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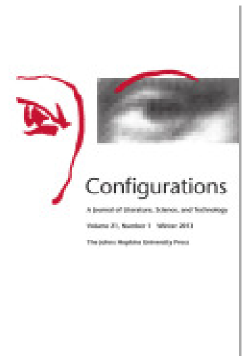

Configurations, Volume 21, Number 1, Winter 2013, pp. 27-52 (Article)

Published by Johns Hopkins University Press
DOI: https://doi.org/10.1353/con.2013.0004

The Automatization of Nikola Tesla: Thinking Invention in the Late Nineteenth Century

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ABSTRACT: By investigating the conflicted relationship between Nikola Tesla (1856–1943) and the electrical engineering community, this essay explores competing representations of "invention" in the fin-de-siècle period. Drawing on the observation that the dominant paradigm of invention was entangled in various inscription practices, I turn to the case of Tesla to examine how inventions that circulated only as discourses were represented and legitimated in the scientific community, popular press, and literature. The essay argues that the rise of transmission media, such as wireless telegraphy, that challenged established conceptions about physical reality informed, in turn, Tesla's singular model of invention.

On the morning of November 6, 1915, the front page of the *New York Times* featured the Nobel Prize winners in physics, literature, and chemistry. According to the dispatch, Thomas Edison and Nikola Tesla were laureates of the distinguished prize in physics.[1] The newspaper issued Tesla's reaction the next day: the Swedish Committee had not notified him officially, but the inventor of the polyphase motor concluded that the honor would be conferred upon him to acknowledge "a discovery announced a short time ago which concerns the transmission of electrical energy without wires." Edison, he noted, was "worthy of a dozen Nobel Prizes."[2] In the following

1. "Edison and Tesla to Get Nobel Prizes," *New York Times,* November 6, 1915.

2. "Tesla's Discovery Nobel Prize Winner: Transmission of Electrical Energy without Wires, Which Affects Present-Day Problems," *New York Times,* November 7, 1915.

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weeks, the announcement circulated through the gears of multiple professional publications, each applauding two of the most famous American inventors.[3] The ceremony showcasing the antagonists, however, never took place; a week following its initial announcement, the *New York Times* stated that the prize was going to Sir William Henry Bragg and his son for their work on the X-ray spectrometer.[4] The editors said nothing about the faux pas.

Most intriguing here is Tesla's rationale for receiving the award, as he attributed it to an invention that had never materialized into a workable, commercialized apparatus. Rather, wireless power had only circulated, like many other claimed inventions by Tesla, in a discursive, promissive mode. The Serbian-born electrical specialist, who was recognized as the inventor of the polyphase system of electricity distribution, was a controversial figure in the expert community that had welcomed him in the late 1880s. In fact, when Thomas Hughes attempted to develop a classification of inventing models—describing Bell and the Wright brothers as amateur inventors, Fessenden and De Forest as full-time inventors, and Edison and Sperry as inventor-entrepreneurs—he found Tesla "difficult to classify."[5] In a recent biographical study of Tesla, W. Bernard Carlson also contends that in the latter part of his career, the inventor was more inclined to create "illusions" than to convert "his ideals into working machines."[6] Indeed, Tesla did not systematically produce the material technology for the inventions he claimed to have invented and as a result, different narratives place him in heterogeneous roles: forgotten genius, ill-fated businessman, showman, visionary, techno-utopian prophet, mad scientist, mad *tout court*.[7]

In the history of technology, how do we approach inventions that circulate only in the form of discourse and never materialize into

3. Including *Electrical World and Engineer*, *St. Louis Post-Dispatch*, *Literary Digest,* and *Electrical Experimenter*.

4. "1915 Nobel Prizes Awarded; One Goes to a German; English Father and Son Divide Another," *New York Times*, November 14, 1915. To add to the confusion, the same newspaper once again introduced Tesla as a "1915 Nobel Prize Winner" in an article titled "Tesla's New Device Like Bolts of Thor," *New York Times,* December 8, 1915.

5. Thomas P. Hughes, *American Genesis: A Century of Invention and Technological Enthusiasm, 1870–1970* (New York: Viking Penguin, 1989), p. 67.

6. W. Bernard Carlson, *Tesla: Inventor of the Electrical Age* (Princeton, NJ: Princeton University Press, 2013), p. 11.

7. The titles of Tesla's biographies are themselves evocative: John J. O'Neill, *Prodigal Genius: The Life of Nikola Tesla* (New York: Ives Washburn, 1944); A. J. Beckhard, *Electrical Genius Nikola Tesla* (New York: Messner, 1959); and Margaret Cheney, *Tesla, Man Out of Time* (Englewood Cliffs, NJ: Prentice-Hall, 1988).

things? Visions, predictions, claims, forecasts, prophecies—even popular narratives and literary fiction—present technologies that do not necessarily become material technology. As Erkki Huhtamo argues in his programmatic piece on media archaeology, "unrealized 'dream machines' or discursive inventions (inventions that only exist as discourse) can be just as revealing as realized artefacts."[8] More recent work in media archaeology has indeed revealed fertile territory to explore unrealized technologies under the conceptual umbrella of "imaginary media."[9] Similarly, David Edgerton makes the case for histories of invention that go beyond success stories to analyze technological failure, and to examine how invention and innovation is constructed at any point in time.[10] These authors argue for a transition away from a focus on invention as "things invented" to one on the conditions of how invention is constructed, both materially and rhetorically.

Noteworthy studies in the history of technology have approached invention from this broader perspective. Hughes, for instance, suggests that physical artifacts are one component within a larger "technological system" that comprises legal, economic, cultural, and political institutions.[11] In her study of Edison's phonograph, Lisa Gitelman shows how the inventor's practice was not just one of making things, but was also characterized by the production of visual, graphic, and textual material. Material artifacts, she notes, "very rarely exist without linguistic and graphic complements, labels, descriptions, drawings, and diagrams."[12] Charles Bazerman, using the case of the electric light, demonstrates how Edison's practice as inventor relied as much on the production of material technology as it did on rhetorical discourses, where the meaning of technology is

8. Erkki Huhtamo, "From Kaleidoscomaniac to Cybernerd: Notes Toward an Archaeology of the Media," *Leonardo* 30:3 (1997): 223.

9. See, for instance, Siegfried Zielinski, *Deep Time of the Media: Toward an Archaeology of Hearing and Seeing by Technical Means* (Cambridge, MA: MIT Press, 2006); and Eric Kluitenberg, "On the Archaeology of Imaginary Media," in *Media Archaeology: Approaches, Applications, and Implications*, ed. E. Huhtamo and J. Parikka (Berkeley: University of California Press, 2011), pp. 48–69.

10. David Edgerton, "Innovation, Technology, or History: What Is the Historiography of Technology About?" *Technology and Culture* 51:3 (2010): 687.

11. Thomas P. Hughes, "The Evolution of Large Technological Systems," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch (Cambridge, MA: MIT Press, 1987), pp. 51–82.

12. Lisa Gitelman, *Scripts, Grooves, and Writing Machines: Representing Technology in the Edison Era* (Palo Alto, CA: Stanford University Press, 1999), p. 7.

shaped.[13] Both Gitelman and Bazerman zero in on various "inscriptions" that are part of a rhetorical apparatus: patent letters, corporate registrations, notebooks, formal lectures, testimonies, and product labels all legitimate technology as invention. In a similar vein, the inquiry made by Rebecca Slayton into death-ray machines shows how popular narratives did not just reflect technoscientific knowledge, but also played a role in shaping these representations.[14]

This body of work resonates with the overarching argument that many have made in science studies about inscriptions. Bruno Latour argues in now classic texts[15] that scientific facts are stabilized through the production of material traces he calls "inscriptions"—scientific instruments, notes, imaging technologies, tables, diagrams, pictures, and sketches.[16] As Timothy Lenoir puts it, "science constructs its object through a process of differential marking, and it makes that object stable through public forms for the construction and dissemination of meaning [using] communication technologies and technologies of representation."[17] The textual and visual inscriptions produced by the inventor in the late nineteenth century played similar roles: they stabilized the meaning of technology *as* inven-

13. Charles Bazerman, *The Languages of Edison's Light* (Cambridge, MA: MIT Press, 2002).

14. Rebecca Slayton, "From Death Rays to Light Sabers: Making Laser Weapons Surgically Precise," *Technology and Culture* 52:1 (2011): 45–74.

15. See, for instance, Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Princeton, NJ: Princeton University Press, 1979); and Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, MA: Harvard University Press, 1987), and "Technology Is Society Made Durable," in *A Sociology of Monsters*, ed. John Law (London: Routledge, 1991), pp. 103–131. On "inscriptions," see Bruno Latour, "Drawing Things Together," in *Representation in Scientific Practice*, ed. Michael Lynch and Steve Woolgar (Cambridge, MA: MIT Press), pp. 455–476.

16. The argument has blossomed in science and technology studies, and a range of scholars conducting historical and ethnographical case studies have turned to the texts produced by scientific activity now recognized as sites of the negotiation of knowledge, a perspective described as the "semiotic turn" in Timothy Lenoir's "Inscription Practices and Materialities of Communication," in *Inscribing Science: Scientific Texts and the Materiality of Communication,* ed. Timothy Lenoir (Palo Alto, CA: Stanford University Press, 1998), p. 1. This work, incidentally, was published as part of the Writing Science series of Stanford University Press that addressed the culture of science and its relationship with different textualities in more than thirty publications. In the series, see in particular Peter L. Galison and David J. Stump, eds., *The Disunity of Science: Boundaries, Contexts, and Power* (1996); Lenoir, ed., *Inscribing Science*; and Bruce Clarke and Linda Dalrymple Henderson, eds., *From Energy to Information: Representation in Science and Technology, Art, and Literature* (2002).

17. Lenoir, "Inscription Practices and Materialities of Communication" (above, n. 16), p. 12.

tion, seemingly objectively, and fostered the inventor's authority. We could infer for the inventor what communication scholars James Taylor and Elizabeth Van Every say about authority in the organization: that authoring texts that speak on behalf of nonhumans incidentally increase the speaker's authority. As they ably explain: "Without texts, no authority! After all, the two words share the same root" (the Latin word "*auctor*").[18]

The absence of "things invented" in Tesla's career as inventor complicates matters further—literally. Patent letters and other inscriptions of the nineteenth century supposed the existence, more or less distant, of the technology they were representing.[19] In Tesla's scheme, however, inventions coincided with these discursive manifestations and did not materialize in the form of a technical object (for example, the invention of wireless power, death-ray weapons, "magnifying transmitters," stormproof dirigibles, or wireless telephony). A history of technology could consider these inventions as cases of technological failure; however, the extent to which these inventions were diffused *as* discourses and the fascination they fostered in the expert community, the popular press, and science writings invite us to look further. Tesla's ability to remain in the expert community, even if he was at its fringe, additionally suggests that his inventions were considered more than mere phantasmagoria, or fantasies of the mind, and that there was something sufficiently meaningful about them to create tensions, debates, and associations.

This essay argues that the debates on the ambiguous notion of invention in science and technology in the fin-de-siècle expert community and popular narratives created a space of undecidability for the materiality of invention, a space that Tesla's controversial

18. James R. Taylor and Elizabeth J. Van Every, *The Emergent Organization: Communication as Its Site and Surface* (Mahwah, NJ: Lawrence Erlbaum Associates, 2000), p. 242. The intimate relationship between authority and authoring has been widely addressed in the field of rhetorical and organizational communication studies. Taylor and Van Every have shown through conversation analysis and ethnomethodology how authority is always an effect and not a cause, echoing what Bruno Latour says of power in his "The Powers of Association," in *Power, Action and Belief: A New Sociology of Knowledge?* ed. John Law, Sociological review monograph, vol. 32 (London: Routledge & Kegan Paul, 1986), pp. 261–277. On the authority in the organization, see Chantal Benoît-Barné and François Cooren, "The Accomplishment of Authority through Presentification: How Authority Is Distributed Among and Negotiated by Organizational Members," *Management Communication Quarterly* 23:1 (2009): 5–31.

19. This is what Bazerman calls "heterogenous symbolic engineering": "For any technology to succeed (that is, to establish an enduring place within the world of human activities), it must not only succeed materially . . . it must also succeed symbolically"; see *The Languages of Edison's Light* (above, n. 13), p. 335.

discursive inventions occupied. I follow here invention as *discourse* rather than invention as *technology*. I analyze episodes in Tesla's career where he claimed inventions in spite of lacking the material technology or "things invented," and I focus on how this rhetoric was received by the scientific community, the popular press, and in the literature. My intention is not to present Tesla as someone who failed to meet the dominant conditions to be an inventor; rather, I use his case, so famously controversial, to navigate across some fragile boundaries between the objects and subjects of science and technology.

In the first two parts of the essay, I describe how Tesla constructed his status as an inventor within the expert community of the late 1880s, even if the young engineer faced a number of difficulties in doing so; for example, the texts describing the invention of the polyphase motor did not fully meet the standards of legitimating actors, and the prototype itself remained concealed for some time after it was announced. Looking more closely at a controversy that erupted between Michael Pupin and Tesla, I argue that the ambiguity of the roles of scientists and engineers within the electrical engineering community opened the way for the growth of uncertainty about the materiality of invention. The last two parts of the essay focuses on the peculiar, medium-like view of the inventor that Tesla developed over the years. I explore some of the correspondence between that subjectivity of the inventor and the rise, in the 1890s, of a network of new models of transmission, particularly wireless technologies. I argue that against the dominant paradigm of representation of inscription technologies, Tesla's model of invention was operating out of a regime of presence, which, in turn, legitimated discursive inventions.

Enter Tesla

As the field of electrical engineering organized in the late nineteenth century, professional societies played a pivotal role in defining the "electrical expert."[20] One flagship organization, the American Institute for Electrical Engineers (AIEE), employed various categories, such as electricians, electrical engineers, technical advisors, electrical experts, inspectors, instructors, scientific experts, professors, and inventors. Unlike scientists and engineers, whose professional status

20. On the institutionalization of electrical experts, see A. Michal McMahon, *The Making of a Profession: A Century of Electrical Engineering in America* (New York: IEEE Press, 1984); and Carolyn Marvin, *When Old Technologies Were New: Thinking about Electric Communication in the Late Nineteenth Century* (New York: Oxford University Press, 1988).

was legitimated through other institutions that set the inclusion conditions, inventors were in a class of their own. Within the AIEE, the category of inventor was limited in scope; in the 1890 census of the society, eleven out of 488 members were recognized as "inventors."[21] The category was also short-lived, as the independent inventor gave way to larger institutions once corporations began agglomerating inventive geniuses at the turn of the twentieth century.[22] As a result, the status of inventors was contested: Was this the category of builders of functional goods, the "makers of Modern America," as Hughes put it, or was it a repository of geniuses with spectacular abilities to conceive and design creatively?[23]

It came as no surprise that Edison, known for his hard work, rigorous methods, and loathing of sleep, belonged to this category, along with Emile Berliner, Frank Sprague, and others. Tesla, conversely, who also figured in the census as "Electrical Engineer and Inventor,"[24] grew into a controversial representative of the group, precisely because he was no such "builder." Tesla joined the expert electrical community as a central actor in the notorious "Battle of the Systems," a sociotechnical controversy that shook the electrical engineering community from the mid-1880s to the early 1890s. In both Western Europe and North America, where the rapid diffusion of lighting systems increased the demand for electricity supply, industrialist rivals, scientists, patent owners, city planners, and manufacturers partook in the heated debate about the establishment of a standardized norm for electricity distribution. Tesla not only sided with the alternating-current enthusiasts against Edison, but he also provided them with a strategic advantage when he described the polyphase induction motor in 1888. The race toward electrification has been told from multiple angles by historians of technology; it

21. Other than Tesla and Edison, the list included Moses G. Farmer, Stephen D. Field, Philip Diehl, Gustav Pfannkuche, Patrick Bernard Delaney, Emile Burliner, W. M. Miner, Frank J. Sprague, and Albert E. Woolf.

22. See Hughes, *American Genesis* (above, n. 5); Eric S. Hintz, "Portable Power: Inventor Samuel Ruben and the Birth of Duracell," *Technology and Culture* 50:1 (2009): 24–57; Walter W. Powell and Eric Giannella, "Collective Invention and Inventor Networks," in *Handbook of the Economics of Invention*, ed. Bronwyn H. Hall and Nathan Rosenberg (Amsterdam: Elsevier, 2010), pp. 575–605; and Tom Nicholas, "The Role of Independent Invention in U.S. Technological Development, 1880–1930," *Journal of Economic History* 70:1 (2010): 57–82, and "Independent Invention during the Rise of Corporate Economy in Britain and Japan," *Economic History Review* 64:3 (2011): 1–29.

23. Hughes, *American Genesis* (above, n. 5), p. 4.

24. "Directory of Members," *Transactions of the American Institute of Electrical Engineers* 7 (1890): appendix 17.

serves to reveal a number of important cultural and technical ruptures.[25] If Tesla was seemingly gloriously welcomed as the inventor of the winning technology, a closer look into that story reveals that his reluctance (or inability) to produce both the material technology and the rhetorical discourses supporting it opened the door for others to claim authority in locating the invention.

Tesla gave his famous lecture on the polyphase motor in an afternoon session on May 16, 1888, and by June 5 he had joined the AIEE.[26] The young newcomer had been invited to deliver a paper before an already divided community, and he made a blunt declaration that his system would "at once establish the superior adaptability of [alternating] currents to the transmission of power."[27] The statement served Tesla well, for the system achieved precisely this: over the course of the following decade, the alternating current was adopted as the standard. Nevertheless, the proceedings of the meeting shows that his lecture was not received as wholeheartedly as some accounts later implied. The invention itself was no surprise for the community: at the time of the lecture in 1888, alternating-current enthusiasts were also working toward the development of an alternating-current motor. The lecture contained only approximations of what the polyphase system could achieve, and Tesla had neglected to bring the motors for demonstration purposes. The community's response to his paper must have been a very tepid one, or at least this was indicated by the supporters of alternating current who were hoping that the invention was not humbug, because the chairman asked professor of physics William Anthony to "properly supplement Mr. Tesla's paper with some remarks." Anthony testified that he had seen the motors and found their action "exceedingly remarkable."[28] Engineer Elihu Thomson added he was "very much interested in the description given by Mr. Tesla."[29] The two men were influential members

25. Percy Dunsheath, *A History of Electrical Power Engineering*, 2nd ed. (Cambridge, MA: MIT Press, 1969), p. 157; Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880–1930* (Baltimore: Johns Hopkins University Press, 1983), and *American Genesis* (above, n. 5); David E. Nye, *Electrifying America: Social Meanings of a New Technology, 1880–1940* (Cambridge, MA: MIT Press, 1990).

26. We do not know Tesla's status when he joined the AIEE in 1888 because the directory of members started including its topology of professional positions only in 1890. In 1889, the entry for Tesla in the directory of members read "Nikola Tesla, Pittsburgh, PA." See *Transactions of the American Institute of Electrical Engineers* 6 (1889): viii.

27. Nikola Tesla, "A New System of Alternating Current Motors and Transformers," *Transactions of the American Institute of Electrical Engineers* 5:5 (1888): 308.

28. "Proceedings of the American Institute of Electrical Engineers Meeting May 16," *Transactions of the American Institute of Electrical Engineers* 5:5 (1888): 324.

29. Ibid., pp. 325–326.

of the AIEE and were also credible representatives of the alternating-current camp before Tesla came on the scene; speaking on behalf of his technical object gave them even more authority. In turn, and to Tesla's advantage, these testimonies acted as what Steven Shapin and Simon Schaffer call "social technology,"[30] supplementing a textual discourse about the invention that did not articulate clearly where it lay. By a way of justification, Tesla had started his paper by warning the audience that he had not been "able to treat the subject as extensively" as he had wished, his "health not being in the best condition at present,"[31] thus shifting the emphasis from the content of the paper to the conditions of its delivery. The president of the AIEE ended the day by inviting everyone to see the technical object in action rather than to deliberate about it:

> Chairman—I have another announcement to make in regard to Mr. Tesla's motor. I believe that this motor—Mr. Tesla can correct me if I am not right—is the first good alternating current motor that has been put before the public anywhere—is that not so, Mr. Tesla? And he says that the system can be seen in practical operation at 89 Liberty Street, second floor, and he invites you all to come and see it.[32]

Yet the doors of 89 Liberty Street remained shut, and colleagues complained about not being able to see the motors.[33] Tesla was concealing and deferring both the material technology and the rhetorical discourses to consolidate his authority. He remained uneasy about producing convincing texts about his new technology. The journal *Electrical Engineer*, for instance, noticed inaccuracies "in the text and illustrations of Mr. Tesla's very important paper," and delayed its June 1888 publication to give the author some time for revisions.[34] Some completely ignored his paper, such as the French

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

31. Tesla, "A New System" (above, n. 27), p. 307.

32. "Proceedings" (above, n. 28), p. 350.

33. Michael Pupin complained to Tesla: "I looked you up twice at your hotel and wrote you once, because I was exceedingly anxious to get from you as much information as I thought that you could certainly give—and above all [I] wanted to see your machines. But all my efforts were in vain." Correspondence between Michael I. Pupin and Nikola Tesla, December 19, 1891, in *Tribute to Nikola Tesla: Presented in Articles, Letters, Documents*, ed. Muzej Nikole Tesle and Vojin Popovifá (Belgrade: Nikola Tesla Museum, 1961), p. LS-11.

34. "Owing to the discovery of some inaccuracies in the text and illustrations of Mr. Tesla's very important paper, read before the Institute of the Electrical Engineers, May 16, as given to the press and published already in several journals, we have delayed the issue of the ELECTRICAL ENGINEER for June, awaiting a revision of both text and illustrations under the direction of the author" (*Electrical Engineer* 7 [1888]: 238).

observer who wrote how it was delivered "*à l'américaine*" and was so sketchy regarding experimental results that there was simply little need to "insist further."[35]

The status of invention of the polyphase motor was negotiated without its materialization into a technical object, in the inscription technologies that rhetorically situated it within a larger sociotechnical system. The first lesson for Tesla was that *all* inventions have discursive modes of existence: before their existence as technical objects, after, and anywhere in-between, the invention is narrated, analyzed, graphed, designed, described, located, and argued. As such, the dominant paradigm of inscription itself had opened the way for the legitimacy of the invention as discourse. Even the system of the patent office was based on protecting ideas and intellectual property, not the things invented.[36] The predominant role of rhetorical discourses in shaping the invention in the early stages fostered a view of invention *as* discourse, one in which the deferring of "making things" was standard practice. We might even consider that these inscriptions are more than discursive supplement for a material technology, but themselves constitute "modes of existence" of the technical object.[37] This uncertainty about the materiality of invention was further reinforced by how the nascent "electrical science" field, then under the care of Michael Pupin, one of the founding faculty members of the Department of Electrical Engineering at Columbia University, viewed invention.

The Rise of Electrical Science: Mingling Science and Technology

In the late nineteenth century, invention was shaped by two well-established though opposed value systems: pure science on the one hand, and applied arts on the other.[38] For those who located it under the auspices of science, invention was the purely theoretical and abstract process used by men of science; according to those with the opposing perspective, inventions were mere "conveniences" and apparatus of technicians and engineers.[39] Especially divisive was Henry

35. E. Hospitalier, "Les moteurs à courants alternatifs," *L'Électricien: Revue générale d'électricité* 12:247 (1888): 369–370.

36. Bazerman, *The Languages of Edison's Light* (above, n. 13), p. 85.

37. On the "modes of existence" of technical objects, see Gilbert Simondon, *Du mode d'existence des objets techniques* (Paris: Aubier-Montaigne, 1958); and Bruno Latour, *Enquêtes sur les modes d'existence: Une anthropologie des modernes* (Paris: La Découverte, 2012).

38. For a recent review of the debate, see Jennifer Karns Alexander, "Thinking Again about Science in Technology," *Isis* 103:3 (2012): 518–526.

39. Lewis Mumford later resorted to a similar and no less polarized distinction when he argued that the essence of invention was found first in the theories and general laws of

Rowland's lecture titled "A Plea for Pure Science," delivered before the American Association for the Advancement of Science in 1883. The physicist deplored that the press referred to the telegraph and the electric light as products of science, and it advocated that they should be protected from being lauded as the product of an obscure American "who steals the ideas of some great mind of the past and enriches himself by the application of the same to domestic uses."[40] Pupin's views on the invention of the polyphase motor echoed Rowland's position, but added some complexity to it. An advocate of the alternating-current system, Pupin took advantage of the embryonic and not yet stabilized nature of the system to bring it closer to a nascent electrical science and away from the industry. In a paper he delivered before the AIEE in 1890, Pupin positioned the progress of the alternating-current system under the auspices of an embryonic hybrid between science and engineering, or "engineering theory":

> The very valuable experimental investigations of two members of this Institute, Dr. L. Duncan of Johns Hopkins University, and Mr. Ryan of Cornell, we all know and appreciate; they afford us an excellent illustration of [the fact] that electricians whose methods of investigation show a perfect mastery of the theory can design and carry out experiments of eminently practical nature.[41]

Incidentally, Pupin discerned invention as a continuous process of conceptualization and materialization that required a theoretical yet practical mind. His position illustrates the "technological spectrum," a term later coined by technology historian Edward Layton: it described the genesis of technology as "ideas at one end and techniques and things at the other, with design as a middle term."[42] From this perspective, invention is a (more) collective process that does not coincide solely with technical objects. The novel view of electrical science by Pupin similarly blurred the boundaries between science

science and not in the derivative and practical instruments of engineering. His examples were unequivocal: "It was Faraday who invented the dynamo, not Siemens; it was Oersted who invented the electric motor, not Jacobi; it was Clerk-Maxwell and Hertz who invented the radio telegraph, not Marconi and De Forest." See *Technics and Civilization* (Chicago: University of Chicago Press, 2010), pp. 217–218.

40. Henry Augustus Rowland, "A Plea for Pure Science," *Nature* 28 (1883): 510. For the reception of the paper in the inventors' community, see also David A. Hounshell, "Edison and the Pure Science Ideal in 19th-Century America," *Science* 207:4431 (1980): 612–617.

41. Michael I. Pupin, "Practical Aspects of the Alternating Currents Theory," *Transactions of the American Institute of Electrical Engineers* 7 (1890): 216–217.

42. Edwin T. Layton Jr., "Technology as Knowledge," *Technology and Culture* 15:1 (1974): 31–41.

and engineering and rendered the expectations of the inventor's productions more ambiguous.[43]

Pupin disregarded Tesla as an actor worth mentioning in the new field of alternating current because the young man failed to contribute to alternating-current *theory*, and because he was not able to build the invention. Indeed, in 1890, the polyphase motor was not yet commercially distributed; Pupin had tried to see the motors, but Tesla had refused to show them to him. The inventor was working with Westinghouse, a situation that further undermined his authority as an independent inventor. An excerpt from *Electrical Engineer* is particularly evocative: "We learn that . . . the apparatus devised by Mr. N. Tesla has, in the hands of the Westinghouse company, been developed into a practical machine."[44] Pupin's omission of Tesla in his lecture titled "Practical Aspects of the Alternating Currents Theory" did not go unnoticed, and correspondence between the two men revealed that Tesla had spoken about it with him. "I don't think that you ought to find fault with me for not having given your inventions a fuller discussion than I did," Pupin wrote back to him on December 19, 1890, "[since] I know of your motors only by hearsay. . . . It was a bit too soon to discuss the practical details in a paper which treats of the most fundamental principles of the polyphase motor."[45]

From the electrical-science perspective that reconciled theory and practice, material technology was no longer the sole objective of the inventor. Pupin condescendingly admitted that he was not "a practical man," having never "designed an alternating current machine."[46] The question remained: How did scientific ideas materialize into technical objects? Writing, sketching, recording, proto-

43. With regards to the spectrum, the case of the polyphase system is particularly interesting because it underlines how the spectrum model works both ways. As historian of technology Ronald Kline argues, "the engineering community transformed the scientific and technological information about the induction motor into a systematic body of knowledge (engineering theory, or 'science') that could be successfully used to design these motors." See "Science and Engineering Theory in the Invention and Development of the Induction Motor, 1880–1900," *Technology and Culture* 28:2 (1987): 312.

44. "The Rival Alternating Current Distributing Systems in London," *The Electrical Engineer: A Weekly Review of Theoretical and Applied Electricity* 8 (1889): 177.

45. Correspondence between Michael I. Pupin and Nikola Tesla, December 19, 1891 (above, n. 33).

46. Michael I. Pupin, "Discussion of Dr. M. I. Pupin's Paper at the General Meeting, Boston, May 1890," *Transactions of the American Institute of Electrical Engineers* 7 (1890): 287.

typing, sampling, tinkering, and registering were the usual lot. But the inventor in the new field of electrical science also had to engage with scientific theories. In the transitory space *between* the facts of science and the apparatus of engineering—what Layton designates as "design"—the materiality of invention was most uncertain. Popular reception of Tesla's experiments and inventions shows that the boundaries between science and technology were eroding, as Rowland had feared, and this confusion served Tesla well for some time. For instance, a *New York Times* article from 1894 explicitly accepted the speculative nature of the invention because its contribution crossed into the realm of scientific investigations:

> when the genius of a scientific investigation of the first rank is combined with the genius of the inventor, humdrum people must prepare to be startled. They doubtless will be when Mr. Tesla's machine is sufficiently perfected to be introduced to the public, and it may surprise people who are not humdrum to learn that this very beautiful piece of mechanical adaptation derives its chief value in the eyes of its inventor from the fact that it will enable him to pursue with new confidence some very far-reaching scientific investigations. . . . This is by no means the only case in Tesla's career that practical achievement comes directly in the line of speculative advance.[47]

The mingling of science and technology, however, was not sufficient to fully justify a sustained absence of material technologies, or inscriptions representing them. As Bazerman put it, "for any technology to succeed (that is, to establish an enduring place within the world of human activities), it must not only succeed materially . . . it must also succeed symbolically."[48] Audiences were increasingly used to public demonstrations of both scientific and technological novelties.[49] In a world where inscription devices were pushing the limits of recording and reproducing phenomena, the fact that Tesla was not making things visible was rather anomalous and soon aroused suspicion. Consider a few samples taken from the press over the years that show the vast confusion among scientists, engineers, and inventors. Commenting on the inventor's latest claims, a reporter noted in 1896 that Tesla, the "New York scientist and electrician," was "not inclined to make public the details of his method for making tubes, although he said he had communicated his principles to several sci-

47. John Foord, "Nikola Tesla and His Work," *New York Times*, September 30, 1894.

48. Bazerman, *The Languages of Edison's Light* (above, n. 13), p. 335.

49. See Marvin, *When Old Technologies Were New* (above, n. 20); Sofie Lachapelle, "Science on Stage: Recreational Physics, White Magic, and Scientific Wonder at the Nineteenth-Century French Theatre," *History of Science* 47:3 (2009): 297–315.

entists."[50] In 1897, a journalist for the *New York Tribune* argued half-heartedly in favor of "the gifted inventor and electrician," judging that his reluctance to publicly demonstrate the wireless apparatuses was "perfectly justifiable. . . . No one has a right to demand details and public demonstrations," even while admitting that "so long as outsiders are kept in ignorance, they cannot compare Mr. Tesla's system with that of Mr. Marconi, which has recently attracted so much attention."[51] In 1898, an article in the *Pagosa Springs (Colo.) News* ironized the "miracles" Tesla promised when he announced a wireless system for controlling boats from a distance.[52] And by 1909, the editor of "Editorial Pen Points" of the *Los Angeles Times* used plain sarcasm: "We think that Nikola Tesla is really one of the greatest men we have ever known in the way of having said what he would do."[53] Tesla responded in 1919 to his detractors: "Not a few technical men, very able in their special departments, but dominated by a pedantic spirit and nearsighted, have asserted that excepting the induction motor, I have given the world little of practical use. This is a grievous mistake. A new idea must not be judged by its immediate results."[54] Tesla was holding on to his status as inventor—a category in which he was perhaps more entrenched than enthroned. He maintained some authority by oscillating between the two poles of the technological spectrum and found a way to address any suspicion by suggesting a new, mediumistic subjectivity for the inventor.

The Medium of Transmission

Writing on the "art of inventing" in 1906, Edward Prindle cautioned against the "popular idea . . . that an invention is produced by its inventor at a single effort of the imagination and complete, as Minerva sprang full grown and fully armed from the mind of Jove."[55] The myth of the independent inventor struck by a flash of genius was fading; indeed, as one reporter asked Edison in 1908: "Is the age of invention passing?"[56] Even so, Tesla not only persisted in

50. "Nikola Tesla's Experiments with Brief Exposure to X-Rays—Messages by Electrical Waves," *New York Tribune,* March 27, 1896.

51. Editorial, *New York Tribune*, June 8, 1897.

52. "Pagosa Spring News," *Pagosa Springs (Colo.) News*, December 30, 1898.

53. "Editorial Pen Points," *Los Angeles Times*, June 16, 1909.

54. Nikola Tesla, "My Inventions," *Electrical Experimenter* (1919): 79–80.

55. Edward J. Prindle, "The Art of Inventing," in *Proceedings of the American Institute of Electrical Engineers* (New York: AIEE, 1906), p. 468.

56. "America's Thinking Men Forecast the Wonders of the Future," *Washington Post,* January 12, 1908.

maintaining this view about inventing, but he also naturalized it. In the autobiographical notes he prepared for *Scientific American* in 1915, Tesla explained that he first envisioned the alternating-current system in Prague in 1880; as he was enjoying a walk in the park while contentedly reciting a passage from Goethe's *Faust*, he was struck by one such vision: "As I spoke the last words, plunged in thought and marvelling at the power of the poet, the idea came like a lightning flash. In an instant I saw it all, and I drew with a stick on the sand the diagrams which were illustrated in my fundamental patents of May 1888."[57]

In this version, Tesla's inventions were "visions" and he considered himself the medium of their transmission (a "visionary" in the fullest sense of the word). The press even came to adopt this vocabulary; for instance, the *New York Times* titled one of Tesla's letters to the editor "Mr. Tesla's Vision."[58] Tesla justified his modus operandi at length by using a peculiar scientific positivism, arguing that humans were nothing more than mere automata, self-propelling machines continuously reacting to external stimuli.[59] He considered the retina to act as projection screens on which prototypes, apparatuses, and machines could manifest; he described the reception of visual impressions as episodes of psychological distress during which, forced to concentrate for days or even weeks on end, he would come close to physical exhaustion.

This narrative about the invention was not, to be sure, the same one that Tesla had given before the AIEE in 1888. It was constructed a posteriori and circulated predominantly in the popular press, the site where Tesla shaped his public persona as inventor. His view of the inventor as a medium remediated in new ways the myth of the genius struck by an idea, and it also coincided with the revival of occult traditions during the last decades of the nineteenth century. His visual impressions (literally *tele*-visions[60]) were not completely

57. Nikola Tesla, "Some Personal Recollections" (*Scientific American*, June 5, 1915), in *Articles, Selected Works / Nikola Tesla*, ed. Vojin Popović, Radoslav Horvat, Branimir Jovanović, Dejan Bajić, Miroslav Benišek, Zorica Civrić, and Dubravka Smiljanić (Belgrade: Zavod, 1999), p. 73.

58. Nikola Tesla, Letter to the Editor, "Mr. Tesla's Vision: How the Electrician's Lamp of Aladdin May Construct New Worlds," *New York Times*, April 21, 1908.

59. "We are all automatons obeying external influences. We are entirely under the control of agents that beat on our senses from all directions of the outside world. Being merely receivers from the outside, it is a very important question how good the receivers are" (Nikola Tesla, "Earth Will Speak to the Planets, Scientist Predicts," *The (Toronto) Globe,* July 11, 1931.

60. Nikola Tesla, "Developments in Practice and Art of Telephotogaphy" (*Electrical Review*, December 11, 1920), in Popović *et al., eds., Articles, Selected Works* (above, n. 57), p. 437.

estranged from the cultural popularity of telepathic and spiritualist phenomena. Echoing the spiritualist medium who acted as an intercessor between two worlds, in Tesla's model, the ability to design things sprang from the inventor being an attuned receiver. The core vocabulary of his model of the inventor was that of transmissions and receptions, also shared by spiritualism (mediumship) and psychical research (telepathy). "My ideas," he wrote, "are always rational because my body is an exceptionally accurate instrument of reception."[61]

This view of the inventor as a receptor of ethereal transmissions may be included in what Linda Henderson terms "vibratory modernism," a period of ebullition when new conceptions of matter and physical reality emerged around the growing scientific investigations on electromagnetic waves. Henderson notes how scientists and occultists alike explain intangible transmissions (wireless telegraphy, of course, but also telepathic transmission) with the model of "vibrating waves in the ether."[62] Telepathy, the hypothetical capacity for communicating someone's thought from a distance, became an important site of debate between science and pseudoscience, and more especially between physics and metaphysics. Tesla knew these arguments quite well, having publicly debated on the nature of ether when William Röntgen discovered X-rays in the mid-1890s.[63] Despite the fleeting materiality of ethereal transmissions, debates around parapsychological and occult phenomena were often settled by turning to the technologies of the inscription of science. Occultists and spiritualists, for instance, employed the currency of scientific instruments and intensified their use of visual inscription techniques to gain legitimacy.[64] Tesla used similar rhetoric when he

61. Nikola Tesla, "A Strange Experience by Nikola Tesla" (unpublished manuscript in archive of the Nikola Tesla Museum), in Popović *et al., eds., Articles, Selected Works* (above, n. 57), p. 76.

62. Linda Dalrymple Henderson, "Vibratory Modernism," in *From Energy to Information: Representation in Science and Technology, Art, and Literature*, ed. Bruce Clarke and Linda Dalrymple Henderson, (Palo Alto, CA: Stanford University Press, 2002), p. 132.

63. Röntgen's X-rays were first attributed to ether vibrations. Tesla wrote that "[i]t might have been proper to say, in the spirit of more modern views on contact electricity, that these streams are formed by ether, but I have preferred to use the term 'primary matter,' for, although the expression 'ether' conveys a perfectly definite idea to the scientific mind, there exists, nevertheless, much vagueness as to the structure of this medium." See Nikola Tesla (*Electrical Review*, December 1, 1896), in Popović *et al., eds., Articles, Selected Works* (above, n. 57), p. 223.

64. This is what John Durham Peters describes as "materializing mediums" in *Speaking into the Air: A History of the Idea of Communication* (Chicago: University of Chicago

described, in 1904, that patent offices would someday use a method for determining intellectual property that would collect and use the photographic records of the images on one's retinas to establish origin of invention.[65] In 1920, he also called television the "next step in the progress of transmission," which he described as an "instantaneous transmission of visual impressions to any distance by wire or wireless . . . a subject to which I have devoted more than twenty-five years of close study."[66] Tesla's claim not only echoed the use of inscription devices by the occult movement, but it also related to some of the laboratory instruments and inscription devices devised to represent the physiological phenomena that remained in the realm of the unseen and imperceptible. Especially relevant were those used to translate thoughts and emotions into visual graphics or textual forms: pneumographs, polygraphs, and sphygmographs. As Melissa Littlefield explains in her study of the lie detector, emotions are transformed through inscription technologies into "mechanically recordable, reproducible, and evocable phenomena."[67] Tesla's visual impressions were exactly these kinds of invisible and unseen phenomena, and the scientific objectivity associated with these instruments was potentially crucial for him to establish his authority.[68]

Press, 1999), p. 98. On the intersection between media and occult movements, see also Erik Davis, *TechGnosis: Myth, Magic and Mysticism in the Age of Information* (New York: Harmony Books, 1998); and Jeremy Stolow, ed., *Deus in Machina: Religion, Technology, and the Things in Between* (Bronx, NY: Fordham University Press, 2013).

65. Tesla wrote that "one of the greatest problems confronting the world is to devise methods and means for protecting intellectual property. As we develop, this need asserts itself more and more. The ultimate aim should be to arrive at laws and regulations at least as precise as those which define the ownership of tangible things. A new principle is still to be discovered which will make this possible. Perhaps in the distant future, photographic records of the retina of the eye may furnish a foundation for a new and more perfect system of protection and just evaluation of the creations of the mind. As far as I am able to understand the working of the human mechanism, such records offer the only chance of doing away with the present imperfect ideas of possession and use of crude equivalents." See Nikola Tesla, "To the Editors of the New York Sun" (*New York Sun,* May 18, 1904), in Popović *et al., eds., Articles, Selected Works* (above, n. 57), p. 332.

66. Nikola Tesla, "Developments in Practice and Art of Telephotography" (*Electrical Review*, December 11, 1920), in Popović *et al., eds., Articles, Selected Works* (above, n. 57), p. 437.

67. Melissa M. Littlefield, *The Lying Brain: Lie Detection in Science and Science Fiction* (Ann Arbor: University of Michigan Press, 2011), p. 50.

68. See also Otniel Y. Dror, "The Scientific Image of Emotion: Experience and Technologies of Inscription," *Configurations* 7:3 (1999): 355–401; and Jimena Canales, *A Tenth of a Second: A History* (Chicago: University of Chicago Press, 2010), esp. chap. 3.

However, unlike spiritualists, psychical researchers, and physiologists, Tesla was still *not* providing textual or visual inscriptions as evidence of his inventions, nor did he produce the objects themselves. The *tele*-vision technology was itself one more discursive invention that virtually included (and precluded) all others. His imagined television apparatus was a means for effecting the ephemeral presence of visual impressions that came simultaneously to the inventor, not a means of inscribing, representing, or reproducing them. And when Tesla stated that knowledge (and thus the visual impressions of inventions) left no traces on the mind, that no permanent record of it could be found on the brain, he was ultimately rejecting all possibilities of inscription as objective representation. Revisiting centuries-old mechanistic theories, Tesla wrote in 1915 that "[i]t is not true, as Descartes taught, that the brain is as an accumulator. There is no permanent record in the brain, there is no stored knowledge. Knowledge is something akin to an echo that needs a disturbance to be called into being."[69]

Tesla seemed to overlook the values of representation embedded in inscription technologies. When he wrote his *Colorado Springs Notes* in 1899, many descriptions and patent notes were grouped in a "To be completed" list, and the "want of time compelled omission" of several descriptions of experiments in his notebooks.[70] Even the photographs taken during his experiments in Colorado in 1899 did not embody the representative function for his work. One of the photographs in this series has become iconic of Tesla: it displays the inventor sitting in a chair reading a book, his legs nonchalantly crossed, while high-voltage electrical sparks fly across the lab. Such photographs of inventors and scientists proliferated at the time, and the genre tended to focus on the subject of an inventor "immersed his work," completely self-absorbed.[71] If the photograph seems to be a dramatic representation of both experiments (the sparks from the coil across the wooden laboratory) and self-absorbed experimenter (the engrossed Tesla might even symbolize his model of invention as reception), Tesla's descriptions of it indicate that he was completely oblivious to the power of such visual inscriptions to stabilize his

69. Nikola Tesla, "How Cosmic Forces Shape Our Destinies" (*Scientific American*, February 7, 1915), in Popović *et al., eds., Articles, Selected Works* (above, n. 57), p. 136.

70. See, for example, the September, October, and November 1899 frontispiece page in Nikola Tesla and Aleksandar Marincic, *Colorado Springs Notes 1899–1900* (Beograd: Nolit, 1978).

71. See David E. Nye, *Image Worlds: Corporate Identities at General Electric, 1890–1930* (Cambridge, MA: MIT Press), esp. pp. 106–109.

public image as an inventor. The picture of him reading was created using a double-exposure method (another classic technique of spiritualist photographs) only to "give an idea of the magnitude of the discharge." Tesla explained: "I did not like this idea, but some people find such photographs interesting. Of course, the discharge was not playing when the experimenter was photographed, as might be imagined! . . . It was found necessary to sit in the chair during the exposure to arc light, as otherwise the structure of the chair would show through the body of the person."[72] The photograph was not meant to be fraudulent; for Tesla, it simply did not perform the function of representation for his inventions. It was not reintegrated as part of a rhetoric Tesla could use to claim ownership of the instruments and their effects; rather, it shows an inventor detached from his creations, a mere witness.

The mediumistic view of the inventor, indeed, was a highly non-authoritative one. Paradoxically for Tesla, he was no longer the originator of the technical innovations he saw; he became one component inside a larger relay system of transmissions and receptions, a passive spectator gazing at a flow of impressions before his eyes. In other words, inventing was for the inventor what communication was for the spiritualist medium: namely, always someone else's doings. As such, the inventor was vulnerable to external influences. Even Tesla had hypothesized that criminals were deranged individuals because their responses to the outside world were no longer "accurate," stating that "[s]ome are sensitive and receive accurately. Others are sluggish and their reception is blurred."[73] What if the inventor suddenly perceived impressions of irrational or morally disruptive inventions? Tesla's discursive invention of a *tele*-energy weapon that would end all wars in the early twentieth century—a technologically deterministic rhetoric also shared by Edison—was one such invention that could serve either good or evil.[74] The fright of scientific and technological experiments gone rogue was a boom-

72. Tesla and Marincic, *Colorado Springs Notes* (above, n. 70), p. 367.

73. Tesla, "Earth Will Speak" (above, n. 59).

74. For Tesla's claim about an invention that would end all wars, see, for example, "Tesla's New Device Like Bolts of Thor" (above, n. 4). For the relationship between the cult of the super-weapon and mad-scientist stories, see H. Bruce Franklin, "Strange Scenarios: Science Fiction, the Theory of Alienation, and the Nuclear Gods," *Science Fiction Studies* 13:2 (1986): 117–128; and Christopher P. Toumey, "The Moral Character of Mad Scientists: A Cultural Critique of Science," *Science, Technology, & Human Values* 17:4 (1992): 411–437 (more specially, see the discussion on the irrationality of the scientific equipment in mad-scientist stories on p. 414).

ing theme in literature at the turn of the twentieth century. A 1908 fiction by Raymond (pseudonym of Edward Richard McDonald) and Charles Beecher Bunnell titled *The Mad Scientist: A Tale of the Future* addressed this by speculating on the materialization of Tesla's unrealized wireless power apparatus. A fictional character, Maxim Folk, discovers a way to perfect the incomplete system and divert its original use. One character explains: "Folk has one of Nicola Tesla's oscillators . . . but the wonderful fellow has added to it a device, the use of which is not quite clear. Undoubtedly he is setting up an intense current, which can be used to develop power at a distance, the transmission being accomplished after the manner of wireless telegraphy."[75] The story is preceded with a warning by the author: "The fact that mankind has been so largely benefited by discoveries and inventions does not prove that these advances in human knowledge are not capable of being perverted and put to unnatural and criminal uses."[76]

From Representation to Presence

Consider some of the media that emerged during the second half of the nineteenth century: photo*graphy*, phono*graphy*, tele*graphy*, kineto*graph*, and type*writer*. These were script-biased media that performed functions of inscription, materialization, and recording, making cuts in the flow of time, creating permanent records, capturing stills through mechanization and reproduction. They remediated writing, not speech. Even the lightbulb fits into this paradigm of permanence and stasis: while the untamed electrical current was known to be constantly in movement, the electric light gave the illusion of a resting, immutable electrical spark of light. As Gitelman puts it, the proliferation of inscriptive technologies like Edison's phonograph generated "a sense of modern experience and discourse made more material, and of modern material made more technological."[77] In their introduction to Friedrich Kittler's *Gramophone, Film, Typewriter*, Geoffrey Winthrop-Young and Michael Wuntz offer a similar reading: "As a correlate to the Edisonian specification of inscription technologies, writers became increasingly aware of the materiality of language and communication."[78] Because these new technologies of

75. Raymond (pseudonym of Edward Richard McDonald) and Charles Beecher Bunnell, *The Mad Scientist: A Tale of the Future* (New York: Cochrane Publishing Co., 1908), p. 123.

76. Ibid., p. 1.

77. Gitelman, *Scripts, Grooves, and Writing Machines* (above, n. 12), p. 94.

78. Geoffrey Winthrop-Young and Michael Wuntz, "Introduction," in Friedrich A. Kittler, *Gramophone, Film, Typewriter* (Palo Alto, CA: Stanford University Press, 1999), p. xxv.

inscription were known to be capable of representing nature, revealing the unseen, and capturing moments of reality—and they could do so objectively—they were useful objects for the conducting of science. It is telling that, as Gitelman notes, patent offices initially considered the phonograph to be a scientific recording device.[79]

This dominant paradigm of inscription that regulated the activities of scientists, engineers, inventors, physiologists, and psychical researchers was founded on a regime of representation. When technology was presented as discourse in this paradigm, it did so with the assumption that the material technology existed or would materialize somewhere else other than in the text. Tesla's discursive inventions were not, based on this point of view, radically different from those of other inventors. Edison himself had filed the invention of the lightbulb at the patent office before he had a working prototype.[80] The rupture in Tesla's model lies in the semiotic relationship between discourse and material technology. His paradigm of discursive inventions articulated its own politics of representation, one where the criterion of reality and the existence of that which is represented consistently failed—in other words, his discursive inventions embodied presence, not representation.

The new technology of wireless telegraphy challenged other inscription technologies and their value of representation in similar ways. While the X-ray machine, polygraph, phonograph, and camera turned the unseen into visualizable, audible, and reproducible forms, wireless was doing just the opposite, turning the writing process with an explicit materiality (the wires) into an intangible one. Amid the plethora of inventions brought to the light of day during the fin-de-siècle, for many observers, wireless telegraphy appeared to be the most unique and remarkable achievement of the period. "Ethereal telegraphy," as a *New York Times* reporter named it in 1897, was shaking the established assumptions about the material systems of communication:

> After Prof. Roentgen's rays and the kinetoscope and the phonograph, we of the latter edge of the nineteenth century have become supercilious with regard to novelties in science. Yet our languor may be stirred up at the prospect of telegraphing through air and wood and stone without so much as a copper wire to carry the message. We are learning to launch our winged words through the silence of that ether which is supposed to exist—for who can see, feel, hear, or smell it.[81]

79. Gitelman, *Scripts, Grooves, and Writing Machines* (above, n. 12), p. 101.

80. See Bazerman, *The Languages of Edison's Light* (above, n. 13), p. 160.

81 "Ethereal Telegraphy," *New York Times*, November 5, 1897.

As an invention, wireless telegraphy stemmed from electrical engineering and was as much a scientific investigation of the electromagnetic spectrum—reviving the debate in physics on the speculative ether—as it was a new practical technology of communication created by electrical engineers. Tesla's transition from the polyphase motor to wireless power and high-frequency apparatuses in the early 1890s was thus timely, as the experiments were conducted in a context of renewed uncertainty about physical reality. Tesla made claims concerning wireless power early in his career as inventor, as early as 1891, when he was still working toward the technical realization of his polyphase system. With the new wireless electric lamps, a reporter joyfully noted, the "walls and ceilings will not be defaced by wires and pipes."[82] Tesla's vision of wireless power quickly evolved from prediction to outright claims of invention. In 1894, he described his system as a way of attaching human machinery to the "very wheelwork of nature,"[83] and in 1897, while both Oliver Lodge and Marconi were experimenting almost exclusively with wireless telegraphy, Tesla stated that the transmission of energy was the field "dominating all others [for] the comfort and welfare, not to say for the existence, of mankind."[84] Tesla's experiments on wireless power transmission were based on theoretical assumptions about electromagnetic vibrations and the propagation of waves, and while some particulars of the proposed system did come in the form of patent documents, wireless power was never realized into a commercial technology.[85]

82. "Wireless Electric Lamps: Mr. Tesla's Experiments with High Frequency Alternations," *New York Times*, July 9, 1891.

83. Foord, "Nikola Tesla and His Work" (above, n. 47).

84. Nikola Tesla, "On Electricity: Address on the Occasion of the Commemoration of the Introduction of Niagara Falls Power to Buffalo at the Ellicott Club (Jan. 12, 1897)" (*Electrical Review*, 1897), in Vojin Popović, Radoslav Horvat, Branimir Jovanović, Dejan Bajić, Miroslav Benišek, et al., eds., *Lectures* (Belgrade: Zavod za udžbenika i nastavna sredstva, 1999), p. 274.

85. The specification for his patent of 1897, "System of Transmission of Electrical Energy," detailed an apparatus for transmitting "energy through the atmosphere to remote places and regions." It included a high-tension transmitter designed to elevate the electrical pressure to such a degree that the oscillations could be conducted through the "natural medium" to a receiving station without the need for wires. Building on William Crookes's work on electrical transmission through gases at very low pressure, Tesla argued that the upper parts of the atmosphere could act as such conductor, and that a high-frequency oscillator located at the right altitude would transmit energy to receivers anywhere on the globe. See Nikola Tesla, "System of Transmission of Electrical Energy," U.S. Patent no. 645,576, filed September 2, 1897, issued March 20 1900 (http://www.google.com/patents/US645576).

Interestingly, the genesis of wireless telegraphy also marked a transition from representation to presence. Through the technological developments that led to the full realization of radio in the early twentieth century, the genre and values of telegraphy moved away from the written word (*-graph*) into the ephemeral space of the transmitted spoken word (*tele-*); they facilitated the transition from a realm of embodied, situated, and reproduced representation to one of disembodied, transitory, and performed presence. We find resonating values of presence in Tesla's discursive inventions, and in his own model of invention. Several of his discursive inventions, such as his World System, perpetual flying machine, and cosmic ray, embodied and promoted distribution, transmission, and circulation, not production, reproduction, and recording. Tesla conceived his World System, for instance, as a means of distributing electricity worldwide, but failed to include any instrument for measuring the transmission of energy at the receiving end, making it an economically flawed system. The values of his discursive inventions—their "technological drama," as Bryan Pfaffenberger puts it—were those of ephemeral, instantaneous, and universal transmission, and these values constituted the core structure of his model for an inventor as well.[86] Tesla was designing technological systems that echoed the annihilation of space by transmission rather than that of time by inscription.

I am not arguing that Tesla explicitly turned to this paradigm of ethereal transmission and fully envisioned how the new immateriality of communication technologies could provide a safe haven that would allow him to avoid producing the textual and visual material expected of inventors. Arguably, however, this work on wireless transmission and its proximity to theories of invisible transmission through the electromagnetic spectrum informed his model of invention as a complex system of ethereal transmissions and receptions, at least providing him with a knowledgeable vocabulary to comment on it. Tesla's dramatic reaction when both Pupin and Edison transitioned from inscription to transmission technologies, trespassing into his territory of vibratory mediums and free flows of circulation, is particularly evocative of the depth of the fracture between the two paradigms: "In so far as wireless art is concerned, there is a vast difference between the great inventor Thomas A. Edison and myself, integrally in my favour. Mr. Edison knows little of the theory and

86. Bryan Pfaffenberger, "Technological Dramas," *Science, Technology, & Human Values* 17:3 (1992): 282–312.

practice of electrical vibrations: I have, in this field, probably more experience than any of my contemporaries."[87]

Conclusions

The precariousness of textual, visual, and material evidence in Tesla's legacy was famously suspicious. His detractors perceived it as a sign of his imposture and inability to bring to completion the inventions for which he was deemed to be responsible. The man was portrayed as a mere visionary whose spectacles of high-frequency currents were, at best, amusing and entertaining.[88] Similarly, his supporters also strongly felt the absence of material technology. Devotee biographers blame this absence to an 1895 fire that destroyed the inventor's laboratory in New York; others suggested that the U.S. government concealed Tesla's inventions at the time of his death.[89] While papers, patent documents, and letters were indeed seized and analyzed by the Office of Alien Property Custodian in 1943, there is no evidence that Tesla bequeathed any actual prototype.[90] The operation nevertheless fueled the rumor mill about the existence of a lethal weapon devised by Tesla, and from 1948 onward, the Federal Bureau of Investigation received dozens of requests to access these documents.

Instead of reading the lack of material technology as dubious, Tesla's case offers a way to understand the position of discursive inventions with regard to some of the existing value systems in science and technology. First, the notion of invention—its processes, ob-

87. Tesla continued: "That you are not as yet able to impart your wisdom by wireless telephone to some subscriber in any other part of the world, however remote, and that the presses of your valuable paper are not operated by wireless power is largely due to your own effort and those of some of your distinguished confreres of this city, and to the efficient assistance you have received from my celebrated colleagues, Thomas A. Edison and Michael I. Pupin, assistant consulting wireless engineers." See Nikola Tesla, Letter to the Editor, "Tesla on Wireless," *New York Tribune*, October 25, 1907.

88. When he wrote one of the first historical accounts of wireless telegraphy in 1899, an innovation that was still in its infancy, J. J. Fahie excluded Tesla from its frontispiece of "Arch Builders" but included Marconi, who had gained international fame only two years before for the first transatlantic wireless-telegraph transmission. Fahie mentions Tesla's work only to brush it aside: "In 1893 Nikola Tesla, the lightning-juggler, proposed to transmit electrical oscillations to any distance through space. . . . Owing to press of other work this experiment was never tried, and so has remained a bare suggestion." See Fahie, *A History of Wireless Telegraphy, 1838–1899: Including Some Bare-Wire Proposals for Subaqueous Telegraphs* (Edinburgh: Blackwood, 1899), pp. 199–200.

89. See, for instance, the biography by O'Neill, *Prodigal Genius* (above, n. 7).

90. Carlson, *Tesla* (above, n. 6), pp. 389–395.

jects, and meanings—was anything but monolithic during the nineteenth century, and discursive inventions played an important function of representation in both expert communities and the general public. The wide circulation and prominent role of inscriptions that narrated invention to diverse audiences, in fact, supported discursive modes of existence for technology. The debates around invention in science and engineering also diminished the necessity for inventors to make technical objects. The emerging view of invention as a collective process rather than as an object had also paved the way for a view of invention that did not inevitably result in the materialization of "things." The discursive inventions of Tesla were thus part of a rather sympathetic network of already established discursive modes of the existence of invention.

Second, the Tesla case also reveals that the category of inventor in the late nineteenth century was rather ambiguous and shaped by the amalgamation of other cultural figures: men of science, electricians, and engineers, along with geniuses, wizards, and mad scientists. As such, no institutions regulated the profession of inventor, and the shaping of an inventor's public persona was done through a network of discourses establishing his authority. To settle his own model of inventor, one that did not include any exigency of producing things, Tesla drew on new cultural explanations for the ephemeral transmission of thoughts and visual information, echoing the medium of the spiritualist tradition. Turning ambivalently away from the inscription devices available to provide the representation of unseen phenomenon, Tesla attempted to justify the absence of his material technology by locating the manifestation of inventions onto a peculiar medium of transmission—the inventor himself. As a result, this model of the inventor effectively mystified and concealed the process of design, while building on the currency of scientificity, or at least on its unsettled nature in other popular cultural phenomena, such as telepathy and mediumship.

Finally, the exploration of Tesla's model of invention has allowed us to zero in on discursive inventions and to approach cases where they did not respond to the paradigm of representation generally associated with them. In Tesla's paradigm, discourse *is* performative; the visual impressions performed technology instead of being semiotically bound to their referents. He remained uncomfortable with inscription technologies (patent documents, photographs, and notebooks) when they provided such representation, and preferred technologies that effected presence (such as letters to the editor and newspaper interviews). In sharp contrast, the networks of discourse in the inscription paradigm epitomized by Edison worked from the opposing assumption that they represented material technology. Tesla's discursive inventions show, perhaps even unwillingly, the fragility of the regime of representation associated with inscription practices. The timely defense of invention as discourse was, in fact, supported by the rise of new values associated with technologies that challenged just such a regime, especially wireless telegraphy. Wireless embodied the core values of Tesla's model of invention: ubiquitous transmissions, disembodied presence, and simultaneity. If the dominant paradigm of invention epitomized by Edison was one of textual remediation, time-biased inscription, and permanent representation, Tesla's was one of oral remediation, space-biased transmission, and ephemeral presence.

Acknowledgments

An earlier version of this essay was presented at the annual meeting of the Society for Literature, Science, and the Arts in Kitchener, Ontario, in September 2011. The author would like to thank Linda D. Henderson, Jeremy Stolow, and the anonymous *Configurations* reviewers for their support and valuable comments at various stages in the preparation of this essay. Research on this essay was supported by a postdoctoral fellowship from the Social Sciences and Humanities Research Council of Canada.