MADE MODERN
Science and Technology in Canadian History

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Introduction
Science, Technology, and the Modern in Canada

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For much of the twentieth century, scholars cast science and technology as great engines of modernity. In a world where revolutions provided the machinery of historical development and Western Europe was its focus, systematic knowledge and radical invention were prime movers.[1] The revolutions of science and industry, that story held, contributed as much to the origins of the modern world as did the political upheavals that shook the eighteenth and nineteenth centuries. Originating in Western Europe, those developments spread over the globe through conquest and commerce. Contemporaries expressed the experiences of those changes in the powerful language of geology and celestial physics – abysses, earthquakes, eruptions, crushing gravitational forces – reaching for a vocabulary to capture magnitudes beyond the scale of the human.[2] Their historians cast knowledge and machines in that disembodied role. With their rationalism and empiricism, their novelty and utility, and their intellectual and physical mastery over the natural world, science and technology provided a model of profound rupture with the past, helping to usher in the rationalized, industrial, democratic, secular societies of the modern age. They furnished "the real origin both of the modern world and [of] the modern mentality" as well as the fountains of its disenchantment.[3]

We have since become wary of these kinds of sweeping claims. The huge variety of historical transformations over the past four centuries makes the neat clockwork narrative of modernity ring false. Revolutions were never

the singular ruptures we were taught. The Scientific Revolution, mirroring Voltaire's quip about the Holy Roman Empire, was neither singular nor "scientific" nor a "revolution."[4] The transformations in production that go under the label of the Industrial Revolution coexisted alongside traditional and adaptive modes of working life and labour.[5] And, rather than strip the world of its charms, modern observers have long attempted to conjure up and preserve enchantment in both natural knowledge and material inventions.[6] The origin story of European modernity has also been challenged by scholars aiming for a more global history of our times.[7] Yet, rather than undermine the relationship between science, technology, and the modern, those studies have made that relationship stronger, more vibrant, and more complex. Knowledge and machines were as much products of their societies as they were progenitors of them. Solutions to the problems of science and technology – how knowledge should be produced, how machines should be designed and built – were simultaneously solutions to problems of social order.[8] Far from being external and autonomous forces, scientific knowledge and technical artifacts formed the very fabric of modernity. They became implicated not only in factory machinery, economic empires, and industrial landscapes, but also in the identities, anxieties, and understandings of people living through those revolutionary yet all too recognizable times.

This volume contributes to this rich and varied scholarship. It explores the utility of thinking about the history of Canadian science and technology through the lens of the "modern." Rather than telling a story of diffusion from European origins, it asks how the relations among scientific knowledge, material artifacts, and the modern were made, mobilized, and challenged in a nation at once deeply embedded in European political, social, and cultural norms and profoundly shaped by colonial anxieties. The chapters tease out the ambiguities, contradictions, and instabilities in Canadian scientific and technical activities throughout the nineteenth and twentieth centuries to engage diverse iterations of the modern. They unsettle historical and contemporary assumptions about the meanings and experiences of modernity, and they make important interventions in national and international historiographical debates. Most of all, they seek to explore how science and technology have formed the sites for Canadians to imagine, renounce, and reshape themselves as modern.

As a category of historical analysis, the "modern" in its various forms – modernity, modernism, modernization – has come under intense criticism

in recent decades.[9] As a term of art, the root "modern" traces its improbable origins back to late fifth-century Latin, where it denoted something "of the present time." By the seventeenth-century battle between the Ancients and the Moderns, it was already linked to the idea of linear time, tying it to a view of the past as both irrevocably lost and somehow flawed, and to ideological programs that saw the present as the first step toward a more perfect future.[10] For nineteenth-century observers such as Gustave Flaubert, it meant newness and the fleeting present, and it was expressed in a series of "modernisms" – literary, artistic, scientific, economic, political – that laid out what it meant to be "of the age." Of all its protean forms, though, the most mist-shrouded and contentious has been its status as a historical condition – "modernity."[11] For scholars who assert its analytical force, modernity signals shifts so rapid that they represent a step-change in human social organization: the rise of the centralized nation-state, of the public sphere, of industrial capitalism, of global commerce, of large-scale bureaucracy, of mass urbanization, and so on.[12] It also signals a set of experiences, often in tension with those broader processes, that call for critical examination – the creation of a society of strangers; a sense of constant change, rupture, and upheaval; a valuation of newness; an attendant narrative of loss; an appeal to overarching rational schemes; and, most consistently, a recurrent set of contradictions, paradoxes, and tensions: hope and fear, despair and exhilaration, degeneration and new birth.[13] For its critics, modernity complacently assumes a linear understanding of historical development, a sweeping narrative of progress and change, implicit judgments of Western European superiority, and a sanctioning of the darker histories of science and technology. As such, it not only normalizes the European experience, but also casts the rest of the world as peoples waiting to become modern – consigned, as Dipesh Chakrabarty has observed, to the "waiting room of history."[14]

As proxies for modernity, Western science and technology are deeply implicated in that history and its problems. As Immanuel Wallerstein has noted, those two enterprises stand for the supposed triumph of humankind over the natural world.[15] Their origin stories are tied to the very idea of the modern. The term "science" as denoting a disciplined inquiry into the phenomena and order of nature, for example, had no coherent counterpart in the sixteenth and seventeenth centuries. The very category of science as we understand it was a creation of the modern period, deeply entwined with its ideologies of progress and perfection, but also of doom, foreboding, and danger. Similarly, the idea of technology as an autonomous historical force

took shape amid the public spectacle of production, transportation, and innovation in the late nineteenth century and early twentieth century.[16] As such, science and technology (as we understand them) carry the contradictions of the modern age. They represent both the abstract, modern ideals of betterment and the concrete agents of change and destruction – of tradition, of values, of the natural world – that have sparked the fury and frustration of antimodernists, saboteurs, luddites, and environmentalists alike. They have been invoked as instruments of freedom, ones that smoothed the transoceanic and transcontinental passages of people, goods, and ideas through networks of exploration and trade. Yet they were also deployed to classify, enslave, and control non-Western peoples, reifying ideas of "purity" that set modern objects against the hybridity of premodern cultures and that ranked premodern peoples beneath the "enlightened" nations of the world.[17] Those contradictions were inscribed in the very fabric of scientific theories and material technologies that, in turn, furnished the central metaphors of utopian social and political ideologies such as Taylorism, Bolshevism, and fascism; that cast human relations in increasingly abstract and quantitative terms; and that inspired the aesthetic modernism of the Futurists, the Dadaists, jazz, and the Precisionist movement of the early twentieth century.

One response to these criticisms has been to expand what counts as modernity – to explore multiple modernities and multiple ways of being modern.[18] These critical responses have the great merit of turning the modern into a global phenomenon, and therefore into the subject of global history.[19] They recognize the wide array of possible actions, reactions, and responses as people grappled with larger historical processes and struggled to feel part of them. At stake, in this view, is the right to historical representation and agency – the ability of the world's peoples to be modern on their own terms, and therefore to appear as full participants in the history of modernity.[20] Others see these attempts to democratize modernity as representing their own presentist judgments, as obscuring and diluting the concept, robbing it of its analytical force.[21] From this view, the modern is a useful category only if it denotes a singular (though possibly contested) process or condition, with commonalities stretching across continents and centuries, even if different societies experience them differently in different places and times. As Carol Gluck writes, modernity is indispensable for historians precisely because societies could not choose another historical condition for themselves; the similarities of their experiences make truly alternative modernities impossible.[22]

As a simple story of origins and superiority, then, modernity holds little promise. Its great value as a category of historical analysis lies in its enormous appeal to people around the globe – to people who helped to coproduce it, particularly in nations that often saw themselves as marginal or diminished.[23] Those people and nations helped to make modernity a global phenomenon rather than "a virus that spreads from one place to another," in Sanjay Subrahmanyam's words.[24] Ignoring this aspirational modernity and its enormous appeal outside Europe simply reinforces the Eurocentrism that threatened to ignore non-European hopes and contributions in the first place.[25]

This book aims to explore the usefulness of the modern, as both historical condition and historical aspiration, for thinking and writing about science and technology in Canada. It begins from the premise that modernity represents a specific and concrete historical condition that shaped Canadian society and Canadians' experiences of themselves and their place in the world. For people around the globe, modernity provided a powerful attraction as a form of life and a way of being.[26] In Canada, its intersections with science and technology formed sites through which contemporaries channelled and expressed their own conscious modernity, sought to bring their modernist visions into being, or reacted to modern anxieties and excesses. Science and technology also gave rise to occasions when Canadians internalized modern values, presumptions, and attitudes that shaped their choices and actions as much as any conscious criteria.[27] As for so many others, for these people, positioning themselves on the map of modernity mattered crucially for their own identities.[28] By studying the historical uses of the idea of the modern and its links to science and technology, scholars can better understand historical experience in general and Canadian experience in particular. Chapters in this volume use midlevel concepts and specific objects – patents, the occult, exploration, scientific rationality, and infrastructure, to name a few – to illuminate the contours of Canadian engagements with science and technology and to situate them within larger national and transnational developments characteristic of the modern world.[29]

Canada Has Always Been Modern

Born in the late nineteenth century, the settler-colonial nation of Canada has always been modern.[30] It is no surprise, then, that historians of English and French Canada – the majority of whom, like those working in other national schools of history, still tend to use the nation or nation-state as their referent – have been keen to interrogate Canadians' multifaceted

experiences of modernity in different times, places, and polities.[31] A handful of historians, including Keith Walden, Christopher Dummitt, Jarrett Rudy, Nicolas Kenny, and Jane Nicholas, have studied iterations of modernity in Canada directly. Their studies range usefully from the late nineteenth century to the late twentieth century, and from Vancouver to Montreal.[32] Most recent Canadian historical writing on the modern, however, has approached the subject more obliquely, through one of three lenses: modernization, as connected most immediately to urbanization and industrialization; antimodernism; or high modernism.[33] A brief look backward through these lenses will help readers to sight similar themes in the chapters that follow.

With the social historical turn well embedded in mainstream Canadian historiography, many scholars have attended to the greatly variable pressures of modernization in this nation. These have left uneven and often inequitable imprints on gendered, racialized, classed, aged and aging, and regionalized bodies. We know more than we did a generation ago about the effects of modernization on men in their private and public lives, including how both managers and the managed fared in newly industrialized and rationalized sites of work.[34] We know much more about women's experiences of modernization at different points in their lives and labours, including those of young women, working women, and mothers, and about the ways in which children and adolescents were prepared in modernizing homes and schools to enter modernizing workplaces.[35] We continue to learn about Indigenous peoples' encounters with modernization and about those of people living in parts of the country coded as "remote" or "un(der)-developed" by metropolitan gazes both historical and contemporary.[36]

These studies collectively demonstrate that, in differing fashions throughout late nineteenth-century and twentieth-century Canada, the bodies of women, men, and children all came, by turns, to signify one or more of the perils of modernization and hence modernity: physical enervation and degeneration through overcivilization, social licentiousness, sexual immorality, and the like. As the subtitle of Carolyn Strange's classic monograph suggests, these perils were all the more urgent since they derived from, or were often experienced most immediately as, distinctly modern pleasures – the newfound freedom that the city offered to young women, or the delight that teenagers of all genders drew from commercialized leisure.[37] These pleasures threatened the integrity not only of individual bodies, but also of the body politic. Given its relative youth compared with other Western

countries, Canada was often discursively figured as an immature or adolescent nation throughout the modern era.[38] It was therefore perceived as all the more important that the forces of modernization be bent toward developing Canada's nascent social and economic potential, and that they produce a fully-fledged nation that used its flourishing human and nonhuman resources *ad majorem patriae gloriam.*

But important to whom, precisely? The will to modernize flowed along sometimes well-worn channels in Canadian society. Power pooled at the feet of particular groups: politicians and civil servants; manufacturers and purveyors of commercial goods; moral reformers and their descendants, social workers and public health officials; medical, educational, and psychiatric professionals; urban planners; and, of greatest interest to this volume, scientists, technicians, and engineers. Although projects undertaken by such modernizers often came cloaked in sleek, modern raiment, they tended to buttress well-established premodern structures of power, as Cynthia Comacchio has noted of early twentieth-century modernization schemes aimed at Ontario's mothers and children.[39] These top-down efforts often had substantial, long-lasting, and sometimes unintended effects on people's lives. Yet Canadian historians have also concluded that the results were rarely as comprehensive or as permanent as modernizers would have liked.

Canadians responded individually as well as collectively to the perils of modernization. Studies of paradigmatic sites in which Canadians were taught, and taught themselves, how to be modern subjects – the department store, the summer camp, the industrial exhibition – emphasize that learning to be modern could be difficult, stressful, and even frightening.[40] Even as they sought the pleasures of modern life, many Canadians also sought to escape its perils. They found refuge in places and practices that historians today term "antimodern," or brimming with intense, authentic, or risk-laden experiences not easily found amid the supposed banality and homogeneity of modern life.[41] In Canada, as elsewhere, antimodernism was often infused with notions of the martial, primitive, folksy, rustic, or wild, and not infrequently some blend thereof. Scholars have demonstrated how both Nova Scotia and the North were constructed as antimodern spaces par excellence.[42] They have also charted the plethora of activities that brought antimodernists physical and psychological relief from the exhausting or otherwise undesirable features of modern life. These activities included, but were not limited to, hunting and fishing, camping, climbing mountains, painting *en*

plein air, collecting folklore and handicrafts, writing and reading sentimental poetry and Mountie adventure stories, engaging in wilderness tourism, and participating in organized sports and drill.[43]

Despite their best and, one assumes, sincerest efforts, Canada's anti-modernists did not so much jettison the modern as force it underground. Not only were their actions and perceptions ineluctably framed by the circumstances and concerns arising from modernization, but they also often carried with them into the bush or the village the very modern habits and values that they ostensibly sought to leave behind. Indeed, some of these outcroppings of antimodernism, particularly those associated with the North and the wilderness, have greatly influenced modern imaginings of the Canadian nation. The (in)famous cultural-mythical-nationalist complex constructed around the Group of Seven and their hinterland art over the last near-century best exemplifies how individual Canadian reactions to modernity could be writ large on a national canvas, shaping others' actions in turn.[44]

Nowhere have the perils of modernity been delineated more acutely in recent years, perhaps, than in the growing scholarly literature on high modernism in Canada. Historians have concentrated especially on hydroelectric dams and power projects, the signature charismatic megastructures of the postwar era. Even before the Second World War, modernization projects were not confined to urban centres, of course. As Stephen Bocking relates in this volume, and as Tina Loo and John Sandlos, among others, have demonstrated elsewhere, state and nonstate conservationists lobbied for and enacted various policies and programs to manage the hinterland's nonhuman (and, indirectly, human) populations and resources in what they considered to be an efficient and rational manner.[45] But the physical, financial, and administrative scales of megaprojects after 1945 dwarfed all previous efforts, sometimes alarmingly so, to those Canadians who stood literally and figuratively in their paths.

Even as Canadian historians have fit James C. Scott's seminal work on high modernism to homegrown contexts, they have inflected it with considerably more nuance. To Scott, "seeing like a state" meant the inability or unwillingness to leaven the characteristic top-down, synoptic gaze of high modernity with "mētis," or local knowledge about the social and environmental particularities of sites slated for development.[46] Yet Tina Loo and Meg Stanley have found just such a downward slide in scale in the preparations to construct hydroelectric dams on the Peace and Columbia Rivers. Engineers and geologists spent years studying sites at first hand and drawing up detailed maps and surveys that contained what Loo and Stanley term

"high modernist local knowledge," or "the knowledge that provided pixels for the larger synoptic picture."[47]

Nor did Canadians experience the "strong" version of high modernism that Scott originally laid out in his case studies of mid-twentieth-century authoritarian states. As a liberal democratic nation, Canada played host to what Daniel Macfarlane has named "negotiated high modernism."[48] Civil servants, engineers, planners, and corporate representatives held community consultations and conducted public relations campaigns to persuade people in the way of these projects to cede their lands and uproot their lives in the name of progress and prosperity. Many citizens took the opportunity to speak back to power and to present alternative visions of modernity that privileged different modes of social and economic life in common.[49] Ultimately, however, their visions did not hold water; hydroelectric dams did. Political and economic powers manufactured and extracted consent with a characteristic high modernist cudgel in hand – the technological power to flood entire landscapes and homelands – that local residents found almost impossible to resist. They paid a heavy price. Abruptly sundered from the natural and social spaces to which they had long been accustomed, they had to deal with the ensuing trauma even as they painstakingly forged new relationships with environments new to them, and often new under the sun, remade as they were through concrete and steel and water.[50]

In our professional duty as critical analysts of the past, and perhaps in our own *fin de siècle* disenchantment with late modernity (beautifully articulated in Eda Kranakis's chapter), historians after the social turn have tended to emphasize the weak, failed, and destructive aspects of modernization and high modernism in Canada. Science and technology loom large in these dark-edged narratives. Motherhood never became as scientific as doctors and child welfare professionals had prophesied; bodies proved to be flawed organic machines in factories and other workplaces; the failures of other machines, as much as their triumphs, defined natural worlds and national identities.[51] Meanwhile, engineers revivified the power, if not the judgment, of God of the Old Testament, flooding plains and valleys and drowning all in their wake. The optimism that many nineteenth-century and twentieth-century Canadians felt about science, technology, and modernity, on display in many of the chapters herein, can strike historians as foreign, stale, or sadly misplaced in the light of subsequent events.

Yet the affective pendulum may be starting to swing in the other direction once more. Historians such as Tina Loo and Joy Parr have drawn lessons of redemption and hope from Canadians' sometimes misguided experiments

with modernity. In a recent review of the Canadian historiography on high modernism, Loo emphasizes megaprojects' creative and transformative as well as destructive powers and demonstrates how a synoptic view can enhance our ability to steward the nonhuman world wisely. Parr concludes her monograph on postwar megaprojects by focusing on residents' resilience in the face of worlds remade.[52] These scholars' turn toward the positive may have stemmed from their familiarity with environmental history and, in particular, that field's struggles with declensionism, or the propensity to tell narratives of unrelenting decline that leave readers with a sense of futility rather than agency in the face of continued large-scale environmental issues.[53] Canadians still live in a modern era, and the problems of late modernity are, alas, not limited to anthropogenic climate change. Historians of modernity in Canada need not don antique pairs of rose-tinted glasses when casting an analytical gaze backward. But they might consider the value of finding and telling stories that showcase the pragmatic, recuperative, hopeful – and yes, even optimistic – ways that Canadians faced and dealt with the challenges and setbacks of modernity in this country, not least because their descendants might find some grains of wisdom or inspiration therein.

Canadian Science and Technology Have Never Been (Just) Canadian

Histories of Canadian science and technology have not traditionally held centre stage in either the national or the thematic historiographies to which they contribute. However, as Beth Robertson reminds us in her chapter, views from the fringe can productively challenge received narratives not only about science and technology but also, indeed, about Canada itself. Take, for example, the multiple perspectives from the country's geographical fringe, the North, on display in this volume. Andrew Stuhl and Tina Adcock, respectively, demonstrate how northern scientific reports and exploratory permits simultaneously enhanced and undermined Canada's sovereign and epistemic power on the North Atlantic stage. Their chapters, along with Blair Stein's, also demonstrate the often tenuous nature of Canada's political and cultural claims to nordicity. Could eschewing their country's long, cold winters in favour of "sun destinations" make Canadians less Canadian? Is snowbirding a national betrayal? Scholars of Canada have regularly presented both technoscience and the North as enrolled in the service of the state, supporting top-down expressions of soft and hard power. But the fidelity of these instruments was not assured. Even when deployed ostensibly to shore up state authority, they could just as easily (and sometimes unintentionally) draw attention to cracks in the nation's façade.

If we look at another set of the nation's liminal spaces, its borders, writing the history of science and technology there reveals not only the instability but also the porosity of the modern nation. A steady procession of humans, nonhumans, and material artifacts circulated freely across its thresholds in the pursuit of these practices. As the volume's first two chapters illustrate, English ethnologists such as Richard King and American explorers such as George Palmer Putnam came to study the human and natural populations of northern Canada. State agents sometimes scrutinized these foreigners suspiciously in turn. Meanwhile, Canadian specimens, scientists, and technologies ranged far beyond Canada's borders, sketching out both familiar and surprising trajectories (as discussed below). From this brief borderland reconnaissance, we can draw two provisional conclusions, which are supported empirically by many of the chapters that follow. First, science and technology in Canada have never been unambiguously Canadian. Second, the modern history of Canadian science and technology does not stop at the border; it is as much a transnational as a national story.

Neither of these points is novel, historiographically speaking. Once-dominant Western narratives of development presented the progress of colonial and settler-colonial states such as Canada toward modernity as the product of international diffusion and transfer. Historians traced the movement of constitutional, scientific, and technological models from imperial centres to territories characterized as peripheral or "virgin," where they were planted atop those of Indigenous cultures and societies. They demonstrated how colonial politicians and scientists drew their countries along neat, unidirectional pathways, past uniform and universal milestones of achievement. By journey's end, they argued, these colonies had not only become nations but had also developed uniquely national styles of techno-scientific endeavour. Although universalist, positivist teleologies of scientific diffusionism and technological transfer have now almost completely fallen out of scholarly fashion, they formed part of the intellectual backdrop against which the field of Canadian science and technology emerged in the mid-1970s and helped to shape the first generation of inquiries into these subjects.[54]

Those initial efforts focused heavily, if implicitly, on central features of technoscientific, Eurocentric modernity – institutions and education, disciplines and professionalization, marginalization and identity, nation building and market economies, technocracies and political power.[55] Reflecting both the historiographical currents traced above and contemporary concerns about Canadian sovereignty and identity beyond the academy, early

scholarship in this field sought to locate the distinctive role of science and technology in Canadian culture and history, even proposing a Canadian "style" of technoscientific development.[56] Here, the work of Richard Jarrell merits particular attention, both for inspiring the conference that gave rise to this volume and for providing the Canadian field with much of its foundation. Trained in both astronomy and the history and philosophy of science at Indiana University, but increasingly disillusioned by political developments in the United States, Jarrell represents a double displacement – an American choosing Canada as both adoptive country and intellectual focus. Across a wide array of topics, regions, and periods, he returned again and again to the central place of science and technology in the social and cultural development of Canada. Like so many scholars in this nascent field, Jarrell was concerned to clarify what distinguished Canadian technoscience from its European and American counterparts.[57] His research explored the ideas and processes of Canadian nationhood; the geographical, political, and environmental factors that gave Canadian science its utilitarian focus; the relationship between seemingly radical European metropoles and conservative Canadian peripheries; and the historical conditions on the ground – population density, political control, economic resources – that enabled a shift to what he (and others) considered a fully national iteration of science and technology in Canada.[58]

At stake in those investigations was an urgency to articulate Canada's place and significance in a world at once defined and transformed by the practices, priorities, and products of modern science and technology.[59] Jarrell, along with Carl Berger, Robert Bothwell, Yves Gingras, Trevor Levere, Suzanne Zeller, and others, took the nation as the foundational unit of analysis.[60] Subsequent scholarship by Canadian historians of science and technology has increasingly probed that assumption, problematizing the nation itself as a historical actor. Few areas better reflect this shift than the emerging body of work linking science and technology to commerce and political economy. In his recent book on the Hudson's Bay Company's scientific networks, Ted Binnema demonstrates how eighteenth-century and early nineteenth-century corporate patronage provided international material and symbolic networks that predated the Canadian nation, while modelling symbiotic relations between science, political status, and commercial profit for the future Canadian state.[61] Similarly, social histories of commercial technology in Canada can reveal things that the view from the nation-state conceals. Building upon the work of business and economic historians, Dorotea

Gucciardo's study of the late nineteenth-century and early twentieth-century electrification of Canada moves away from the view of electricity as an object of political governance. It presents electrification as an international social phenomenon, one profoundly linked to the gendered histories of consumption, domesticity, and labour in Canada.[62] A focus on corporations, consumers, commercial infrastructures, and networks provides an alternative perspective on "national" science and technology, one that points us to the scales, systems, and processes that underlie and supersede the modern nation-state. It also transforms our understanding of the kind of nation Canada has been and has been understood to be, both inside and outside its borders. Pierre Bélanger's recent engagement with the subject of mining, a topic that has long preoccupied Canadian historians, does more than illustrate how modern Canadian life came to be mediated through mineral extraction. By placing Canadian mining activities within the context of global economic infrastructures, Bélanger also charts the nation's surprising course from *colony* to *empire*: from a resource-producing colony of Great Britain to an extractive empire in its own right. What would it mean for Canadians to think of themselves, as Bélanger argues they should, as the planet's pre-eminent "extraction nation" – as not just a giver but also a taker of natural wealth the world over?[63]

As these examples indicate, scholars have come to favour scales both smaller and larger than the nation. Historians of new imperial, postcolonial, and global science and technology encourage us to focus upon the dynamic tension between the local, contextual features that play an important role in determining how science and technology are practised and experienced in a given place (and time) and the transnational flows of people, goods, and ideas that connect disparate sites of technoscience and bring new and transformative influences to bear on modes of scientific and technological conduct there.[64] Such methods draw from and are further developed in tandem with those now used in the broader fields of postcolonial, transnational, and global history. Their findings are often of interest to scholars working in those traditions as well, including those whose work nourishes a small but growing body of transboundary, transatlantic, and transnational histories of Canada.[65]

Even as it contributes to the wider transnational turn in Canadian history, then, this volume initiates a similar turn in the history of Canadian science and technology. Taken together, its case studies move between micro- and macroscales, revealing distinctive local elements of scientific

and technological cultures, practices, and artifacts across Canada and situating them within larger historical circuits and historiographical conversations. These chapters begin to locate the place of knowledge in Canada. They demonstrate how the particularities of specific sites and localities were integral to the fashioning of Canadian science and technology.[66] By establishing a handful of discrete data points, the authors contribute to the ongoing project of assembling a more coherent, if inevitably pointillist, history of these activities in modern Canada.[67] Even if we discard notions of some kind of inevitable or hegemonic Canadian style of science and technology, we still know far too little, as David Theodore notes in his chapter, about the precise contours of modern science and technology in Canada. Is the figure of Gerald Bull, the aeronautical engineer turned arms dealer, as atypical as Edward Jones-Imhotep suggests? (In all fairness, we suspect so.) In piecing together the larger technoscientific history of modern Canada from smaller actor- and site-specific narratives, we aim to help future historians better distinguish between the normal and the exceptional, the usual and the unusual, and the mean and the deviations, and to adjust their hypotheses and methods accordingly.

While eschewing an exceptionalist approach to the modern history of science and technology in Canada, we build upon scholarship that tries to identify signature influences, themes, and patterns in Canadian scientific and technological practices, whether at the local, regional, or national scale. Both historians of science and technology and environmental historians have weighed in, pinpointing features such as the central role of technology in Canadian history, the diversity and extremity of Canadian ecosystems and climates, the country's abundance of renewable and nonrenewable natural resources, and the prominence of the state in scientific and technological endeavours.[68] The authors herein add their own suggestions, most notably David Theodore, who asserts that "normal science in Canada is small science." In light of the considerable archival and analytical spadework that lies ahead for historians of Canadian science and technology, we offer such statements more as hypotheses that require further testing than as definitive assertions about the nature of science, technology, and the modern in this country.

The authors also position these local and localist histories of science and technology as nodes within larger transnational networks of circulation and exchange. They inquire into how the movements of scientific and technical personnel, objects, and knowledge across borders connected Canadian manifestations of science and technology to those practised elsewhere, and

they suggest how Canadian science and technology transformed, and were transformed by, these bodies and ideas in motion.[69] Many of the human and nonhuman itineraries charted in these pages will be at least somewhat familiar to readers. They follow paths similar to those laid out in older continental and imperial histories of Canada, as well as in newer borderland and transnational ones.[70] The chapters reveal how different streams of medical, technological, and engineering knowledge, actors, and practices flowed north from the United States and west across the North Atlantic from Europe. For its part, Canada offered the world both raw and processed versions of technoscientific personnel, knowledge, techniques, and objects – the most delicious of which was likely vanillin, as James Hull details in his chapter.

This volume also bears witness to transnational trajectories and circuits less often discussed in the pages of globally minded Canadian histories. All-weather, jet-age airplanes helped mid-twentieth-century Canadian vacationers to engage, albeit a little uneasily, with the sun-soaked environments of Florida and the Caribbean. Similar landscapes served as sites of technologically mediated work as well as leisure, as we see in the case of McGill's High Altitude Research Project on Barbados.[71] Canada has entered the scholarly literature on Cold War geographies of hostile or "intemperate" environments – arctic, desert, tropic, alpine – chiefly by way of the Arctic.[72] Edward Jones-Imhotep's chapter reveals that Canadian scientists contributed to research on the Tropics, too. Following Gerald Bull's peripatetic career reveals what is perhaps the most surprising extra-Canadian connection in this volume – Saddam Hussein's Iraq. Bull repackaged ballistics technology originally intended to help a middle-power nation such as Canada compete with better-funded nations in the space race and resold it to the Iraqi government as a means by which to modernize Iraq in the late twentieth century. The example of Bull underscores the potential value of individual "life geographies" in delineating the scope and trajectories of Canadian histories of science and technology outside Canada. Such travelling actors can double as ad hoc dye injections, their movements illuminating pathways previously hidden from the historian's gaze.[73]

By telling stories about modern Canadian science and technology that reach well beyond the nation's borders, this volume joins other transnational histories of Canada in articulating and analyzing Canada's contributions to global social and economic networks, including the defining structures of industrial capitalism. The chapters by Jan Hadlaw, James Hull, and Eda Kranakis reveal Canadian reactions and contributions to sweeping historico-economic

developments: how people were taught to be customers and consumers; how industrial production was reimagined as a scientific process; how natural objects were recast as intellectual property. Their accounts reshape global histories of capitalism by centring perspectives often considered to be peripheral. As Adele Perry notes, there is "power in studying empire from its ragged margins."[74] We submit that the same holds true for studying modern Canadian history from the perspective of science and technology, which have often been relegated to the margins of Canadian historiography. The stories told from the fringes in these pages subtly upend well-known narratives of nation. Listening to them, one begins to sense that modern Canada is less northern (Adcock, Stuhl, Stein), less peaceful (Jones-Imhotep, Kranakis), and smaller (Theodore) than we have been led to believe.

Centres and peripheries are relative, mutable spaces, however. They attain such status by dint of their social, economic, intellectual, and institutional capital (or lack thereof) as much as by their physical placement.[75] Are science and technology really marginal in modern Canadian history, then? Or have they simply enjoyed the attention of fewer historians for a briefer period of time? With this in mind, we further submit, in a twist on Percy Bysshe Shelley's phrase, that science and technology have been the unacknowledged legislators of modern Canada.[76] They have been essential to Canada's (high) modernization, for better *and* for worse, and they richly embody the hopes and contradictions of modern life in this country, as the chapters that follow ably demonstrate.

Bodies, Technologies, Environments

This volume is organized around three key themes – bodies, technologies, and environments – that reflect traditional and contemporary strengths among historians of Canadian science and technology, including historians of medicine, architecture, and the environment. The three are interlinked in modern Canada, as Dolly Jørgensen's epilogue shows. Guided by these themes, the authors train their analytical gaze on exemplary discursive and material sites, asking and answering a series of linked questions. How do bodies help us to understand the confluence of science, technology, and the modern in Canada? How do technologies? How do environments?

The chapters corresponding to the first theme join a growing Canadian literature on sensuous and corporeal histories, often grounded in experiences of modernity.[77] They also join a rich literature on the conceptual, material, and social intersections of medicine with science, technology, health, and the body in Canada.[78] Their particular interest, however, lies in studying

how Canadian bodies were remade and reimagined through new scientific categories and theories and technological therapies, and how they were taught to be modern through the mastery of new practices and disciplines. In different ways, they focus on bodies or activities on the fringes, whether geographical, intellectual, or social. These fresh perspectives on the modern invite readers to reconsider the relationship between Canadian bodies and the Canadian nation, a matter of interest in other recent scholarship.[79]

We begin at the temporal edge of the modern and at the spatial edge of what would become Canada with Efram Sera-Shriar's chapter on the British physician Richard King and his early nineteenth-century expedition to what are today Nunavut and the Northwest Territories. Sera-Shriar places the ethnographic view from nowhere in northern Canada, illustrating how King's experiences there led directly to the reform of British race science.[80] Even as King sought to modernize ethnographic witnessing and reporting, providing both data for armchair ethnologists and methods for fieldworkers to follow, he was unexpectedly touched by the hardships that northern Indigenous peoples faced, which he believed the Hudson's Bay Company's policies had exacerbated. For King, modern ethnography was inherently humanitarian. Its duty was to civilize the people whom it studied and so to lead them into the modern world, where they could interact with other moderns on common ground.

Remaining on northern soil, Tina Adcock examines two expeditions of more recent vintage, those led by the American publisher George Palmer Putnam to the eastern Canadian Arctic in the mid-1920s. Adcock uses these expeditions and the diplomatic furor they caused as a vehicle to analyze the boundary-work surrounding the state's regulation of foreign scientists and explorers wishing to work in the Northwest Territories. The newly minted Scientists and Explorers Ordinance gave civil servants the ability to compel fieldworkers to abide by certain rules and regulations, but it also produced an unexpected, if rather modern, problem of classification (and, by extension, professionalization). What, exactly, constituted science or exploration, as opposed to sport hunting or tourism? Putnam's expeditions appeared legitimate enough on paper, but their use of migratory birds for target practice and consumption transgressed the epistemic and legal boundaries of northern field science. Although American diplomats rushed to mend the damage, the incident exposed the limits of Canadian scientific as well as political sovereignty in the Arctic Archipelago.

Both Adcock's chapter and the one that follows, by Dorotea Gucciardo, reflect different therapeutic solutions to the enervating hustle of late

nineteenth-century and early twentieth-century urban life. While Putnam and his son David turned to the archetypal antimodernist cures of hunting and fishing in "wild" surrounds, other city dwellers sought technological cures for modern problems. Gucciardo charts the rise and fall of electrotherapy in urban Canada between 1880 and 1920. Electricity was a double-edged sword, she argues: it raised modern life to the fevered pitch that caused neurasthenia and hysteria, but it could also supposedly cure those same ills. Like Adcock, Gucciardo probes the boundary between licit and illicit practices of modern science. Electrotherapeutists rarely had medical training, but the presence of such technologies in physicians' offices helped to legitimate their wider use. In pulling back the curtains shielding these spaces from view, Gucciardo reveals the intimate and gendered nature of modern encounters with medical technology. Both rhetorically and materially, electricity penetrated and modernized Canadian bodies for a time. But the changing social and intellectual contours of medicine eventually disconnected electrotherapy from mainstream currents of thought, leading to its interwar demise.

Beth Robertson's chapter evinces a similarly intimate gaze with respect to bodies and modernity. It examines another set of fringe discourses and practices, this time pertaining to the occult. Focusing on a group of spiritualists based in Kitchener-Waterloo and led by the medium Thomas Lacey, Robertson charts their engagements with new theories of atomic energy from the 1930s to the 1950s. These spiritualists not only integrated knowledge produced by modern physicists into their discourses on the nature of bodily and psychical energies but also questioned the very boundary between spiritualism and science, as captured in the phrase "occult science." Lacey's group viewed the advances of atomic science in a predominantly positive light, believing that this power could ultimately lead to the rejuvenation of human bodies and perhaps even human immortality. This optimism about the ability of modern science and technology to ameliorate the human condition recurs throughout the chapters in this section, as in the sections that follow.

In 1974, the editors of a primary-source reader on technology and society in Canadian history averred that "Canadians know more of prime ministers than they do of the creation of the technological structure that is the framework for the nation's economic and social life."[81] Just as a generation of social historians has broadened Canada's knowledge of past actors beyond the prime ministerial, so too historians of technology have begun to put

flesh on the infrastructural and mechanical bones that support Canadian society. The chapters in the second section approach the specific question of technology and the modern in Canada in various ways. Some situate practice in place, examining the emergence of distinctive technoscientific cultures at the regional or national level in Canada. Others illustrate how technologies could reinforce or challenge what it meant to be modern in Canada, or to be Canadian in the modern era. Still others trace the circuits of technicians, technical knowledge, and technological artifacts between Canadian sites and those located elsewhere, extending the history of Canadian technology beyond the Canadian ecumene.

In the section's opening chapter, James Hull questions the supposed causal connection between urbanization, first-wave industrialization, and modernization in Canada. He argues that modernization actually emerged from Canada's "Second Industrial Revolution," or the move toward industrial research and applications grounded in science and technology and based upon an improved understanding of the natural world. His chapter discusses this concept with precision, considering the nature of production and organization in this revolution; the roles played by gender, class, and the state; the connections between Canadian and American industries; and the distinctive and outstanding features of the Canadian experience of this revolution. Hull seeks to trouble supposed turning points in Canadian modernization, such as the Laurier boom and the First World War, and gives Canadian actors full credit for technological success where credit is due. He concludes that the Second Industrial Revolution brought significant change to Canadian society by 1914 and that certain second-wave industrial sectors in Canada really were world class, in the sense of making important international contributions.

As Jan Hadlaw notes, the ability to use new technologies was not automatically acquired, but little information on technical education in past eras has survived.[82] Having uncovered such sources, Hadlaw is able to tell a relatively rare kind of technological story, about Bell's educational campaign in central Canadian cities to ease its subscribers' transition to dial telephony between the wars. The introduction of automatic dialling threatened well-established cultures of sociability surrounding the telephone and stoked all-too-modern fears about the dark side of mechanization, including social atomization and technological unemployment. Deftly defusing these modern anxieties by drawing upon pre-existing telephonic relationships and practices, Bell strove to convince its customers that dialling for oneself was

"preferable and progressive." The company deployed a plethora of strategies, including window displays, print manuals, and person-to-person demonstrations, to teach customers how to operate the new instruments properly. Hadlaw argues that it was by learning how to use modern technologies such as dial telephones that Canadians acquired the ability, both practically and imaginatively speaking, to think of themselves as modern.

David Theodore offers a novel perspective on postwar science in Canada, one situated firmly in a specific place: the Montreal Neurological Institute at McGill University. Using the career of Christopher Thompson and his PDP-12 minicomputer as his narrative and analytical vector, Theodore develops the notion of "small science." In contradistinction to "big science," often considered the dominant or default mode of practice after the Second World War, small science was characterized by several key factors: a one-man research team, the idea of trained acquaintance, and bounded experiences of space (built and unbuilt) and time. A focus on small science, Theodore argues, may help researchers to glimpse and capture telling stories that often fly beneath the radar of historians of science attuned to bigger, multidisciplinary iterations of this activity. It also brings to the fore the importance of biographical or smaller-scale factors in the creation and maintenance of particular scientific workplaces. Finally, if "normal science in Canada is small science," as Theodore asserts, then his chapter may point the way to a better overall understanding of modern scientific practice in this country.

A man and his machine(s) also lie at the heart of Edward Jones-Imhotep's chapter, which traces the curious rise and fall of Gerald Bull and his outsized cannons. Bull's story exemplifies many of the tensions surrounding science, technology, and the modern in mid-to-late twentieth-century Canada. Like the optical illusion of Rubin's vase, depending on one's perspective, Bull's cannons could appear either as scientific instruments designed to forward atmospheric research and secure Canada's place in the global space race or as superguns designed to intimidate one's neighbours and thus recalibrate regional Cold War geographies of power. Place mattered: something that clearly facilitated research when positioned on the Quebec-Vermont border assumed a more threatening mien when embedded in Barbados or Iraq. But the cannons and the modern sentiments that encircled them also travelled well. As they moved from mid-twentieth-century Canada to late twentieth-century Iraq, they continued to embody a particular technological panacea for fears of insufficiently rapid national

modernization. Yet, as Jones-Imhotep shows, Bull's technocratic, rational arguments about the peaceful nature of his superguns neither crossed space so easily nor wore so well over time, something mirrored in Bull's own transition from research scientist to arms dealer to assassination target.

Similar themes of violence and disorder permeate Eda Kranakis's chapter about Monsanto's patented Roundup Ready® strain of canola and the legal wrangles that ensued after its introduction to the Prairies near the end of the last century. Wielding biotechnological patents expertly, Monsanto challenged at long-standing modes of rural agrarian sociability and patterns of land use in its quest to saturate the Prairies with its new, weed-resistant seed regime. Monsanto approached the space of the court with equal expertise, redrawing the human-nonhuman boundary for its own benefit and relying on widespread scientific illiteracy among members of the legal profession and the Canadian public to press home its advantage. Canadian farmers had long operated according to the tenets of high modernist agriculture, in which science and technology represented the possibility of controlling and ordering agricultural landscapes. Kranakis illustrates how that ideological compact unravelled rapidly under Monsanto's onslaught; science was used as a means of control *against* farmers and as a tool to foment social *disorder.* Percy Schmeiser, the Saskatchewan farmer who bore the brunt of Monsanto's wrath, now stands as a global symbol of the power of late modern technoscience to harm, rather than help, farmers and agricultural landscapes.

Kranakis's chapter leads naturally into the volume's final section on environments, which reflects the nonhuman world's propensity to loom large in Canadian histories of all stripes, including those dealing with science and technology. These disciplines, practices, and artifacts have found an equally natural home in the pages of Canadian environmental historical scholarship, an especially fertile (and still growing) field within the past decade or so. The strengthening rapprochement between scholars of science and technology and those of the environment is evident outside Canada as well, perhaps most notably in the hybrid field of "envirotech," or envirotechnical history.[83]

Within the Canadian academy, Stephen Bocking has been among the scholars most committed to studying science and the environment in tandem. He continues that work in his contribution to this volume, which surveys what he terms the "landscapes of science" in modern Canada.[84] Bocking charts the history of modern scientific and technological interventions

in Canadian landscapes, organizing his narrative around four key themes: the extension of state authority over territory, the transformation of landscapes for profit, the administration and regulation of environments and human activities therein, and the disruption of views about science and human interactions with the nonhuman world in the late modern era, most notably through Indigenous traditional ecological knowledge and citizen science. The symbiotic relationship between science and modernity helped to tame and rationalize unruly Canadian landscapes and their inhabitants. Yet, as Bocking illustrates humans and nonhumans outside this privileged coupling continually challenged and confounded the best-laid plans of scientists and modernizers alike.

Andrew Stuhl picks a different path through the landscapes of Arctic, Canadian, and global science. He follows the transnational production and circulation of one set of scientific texts, the fourteen-volume *Report of the Canadian Arctic Expedition 1913–1918,* throughout the interwar years. Although this expedition is often depicted, not without reason, as a story of scientific adventure in the service of the nation, its reports were produced with the assistance of and according to the standards of the international scientific community. Once complete, they helped to burnish the profile of Canadian science on the world stage. As the *Report* circulated throughout the Western world, it informed subsequent scientific endeavours in projects and disciplines sometimes quite distant from the field site and nation of its birth. Closer to home, as Stuhl illustrates, the *Report* produced new economic and environmental visions of the Arctic that enhanced, yet also subverted, established notions of Canada's northernness. In narrating this object biography and tracing its transnational geographies, Stuhl's chapter nicely complements other chapters' investigations of individual scientific actors and their thought-provoking travels through more-than-national networks.

In her chapter, Blair Stein, like Sera-Shriar, Adcock, and Stuhl, turns her gaze on Canada's cold climes; unlike her fellow authors, however, she is primarily concerned with questions of technology. Stein studies Trans Canada Air Lines/Air Canada's innovations in aviation between the 1940s and the 1970s, including the introduction of the Canadair DC-4M North Star and "sun destination" routes, and considers how they were conceived and marketed as solutions to Canadians' midcentury anxieties concerning winter mobility. Even as these new technologies and routes helped Canadians literally transcend their country's unique geographical and seasonal challenges, their characteristically modern disruption of space and time began to

destabilize national identities rooted in common experiences of Canada's vast distances and cold winters. Climatic claims of triumphalism in the face of inevitable Canadian winters gave way to climatic expressions of ambivalence once Canadians could fly south on jetliners to the Caribbean and swap Canadian winters for "Canadian summers," or escape Canadian winters altogether. As with northern science in Stuhl's chapter, midcentury technologies of aviation both propped up and destabilized Canadians' long-held assertions of nordicity. The ability to spend the winter on sunny, warm beaches was cold comfort for some climatic patriots, leading to John Crosbie's call in 1977 to "ban the tan."

Daniel Macfarlane returns our gaze to Canada's heartland and, more specifically, to the St. Lawrence River, which became host to the eponymous Seaway and Power Project in the 1960s. This megaproject becomes the crucible in which Macfarlane develops the idea of "negotiated high modernism," a version of this ideological program tailored to liberal democratic states such as Canada. Negotiated high modernism bore many of the same hallmarks as high modernism, at least on the St. Lawrence. Engineers full of enthusiasm for rational, quantitative ways of understanding complex environments gathered local knowledge, modelled landscapes as they were and would soon become, and created whole new envirotechnical systems on the ground. People were relocated into modernized villages, but only after the local power authority had undertaken elaborate, multifaceted measures to manufacture their consent to do so. Knowledge travelled as well. The St. Lawrence Seaway and Power Project drew on personnel and expertise from other engineering megaprojects around the world, and it became a pedagogical site of high modernity to which non-Canadian hydraulic engineers flocked. Although negotiated high modernism favoured the carrot rather than the stick to bring about its desired outcomes, it still demonstrated the capacious power of governments and companies to permanently reshape Canadian lives and landscapes along the St. Lawrence River.

In 1980, Bruce Sinclair predicted that "we shall discover science and technology to be close to the centre of Canadian experience."[85] Since then, historians of these activities have done much to reveal the truth of this assertion. We now know that science offered settler-colonial Canadians the ability to comprehend and thus claim a sprawling territory through techniques of inventory and description.[86] Technology offered them the ability to "collapse" space and time, helping to knit a disparate and far-flung citizenry together. The discovery of insulin in the Banting laboratory brought hope to diabetes patients everywhere; the discovery of uranium in

the Subarctic made Canada complicit in the real and potential destruction of the atomic age. Modern science and technology were perceived as a conduit for Canada's national maturation, holding out the prospect of pride and glory on an international stage. But they could also bring shame, as when doctors performed nutritional experiments on Indigenous children on reserves and in residential schools.[87] This volume affirms the central role that science and technology played in the creation of modern Canada and the value of circulating Canadian case studies to scholars of science, technology, and modernity beyond Canada's borders.

NOTES

The authors would like to thank Nicolas Kenny and the two anonymous reviewers for their thoughtful comments on earlier versions of this introduction.

1 For representative works, see David S. Landes, *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present* (London: Cambridge University Press, 1969); J.D. Chambers, *The Workshop of the World* (London: Oxford University Press, 1968); E.J. Hobsbawm, *Industry and Empire* (New York: Random House, 1968); E.P. Thompson, *The Making of the English Working Class* (New York: Pantheon, 1964); and A. Toynbee, *The Industrial Revolution* (Boston: Beacon Press, 1957).

2 Marshall Berman, *All that Is Solid Melts into Air: The Experience of Modernity* (New York: Viking Penguin, 1988), 13.

3 Herbert Butterfield, *The Origins of Modern Science: 1300–1800* (New York: Free Press, 1965), 8; Edwin Arthur Burtt, *The Metaphysical Foundations of Modern Science* (Garden City, NY: Doubleday, 1954), 15–24; Alexandre Koyré, *From the Closed World to the Infinite Universe* (Baltimore: Johns Hopkins University Press, 1979), 1–3; Katharine Park and Lorraine Daston, "Introduction: The Age of the New," in *The Cambridge History of Science,* vol. 3, *Early Modern Science,* ed. Katharine Park and Lorraine Daston (Cambridge, UK: Cambridge University Press, 2006), 15–16.

4 Steven Shapin, *The Scientific Revolution* (Chicago: University of Chicago Press, 1996).

5 Charles Sabel and Jonathan Zeitlin, "Historical Alternatives to Mass Production: Politics, Markets, and Technology in Nineteenth-Century Industrialization," *Past and Present* 108, 1 (1985): 133–76; Daryl Hafter, *European Women and Preindustrial Craft* (Bloomington: Indiana University Press, 1995); Francis Sejersted, "An Old Production Method Mobilizes for Self-Defense," in *Technological Revolutions in Europe: Historical Perspectives,* ed. Maxine Berg (Northampton, MA: Edward Elgar, 1998); Thomas Max Safley, *The Workplace before the Factory: Artisans and Proletarians, 1500–1800* (Ithaca, NY: Cornell University Press, 1993).

6 See, for example, John Tresch, *The Romantic Machine: Utopian Science and Technology after Napoleon* (Chicago: University of Chicago Press, 2012).

7 For the specific case of the history of science and technology, see, for example, David Edgerton, *The Shock of the Old: Technology and Global History since 1900* (Oxford:

Oxford University Press, 2011); Vanessa Ogle, *The Global Transformation of Time: 1870–1950* (Cambridge, MA: Harvard University Press, 2015); Avner Wishnitzer, *Reading Clocks, Alla Turca: Time and Society in the Late Ottoman Empire* (Chicago: University of Chicago Press, 2015); Gyan Prakash, *Another Reason: Science and the Imagination of Modern India* (Princeton, NJ: Princeton University Press, 1999); Joel Wolfe, *Autos and Progress: The Brazilian Search for Modernity* (Oxford: Oxford University Press, 2010); David Arnold, *Everyday Technology: Machines and the Making of India's Modernity* (Chicago: University of Chicago Press, 2013); Marian Aguiar, *Tracking Modernity: India's Railway and the Culture of Mobility* (Minneapolis: University of Minnesota Press, 2011); On Barak, *On Time: Technology and Temporality in Modern Egypt* (Berkeley: University of California Press, 2013); and Timothy Mitchell, *Rule of Experts: Egypt, Techno-Politics, Modernity* (Berkeley: University of California Press, 2002).

8 Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton, NJ: Princeton University Press, 1985).

9 Although the contributions to this volume partly interrogate these various forms, our working assumption is that modernization represents the institutional transformations that characterize the emergence of modernity, whereas modernism represents either implicit or explicit expressions of what it means to be modern. For a persuasive criticism of modernity as a historical construct, see, for example, Kathleen Davis, *Periodization and Sovereignty: How Ideas of Feudalism and Secularization Govern the Politics of Time* (Philadelphia: University of Pennsylvania Press, 2008); and Kathleen Davis and Nadia Altschul, eds., *Medievalisms in the Postcolonial World: The Idea of "the Middle Ages" outside Europe* (Baltimore: Johns Hopkins University Press, 2009).

10 Richard Foster Jones, *Ancients and Moderns: A Study of the Rise of the Scientific Movement in Seventeenth-Century England,* rev. ed. (New York: Dover, 1982); Joseph M. Levine, *Between the Ancients and the Moderns: Baroque Culture in Restoration England* (New Haven, CT: Yale University Press, 1999).

11 The literature on modernity is vast. On the controversy surrounding it, see David Lyon, *Postmodernity* (Minneapolis: University of Minnesota Press, 1999); P. Osborne, Michael Payne, and Jessica Rae Barbera, "Modernity," in *A Dictionary of Cultural and Critical Theory,* ed. Michael Payne (West Sussex, UK: Wiley-Blackwell, 2010), 456–59; and "AHR Roundtable: Historians and the Question of 'Modernity,'" *American Historical Review* 116, 3 (2011): 631–751.

12 C.A. Bayly, *The Birth of the Modern World, 1780–1914: Global Connections and Comparisons* (Oxford: Blackwell, 2004), 11.

13 Dipesh Chakrabarty, "The Muddle of Modernity," *American Historical Review* 116, 3 (2011): 663–75. On modernity as a set of contradictions, see Berman, *All that Is Solid Melts into Air;* and Torbjorn Wandel, "Too Late for Modernity," *Journal of Historical Sociology* 18, 3 (2005): 255–68. On modernity as loss, see Sumathi Ramaswamy, *The Lost Land of Lemuria: Fabulous Geographies, Catastrophic Histories* (Berkeley: University of California Press, 2004). See also Zvi Ben-Dor Benite, *The Ten Lost Tribes: A World History* (Oxford: Oxford University Press, 2009); Dick Teresi, *Lost Discoveries: The Ancient Roots of Modern Science – from the Babylonians*

to the Maya (New York: Simon and Schuster, 2002); Michael Hamilton Morgan, *Lost History: The Enduring Legacy of Muslim Scientists, Thinkers, and Artists* (Washington, DC: National Geographic, 2007); Elizabeth McHenry, *Forgotten Readers: Recovering the Lost History of African American Literary Societies* (Durham, NC: Duke University Press, 2002); and Jonardon Ganeri, *The Lost Age of Reason: Philosophy in Early Modern India, 1450–1700* (Oxford: Oxford University Press, 2011).

14 Chakrabarty, "The Muddle of Modernity," 663; Gurminder K. Bhambra, "Historical Sociology, Modernity, and Postcolonial Critique," *American Historical Review* 116, 3 (2011): 653–62; Dipesh Chakrabarty, *Provincializing Europe: Postcolonial Thought and Historical Difference* (Princeton, NJ: Princeton University Press, 2000), 8. As Lynn Thomas notes, African history came into being partly as a way of challenging the racist, teleological, and condescending presumptions of this understanding of modernity. Lynn Thomas, "Modernity's Failings, Political Claims, and Intermediate Concepts," *American Historical Review* 116, 3 (2011): 727–40. Achille Mbembe has argued that the burden of responding to this racism has limited writing and thinking about Africa. Achille Mbembe, "African Modes of Self-Writing," trans. Steven Rendall, *Public Culture* 14, 1 (2002): 239–73; Achille Mbembe, "On the Power of the False," trans. Judith Inggs, *Public Culture* 14, 3 (2002): 629–41.

15 Quoted in Alexander Woodside, *Lost Modernities: China, Vietnam, Korea, and the Hazards of World History* (Cambridge, MA: Harvard University Press, 2006), 18. For a discussion of the relationship between science, technology, and competing understandings of "nature," see the introduction to Edward Jones-Imhotep, *The Unreliable Nation: Hostile Nature and Technological Failure in the Cold War* (Cambridge, MA: MIT Press, 2017).

16 On the history of science, see Park and Daston, "Introduction," 2. On the emergence of technology, see Leo Marx, "Technology: the Emergence of a Hazardous Concept," *Technology and Culture* 51, 3 (1997): 561–77; and Eric Schatzberg, "'Technik' Comes to America: Changing Meanings of 'Technology' before 1930," *Technology and Culture* 47, 3 (2006): 486–512.

17 See Michael Adas, *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance* (Ithaca, NY: Cornell University Press, 1990). For an extended discussion of modern concerns about purity and hybridity, see Bruno Latour, *We Have Never Been Modern*, trans. Catherine Porter (Cambridge, MA: Harvard University Press, 1993).

18 See S.N. Eisenstadt, "Transformation of Social, Political, and Cultural Orders in Modernization," *American Sociological Review* 30, 5 (1965): 659–73; *Early Modernities,* special issue of *Daedalus* 127, 3 (1998), including Shmuel N. Eisenstadt and Wolfgang Schluchter, "Introduction: Paths to Early Modernities – a Comparative View," 1–18; *Multiple Modernities,* special issue of *Daedalus* 129, 1 (2000); Shmuel N. Eisenstadt, ed., *Multiple Modernities* (New Brunswick, NJ: Transaction Publishers, 2002); Dominic Sachsenmaier and Jens Riedel, with Shmuel N. Eisenstadt, eds., *Reflections on Multiple Modernities: European, Chinese, and Other Interpretations* (Leiden: Brill, 2002); Charles Taylor, *Modern Social Imaginaries* (Durham, NC: Duke University Press, 2004); and Ibrahim Kaya, *Social Theory and Later Modernities: The*

Turkish Experience (Liverpool: Liverpool University Press, 2004). For a summary of the multiple modernities approach, see Bhambra, "Historical Sociology, Modernity, and Postcolonial Critique."

19 Zvi Ben-Dor Benite, "Modernity: The Sphinx and the Historian," *American Historical Review* 116, 3 (2011): 638–52. For debate regarding the distinction between global and world history, see Bruce Mazlish, "Comparing Global History to World History," *Journal of Interdisciplinary History* 28, 3 (1998): 385–95; Maxine Berg, "From Globalization to Global History," *History Workshop Journal* 64, 1 (2007): 335–40; and William Gervase Clarence-Smith, Kenneth Pomeranz, and Peer Vries, "Editorial," *Journal of Global History* 1, 1 (2006): 1.

20 Carol Symes, "When We Talk about Modernity," *American Historical Review* 116, 3 (2011): 715–26.

21 Frederick Cooper, *Colonialism in Question: Theory, Knowledge, History* (Berkeley: University of California Press, 2005), 127; Chakrabarty, "The Muddle of Modernity," 665; James Vernon, *Distant Strangers: How Britain Became Modern* (Berkeley: University of California Press, 2014).

22 Carol Gluck, "The End of Elsewhere: Writing Modernity Now," *American Historical Review* 116, 3 (2011): 676–87. For a criticism of this usage, see Cooper, *Colonialism in Question,* 113–49.

23 Gluck, "The End of Elsewhere."

24 Sanjay Subrahmanyam, "Hearing Voices: Vignettes of Early Modernity in South Asia, 1400–1750," *Daedalus* 127, 3 (1998): 99–100.

25 Ibid.

26 Ibid.

27 On the wider self-conscious modernity of societies, see Bayly, *The Birth of the Modern World.*

28 Dorothy Ross, "American Modernities, Past and Present," *American Historical Review* 116, 3 (2011): 702–14. For an analysis of how American modernity differed from European modernity, see Jürgen Heideking, "The Pattern of American Modernity from the Revolution to the Civil War," in Eisenstadt, *Multiple Modernities,* 219–47.

29 Thomas, "Modernity's Failings, Political Claims, and Intermediate Concepts," 737.

30 Cynthia R. Comacchio, *The Dominion of Youth: Adolescence and the Making of a Modern Canada, 1920–1950* (Waterloo, ON: Wilfrid Laurier University Press, 2006), 12.

31 Although Quebeckers' experiences of modernity and modernization align in many respects with those of other Canadians and citizens of other industrializing nations, they have also been shaped, both in the past and present, by political and religious trends distinctive to that province. A full discussion of Quebec's historical and historiographical encounters with the modern lies outside the scope of this introduction. For pathways into this subject, see, for example, Jean-Philippe Warren, "Petite typologie philologique du 'moderne' au Québec (1850–1950). Moderne, modernisation, modernisme, modernité," *Recherches sociographiques* 46, 3 (2005): 495–525; Martin Petitclerc, "Notre maître le passé?: Le projet critique de l'histoire

sociale et l'émergence d'une nouvelle sensibilité historiographique," *Revue d'histoire de l'Amérique française* 63, 1 (2009): 83–113; and Peter Gossage and J.I. Little, *An Illustrated History of Quebec: Tradition and Modernity* (Don Mills, ON: Oxford University Press, 2012).

32 Keith Walden, *Becoming Modern in Toronto: The Industrial Exhibition and the Shaping of a Late Victorian Culture* (Toronto: University of Toronto Press, 1997); Christopher Dummitt, *The Manly Modern: Masculinity in Postwar Canada* (Vancouver: UBC Press, 2007); Jarrett Rudy, "Do You Have the Time? Modernity, Democracy, and the Beginnings of Daylight Savings Time in Montreal, 1907–1928," *Canadian Historical Review* 93, 4 (2012): 531–54; Nicolas Kenny, *The Feel of the City: Experiences of Urban Transformation* (Toronto: University of Toronto Press, 2014); Jane Nicholas, *The Modern Girl: Feminine Modernities, the Body, and Commodities in the 1920s* (Toronto: University of Toronto Press, 2015).

33 A decade ago, Cecilia Morgan noted Canadian historians' fascination with anti-modernism and their concomitant lack of attention to modernity. Cecilia Morgan, *"A Happy Holiday": English Canadians and Transatlantic Tourism, 1870–1930* (Toronto: University of Toronto Press, 2008), 18–19.

34 Craig Heron, *Lunch-Bucket Lives: Remaking the Workers' City* (Toronto: Between the Lines, 2015), and Dummitt, *The Manly Modern,* provide good place-specific overviews of these broader changes. Placed side by side, these two narratives span most of the modern era.

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40 Donica Belisle, *Retail Nation: Department Stores and the Making of Modern Canada* (Vancouver: UBC Press, 2011); Sharon Wall, *The Nurture of Nature: Childhood, Antimodernism, and Ontario Summer Camps, 1920–55* (Vancouver: UBC Press, 2009); Walden, *Becoming Modern in Toronto.*

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65 See, for example, Karen Dubinsky, Adele Perry, and Henry Yu, eds., *Within and without the Nation: Canadian History as Transnational History* (Toronto: University of Toronto Press, 2015); Benjamin H. Johnson and Andrew R. Graybill, eds., *Bridging National Borders in North America: Transnational and Comparative Histories* (Durham, NC: Duke University Press, 2010); Nancy Christie, ed., *Transatlantic Subjects: Ideas, Institutions, and Social Experience in Post-Revolutionary British North America* (Montreal/Kingston: McGill-Queen's University Press, 2008); Allan Greer, "National, Transnational, and Hypernational Historiographies: New France Meets Early American History," *Canadian Historical Review* 91, 4 (2010): 695–724; and Adele Perry, *Colonial Relations: The Douglas-Connelly Family and the Nineteenth-Century Imperial World* (Cambridge, UK: Cambridge University Press, 2015).

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68 The first three points have been made most recently by contributors to the special forum on Canadian environmental history in the *Canadian Historical Review*'s December 2014 issue; see especially the essays by Stephen J. Pyne and Sverker Sörlin. On technology, see also, for example, the introduction to Bruce Sinclair, Norman R. Ball, and James O. Petersen, eds., *Let Us Be Honest and Modest: Technology and Society in Canadian History* (Toronto: Oxford University Press, 1974), 1–3. On the state, see, for example, Richard Jarrell, "Measuring Scientific Activity in Canada and Australia before 1915: Exploring Some Possibilities," in Jarrell and MacLeod, *Dominions Apart,* 27–52; and Philip Enros, ed., "Science in Government," *Scientia Canadensis: Canadian Journal of the History of Science, Technology, and Medicine* 35, 1–2 (2012): 1–149.

69 For a good overview of the rise of mobility in the history of science, see James A. Secord, "Knowledge in Transit," *Isis* 95, 4 (2004): 654–72.

70 See Paula Hastings and Jacob A.C. Remes, "Empire, Continent, and Transnationalism in Canada: Essays in Honor of John Herd Thompson," *American Review of Canadian Studies* 45, 1 (2015): 1–7.

71 Other scholarship on connections between Canada, the Caribbean, and Central and South America includes Karen Dubinsky, *Babies without Borders: Adoption and Migration across the Americas* (Toronto: University of Toronto Press, 2010); Sean Mills, *A Place in the Sun: Haiti, Haitians, and the Remaking of Quebec* (Montreal/Kingston: McGill-Queen's University Press, 2016); and a number of the essays in Dubinsky, Perry, and Yu, *Within and without the Nation.*

72 See, for example, Stephen Bocking, "A Disciplined Geography: Aviation, Science, and the Cold War in Northern Canada, 1945–1960," *Technology and Culture* 50, 2 (2009): 265–90; and Matthew Farish, "Frontier Engineering: From the Globe to the Body in the Cold War Arctic," *Canadian Geographer* 50, 2 (2006): 177–96.

73 For "life geographies," see David N. Livingstone, *Putting Science in Its Place: Geographies of Scientific Knowledge* (Chicago: University of Chicago Press, 2003), 182–83. Historians of the early modern world have recently demonstrated how a specific kind of travelling actor, the go-between, facilitated the translation and circulation of knowledge in that era. See Schaffer et al., *The Brokered World.*

74 Perry, *Colonial Relations,* 255.

75 Sverker Sörlin, "National and International Aspects of Cross-Boundary Science: Scientific Travel in the 18th Century," in *Denationalizing Science: The Contexts of International Scientific Practice,* ed. Elizabeth Crawford, Terry Shinn, and Sverker Sörlin (Dordrecht: Kluwer, 1993), 45, as quoted in Chambers and Gillespie, "Locality in the History of Science," 223.

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80 See Steven Shapin, "Placing the View from Nowhere: Historical and Sociological Problems in the Location of Science," *Transactions of the Institute of British Geographers* NS 23, 1 (1998): 5–12.

81 Sinclair, Ball, and Petersen, *Let Us Be Honest and Modest,* 3.

82 An invaluable contribution here is Richard Jarrell's posthumously published monograph *Educating the Neglected Majority: The Struggle for Agricultural and Technical Education in Nineteenth-Century Ontario and Quebec* (Montreal/Kingston: McGill-Queen's University Press, 2016).

83 See, for example, *Scientia Canadensis: Canadian Journal of the History of Science, Technology, and Medicine* 40, 1 (2018), a special issue on environmental history and the history of technology co-edited by Daniel Macfarlane and William Knight; Dolly Jørgensen, Finn Arne Jørgensen, and Sara B. Pritchard, eds., *New Natures: Joining Environmental History with Science and Technology Studies* (Pittsburgh: University of Pittsburgh Press, 2013); and Dolly Jørgensen and Sverker Sörlin, eds., *Northscapes: History, Technology, and the Making of Northern Environments* (Vancouver: UBC Press, 2013). The introduction of Sara Pritchard's monograph *Confluence: The Nature of Technology and the Remaking of the Rhône* (Cambridge, MA: Harvard University Press, 2011) also provides a useful primer in envirotechnical theory and methods.

84 See also Bocking's related but distinct blog post on this topic: "Landscapes of Science," *The Otter~La loutre* (blog), Network in Canadian History and Environment (NiCHE), January 14, 2015, http://niche-canada.org/2015/01/14/landscapes-of-science/.

85 See Sinclair, "Preface," in Jarrell and Ball, *Science, Technology, and Canadian History,* xiii.

86 Zeller, *Inventing Canada*.

87 See Ian Mosby, "Administering Colonial Science: Nutrition Research and Human Biomedical Experimentation in Aboriginal Communities and Residential Schools, 1942–1952," *Histoire sociale/Social History* 46, 91 (2013): 145–72.

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