover, few institutions fulfill their jurisdictional functions without recourse to science and technology; institutional imaginaries often come with technological promises and perils built right in (see Burri, Hurlbut, Kim, this volume).

Nancy Chen dissects one such mode of extension through governance, the incorporation of biotechnology into China’s long national engagement with culturing rice. Operating through the private, but publicly funded, Beijing Genomics Institute (BGI), China muscled its way into rice genome sequencing with a “China first” strategy that led to the selection of the nation’s preferred *indica* strain as the target for sequencing. At BGI, work on the rice genome played out alongside other projects of distinctively Chinese interest, such as research on the panda and the silkworm. BGI emerged in short order as a site for hybridizing international genomic science and technology with Chinese priorities so as to underwrite a biotechnological imaginary of, by, and for the nation.

The process of integrating biotechnology into the Chinese government’s promise to safeguard the nation’s food security required strengthening some networks at the expense of others, Chen argues. The genome sequencing effort forged strong links between BGI scientists and the state but diminished the role of farmers, who were relegated to the position of technicians while scientists become de facto rice breeders through their specialist knowledge of plant genetics. While giving agricultural biotechnology a national face, then, the Chinese story also paradoxically extends and internationalizes a transnational imaginary of science-led development that puts China on the same page as the United States with respect to naturalizing—indeed imperializing (Jasanoff 2006)—a particular vision of GM technology. BGI also participated in demoting the relatively more complex understandings of ecologists and farmers in relation to the techniques of molecular biology. These are moves that Austria, along with other European states, successfully resisted (Felt, this volume), showing that extension can never be taken for granted or free from contestation.

Extension, moreover, does not imply an abandonment of political particularities. Regula Burri’s chapter uses cross-national comparison to illustrate variations between U.S. and German approaches to defining nanotechnology as a regulatory object. She shows how benefits and risks were differently weighted in these two policy environments, though both were extremely hospitable to and supportive of this promising technological sector. The U.S. sociotechnical imaginary emerged as less symmetric. American policy documents assessed the presumed benefits of nanotechnology more highly than possible negative consequences and put greater emphasis on achieving economic and political leadership than on environmental hazards. U.S. governmental authorities also imagined risks to be manageable, whereas German authorities stressed the minimization or avoidance of risk. In keeping with its more positive outlook on the future, U.S. policy placed greater emphasis on producing the ideal citizen-consumer who would help ensure a successful market for nano-products across a wide range of applications. Accordingly, while German policy envisioned a need for two-way dialogue with publics, the U.S. National Nanotechnology Initiative (NNI) invested in research centers to educate citizens so as to foster what NNI planners saw as more informed decisionmaking. Burri suggests that these differences in framing and policy focus speak to the institutionalized ways of public knowledge-making, reasoning, and uptake that I have called civic epistemologies (Jasanoff 2005b, 2012). In other words, sociotechnical imaginaries are embedded in the political cultures of nations. Projects of world-making succeed best when they are well synchronized with ongoing projects of nation-building and the reaffirmation, or re-performance, of dominant national identities.

Burri directs her attention to the public sphere, where institutionalized discourses of reason are always and already in play. Elta Smith offers one of the clearest examples of a private sector institutional imaginary in her analysis of Syngenta Corporation’s “humanitarian contract” for Golden Rice. In her analysis, the process of licensing this vitamin-enriched rice strain for use in developing countries becomes a locus for sophisticated forms of boundary drawing. Smith focuses particularly on the tacit accommodations between Syngenta’s private economic interests and its interpretation of its “corporate social responsibility” (CSR), itself shorthand for justifying self-governance by multinational corporations in the twenty-first century. This is at bottom a story of co-production, showing how a new biological entity, Golden Rice, operates simultaneously as an engineered device promising to deliver needed nutrients to at-risk bodies and as a bearer of corporate ideologies of property and ownership. As a material-legal package, the rice and the license that enables its distribution divide the world’s consumers into two distinct classes—imagined as either capable or incapable of innovating for themselves. Indeterminate contractual terms such as “humanitarian research and use” in effect delineate, and potentially hold in place, distinctions between passive consumers (the “developing”) who may derive present benefit from “donations,” but are not allowed to profit from their use, and active producers (the “developed”) who are regarded as capable of deriving future value by adding to Syngenta’s inventions.

International organizations are prominently involved in creating, institutionalizing, and extending sociotechnical imaginaries. One salient example of such extension is the emergence of globalism itself as a newly imagined space of governance in the latter part of the twentieth century. Clark Miller traces the growth of the global sociotechnical imaginary through the interaction of three frames: global security, global systems, and global governance. Humanity as a whole confronted threats perceived to be on a worldwide scale during and soon after the Second World War, largely as a result of the atomic bombing of Hiroshima and Nagasaki. But as Miller demonstrates through a close reading of statements by President Harry Truman and other officials, response capability was still thought to lodge in nation states, whose job was to create the “one world” in which all could work together to solve those big problems.

The crafting of a new imaginary of governance, with the scale of problem definition and response moved up and away from the nation state, was a product, Miller argues, of science-driven thinking in the specialized agencies of the United Nations system, most notably the World Health Organization (WHO) and the World Meteorological Organization (WMO). Increased modeling capabilities played their part, along with other scientific techniques of visualization and calculation that allowed populations to be constructed independently of national boundaries, such as people infected by HIV-AIDS or at risk from sea level rise or pandemics. The result is not a simple superseding of national authority by global institutions, but rather the emergence of new, expert-driven imaginations of how threats to the human condition should be framed and which institutions are best positioned to offer relief.

Andrew Lakoff’s chapter on global health offers an interesting counterpoint to Miller’s story. Like Miller, Lakoff focuses on the emergence of the global as a space of problem-framing and agenda-setting, with the WHO again taking center stage by developing the imaginary of “global health security.” This potentially apocalyptic scenario feeds on the confluence of novel pathogens, rapid circulation of people, and poorly distributed monitoring and response capabilities around the world. Outbreaks of infectious diseases such as Ebola, SARS (Severe Acute Respiratory Syndrome), and humanly transmissible avian flu (e.g., H5N1) have prompted a discourse of preparedness for public health disasters which, in the ideal case, will never be realized. To implement this imaginary, WHO has attempted to hold together a vast network of global surveillance with the aid of a new governance tool, the International Health Regulations, whose protocols and provisions remain open to contestation.

Lakoff’s study of a global sociotechnical imaginary in-the-making illustrates much that is problematic about extension. WHO’s project of preparedness for global health emergencies depends on the acquiescence, indeed submission, of older centers of calculation (Latour 1990), the national public health authorities that came into being with the rise of the modern state. As so often happens in national political disputes, disagreements between levels of governance, fundamentally a matter of jurisdictional struggle, translate into expert controversies. Lakoff offers two illustrations: the Indonesian Health Ministry’s refusal, starting in 2006, to share influenza virus with the international community under a doctrine of “viral sovereignty”; and the debate over whether WHO experts had overreacted in advising expensive and unwarranted precautionary measures against swine flu in 2009. Charges against the WHO experts ranged from faulty modeling to conflicts of interest, the latter rejected by a review committee appointed to study the episode. For our purposes, however, the key point here is that the WHO’s imaginary of global governance, underwritten by new knowledge and enabled by new technologies of monitoring and surveillance, remains as yet imperfectly realized. Even in an era of intensified globalization, nation states remain alive and well as sovereign centers of imagination and governance.

Miller’s and Lakoff’s chapters not only chronicle the birth of an imaginary of supranational governance, but also the frictions and conflicts that accompany any effort to extend imagination’s rule over new subjects and territories. Resistance in these cases operates almost as a physical force impeding the supposedly free flow of globalization. But oppositional movements could also stimulate the creation of new sociotechnical imaginaries that might lay the groundwork for far-reaching reforms in current understandings of sovereignty, constitutionalism, and democracy.

**Conclusion: Fabricating the Future**

Science fiction, I suggested in the introduction, is a repository of sociotechnical imaginaries, visions that integrate futures of growing knowledge and technological mastery with normative assessments of what such futures could and should mean for present-day societies. Utopic or dystopic, these fictions underscore the self-evident truth that technologically enabled futures are also value-laden futures. Science fiction stories express fears and yearnings that are rooted in current discontents, either signaling possible escape routes or painting in morbid colors the horrific consequences of heedlessness in the present. They thus offer a deeper look into—possibly even predictions of—what harms societies are most desperate to avoid and what good they may achieve through foresight and imagination.

Marking its fiftieth anniversary in 2013, the celebrated British television series *Doctor Who*, the longest running science fiction show ever, and like James Bond a marker of Britain’s high cultural standing, gave *New Statesman* columnist Laurie Penney a chance to comment on fiction’s power to shape the future. The time-traveling Doctor, Penney noted, had gone through numerous incarnations in the show’s half-century of colonizing the national psyche, with a third of the British population tuning in to the series. Yet, though change was built into the plot line from early on, the eleven Doctors since the show’s inception had all been white men. Arguing that it was time to shift basic assumptions about the Doctor’s color and gender, Penney (2013:21) observed, “Sweeping social change usually happens in stories first, and science fiction often has an agenda. What could be more political, after all, than imagining the future?” Indeed! The twelfth Doctor, Peter Capaldi, however, was not to be the harbinger of that particular revolution.

This volume attests to the basic rightness of Penney’s intuition—that imagining the future is political—but it carries that intuition one symmetrical step forward, showing that political action is also profoundly imaginative. People, in Penney’s view, “do the work of changing the world—but stories give us permission to reimagine it” (Penney 2013:21). That statement overlooks the degree to which the political life of societies is itself a form of collective story-telling, a joint and several imagining of the purposes and the potential of living and working together on an Earth at once malleable and constraining. Political imaginaries shape the future as they reinscribe or reconfigure the past (see Ezrahi 2012). Politics, in other words, continually enacts, and therefore also engenders, the dreamscapes of modernity. This volume has sought to establish the centrality of science and technology in those acts of imagining, not only through the material productions of technoscience, but through the very ideas and practices of “science” and “technology” as formative, and normative, forces in the world.

Politics, in the terminology of this volume, is a space in which sociotechnical imaginaries originate and flourish. Those imaginaries help explain why societies differ (Burri, Felt), how they evolve through time (Dennis, Kim, Moon, Storey), how powerful visions spread through space (Bowman, Chen, Lakoff, Miller, Smith), and how they in turn burrow into human identity and subjectivity (Barker, Felt). The framework of imaginaries allows analysts to gain purchase on the dynamics of social change, asking how reality comes about at any given moment rather than taking the plainly visible structures of society for granted. In this respect, sociotechnical imaginaries are part of the repertoire of the constructivist and interpretive social sciences. They consistently direct our attention toward the practices of collective sense-making and the tacit assumptions that allow collectives to hold together in understandable, sustainable, livable modes of being.

Reading across the preceding chapters, we have identified four phases in the construction of sociotechnical imaginaries: origins, embedding, resistance, and extension. In each phase, there is a tension between stability and change which the lens of imaginaries permits us to interrogate more closely. That push and pull is perhaps clearest in the phase of resistance, which can block change as well as facilitate it. The Indonesian stories told by Moon and Barker suggest, however, that resistance is most likely to lead to reorderings of technology and society when an imagined new order draws on deeper notions of how societies ought to fit together and how they ought to be. Memory work serves a similar function in the phases of embedding and extension, allowing novel technoscientific constructs to be most readily naturalized when they fall in line with the way things are remembered as being. Those recovered memories, as Felt and Hurlbut show in their chapters, become internalized in human subjects, giving new meaning to what it means to be an Austrian, for example, or a member of a biosciences community.

A persistent risk of working with imaginaries is that they may come to be taken as unproblematic, as mere descriptions of things as they are in the collective consciousness of various sorts of groups. Ascribing a fixed ontological status to sociotechnical imaginaries, however, would rob them of their analytic value. Such an approach could easily become both overwhelming and superficial, elevating any and every act of projection or prediction to the status of an imaginary. Instead, what makes the careful study of imaginaries rewarding is that one is forced to look at the stylized moves through which collective mindfulness is trained, moves that may, as we have repeatedly seen, endow social actors with some forms of prescient vision, even with the capacity to move mountains, while rendering them oblivious to alternate forms of organization, order, and justice. An inquiry into sociotechnical imaginaries allows at its best a deep meditation on the basis of a technological society’s particular forms of sightedness and blindness, and the trade-offs that inevitably accompany attempts to build a shared normative order.

Above all, the turn toward the imagination, together with an emphasis on the creative potential of science and technology, makes possible a study of alternative futures. That sociotechnical orders are not natural, that they do not reflect any intrinsic properties of humans or things, is by now too well established to need belaboring—at least for interpretive analysts. But the corollary that other worlds are always there for the making is less well understood and still less acted upon. At times, the juggernaut of global capital, driven by the furious whip of technological innovation and tuned to a univocal discourse of progress, seems unstoppable. Yet, as almost all of the studies in this book plainly demonstrate, multiple imaginaries can be spun from the same raw materials of invention and will. By situating their stories in specific contexts of struggle and achievement, the authors in this volume continually point to roads less seen and less traveled, but that are there nonetheless for the critical imagination to map and explore. Analyzing sociotechnical imaginaries emerges, then, as a form of intensely political narration, reminding both observers and observed that the seen reality is not the only one about which we can dream.

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ENDNOTES

1. Many outside the field of science and technology studies understand STS to be simply about characterizing how science works and how technological objects and systems are produced. This is STS in a narrow sense. STS, properly understood, includes the full-blown investigation of science and technology in society, hence not only how truth claims are established or machines are made, but also how the social, political, and cultural authority of science interacts with that of other powerful institutions. [↑](#endnote-ref-1)