

TECHNOLOGY AND PARADIGM

The X-Ray, Electrical Therapeutics, and the Consolidation of Biomedicine

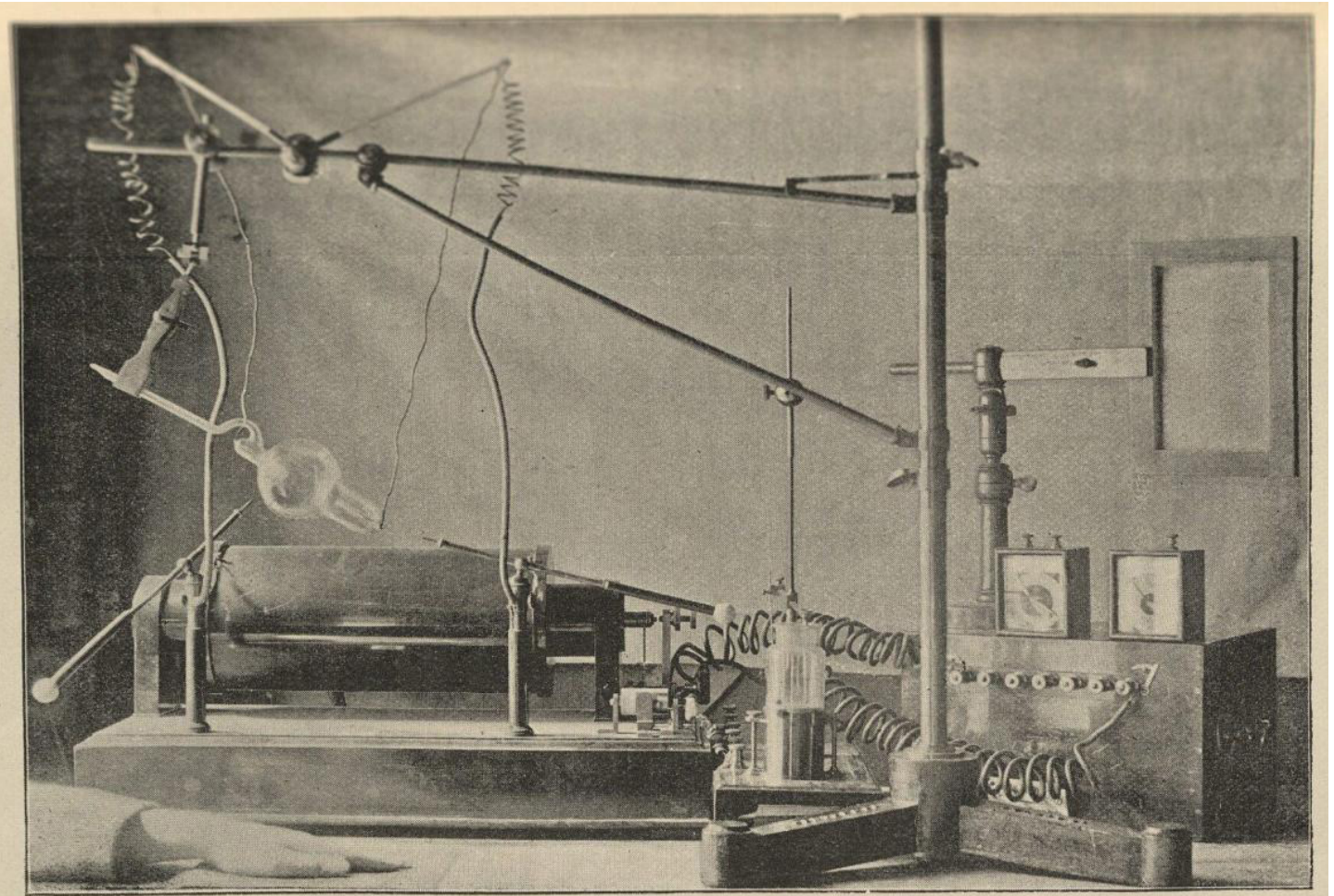


FIG. 17.—COMPLETE APPARATUS FOR RÖNTGEN-RAY WORK, CONSISTING OF SECONDARY BATTERY, VOLTMETER, AMMETER, APPS' INDUCTION COIL WITH ORDINARY AND MERCURIAL BREAK, ROWLAND'S STAND, FOCUS TUBE, FLUORESCENT SCREEN ON STAND, AND HAND IN POSITION UPON PHOTOGRAPHIC PLATE.

An 1897 setup for taking an x-ray of the hand. [1]

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INTRODUCTION

IN NOVEMBER OF 1895, physicist Wilhelm Röntgen discovered a wavelength of electromagnetic radiation that came to be known as the “x-ray” or the “Röntgen ray.”

Within months, experimenters and laypeople were producing x-ray images using a simple set of machinery. In order to make an x-ray exposure, one needed just three elements: a current source, a Crookes tube, and a photographic plate.¹ Although the process was relatively simple, material limitations made the apparatus breakable, bulky, and unreliable. Historians have referred to this phase of the x-ray’s existence as the “gas tube era,” which more or less ended in 1913 when stronger and more versatile equipment was developed.²

The unwieldiness of the x-ray machine as a physical object mirrored its clumsy implementation in various medical and non-medical enterprises. The x-ray was regarded with fascination as a device that clearly did something—it “miraculously” revealed the body’s interior and produced outwardly observable effects on the body—but it had ambiguous uses and meanings. It was entertained as a therapeutic tool in treating everything from blindness to cancer,³ a photographic novelty that produced chic and “coquettish” images of women of means,⁴ and a way to substantiate prosecuted criminals’ claims to insanity,⁵ among many other uses.

Historians have duly noted the dramatic public reception of the x-ray, as well as many of its initial experimental applications. Theorists in visual studies particularly emphasize the public’s reaction to the x-ray as “spectacle” and the capitalization of novelty by professionals of various standings to substantiate their authority. This interpretation importantly complicates teleological narratives of the x-ray and articulates the multiple and unstable signifi-

cations of a new technology. It upends the idea that the x-ray was, from its inception, destined to claim the authoritative place it holds in current healthcare practices. It affirms that technologies do not arise in response to pre-existing needs, but they become institutionalized by and in service of contingent relations of power.⁶

Most histories of the x-ray, however, consider its development as a diagnostic screening tool and fail to consider, or make only cursory reference to, its use as a therapeutic agent. These accounts obscure the epistemological complexities implied by the selection of the nascent technology’s diagnostic use over its therapeutic one. In this chapter, the narrowing epistemic field of the x-ray is considered alongside the shifting contexts and contents of American medicine. Across approximately the first half of the twentieth century, multiple potentialities of the x-ray were winnowed to a single diagnostic use just as a modern scientific healthcare paradigm was emerging. In other words, the x-ray technology and its symbolic power evolved alongside changes in the knowledge practices sanctioned by modern healthcare. The negotiation of the x-ray’s potentialities can be contextualized by investigating how the uses for the x-ray were entertained in a medical context that was itself uncertain. Different philosophies, metaphors, and interests were called upon to justify its privileged position as a device of specialized visibility.

While the x-ray was invented in Germany, many novel uses of and deliberations over the technology took place in American hospitals, journals, and other sites of medical activity. The x-ray’s early days of use and experimentation—from its invention in 1895 until roughly 1940—reveal an unruly history that broadly parallels navigations of ambiguity in the American medical system. The x-ray moved through a series of epistemological and professional paradigms, each of which shaped and were shaped by x-ray practice. The x-ray debuted in a medical system that was largely constituted by idiosyncratic doctor-patient relationships, which were themselves

1 Matthew Lavine, “The Early Clinical X-Ray in the United States: Patient Experiences and Public Perceptions,” in *Journal of the History of Medicine and Allied Sciences* 67, no. 4 (Oxford: Oxford University Press, 2011), 590.

2 Richard F. Mould, *A Century of X-Rays and Radioactivity in Medicine: with Emphasis on Photographic Records of the Early Years* (London: Institute of Physics Publishing, 1993), ch. 5.

3 “Wonderful X Ray Tests: Blind Man Sees Through Top Of His Own Head,” *Chicago Daily Tribune*, January 2, 1897, 14.

4 “Her Latest Photograph: It Is An Electrical Picture,” *New York Times*, May 29, 1898, 14.

5 “Electricity Consumption: The New Treatment Of Phthisis By The Use” *Los Angeles Times*, September 5, 1897, 16.

6 See Lisa Cartwright, *Screening the Body: Tracing Medicine’s Visual Culture* (Minneapolis: University of Minnesota Press, 1995); Joel D. Howell, *Technology in the Hospital Transforming Patient Care in the Early Twentieth Century* (Baltimore: Johns Hopkins University Press, 1995) for analyses of the x-ray’s implication in public visual culture and the development of the 20th century hospital, respectively.

relatively closed worlds of therapeutic practice. In the context of this testing ground, the x-ray proved amenable to a number of explanatory frameworks, as eclectic practitioners integrated the device into their own ideological priorities. Many early practitioners understood the x-ray's therapeutic potential in relation to other therapeutic uses of electricity, thus revealing the technology's absorption into vitalistic, or spiritualized, medical paradigms.

During the x-ray's "middle years," approximately 1900 to 1918, the technology assumed an aura of professional appeal based on its capacity to authoritatively image the body's interior. At this time, the x-ray became privileged for its capacity to produce certain scientifically verified images. The ascendance of the x-ray's diagnostic use sheds light on the growing primacy of visual knowledge, and specifically of mechanically-produced images, within medical practice.

In its post-WWI years, the x-ray became embedded in large industrial-scientific medical institutions. It was in this context of broad redefinitions of healthcare that the x-ray assumed its diagnostic legitimacy, taking its place alongside a host of other organizational and information technologies that tethered together the practices of different physicians into a single system. At this time, healthcare was increasingly reconfigured as a business that was premised on the modern individual's health-seeking efforts. The x-ray helped to produce the notion of the body as a site of continual maintenance, as it made the authoritative visualization of the body's interior a coordinating principle for diagnostic activity. Esteemed medical professionals increasingly augmented their medical judgment with the x-ray's technologically-advanced capacity to objectively discern the most fundamental structures of any individual.

MEDICINE BEFORE BIOMEDICINE

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HE X-RAY EMERGED at a moment of confusion about how best to govern the body. In the latter part of the nineteenth

century and into the early twentieth century, the set of possibilities for this governance was expansive. The American medical community was actively deliberating between different paradigms for understanding and treating the body. A representative, though not comprehensive, example of the uncertainty regarding medical paradigm was the dispute between allopathic and homeopathic philosophies of care. The tensions between the two illustrate the emergence of an ideologically bounded modern medicine, in relation to which other paradigms would be relegated to the domain of "alternatives." Homeopathy and allopathy coordinated their professional activities against one another: the American Medical Association formed in 1847 in response to the organization three years prior of the American Institute of Homoeopathy.⁷ And, increasingly, regulatory provisions were made to silo the fields from one another: written into the AMA charter was a consultation or exclusion clause, meaning that an orthodox doctor could not consult with a homeopath or help a patient who was under concurrent treatment by a homeopath.

"Allopathy" was and remains a somewhat contentious term. It was coined by Samuel Hahnemann, the inventor of homeopathy, in 1807, to designate the opposing ideologies underlying the two medical practices. Homeopathic practitioners operated under the principle that "like cures" would cure "like symptoms." They believed that minute concentrations of a particular toxin would cure the symptoms that the same toxin produced in larger doses. Allopathic practitioners, on the other hand, prescribed cures that opposed the observed symptoms. They sought out substances that would counteract the toxins believed to be causing patients' ailments.⁸ Hahnemann used the word "allopathic" to denigrate antagonistic remedies that he believed could only address symptoms and would inevitably fail to treat the underlying disease.

Homeopathy and allopathy existed alongside one another in the nineteenth century and into the twentieth century, showing that not only were particular cures being deliberated, but the very idea of what constituted a cure was uncertain. The debate between paradigms of care reflected disputed assumptions about what kinds of substances or forces could act on the body to move it closer to health. The way that a body was seen to respond to forces and substances in turn reflected prevailing ways

⁷ P. Thomas, "Homeopathy in the USA," in *British Homeopathic Journal* 90, no. 2 (New York: Thieme, 2001), 99-103.

⁸ James C. Whorton, *Nature Cures: The History of Alternative Medicine in America* (Oxford: Oxford University Press, 2002), 18.

of understanding the physical makeup of the world. In charting the unruly history of the x-ray across medical paradigms, different justifications for its use appear in relation to shifting ideas about the constitution of the external world. The ways in which the x-ray is and has been authorized in medical practice reveal much about the assumptions that structure the practice of medicine. Medicine is a space where ideas about the world are concretized in bodies, and in the social and material relations that produce health and sickness. In tracking the way that certain explanatory paradigms take precedence over others, one can situate the priorities of medicine within a vast and contingent field of knowledge production and recognize the tensions that lie within it.

ELECTRICITY AND VITALISM (1895-1900)

IN ASKING HOW practitioners made sense of the x-ray's potentialities in the context of prevailing understandings of the world around them, it is helpful to look at the paradigms that shaped the x-ray's early development. Historians of the x-ray have noted that practitioners of the new device drew on metaphors of light, as they "illuminated" the interior of the body. The public would have been familiar with a number of other light therapies that existed at the time, including the Finsen light, the light bath, and a light bulb that would literally illuminate one's body from within. These often unorthodox electrical therapies challenge the device's reputation as a squarely modern scientific tool. As a therapy that is continuous with both 'occult' traditions and distinctly modern ideas about causality, the potency of the x-ray could be situated in seemingly contradictory ways of understanding the world.

Uncertainty about the x-ray was in part mitigated by the American public's familiarity with electrical therapeutics. The x-ray was new in its ability to produce photographic plates of the body's interior, but the concept

of using electricity for medical therapies was not new. In addition to general public interest in new applications of electricity—newspapers featured regular columns on recent developments in all things electrical—medical professionals had been experimenting with "electrotherapy" for much of the latter half of the nineteenth century.⁹ Electrotherapeutics denoted a broad set of techniques used to run an electric current through a particular part of the body. The term was utilized by practitioners with a range of professional standings and was applied to a large array of technologies and apparatuses. Electrotherapeutic textbooks were published, colleges inaugurated, and journals convened, indicating that electrotherapy consisted of a fairly well-defined set of practices, coordinated by particular rationales for their use.

Developments in electrotherapeutics were part of a long history of fascination with vital forces. Natural philosophers throughout the nineteenth century were concerned with identifying an animating force that would explain the aliveness of living things in the context of a purely physical world. Vitalism, broadly defined, was this quest for a single life energy. The term "electrics" was coined in the sixteenth century in the context of naturalists' "predilection to sustain this notion of a life-giving energy,"¹⁰ and was used variously to talk about gravity, magnetism, and electricity. These mysterious forces were weightless and invisible, yet they could act on living matter. Theorizing the relationship between these forces and the human body, Sir Isaac Newton proposed that this ethereal substance also imbued nerves. Modifying Descartes' understanding of the nerves as hollow tubes through which vital spirit flowed, Newton supposed, rather, that nerves were solid filaments that produced Animal Motion through vibration. This modified theory led eighteenth-century scientists to demonstrate the affinity between "artificial electricity" and "animal electricity"—the former externally-produced and the latter intrinsic to animate beings' physiological makeup. A singular substance was understood to course through both living bodies and the external world; this was the mechanism whereby qualities of the external world animated the human body.

In addition to being a pragmatic way to make sense of how forces inside the body were related to forces outside the body, electricity was also useful in thinking

⁹ Lisa Rosner, "The Professional Context of Electrotherapeutics," *Journal of the History of Medicine and Allied Sciences* 43, no. 1 (Oxford: Oxford University Press, 1988).

¹⁰ Linda Simon, *Dark Light: Electricity and Anxiety from the Telegraph to the X-Ray* (Orlando: Harcourt Books, 2004), 11.

through the connection between different parts of the body. Around the turn of the century, medical practitioners were theorizing the body as an integrated whole, coordinated by some set of unifying processes.¹¹ However, even prior to advances in fields like psychotherapy and endocrinology—both of which are based on theories of homeostasis in the body—electricity was used to conceptualize the way the body was harmonized. James Miller Beard, a neurologist and contemporary of Edison, popularized the term “neurasthenia” in 1869 as a disease that caused depression and anxiety in modern, intelligent people with fast-paced urban lives. In the paradigm of neurasthenia, the nervous system and electricity were closely related both causally and conceptually. Beard theorized that electricity was one of the reasons individuals might develop neurasthenia, as electricity was a prominent feature of modern urban life; those living in cities could not escape the stimulation that was induced by constant artificial light.¹² Electricity also allowed Beard to theorize the relationship between mental states and physiological activity through the nervous system, which was increasingly understood as the intersection of body and brain.¹³ As in both psychotherapy and endocrinology, neurasthenia conceived of a relationship between mental states and the chemical or physical makeup of the affected individual’s body. Electricity enabled Beard to describe this movement between the material and the immaterial. Electricity seemed to coordinate the activity of the outer and inner worlds, generating bodily effects from non-living external objects.

The effects of electricity on the body could be understood within the frameworks of both scientific medicine and unorthodox therapies. As electrotherapy became a popular modality, Beard supposed that electricity could be used to cure neurasthenia.¹⁴ Although Beard was a noted skeptic of spiritualism, the idea that electricity could be simultaneously a cause and a cure for neurasthenia accorded with the homeopath’s assumption that the cure could be the same as the cause of a disease. Beard’s theory gained respectability for its focus

on electricity as a feature of the modern world; it was credible to many who sought scientific explanations for the perceived effects of electrical devices. But it was also situated well within theories of causation that would soon be understood by allopathic medicine as primitive and unscientific.

Electrotherapeutics appealed to the mysterious mediation of electricity between artificial and natural entities in the world. Practitioners of electrotherapeutics justified their modalities in ways that called upon electricity’s affinity with vital forces in the public imagination. An 1863 pamphlet published by Dr. E.J. Fraser, who designates himself a “practical medico-electrician,” is entitled “Medical Electricity: A Treatise on the Nature of Vital Electricity in Health and Disease, With plain Instructions in the uses of Artificial Electricity as a curative agent.”¹⁵ Another pamphlet, this one from 1891, is entitled “Ethereal Matter, Electricity and Akasa.” Akasa, or Akasha, is a Sanskrit word that means “space” or “sky,” and in Theosophical understanding was seen as a spiritual primordial substance that pervades all of existence.¹⁶ The pamphlet’s contents include information on new devices to detect “different conditions of ethereal matter,” “something new about the human organism,” “transmission of ideas to a distance,” and “occult tricks.”

Vital forces were understood to operate in a human organism governed by both physiological and mental states. The title page of a 1903 publication by the Physico-Therapeutic Institute indicates that electricity was a candidate, alongside “water, air, heat, light, movement, ozone, oxygen, carbonic acid, etc.,” for treating a number of conditions that were neither wholly physical nor wholly mental. The same title page features a quote by D.J. Rivieré, the publisher of the pamphlet (who did not indicate any professional credentials): “The object of the physico-therapeutic cure is to raise the nervous function when depressed, to put right the trophic functions when out of order. It raises the chemical activity of medicines and it insures the organic eliminations necessary to the

11 Stefanos Geroulanos and Todd Meyers, *The Human Body in the Age of Catastrophe: Brittleness, Integration, Science, and the Great War* (Chicago: The University of Chicago Press, 2018).

12 Simon, *Dark Light*, 6.

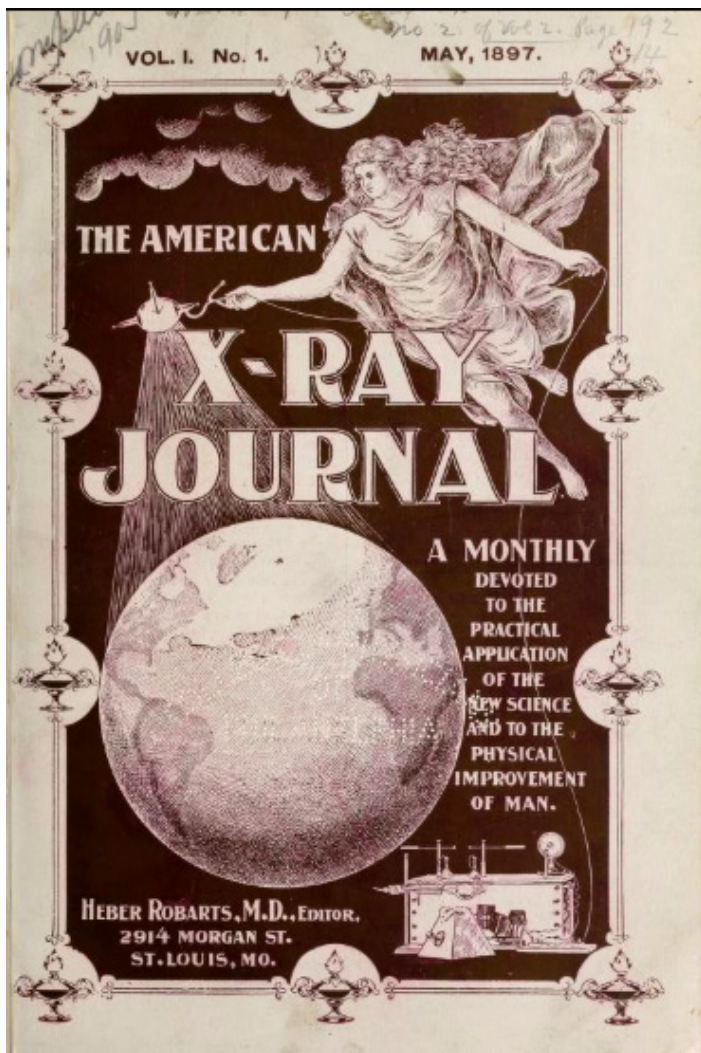
13 Beatriz Colomina, *X-Ray Architecture* (Baden, Switzerland: Lars Müller Publishers, 2019).

14 Simon, *Dark Light*, 152.

15 Dr. E. J. Fraser, *Medical Electricity: a Treatise on the Nature of Vital Electricity in Health and Disease, With plain Instructions in the uses of Artificial Electricity as a curative agent* (Chicago: S. Halsey, 1863).

16 Helena Petrovna Blavatsky, *The Theosophical Glossary* (London: The Theosophical Publishing Society, 1892).

13. Theosophy was an occultist religious movement begun in America in the late 19th century.



The cover of the first issue of *The American X-Ray Journal*. [2]

regular purification of the Economy.”¹⁷ Rivieré appeals to discourses of chemistry, neurology, physiology, and hormonal (“trophic”) functions to justify his therapeutic method. These multiple discourses, as well as his description of the body as an “economy,” reveal the impulse within the medical community to theorize health and sickness as involving the equilibrium of the entire organism. Electricity provided a pivot from vague understandings of the body based on the harmonization of its parts to scientific medicine’s updated models of homeostasis based on biochemical entities. Electricity connoted the vital force that coordinated activity but was also distinctly modern, a powerful tool with vast potential to know the world in ever more precise ways.

Electricity was an enticing cure for a medical community that was actively deliberating over the proper way to treat sick bodies. The flexible ontologies underlying electricity authorized its use as a therapeutic modality in both allopathic and homeopathic practices. The debate between allopathy and homeopathy as the most appropriate medical system roughly mirrored the debate between those who thought that diseases ought to be cured by treatments administered externally from the body and those who believed that the disease’s natural course of development in the body would cure the patient. Allopathic practitioners sought different kinds of substances to administer to the body, while homeopaths supposed that the body naturally stored the entire pharmacopeia of substances it could need. Allopaths tended to celebrate the variety of pharmaceutical compounds that were being synthesized or discovered with increasing frequency. New therapies presented new tools to combat disease. Homeopaths tended to criticize the search for new compounds. Medical pamphlets and journals featured both drug advertisements and polemics, written by and for doctors, against the use of drugs in medical care. In this space of contradictory mindsets, electricity could be configured as both external and internal; it was integral to the matter of the natural world but also existed innately within the living body.

The x-ray’s continuity with electrical modalities meant that its therapeutic potential could be justified by appeals to vitality and energy. The x-ray’s association with vitalism is evident in looking at the cover of the first issue of *The American X-Ray Journal*. This journal began in May 1897 with the stated intention “to give to its readers a faithful resume of all x-ray work.”¹⁸ The American medical field saw an increase in the number of published medical journals in the nineteenth century as physicians returned from graduate training in Austria and Germany. They grouped themselves into professional associations and consolidated their reports of clinical and laboratory research in medical publications.¹⁹ However, even as x-ray practitioners began to coalesce around professional organizations, they did not abandon the vitalistic connotations of the x-ray. The cover of the first issue of *The American X-Ray Journal* depicts a figure administering the x-ray to the globe from outside the globe, indica-

¹⁷ D. J. Rivieré, *Annals of Physico-Therapy* (Paris: Physico-Therapeutic Institute of Paris, 1903).

¹⁸ Herbet Roberts, *The American X-Ray Journal* 1, no.1 (1899).

¹⁹ Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health “200 Years of American Medicine (1776-1976),” an exhibit at the National Library of Medicine.

ting that the x-rays were seen to come from a mysterious, non-earthbound, place. The spiritual connotations of a figure floating above the earth connotes the idea of an immaterial substance that animates the physical world, flowing freely between living and non-living matter.

MECHANICAL OBJECTIVITY AND THE DOCTOR-PATIENT RELATIONSHIP

HISTORIANS HAVE NOTED the utility of the x-ray in consolidating the professional authority of allopathic doctors and radiological specialists—those in fields that would later professionalize in relation to the x-ray’s diagnostic capabilities. However, there has been considerably less attention given to the way that non-allopathic practitioners justified their authority through the x-ray, often continuing to use the machine for non-diagnostic purposes. After the x-ray had been wrangled as a specifically medical instrument, but before it became a standardized diagnostic tool, various medical sects incorporated the technology into their practices as a method of legitimization. This period—approximately the first ten years of the twentieth century—represents a middle space in the x-ray’s early years that corresponds to the shifting context of professional medicine.

Historians have noted practitioners’ self-legitimation through the use of the x-ray, as the device came to symbolize advanced scientific medicine. However, they have not engaged with the particular nature of this symbolism—the specific capacities that made the x-ray authoritative. The invocation of the x-ray’s authority by non-allopathic practitioners (those who would not go on to coordinate their activities in relation to this authority) shows that the regard given to the technology was not solely a response to its association with the kind of scientific biomedicine that would go on to dominate health-

care. Rather, its authority was premised on its ability to produce objective scientific images. Even when homeopathic practitioners used the x-ray in therapeutic vitalistic contexts, they legitimized their practice by recourse to the x-ray’s privileged capacity for visualization.

After the x-ray had become widely known to the general public, but before it attained its diagnostic role in institutionalized biomedicine, it was seen as the most authoritative form of electrical healing. An 1899 article in the *Chicago Daily Tribune* chronicles the moment the x-ray became a privileged electrical therapy. After expounding the various specialties in which electricity was useful and effective “in the hands of a skilled physician”—dentistry, medicine, surgery, cauterization, thermal and chemical effects—the author laments the hindering of the field’s development at the hands of “quackery practiced in early days.”²⁰ The authority of “regular practitioners,” he says, was threatened by individuals who peddled products like electric belts and electric hairbrushes. The author then suggests that legitimate practitioners, who previously refrained from publicizing electrical therapies, were becoming louder voices in the field. This “change in public sentiment,” he suggests, “[is] greatly stimulated by the discovery of the X ray by Baron Röntgen.” This article also affirms that the x-ray was not considered a distinctly new kind of machine. Articles in *The American X-Ray Journal* even continued to refer to the x-rays as “vibrations,” indicating the x-ray’s continued association with a broader set of other electro-therapeutic machines. An article in the same journal states that the x-ray had “brought more forcibly before the minds of physicians the value of the electric current as a therapeutic agent.”²¹ The x-ray, then, was beneficial not only in consolidating the authority of scientific medicine, but also in justifying the continued use of electrical therapeutics.

The x-ray, out of all other electrical therapies, became associated with advanced scientific medicine because it was the only electrical therapy that produced an image. The x-ray’s image-making capacity makes it a case study for the history of modern scientific medicine’s self-legitimation through the technique of specialized perception. In the eighteenth century, the epistemically authoritative gaze helped to standardize the interpretation of the body’s interior, so that medical professionals could amass a stable body of knowledge about anat-

20 "Electro-Therapeutics," *Chicago Daily Tribune*, July 23, 1899, 30.

21 Herbet Robarts, *The American X-Ray Journal* 1, no. 2 (1899), 30.

mical structures that were beyond the reach of ordinary perception.²² After the prior sanction against dissection was lifted, practitioners revealed and recorded the typical structures that existed below the surface of an individual's symptoms and experience, thereby decreasing the need for the patient's own narrative and symptomatology. Doctors' ordinary sight was augmented by a professional vision that relied upon the delineation of ideal types.

The x-ray capitalized on the deep legacy of scientific visuality while also benefiting from the technology's affinity with photography. Photography, which was invented 60 years before the x-ray, both allowed for "objective" images to be produced mechanically and increased the number of images that individuals encountered, thereby contributing to a visual culture that associated knowledge with sight. The x-ray became authoritative because it could reveal the structure or ideal type—the skeleton—beneath the surface of the patient's skin and could do so objectively. An early manual that delineates the parts of the x-ray machine and its potential use in surgery is subtitled "Photography of the Invisible," implying that the technology helped to produce legitimate ways of seeing, and thereby knowing, what was beneath the surface of the body.²³

Use of the x-ray was justified by its capacity to visualize the body's interior, even when it was not being used for diagnostic purposes. Rather, the x-ray's association with scientific visuality allowed its continued use in multiple non-allopathic and non-scientific contexts. A feature in *The American X-Ray Journal* registers a moment in which the vitalistic powers of the x-ray were called upon, even while the technique was also being valorized for the objective qualities associated with modern scientific vision. An issue from March of 1898 features an article entitled "Is There a Relationship Existing Between The X-Ray and the Luminating Power that Obtains in Telepathic Vision?" written by a "J.J. Fly, M.D."²⁴ (There were not rigorous standards for medical school at the time, nor would it have been unheard of for a non-doctor to claim medical credentials in the press, so the professional standing of the author is open to ques-

tion). The article narrates what the author considered to be the four great stages in the discovery of the qualities of light, with the last one being the x-ray. The forms of light discerned move "from the coarser to the finer, from the ordinary to the inordinary," so that the x-ray was seen as a culminating "pulsating stream of ethereal atoms." The molecules of the latter forms of light were thought to be farther apart so that the light could be compared to a gas or liquid. This characterization of the x-ray recalls earlier notions of electricity as a "fluid."²⁵ By describing the x-ray in terms of its ethereal qualities, the author explained the x-ray's effects in vitalistic terms. In comparing the ray to gas and liquid states, he portrayed it as a substance that moves freely between bodies. However, this vitalistic x-ray energy was simultaneously configured as scientifically sophisticated. The x-ray, as an advanced stage in the "evolution of the phenomena of light," allowed the "objective mind" to visualize what could not be seen with the "natural eye." The x-ray was called upon for its power to augment everyday vision with a professionally-backed scientific sight.

It is not clear what exactly the author saw as the possible relationship between the x-ray and telepathy. However, he clearly recognized the symbolic potency of the x-ray as an effective way to coordinate sight with knowledge. The author asks early in the article: "How is it that we know a thing? And how do we come to know? What is knowing?" In his account of the history of light, he articulates a form of knowing defined by the priority of the visual in its ability to impress knowledge from the immaterial world onto the faculties of the mind. The x-ray was seen as the most sophisticated iteration of a revelatory light that was considered to act on the mind itself. As medical professionals were theorizing the relationship between mind and body, between mental states and physiology, the x-ray was both vitalistic enough and scientific enough to authorize research into telepathy, what might have easily been deemed a "quack" practice.

Having become squarely associated with the privileges of objective scientific visuality, the x-ray technique was regarded as legitimate enough to explore suspected

22 Michael Foucault, *The Birth of the Clinic: an Archaeology of Medical Perception* (London: Tavistock Publications Ltd., 1973), xii.

23 William James Morton, *The X-Ray; Or, Photography of the Invisible and its Value in Surgery* (New York: American Technical Book Company, 1896).

24 J.J. Fly, "Is There a Relationship Existing Between The X-Ray and the Luminating Power that Obtains in Telepathic Vision?" in *American X-Ray Journal* 1, no. 5 (1898), 268.

25 Simon, *Dark Light*, 46.

relationships between invisible or difficult-to-visualize entities in the world. The impulse might not have seemed so unreasonable, given that Thomas Edison himself thought that the x-ray would one day be able to read people's thoughts.²⁶ What is important is that the author justifies a practice based on thoughts or mental states, things that could not be seen, by appealing to the x-ray's association with sight. The emphasis on sight becomes even more clear when he cites the potential for the x-ray to cure blindness, writing that "those who never knew what the sensation of sight was like, have been blessed for the first time in life with that knowledge." Vision and its intimate connection to knowing were repeatedly called upon to legitimize the x-ray's epistemic authority, even when the relevant practices involved entities that could not be visualized through the x-ray.

Visuality became associated with scientific management in the context of the shifting nature of the doctor-patient relationship between the nineteenth and early twentieth centuries. As visuality became a privileged way of knowing the body, physical manipulations and diagnostic tests became less frequently used. The encounter between the doctor's body and the patient's body took a radically different form, as the doctor's physicality was diminished in favor of an objective diagnostic eye. Foucault's analysis of the role of the stethoscope in *Birth of the Clinic* points to the way that the doctor-patient interaction was assimilated into the nexus of knowledge and perception inaugurated by the discovery of pathological anatomy. While the stethoscope was a listening device, it served to both diminish the amount of physical touch in the doctor-patient consultation (by making hand palpitations obsolete) and enforce diagnosis based on images of the ideal healthy body.²⁷ The x-ray occupied a similar role in the doctor-patient interaction, as it allowed the doctor to incorporate the expert perception into the evaluation of the patient's body. Doctors in the early years of the x-ray's use expressed both enthusiasm and trepidation over the way that the x-ray would change their interactions with patients. The x-ray's diagnostic potential was immediately glimpsed, as doctors noted the use of x-rays to detect fractures, particularly in military contexts. While some doctors capitalized on this opportunity to substantiate their medical expertise, some

expressed resistance toward using the x-ray for diagnosis, arguing that manipulations of the bone by hand were more accurate.

The x-ray's image-producing capacity was conducive to the new role assumed by medical practitioners in the early years of the twentieth century. Whereas the doctor was previously an individual whose healing powers were intimately related to his or her own physicality, around the turn of the century the doctor was reconfigured as a detached interpreter of the body and its processes. The shifting grounds of medical knowledge were conditioned by changing notions of scientific objectivity. In the latter part of the nineteenth century, objectivity came to be defined against the dangerous and even immoral subjectivity of the individual practitioner. The scientist, who in the past may have been admired for qualities of genius, inspiration, and interpretation, was now instructed to censure his or her personal subjectivity. Scientists were commanded to "let nature speak for itself," a refrain also commonly heard in discourses around the early invention of photography. Images, in this scientific context, were thought to be the least vulnerable to "subjective intrusions," and so became privileged signifiers of the emerging non-interventionist objectivity.²⁸ And like the camera, the x-ray could purportedly generate images without the polluting individuality of the practitioner. These images would be important in both constituting and symbolizing stable bodies of scientific knowledge.

Although early twentieth century x-ray practitioners called upon the visual authority of the device, the context in which they practiced medicine was still largely the medicine of the nineteenth century. Nineteenth-century medical practice in America was predominantly constituted by individual encounters between doctor and patient. There were few professional organizations, little regulation of medical education, and no standardized research protocols to speak of. The earliest volumes of *The American X-Ray Journal* consisted of a miscellany of anecdotes and curiosities about individual practitioners and experiments. And, because the components of the x-ray were easy to obtain, "practitioners" could refer to individuals of variable professional standing and with variable amounts of clinical medical experience. The journal itself was part of a movement within medicine

26 Colomina, *X-Ray Architecture*, 132.

27 Foucault, *The Birth of the Clinic*, 184-7.

28 Lorraine Daston and Peter Galison, "The Image of Objectivity," in *Representations* 40 (Los Angeles: University of California Press, 1992), 81-128.

toward professionalization, but its contents indicate that knowledge about the x-ray as a medical device consisted of an accumulation of isolated, ad hoc experiments.

INFORMATION AND AUTHORITY (1918-1940)

INDIVIDUAL MEDICAL encounters afforded practitioners their own particular notions of what constituted medical knowledge. This epistemological idiosyncrasy changed in the twentieth century as the doctor-patient interaction became situated within larger systems. Whereas treatments and protocols in the nineteenth century were generated idiosyncratically between the physician and the patient, in the early twentieth century, this epistemological space expanded to include a multitude of specialists within complex hospital systems. Whereas medical knowledge in the nineteenth century was generated through the doctor's use of interpretive subjectivity over a living body, in the twentieth century the "perceptive act" moved "outside of heart and head and into the information systems and professional organizations that organize the bits of available knowledge and develop guidelines and clinical pathways that inform clinical practices."²⁹ The doctor's own mind and body were present in x-ray experimentation, particularly as they were predisposed to try out the new rays on their own bodies. But between the nineteenth and twentieth centuries, the shifting character of medical knowledge, and with it the legitimation of the x-ray as a producer of images, was personified in the changing roles of doctor and patient. As the doctor-patient relationship became embedded in complex systems of medical scientific management, the creation of medical knowledge was dispersed between a

profusion of actors. Radiologists, scientific researchers, and hospital bureaucrats assumed positions in a self-consciously scientific practice of medicine, thereby facilitating the standardization and stabilization of objective medical knowledge.³⁰

The rise of the modern hospital accompanied reforms that advocated for increased professionalism and scientism in medicine. In particular, the Flexner Report of 1910 was greatly influential in establishing modern scientific medicine as the predominant paradigm for healthcare in America. Abraham Flexner, who was trained in the natural sciences at Johns Hopkins University, promoted a scientific paradigm of academic education and research based on the German university system. He sought to eliminate "nonscientific" approaches to medicine, as he believed that "alternative medicine" competed with and threatened appropriately scientific medical practices. He recommended higher admission and graduation standards for medical schools; standardization across curricula, including basic science courses; and centralization of medical institutions. The report had almost immediate effects both for establishing mainstream medical practice and for eliminating non-mainstream practices. Between 1900 and 1922, 18 of the country's 22 homeopathic colleges were closed, along with colleges in electrotherapy.³¹ Some doctors who practiced homeopathy, osteopathy, eclectic medicine, and physiomedicalism were jailed.³²

In 1914, the board of managers of the Pennsylvania Hospital, one of the first recognizably modern American hospitals, made a decision to have all patients x-rayed.³³ The scientific authority of the x-ray justified the professionalization and coordination of activity within the American hospital at the same time that the demands of professionalization and coordination standardized the use of the x-ray. Radiology emerged as a specialty in medicine in part because radiologists claimed that the x-ray, rather than being the fairly simple and easy-to-operate machine that could be used by amateur practitioners, was a complex

29 George Khushf, "A Framework for Understanding Medical Epistemologies," in *Journal of Medicine and Philosophy* 38, no. 5 (Oxford: Oxford University Press, 2013), 461-486.

30 Howell, *Technology in the Hospital*.

31 Martin Kaufman, *Homeopathy in America: The Rise and Fall of a Medical Heresy* (Baltimore: Johns Hopkins Press, 1971), 166.

32 Frank W. Stahnisch and Marja Verhoef, "The Flexner Report of 1910 and its Impact on Complementary and Alternative Medicine and Psychiatry in North America in the 20th Century," in *Evidence Based Complementary and Alternative Medicine* (London: Hindawi, 2012).

33 Howell, *Technology in the Hospital*, 130.

and sophisticated piece of technical machinery. The standardization of radiology, and of hospital infrastructure in general, demanded that the x-ray be used in the same way by all practitioners. This need for replicability and reliability helped to institute the specific diagnostic capacity of the x-ray in medical practice.

In their movement toward standardization, industrialization, and professionalization, hospitals adopted techniques of Taylorism, the strategy of scientific management designed in the nineteenth century to increase efficiency in factories. Specifically, hospitals looked to railroad companies' use of cost accounting.³⁴ Hospitals partly modelled their technologies and infrastructure on successful business strategies as a response to the fact that hospital occupants were no longer predominately the urban poor, but middle-class patients who were willing to pay for hospital services. The division of activity into different departments reflected both the increased specialization of medical knowledge and the ease with which this specialization enabled accountants to track hospital costs. The functions of the hospital, then, were recalibrated along the lines of efficiency and rationalization. The x-ray and the business strategies adopted from successful companies were each complicit in the application of scientific and industrial discoveries to medical practice. Their simultaneous integration into the American hospital system demonstrates the way that new therapeutic technologies accompanied and facilitated new technologies of power and organization.

Changes in the role of the x-ray within the hospital were associated by changes in the technology itself. The "gas tube era," in which machines were large, loud, smelly, and imprecise, ended with advances in machinery, particularly after World War I. In the gas tube era, the experience of being x-rayed was one of sensory overload; the patient experienced the emission of sparks and sounds, smelled ozone and nitrous oxide from the machine and gasoline from the generator, and perhaps tasted the barium in drinks that were prescribed in order to induce a visible radio-opaque effect. These dramatic effects often made patients anxious or nauseous, and these side effects paled in comparison to the burns

and deaths suffered by early x-ray "martyr" experimenters.³⁵ Thomas Edison himself swore off x-ray experimentation after he nearly lost his vision, and his assistant, Clarence Dally, developed a carcinoma leading to the amputation of an arm. Following these unforeseen consequences, Edison announced to a reporter from *New York World*: "Don't talk to me about X-rays... I am afraid of them."³⁶

The public's growing unease with the unreliability and danger of the x-ray, as well as the embedding of radiology in complex hospital systems, led to improvements in every element of the x-ray apparatus in the 1910s and 1920s. The increasing call to administer scientifically rigorous and experimentally replicable treatments also led to a standardization of the way that the x-ray's effects were measured.³⁷ The amount of radiation administered had previously been measured by observing visible effects on the patient's skin. However, as medical practice became less idiosyncratic and medical practitioners endeavored to aggregate information about care into large, centralized institutions, radiologists developed instruments to precisely measure radiation exposure.³⁸ Measurements of radiation, as well as of allowable risk, standardized the practice across practitioners. These developments, in addition to the fact that by 1918 a much greater portion of the population had become accustomed to being x-rayed, led to a decrease in the spectacle and novelty of the machine.

The diminishing physicality of the x-ray, and the consequent decrease in its visible effects on the body, facilitated its placement in an increasingly consumer-oriented paradigm of health management. The x-ray as a therapeutic agent was predicated on its ability to demonstrate the activation of vitality in the human body, an ability which necessitated the proximity, and relative insularity from bureaucracy, of the individual doctor and patient. As healthcare became dispersed across large institutions and administrative apparatuses, the x-ray assumed its role as a mode of producing information that would lead to diagnoses. The capacity to visualize the interior of the body was conducive to an

34 Howell, *Technology in the Hospital*, 31.

35 Lavine, "The Early Clinical X-Ray in the United States," 607-611.

36 Lavine, "The Early Clinical X-Ray in the United States," 596.

37 Anne Hessenbruch, "Calibration and Work in the X-Ray Economy," in *Social Studies of Science* 30, no. 3 (Los Angeles: SAGE Publications, 2000).

38 Hessenbruch, "Calibration and Work in the X-Ray Economy," 412.

increasingly prevalent mandate to maintain individual health—an imperative that called for continual discernment of the hidden structures and mechanisms of the body. The category of diagnosis was useful in substantiating a paradigm wherein the patient sought not an immediate cure but information with which to make decisions about long-term health.

Although the x-ray was just one piece of technology within a complex healthcare system, and the physical presence of the machine itself was diminished, the aesthetic of the technology remained significant. In the years after World War I, the x-ray symbolized not only modern scientific visuality, but modern industrial machinery generally. Radiologists appealed to the x-ray's aura of technological sophistication to justify their role in hospital systems as qualified professionals. In the hospital's integration of multiple medical practices into a single system, there was sometimes tension between radiology departments and the demands of a large business-oriented hospital. A 1934 article published in *Radiology*, a professional journal started in 1929, identified a "peculiar relationship between hospital and roentgenologists," in which the hospital owned the equipment and facilities that the radiologist used, but the radiologist performed services that he/she saw as involving distinct technical expertise. Hospitals, on the other hand, believed that they could produce "roentgenograms" without the help of the radiologist and that the radiologist simply provided interpretation of the images. This discrepancy resulted in confusion over how to divide compensation between the hospital and the radiologist.³⁹ A 1935 article in the same journal lamented that "many physicians consider the roentgenologist a mere photographer."⁴⁰

The "domestication" of the x-ray machine from a cumbersome instrument to a modern and efficient technology embedded in the hospital threatened the radiologist because he or she could no longer demonstrate the miraculous powers of the x-ray. Previously the side effects, even when they were unpleasant or fatal, proved that the x-ray was working. One radiologist in

the gas tube era noted that he even "ma[de] it a point in every case to produce a burn," as the visible effects of the rays indicated its curative efficacy.⁴¹ Radiologists after WWI, on the other hand, did not attempt to produce visible effects, nor was the public nearly as willing to tolerate them. Instead, they fashioned their authority as technicians who provided the service of interpreting information produced by sophisticated machines. They claimed their professional status in reference not to the patient's body as a site of visible effects but to the x-ray machine itself and its ability to produce diagnostic information. The radiologist modified the role that was vacated by the individual doctor as a demonstrator, or even entertainer, who produced observable therapeutic effects, and became the interpreter of mechanically-produced scientific images that could then be used to generate a diagnosis.

Much of the appeal of the x-ray in the years after WWI lay in its mechanical sophistication. X-ray technology became a mass industry as companies in the U.S. and Germany marketed their high-quality equipment domestically and abroad. Radiology epitomized mass production, with its "investment in apparatus and its striving to routinize labour" and its call for "elaborate plants, machinery and other equipment, and consequently for heavy investment."⁴² Radiology and the x-ray industry, along with the hospital, increasingly fit into paradigms of big business undergirded with the appeal of advanced technology.

The conception of the x-ray as a sophisticated machine, and the radiologist as a sophisticated machine technician, accorded well with the emerging view of the body as a machine. The machine metaphor was prevalent in the work of Fritz Kahn, a German physician who was known for his widely-circulated popular science books and illustrations. He published an image entitled *Der Mensch als Industriepalast*, or *Man as Industrial Palace*, that depicted the human body as a modern chemical plant. In the image, the interior of the human body consists of a network of parts that correspond to functions. Unlike the metaphor of the body as an economy, which understood the body as an interconnected whole

39 Leon Menville and Howard Doub, "The X-ray Problem and a Solution: A Discussion of the Proposed Separation of the X-ray Examination into Technical and Professional Portions," in *Radiology* 23, no.5 (Oak Brook, Illinois: The Radiological Society of North America, 1934).

40 Emmet Keating, "Fee Tables and the Roentgenologists," in *Radiology* 24, no. 3 (Oak Brook, Illinois: The Radiology Society of North America, 1935).

41 Lavine, "The Early Clinical X-Ray in the United States," 612.

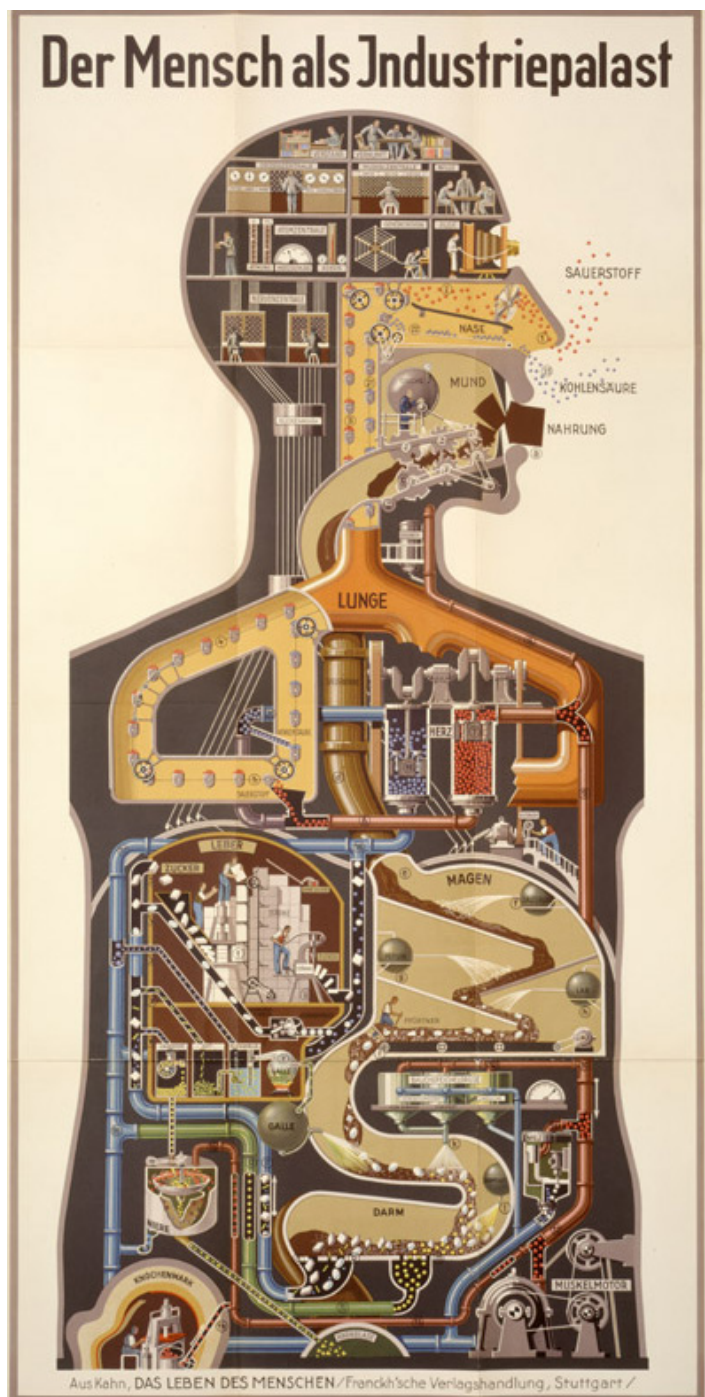
42 Hessenbruch, "Calibration and Work in the X-Ray Economy," 414.

coordinated by immaterial forces, the factory metaphor proposed a functional relationship between parts of the body and the body as a whole. Whereas the ‘economy’ of the body was regulated by the flow of material-immaterial substance between undifferentiated parts, the body as ‘machine’ integrated the specific functions of the parts into a system optimized for efficiency. The body, like the modern hospital, was conceived along the lines of a factory, where labor was divided so as to maximize the production of power.

Other captions for Fritz Kahn’s illustrations include “Comparison of force transmission in a car and the outer ear” and “the basic forms and functions of the bones and joints in man’s body are very similar to our own architectural and technological constructions.”⁴³ Kahn’s graphics portray the modern preoccupation with the body as an energy system designed for maximum efficiency.⁴⁴

The body was a machine engineered for efficiency, but, like the x-ray machine, it required the expertise of trained technicians to maintain it. This expertise existed not in the space between the patient’s and the doctor’s bodies, as it had in the first years of x-ray treatment. Rather, expert medical opinion was produced in reference to an increasingly large body of knowledge that was generated between hospitals and research facilities and between various departments within the hospital. In the context of the proliferation of scientifically-backed research studies and the dispersal of care between multiple departments and practitioners, health evaluations were increasingly produced in reference to stable bodies of knowledge that existed outside of the doctor’s experience and judgment. The patient’s own symptoms and accounts of illness played a smaller role in orienting diagnosis and treatment. Rather, medical evaluation was increasingly conducted through measurement and statistics. Blood tests, urinalysis, and other diagnostic tests became more prevalent, as did standardized written forms that allowed practitioners to easily extract and compare patient information.⁴⁵

By the 1940s, the Eastman Kodak Company advertised its radiographic equipment by its ability to “provide inside information.” A pamphlet circulated by the



Fritz Kahn's illustration entitled *Der Mensch als Industriepalast*, or *Man as Industrial Palace*, depicting the human body as a modern chemical plant. [3]

company proclaimed that radiography “in modern industry” was useful for its ability to procure “a wealth of

⁴³ National Library of Medicine, History of Medicine Division, National Institutes of Health, “Dream Anatomy” online gallery.

⁴⁴ Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (Berkeley, CA: University of California Press, 1992).

⁴⁵ Howell, *Technology in the Hospital*.

invaluable data.”⁴⁶ Nowhere in the ad was the body of either the patient or the practitioner depicted; rather, the ad featured pictures of the machine and its parts and of diagnostic images produced by the machines. Emphasis had shifted to the x-ray’s ability to produce data or information, a function that suited the information-centric organization of emerging medical institutions.

The x-ray, as a machine both symbolic of and functional to the priorities of American medicine, articulated a new conception of health in modern life. Rendered a site of constant calibration and maintenance, the body was “an entity in the process of becoming, a project to be worked at and accomplished as part of an individual’s self-identity.”⁴⁷ The project was to make the body beautiful and efficient, as good health was associated with both a certain conspicuous consumption and the capacity for work. The activity of health was not confined to the hospital; the imperative to produce and maintain a healthy body permeated all manner of physical and psychic spaces.

The x-ray, from its inception, emphasized not just the exposed body, but the body being exposed. It was seen as a threat to privacy in its power to reveal the inside of the body; the body revealed was often the body of a woman, and the still-discernible contours of her skin reminded the viewer that this was an intimate act.⁴⁸ The x-ray’s association with the voyeuristic gaze was reinforced as modern architecture adopted the x-ray aesthetic by incorporating transparent glass and exposed frames that revealed the activity of those inside the building. (Pyrex and other transparent consumer goods became popular in the same years). Modern architecture, which is dated as beginning around the same years as the x-ray was invented, was predicated on the sick body, as the private space of the home was configured as a sanatorium. Sanatoriums were becoming status symbols, places where the wealthy went to escape the city. The same white surfaces, glass windows, and ac-

cess to sunlight that characterized medical facilities were installed in homes, private spaces that, like the interior of the body, were subject to public scrutiny.⁴⁹ Space itself was seen as an antidote to sickness; non-ornamental cubic white forms were seen to counteract “modern nerves”—a diagnosis reminiscent of James Beard’s neurasthenia. Modern architecture and medical discourse reinforced the notions that the modern individual was one with a fit and healthy body and that the maintenance of this body should be an ongoing activity.

The diagnostic capacities of the x-ray were conducive to the health culture that emerged in the United States in the years after WWI. In this culture, individuals who were well-off enough to pay for medical services interacted with a complex medical system, made up of sophisticated technology and skilled technicians, that would provide them information necessary for health maintenance. Sickness came to be seen as the norm, rather than an exception, such that individuals were mandated to continually fend off disease. This ongoing maintenance included regular visits to medical professionals who could furnish them with diagnoses, increasing the amount of information they had about their own well-being.

Individual health-seekers were reconfigured as consumers in accordance with the increasingly business-like modern hospital. The first public health campaign, against tuberculosis, epitomized the trend toward healthcare as a consumer-oriented, prevention-based practice. A poster circulated by the Christmas Seal campaign, a fundraising effort begun by the American Red Cross, features a healthy and fit man.⁵⁰ The poster urged individuals to make the decision to be x-rayed even though they might not have any symptoms, reinforcing the idea that health maintenance involved a fundamental information asymmetry: there was important diagnostic information that could only be discerned by the x-ray and its interpreter.

46 Kodak, “3 Ways Radiography Can Provide Inside Information,” *Science* 109 (Washington D.C.: American Association for the Advancement of Science, 1949), 9.

47 Chris Shilling, *The Body and Social Theory* (London: SAGE Publications, 2012), 5.

48 Lisa Cartwright, *Screening the Body: Tracing Medicine’s Visual Culture* (Minneapolis: University of Minnesota Press, 1995).

49 Colomina, *X-Ray Architecture*, 97.

50 U.S. National Library of Medicine, “Visual Culture and Public Health Posters.”

CONCLUSION: INTERIORITY

OVER THE COURSE of approximately fifty years from its invention, the x-ray was progressively fashioned into a medical technology that fit the particular aims of institutional biomedicine in the United States. The technology has continued to exist as an authoritative method of representing and knowing the body. In organizing diagnoses around the structures discernable beneath the surface of heterogeneous human experience, the x-ray helps to maintain boundaries between health and illness. But the x-ray was not adapted to fit circumscribed notions of health and disease; it helped to produce a particular form of diagnosis at the same time that the epistemic landscape of American medicine was evolving. Debuting onto a field of divergent medical sects and little to no professional organization, the x-ray in its early years was understood in the context of ambiguously efficacious experimental modalities. In this context, it was considered a potential therapy along the lines of other electrical devices that would soon go out of fashion. Its diagnostic capacity was selected as the space of American medicine was narrowing to sanction scientific medicine as the only allowable medical paradigm.

The x-ray's eventual institutionalized use privileged certain ways of knowing the body at the expense of others. It enabled genuinely new representations of the healthy body and of the pathologies that threatened it, allowing for new sites of intervention and curative techniques. However, it simultaneously narrowed the field of interpretations of illness that could count as legitimate. The x-ray enforced a paradigm in which treatment and diagnosis were framed in relation to the disease, rather than to the patient. By the 1920s, certain medical professionals had identified the tendency for the specialist's understanding of particularities to cut against medicine's goal of promoting health for the whole person. Ernst Phillip Boas, a prominent physician, medical director, and author, noted that young

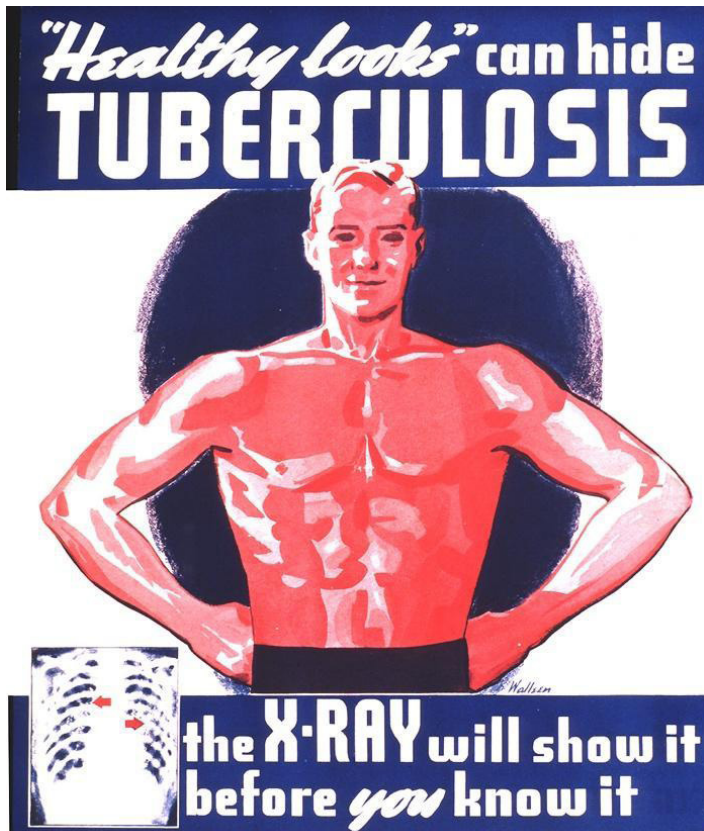
practitioners who were trained in particular disorders did not know how to assess subtle indications in a person's constitution that were associated with systemic disease. He noted that "they could treat diseases but not the sick," and that "the reality of medical practice [is] the opposite: 'We treat the sick not diseases.'"⁵¹

The x-ray was implicit in circulating the notion of an individual's health as the proper functioning of individual parts. This notion enabled philosophies of care that prioritized technical intervention into particular body parts and systems. But adequate treatment often called not for "fixing that specific part," but for "returning the whole to a sense of normality."⁵² Electrical therapies in the nineteenth century were justified by their ability to act on bodies that were understood to exist in the same ontological category; the same vital substance flowed through both the device and the body in which it produced effects. Homeopathic practices interpreted their cures along the same lines; substances in the world were liable to induce effects on the body due to their being of the same kind as the treated ailment. Although the x-ray eventually distanced itself from these theories that were deemed unscientific, it internalized many of the same assumptions about causation in the body. The x-ray, conceived as a machine with interrelated functional parts that together produced energy in an efficient way, was understood to act on bodies that were constituted in precisely the same manner.

The x-ray's effects often could not be explained on the terms that it helped to enforce as legitimate. Although the machine was taken to embody the successful integration of science and industry into American medicine, its authority was conceptualized in the very paradigms that it had rejected as characteristic of an esoteric or non-modern way of practicing medicine. In casting light on affinities between orthodox and unorthodox medical paradigms, the x-ray shows how legitimation is negotiated through explanations and uses for particular technologies at particular times. If the x-ray is one thread in the passing over from heterodox therapeutic practices to the institutionalization of scientific technologies of care, it reveals important contradictions within the ascension of biomedicine. ♦

51 Robert Charles Yamashita, "Intervention before disease: Asymptomatic biomedical screening," (PhD diss., University of California, Berkeley, 1992), 66.

52 Yamashita, "Intervention before disease," 66.



Christmas Seals Fight Tuberculosis

A poster circulated by the Christmas Seal campaign, a fundraising effort begun by the American Red Cross, featuring a healthy and fit man. [4]

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