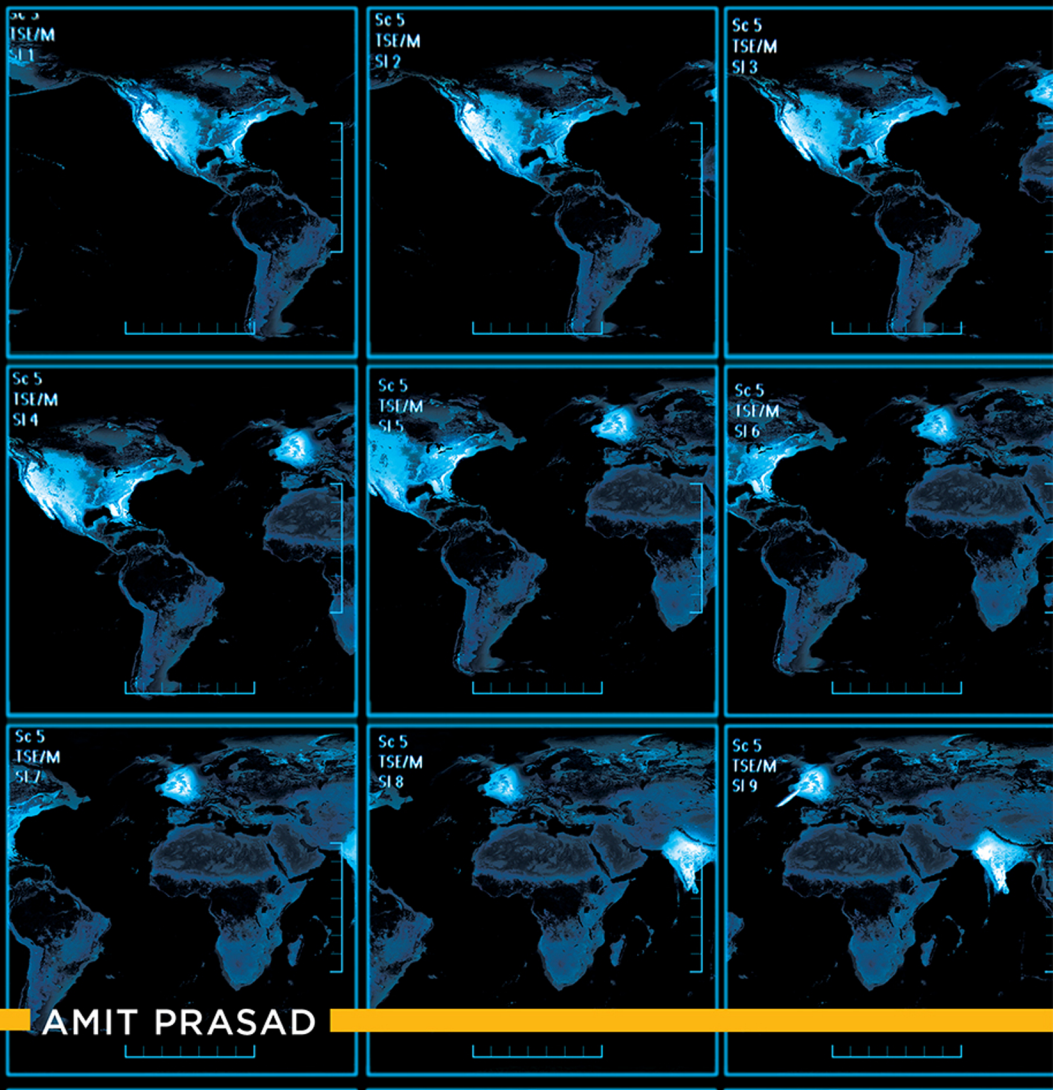
IMPERIAL TECHNOSCIENCE

TRANSNATIONAL HISTORIES OF MRI IN THE UNITED STATES, BRITAIN, AND INDIA



AMIT PRASAD

Imperial Technoscience

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Imperial Technoscience
Transnational Histories of MRI in the United States, Britain, and India

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For Awadh Nandan Prasad and Supriya Guha

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Introduction

"The world is flat." As soon as I wrote [these words], I realized that this was the underlying message that I had seen and heard in Bangalore in two weeks of filming. The global competitive field was being leveled. The world was being flattened.

I had come to Bangalore, India's Silicon Valley, on my own Columbus-like journey of exploration. . . . Columbus accidently ran into America but thought he had discovered part of India. I actually found India and thought many of the people I met there were Americans. Some had actually taken American names, and others were doing great imitations of American accents at call centers and American business techniques at software labs.

—Thomas Friedman, *The World Is Flat: A Brief History of the Twenty-First Century*, 2007

"The world is flat," despite its seductiveness, is as chimerical a notion today as it was in the medieval times.[1] Nevertheless, there can be little dispute that the transnational geography of science and technology has dramatically shifted in recent times.[2] In the last four decades, during which magnetic resonance imaging (MRI) has emerged as a cutting-edge medical technology and a "cultural icon," technoscientific practices and imaginaries have undergone a profound change.[3] In the 1970s and the early 1980s, when the first possibilities for MRI were being explored, India, for example, was considered a part of the "noninnovating South."[4] The next decade, in which MRI stabilized as a clinical tool, brought no change in this viewpoint. Sociological and historical studies continued to highlight the "lag" that seemed to bedevil scientific research in India, while proposing reasons for the "lack of creativity" among the Indian scientists.[5] With the new millennium, however, as MRI moved into new research and diagnostic domains, divergent voices could be heard.[6] In 2006, "The New Geography of Innovation," a Sitra report published by a British think tank, called for a radical departure from the commonly accepted historiography of transnational

technoscience.[7] "India has a scientific heritage that belies its 'developing country' tag," the report categorically asserted. "The widely held belief that modern science began following the European dark ages neglects the fact that the dark ages were not dark everywhere."[8]

It is hard to imagine a major policy document on technoscientific innovation questioning the Eurocentric genealogy of "modern science" at that time, much less decades earlier. Nonetheless, the Sitra report went on to say:

> "Modern science" was introduced to India under the shadow of British colonialism. This was the period when the structures, foundations and guidelines for science were laid down. As the British founded the first universities in the late 19th century and imposed English education, which was rapidly appropriated and propagated by the Indian elite, more and more training was received in Europe and Indians were directed into scientific lines of enquiry laid down by the West in the institutions that followed Western design.[9]

Transnational technoscience, as this report and several other texts illustrate, seems to be trapped in a betwixt and between position. On the one hand, the shifting transnational geography of technoscience is making Euro/West-centric categories and historiography untenable. On the other hand, Eurocentric historicism, which constitutes all history within the temporal order of "first in Europe/the West and then elsewhere," continues to undergird analyses and imaginaries of transnational technoscience.[10] I use the phrase "imperial technoscience" to highlight the contradictory and ambivalent folding of Euro/West-centrism with emergent and unpredictable features of technoscience.

Euro/West-centrism is not simply a discursive category that comes into play when the West/Europe constitutes the non-West as its "other." Rather, it is parasitic to a broader and multilayered hierarchical constitution of epistemology, culture, and historiography of science. I call these hierarchical attributes of science "imperial" because they not only exclude but also appropriate the "other" at every level of technoscientific practice.[11] Although the imperial features of science do not necessarily overdetermine the emergent aspects of technoscientific practice, these two contradictory characteristics are commonly folded together, and this becomes most starkly evident in the context of transnational technoscientific practices, often in the form of Euro/West-centrism.[12]

The paucity of transnational studies of particular technosciences, such as those of MRI, has resulted either in ignoring this contradiction or in reinforcing contradictory alignments with Euro/West-centrism, as is evident in

the Sitra report discussed above.[13] This is particularly noteworthy because technoscientific research so often has transnational entanglements.[14] As a U.S. Office of Technology Assessment report pointed out already in 1984, the development of MRI was from the outset located within a transnational network.[15] Nonetheless, it would be shortsighted to assume that transnational histories necessarily take us beyond Euro/West-centrism.

Can a Transnational History of MRI Tell a Different Story?

From Thales to Lauterbur, or From the Loadstone to MR Imaging.
—Manuel Mourino, Historical Perspective, *Radiology*, 1991

A professor at UCLA, Bill Oldendorf gave a lecture about the imaging of the brain with magnetic resonance technology. . . . He concluded his lecture by saying, "NMR is here to stay." I understood then that MR technology would be developing more, and I decided that I would try and get such an NMR device.
—An MRI scientist, 1983[16]

In 1987, when the first MRI scanner was installed at the Institute of Nuclear Medicine and Allied Sciences (INMAS) in New Delhi, the United States had nearly 900 MRI machines deployed for clinical use.[17] Siemens, a multinational company based in Germany, manufactured the scanner that was installed at INMAS. Moreover, as Lieutenant General N. Lakshmipathy, then director of INMAS, recounted, he had decided to import the machine after he came to know about MRI through a British scientist.[18]

In contrast, by the second half of the 1980s, U.S.-based General Electric Medical Systems (hereafter "GE" for short) was a global frontrunner in the manufacture and supply of MRI. By the time India got its first MRI machine, Raymond Damadian and Paul Lauterbur, two U.S. scientists, had been in the midst of a bitter priority dispute over the invention of MRI for more than a decade and, eventually, in 2003, Lauterbur and Peter Mansfield, a British scientist, received the Nobel Prize for the development of MRI.

By all accounts, the contribution of scientists from India has been negligible, if not altogether absent, in the invention, development, and diffusion of MRI. In fact, the history of MRI in India appears to be a classic exemplification of the diffusion model of science.[19] Not only do the invention and development of MRI appear to have taken place in the Western countries, but there also seems to be a lag in diffusion of knowledge about MRI to India.[20]

These brief remarks about MRI research in India present us with something of a paradox that is not unique to the history of MRI. There are negligible historical records of technoscientific practices in India.[21] And yet historical and sociological studies have continually analyzed and affirmed the West versus non-West technocultural divide. This paradox is easily resolved, however, if the information presented earlier constitutes sufficient evidence to define "lag" or "lack" in technoscientific research in India.[22]

The issue here is not simply whether the history of MRI in India is partial or not yet known and hence requires further historical investigation. It is important to recognize that such a state of affairs is, in the first instance, an artifact of the Eurocentric construction of modern science. That, for example, the role of the social in the epistemology and practice of modern science was rarely investigated prior to the emergence of science and technology studies was not simply an exemplification of missing data.[23] Rather, a particular discursive construction of modern science made the role of the social irrelevant or secondary to the epistemology and practice of science. There is no possibility of writing a non-Eurocentric history of MRI (and more generally of science) without challenging the discursive construct of modern science that relegates the non-West to the "waiting room of history."[24]

Although historians and sociologists of science have long critiqued Eurocentrism, more recently, they have also engaged with postcolonial analytics and concerns.[25] These recent postcolonial engagements have initiated a very fruitful dialogue within science and technology studies, and this book ia an attempt to contribute to this important body of work. Nevertheless, I have remained ambivalent toward these postcolonial interventions because they sometimes conflate politics of location with politics of identity and at times even reduce the former to the latter. There is also a tendency to critique the Eurocentric structure of modern science by substantively locating and thereafter displacing a fixed "center" (e.g., Europe or the West, or by identifying the "periphery"), without carefully analyzing Eurocentism's enduring and hierarchical entanglements.[26] Such a focus, despite intentions to the contrary, reinforces the hierarchical and Eurocentric structure of modern science. It does so because, as Jacques Derrida has pointed out, the center is "that very thing within the structure which governs the structure, while escaping structurality. . . . And, as always, the coherence in [this] contradiction represents the force of desire."[27] Consequently, on the one hand, attempts to locate and then displace a fixed center of modern science have resulted in the free play of substitutions (or "supplementarity") and produced "the sense of the very thing they defer: the mirage of

thing itself."[28] On the other hand, the insidious and yet pervasive implications of Eurocentrism remain largely invisible or are ignored in analyses of technoscience.

The obviousness of Euro/West-centric claims about technoscience in relation to MRI research in India, for example, is parasitic to two concatenated overdeterminations. On the one hand, analytical categories of lag and lack are hypostatized and thereby acquire self-evident explanatory power. On the other, the linear construction of technoscientific practice (idea/invention → implementation/technology → diffusion) imparts self-evident valence to certain empirical data.

A study of transnational technoscience thus necessitates an empirical-deconstructive analysis. We have to empirically show how science travels as "immutable mobiles" and consists of not facts but "factishes" (the Latourian hybrids of fact and fetish).[29] But, at the same time, we must also deconstruct Eurocentric genealogies of technoscience and analyze the hierarchical implications of dualist distinctions that are often held together by the "force of desire" of Western exceptionalism.[30] Dualist distinctions do not just restrict and usurp certain trails of technoscientific research (and along with them agency of certain people, cultures, etc.).[31] By projecting an illusion of the "true" picture of science, they also naturalize exclusions and hierarchies.[32]

If, however, we look beyond the "reality" that is constituted through Eurocentric constructions of science, we open a Pandora's box.[33] For example, what was going on in the Indian nuclear magnetic resonance (NMR, from which magnetic resonance imaging, or MRI, emerged) laboratories? Was research there yet another reflection of lag in the diffusion of knowledge and technologies? Did Indian scientists know about magnetic resonance imaging before the first MRI machine was imported? If they did know about it—and my research shows they were among the first in the world to know about it—then why had the director of a premier research center such as INMAS not even heard about MRI before learning of it from a British scientist visiting India?

Moreover, MRI research within the "West" has also been folded within Eurocentric constructions of modern science.[34] Thus the West, in relation to which the "peripheries" of technoscience have been defined, has never been homogeneous.[35] Its "homogeneity" and "singularity" are artifacts of the free play of "supplementarity" produced and sustained through the "force of desire" of Western exceptionalism. For example, the MRI scientist quoted in the epigraph to this section is not a scientist in India, but a Swedish scientist who was trying to import MRI into Sweden (see also chapter 4).[36]

Popular misperceptions to the contrary, most of the early MRI research and development occurred not in the United States, but in Britain. In fact, as late as December 1981, GE, which, as mentioned earlier, became the MRI market leader in the second half of the 1980s, had chosen not to explore the possibility of MRI because its management had concluded that MRI was technically not feasible. Nonetheless, in the span of just a few years, the transnational geography of MRI research changed dramatically, and the United States became the "center" (see chapter 2). John Mallard, whose group at Aberdeen, Scotland, was at the forefront of MRI development until 1981, ruefully recounted how he and his colleagues could not compete because their machines "were no longer 'state of the art.'"[37]

How are we to understand such shifts, discontinuities, and hierarchies across nations? Dichotomous distinctions such as that between West and non-West, center and periphery, or developed and developing are clearly inadequate in this regard. We also have to be extremely careful in using the category of nation. MRI research in Britain, as well as in the United States, India, and the rest of the world, depended on transnational flows of scientists, technologies, financial resources, and so on throughout its history. But the very fact that MRI research and development in the United States, Britain, and India have been framed as "U.S.," "British," and "Indian," respectively, and, more broadly, as "Western" and "non-Western" testifies to the hegemonic influence of such categories.

Imperial Technoscience investigates these and other related concerns through a study of the entangled histories of MRI. I have deliberately conducted a three-nation—United States, India, and Britain—study of research and development of MRI. This has allowed me to problematize the West versus non-West technocultural divide in relation to a cutting-edge medical imaging technology. MRI research in these three countries have been, and continue to be, entangled and also strongly, albeit hierarchically, influenced by one another. Instead of a relativistic comparison across nations, I have focused on hierarchically entangled histories of technoscientific practices.

Entangled Histories, Distributed Cognition, and Disconnected Trails

> The case of the concept of structure . . . can simultaneously confirm and shake logocentric and ethnocentric assuredness. It is not a question of junking these concepts, nor do we have the means to do so. . . . It is more necessary . . . to transform concepts, to displace them, to turn them against their presuppositions, to reinscribe them in other chains, and little by little to modify the terrain of our work and thereby produce new configurations.
>
> —Jacques Derrida, *Positions*, 1981

We need to think about world-making flows not just as interconnections or networks, but also as the "re-carving of channels and the re-mapping of the possibilities of geography." This means becoming more sensitive to the culture and politics of "scale-making," and to emergent forms of subjectivity and agency in "global projects."

—Warwick Anderson and Vincanne Adams, "Pramoedya's Chickens: Postcolonial Studies of Technoscience," 2008[38]

A shift in focus "from a strictly Indian [or British, U.S., Western, etc.] history to a connected (rather than a more familiar, comparative) history," Sanjay Subrahmanyam warns us, "is not as simple a shift of perspective as might appear at the outset. . . . Along with rethinking our notions of periodization, we are obliged to more less constantly rethink our notions of frontiers and circuits, to redraw maps that emerge from the problematics we wish to study rather than invent problematics to fit our pre-existent cartographies."[39]

Although I locate my study within this broader perspective, I prefer the term *entangled* to *connected* because it better signifies the complex, tenuous, and often invisible folding of ideologies, classificatory schemas, institutions, political economies, cultures, and so on from different time periods and across distant geographies, as well as between the structured and emergent practices of technoscience. Hence, for example, hierarchically structured and temporally emergent characteristics of technoscience may not be connected, but they can be entangled, particularly their impact.[40] A classic example in this regard is contestation over inventions and discoveries, which, even while reflecting open-endedness, context dependence, and flows across different "boundaries," remains entangled within the authorship regime that emerged in Europe (see chapter 1).[41]

Imperial Technoscience focuses on three levels or kinds of entanglements, namely, discursive, technosocial, and cognitive. I must clarify at the outset that these three can be separated only analytically; within technoscientific practice, they are themselves entangled. Moreover, each of them also embodies several levels of entanglements. I use the term *discursive*, for example, to imply a folding of a wide range of discourses—Eurocentric, nationalist, technoscientific (e.g., "big science"), and so on. My main concern is to highlight the hegemonic and hierarchical articulation of these discourses through dualist distinctions and to map their interplay with temporally emergent and contextually bound technoscientific practices.

Dualist distinctions, as Bruno Latour has pointed out, are the work of "purification" and its separation from "translations."[42] These distinctions

(such as that between invention and innovation, West and non-West) not only exclude, but also appropriate the "other" (e.g., the non-West, role of other contributors apart from those designated as inventors and discovers, and, more generally, social factors).[43] Moreover, they constitute a "reality" in which such exclusions and appropriations seem natural and logical. Dualist distinctions are "fictions" in the sense that they are mythopoeic artifacts of "force of desire." We cannot wish them away, however. Both technoscientific analysis and practice have borne, and continue to bear, the weight of dualist distinctions.

Technoscientific practice in the laboratories is entangled not only within discourses, but also within technosocial networks, which do not operate as level playing fields.[44] The impact of asymmetries in these networks is neither arbitrary nor random. Technoscientific developments, even when they are contingent on circumstances, are very often appropriated by the dominant, which thereby results in further perpetuation of hierarchies and exclusions. Because, as I argue, the history of MRI has been marked by shifts toward bigger and bigger science, my particular focus is on the impact of "big science" in relation to technosocial networks of MRI research.

"'Big' in big science," as Peter Galison explains, "connotes expansion on many axes: geographic (in the occupation of science cities or regions), economic (in the sponsorship of major research endeavors now costing on the order of billions of dollars), multidisciplinary (in the necessary coordination of teams from previously distinct fields), multinational (in the coordination of groups with very different research styles and traditions."[45] The "big" of "big science" is relative, however. What constitutes big at a particular time in history or in a particular nation or society may not be big enough or may be much bigger in another society or at another historical juncture (such variations may exist even within a particular nation).[46] Indeed, as Andrew Pickering has argued, big science represents a "form of life."[47] It is thus a broadly encompassing technosocial practice, whose multifaceted impact is often hierarchical and exclusionary.[48] In relation to MRI research, it has led to the establishment of transnational hierarchies and to the usurpation of certain technoscientific trails.

The above-discussed multilayered and hierarchical entanglements are embodied in everyday technoscientific actions. *Imperial Technoscience* builds out from the growing body of work on distributed cognition to account for the role of "location" within technosocial networks and technoscientific discourses. Distributed cognition, Edwin Hutchins notes, implies that cognition is socially, materially, and historically distributed.[49] Distributed cognition thus securely locates "cognition" in the everyday practice itself.

Karin Knorr Cetina explains that "the information resides, and remains, in the immediate environment of technical objects, where it is transported by the scientists engaged with these objects."[50] According to Knorr Cetina, "the reflexive integration of objects and subjects in discourse spaces and forms of talk" produces a "conscience collective."[51]

The distributed and situated character of technoscientific activities also enfolds hierarchy and exclusion. The "conscience collective" often represents the technoscientific norms of the dominant groups or the "centers" that the rest of the world ends up following. Issues such as what machines to use for data collection, which journals to publish in, where to patent, which awards to get, which research agendas to pursue, and so on are defined by practices in the "centers" that thereby assume the character of a broader collective conscience. Alternative practices are pursued as well; but these often do not succeed (particularly if one is located outside the "centers"). At the very least, they are very difficult to pursue successfully.

An important consequence of hierarchies and exclusions within technoscientific practice is that certain trajectories of research (which may be innovative and in frontier areas) become disconnected trails.[52] The reverse is also true, however. An invention acquires its status not just from the "genius" of its inventor(s), but also from the distributed cognition of a variety of actors and their entanglements within discourses and technosocial networks. That is to say, successes and failures in technoscientific innovations or inventions are not autonomous and singular events. They are exemplifications of hierarchically connected or disconnected trails.[53]

A disconnected trail within a particular historical or geographical context (e.g., in India, Britain, or the United States) or even in a particular laboratory is not necessarily "undone science."[54] Indeed, if it becomes a part of the entangled histories of technoscience and the accompanying distributed cognition of other actors, a disconnected trail can become a successful (i.e., connected) trail. The connectedness or disconnectedness of trails provides a much more useful parameter for the study of transnational transformations in technoscience than, say, investigations of patent citations or authorships (which may not even exist, particularly if the trails are disconnected).[55]

Methodology and Outline of Chapters

"Something out there" is changing social relations between races, classes, and cultures as well as between genders—probably quite a few "somethings"—at a pace that outstrips our theorizing.

—Sandra Harding, *The Science Question in Feminism*, 1986

> Location is not a listing of adjectives or assigning of labels such as race, sex, and class. Location is not the concrete to the abstract of decontextualization. Location is always partial, always finite, always fraught play of foreground and background, text and context, that constitutes critical inquiry. Above all, location is not self-evident or transparent.
>
> —Donna Haraway, *Modest_Witness@Second_Millennium*, 1997

The expanse of the technosocial networks of MRI makes it practically impossible to comprehensively collect data within a reasonable time frame, particularly because MRI development has borrowed from so many different disciplines and spread in so many new directions. I have therefore investigated MRI research genealogically, focusing on the trails that were critical for MRI development.[56] Taking an empirical-deconstructive approach, I collected data about five commonly accepted facets of transnational technoscience, namely, the invention, industrial development, marketing, history in a non-Western context, and cultures of MRI.

I analyzed available documents and selected certain sites and trails of MRI-related research. In relation to MRI research in the United States and Britain, I gathered data from the biographical notes of NMR and MRI scientists available in *The Encyclopedia of Nuclear Magnetic Resonance*, volume 1, as well as from several historical and sociological accounts of MRI development or deployment.[57] The Wellcome Witness Seminar, attended by most of the key British scientists engaged in MRI development, was another good source of information.[58]

I investigated different sociotechnical trails of MRI research at the selected sites and analyzed their embeddedness within national and transnational networks on the basis of information obtained through a hybrid methodology. This consisted of structured and unstructured interviews of scientists, policy makers, and industry managers, both practicing and retired; archival research in the MRI and NMR laboratories; and analysis of newspaper, magazine, and journal articles and advertisements, as well as policy documents.[59]

My investigations often led me to other interconnected trails, which I followed using the same hybrid methodology. That is, interviews, archival research, and analyses of newspaper reports, policy documents, and journal articles were dialectically related to one another; together, they helped me conduct my research and construct the genealogy of MRI research within local, national, and transnational networks.

In the United States, Damadian, Lauterbur, and scientists at the University of California, San Francisco (UCSF) contributed significantly to MRI

research and development in the 1970s. In Britain, the University of Nottingham, the University of Aberdeen, and EMI (the British music company) in collaboration with London's Hammersmith Hospital were the main centers of MRI research in the 1970s. I interviewed MRI scientists in Britain and the United States who worked in the above-mentioned laboratories, and I collected archival data from them as well. I also collected data from the Office of History of the U.S. National Institutes of Health and interviewed other scientists and industrialists, who were involved in MRI development in these two countries.

India's case was different and required a retooling of my methodology. In contrast to the United States and Britain, there were no documents on MRI-related research in India, no information about when the first MRI was installed there or which laboratories conducted NMR or MRI-related research. Identification of sites or trails of research was therefore quite difficult. I started my research in 2001 as a visiting researcher at the All India Institute of Medical Sciences (AIIMS) in New Delhi, a premier center for MRI research and diagnosis. During the course of my interviews with radiologists and scientists, I was able to track sites and trails of MRI-related research in India. I eventually traveled to twelve laboratories all over India and collected information through interviews, which I supplemented with the data I obtained from journal articles.[60]

The five chapters of the book utilize the theoretical and methodological framework described above to provide an analysis of the entangled histories of MRI in the United States, India, and Britain. Each chapter investigates one of the five facets of transnational technoscience—invention, industrial development, marketing, history, and culture.

The first chapter focuses on the "invention" of MRI. The history of MRI has been marred by a long-standing priority dispute between two U.S. scientists, Paul Lauterbur and Raymond Damadian. In their analysis of this dispute, natural and social scientists alike have anointed one of the two as the more legitimate claimant for the invention of MRI. Priority disputes, such as that between Lauterbur and Damadian, have been common throughout the history of science. In analyzing them, two key concerns for historians and sociologists of science have been (1) epistemic and historiographic demarcation of an invention, and (2) utilization of the priority dispute (as a controversy) to open the "black box" of scientific practice and knowledge. Chapter 1 aims to shift the debate over technoscientific inventions to a different level, arguing that analyses of technoscientific inventions, apart from obscuring the role of the social, also hide the impact of the authorship regime that emerged in Europe. The chapter problematizes

the historiography as well as technoscientific practices of MRI invention by showing how they were folded within a particular, historically constituted, regime of authorship that not only led to a linear and dualist construction of MRI developments, but also made the process exclusionary.

Chapter 2 analyzes the "emergence" of MRI. Postinvention history of a technology is often presented as accounts of further innovation and implementation of the "ideas" that constituted the invention. A genealogical approach focused on technoscientific trails that are dependent on distributed cognition and entangled histories radically calls into question such historiography. As chapter 2 will show, MRI emerged as a result of engagements during this "postinvention" period. Analyzing how this occurred at the intersection of epistemic, business, and health-care concerns, the chapter also shows how a shift occurred in the mid-1980s, with the United States becoming the "center" of MRI research, even though most of the early MRI developments did not take place there. Two key elements in this transformation were the transformation of MRI research into big science and the role of the U.S. health-care market, analyzed in chapter 3.

Richard Powers has a telling though not surprising comment in his novel *The Gold Bug Variations*—invention is the mother of necessity.[61] As chapter 3 will show, the marketing of MRI reflects a somewhat similar pattern. In the 1970s, a market for MRI did not exist in the United States. Moreover, concerns over rising health-care costs had led to the enactment of a number of laws during the 1970s and the 1980s to control the proliferation of expensive technologies such as MRI. Until the early 1980s, clinical utilities of MRI were also largely ill defined. Nevertheless, MRI spread very fast in the United States. Drawing on Michel Callon's definition of *market* as a "collective device" and Adele Clarke and her colleagues' concept of the Biomedical TechnoService Complex, Inc., the chapter shows that the market for MRI in the United States emerged as a result of innovative business strategies that were also exclusionary and hierarchical. It argues that the proliferation of MRI in the United States radically redefined trajectories of MRI research and development, domestically as well as globally.

The hierarchical and exclusionary characteristics of science impact not only different facets of technoscientific research, development, and deployment, but also their historiography. Because, for example, India has been considered a part of the "periphery," almost nothing about MRI or NMR research in India is documented. An added consequence is that little is known about the genealogical links of recent transnational transformations that are making India an important site for technoscientific innovations.

Chapter 4 analyzes NMR research in India from its beginnings in the late 1940s and maps its links to MRI research and development. It argues that empirical investigations of particular technoscientific trails in India (as elsewhere) not only lead to a very different understanding of the "center-periphery" relationship and the West versus non-West technocultural divide, but also allow a better understanding of present day technoscientific transformations.

Chapter 5—the last chapter—analyzes a particular technocultural dominant in each of the three nations studied, arguing that, to better understand the contextual characteristics of a culture, we have to deconstruct its Eurocentric entrapments. The chapter shows that the hierarchical and Eurocentric influence of scientific culture lies in a powerful paradox, whereby the "origin" of modern science is located in Europe, even while the role of location in scientific culture is erased, thereby denying its social roots. In relation to the non-Western societies in particular, scientific culture thus came to signify a "lack" that had to be overcome for these societies to develop and become modern. The impact of such a belief can be seen in the fact that one of the "Fundamental Duties" in the Indian Constitution is to spread "scientific temper."[62] Cultures of science have also been used to define national identities. Chapter 5 analyzes scientific culture as a product not of located and static national cultures, but, rather, of located and shifting entangled transnational histories. It shows how the cultures of MRI in the United States, Britain, and India were entangled within hierarchical networks of transnational, national, local, and laboratory policies and practices.

It may seem that despite my claim to the contrary, the chapters in my book present a linear history that starts at the "origin" (invention →development →diffusion). Such linearity is, however, deliberate and limited to the structural organization of the chapters; it allows me to highlight the power of hierarchical and exclusionary characteristics of science, even while providing a deconstructive analysis of the categories that undergird them. MRI, for example, was not even called "MRI" until the mid-1980s. Indeed, had it not been for its development and marketing (described in chapters 2 and 3), MRI would most likely have remained a footnote in the history of NMR. The chapter on the history of MRI-related research in India—chapter 4—comes toward the end of my study not because I want to signify a lag, as suggested by the diffusion models (I trace the history of NMR from the late 1940s), but because I want to put into broad relief how Eurocentrism seriously limits, if not completely erases, possibilities of inclusion in both

the practice and the history of technoscience. Even though I discuss cultural aspects of MRI development throughout the book, I have reserved my analysis of "scientific culture" for the last chapter because I want to highlight that the commonly professed separation of "science" and "culture" is an illusion, born of our discursive embeddedness within the Eurocentric and dualist structure of modern science, which, nevertheless, has very real and profound effects.

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