



TESLA'S VISION OF THE WIRELESS GLOBAL COMMUNICATIONS

Ljiljana Trajković

Communication Networks Laboratory

<http://www.ensc.sfu.ca/research/cnl>

School of Engineering Science

Simon Fraser University



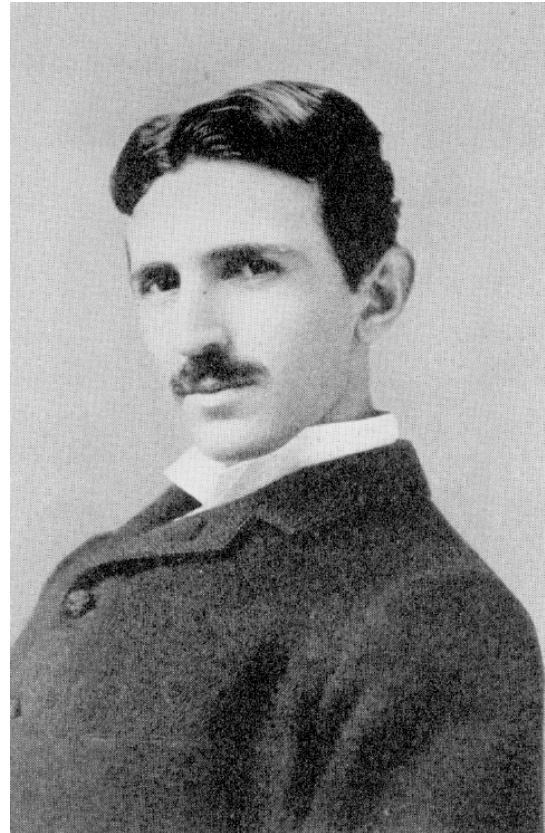
A decorative graphic on the left side of the slide, featuring overlapping yellow, red, and blue squares with a black crosshair.

Road map

- Tesla in 1890's
- First wireless experiments
- Colorado Springs laboratory
- Wardenclyffe tower
- Worldwide radio and wireless transmissions
- End of a dream
- Legacy



Fame at age 39





Alternate currents

- Tesla left Edison in 1885.
- He formed his own laboratory "Tesla Electric Company" in 1887 on Grand street in New York.
- He built single-phase and several poly-phase systems.
- On May 16 1888, at an AIEE meeting in New York, Tesla presented a lecture entitled "*A New System of Alternate Current Motors and Transformers.*"
- Shortly after, G. Westinghouse employed Tesla as a consultant.



High-frequency currents

- Independently wealthy, in 1889 Tesla returned to his New York laboratory to pursue his interest in high-frequency currents.
- At an AIEE meeting in May 1891, Tesla gave his first public lecture and demonstrations of his high-frequency work.
- He created sheets of flame and caused sealed tubes of gas (Geissler tubes) to glow without a direct electrical connection to them.



Wireless demonstrations: 1893

- At the Spring meeting of the National Electric Light Association in St. Louis, Tesla gave his first public demonstration of the wireless transmission of electrical energy.
- **Transmitter:**
 - tuned circuit with a bank of Leyden jar capacitors and a coil
 - spark gap
 - 5 kVA power-distribution transformer
 - antenna extending from the coil to the ceiling.



Wireless demonstrations

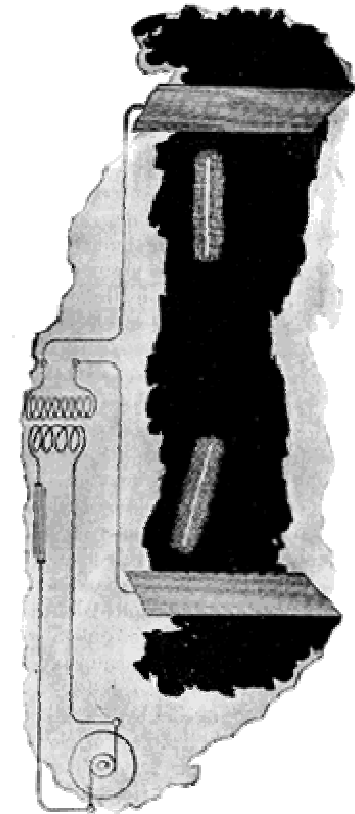
- **Receiver:**
 - identical tuned circuits
 - antenna extending to the ceiling
 - gas-filled Geissler tube (in place of the spark gap used in the transmitter).
- **The Geissler tube glowed.**
- During 1894-95 Tesla built a transmitter together with a portable receiver and demonstrated wireless transmission of electrical energy.



Wireless at home: 1894

- Tesla's wireless house lighting scheme:
 - two high voltage AC plates fill the room with a fairly uniform electric field.
 - the bulbs are vertically oriented to align with the electric field.

The Inventions, Researches and Writings of Nikola Tesla





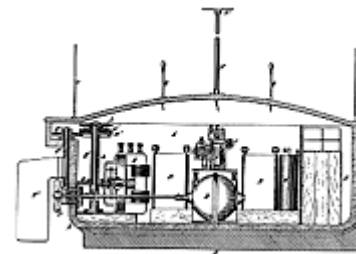
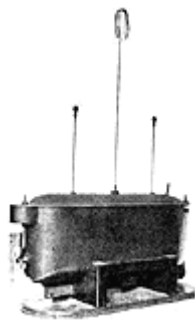
Wireless patents: 1897

- After the fire that destroyed his New York laboratory, Tesla resumed wireless transmission tests.
- The receiver was operated on a boat traveling up the Hudson River.
- Two fundamental wireless patents were issued:
 - No. 645,576
 - No. 649,621.
- In 1943, U.S. Supreme Court ruled that this work, together with works of Oliver Lodge and John Stone, anticipated Marconi's work.



Teleautomation: 1898

- Remotely Controlled Apparatus
- A boat could move and turn remotely without any wires. Inside the vessel, there were Tesla transformers tuned to other transformers controlled by Tesla on the shore.
- Patent No. 613,809.





Colorado Springs: 1899-1900

- Tesla received a request from the U.S. Government to develop a wireless communications system.
- Tesla moved to high plateau near Colorado Springs.
- There, he constructed a large experimental radio station unlike anything the world had ever seen before.
- His plan was to study the characteristics of high voltage, high frequency alternating electrical currents.
- The goal was to test "the laws of propagation of currents through the earth and the atmosphere."
- His first task was to develop an extremely powerful transmitter and perfect a method to channel, "individualize," the transmitted energy.



Developments at Colorado Springs

Tesla developed:

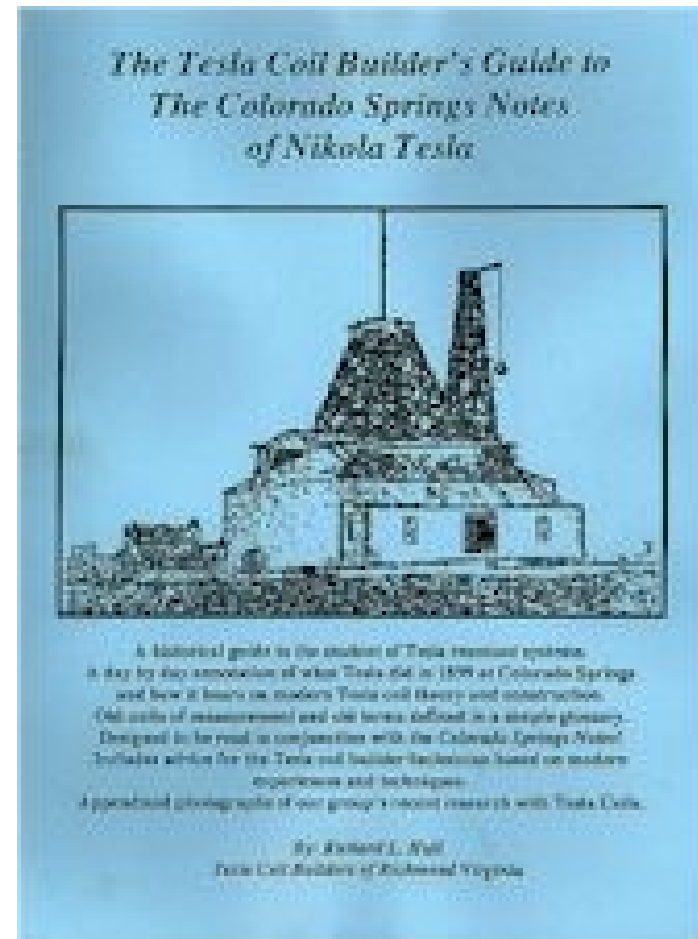
- a number of sophisticated receivers “*for individualizing and isolating the energy transmitted*” that would allow a transmitter's signals to be selectively tuned in.
- a series of experiments contributing to the understanding of radio propagation and earth resonance, and culminating nearly a decade of work related to the study of synchronized electrical tuned circuits.

Tesla's was convinced that wireless communication to any point on the globe was possible by the help of devices he had perfected. This set the stage for Tesla's next grand project: establishment of an international wireless broadcasting facility that was to become known as Wardenclyffe.

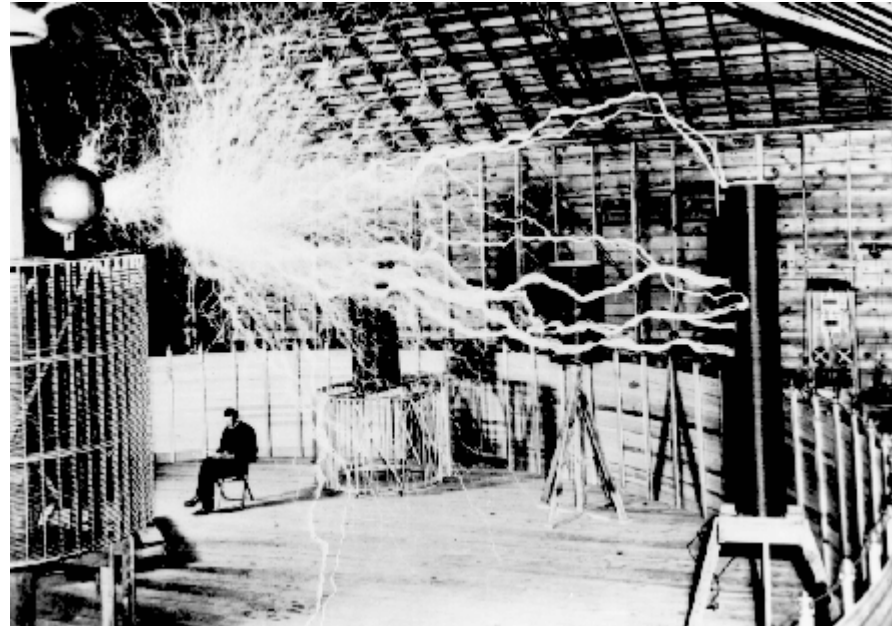


Colorado Springs notes

- 200 feet tower
- 3 foot copper sphere
- giant high-frequency oscillator “**magnifying transmitter**”



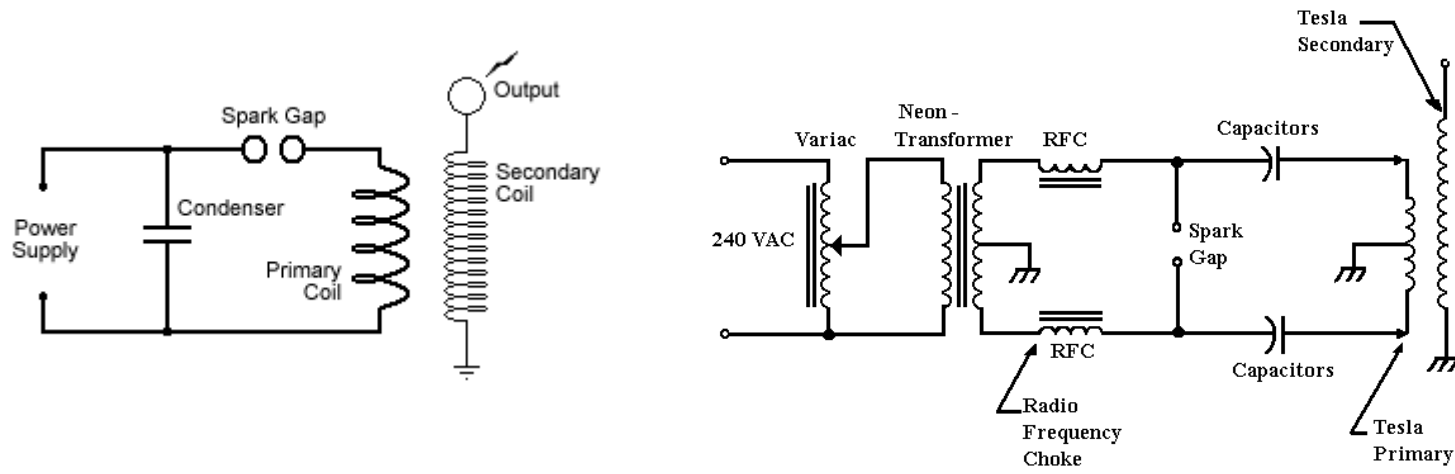
Colorado Springs laboratory



- Tesla in his laboratory in Colorado Springs seating under his large transformer.



Tesla transformer





Tesla coil

- Tesla transformer, also known as the **Tesla coil**, produces high voltage at high frequency currents.
- It was used by Tesla in several sizes and variations for his experiments.
- It is used today in various applications in radio and television.



Wardenclyffe architect

Stanford White:

- an important American architect
- with lavish Italian Renaissance style (Shingle style)
- his firm (est. 1880) was one of the best-known of the late 19th and early 20th centuries
- He designed a wide variety of public, institutional, and religious buildings:
 - Washington Square Arch (1889)
 - The first Madison Square Garden (1890)
 - New York Herald Building (1894)
 - Vanderbilt family residence (1905)
- Now, only Washington Square Arch still stands.



The initial design

- White and Tesla meet at the Players Club in New York's Gramercy Park.
- White was thrilled to meet Tesla, whose plan for a world broadcasting system had recently been extensively covered in Century magazine.
- White offered to create the design of the laboratory and tower for the Wardenclyffe laboratory.
- Over the following months he finished the design, corresponding regularly with Tesla on the specifications.

In June, 1906, while attending the opening of Madison Square Garden's roof show in the building he had designed, White was shot and killed, leaving Wardenclyffe as his final creation.



Wardenclyffe laboratory





Wardenclyffe tower

- 187 feet high
- 68 feet in diameter





Promoting Wardenclyffe project

- Tesla's 1904 resume advertising his services and those of the Wardenclyffe facility



PAGE FROM CIRCULAR SHOWING TESLA TOWER, WARDENCLIFFE, LONG ISLAND.

Global Wireless System

Long Island facility



- The Wardencllyffe World Wireless Facility was envisioned to be quite different from radio broadcasting stations as they presently exist.
- Conventional transmitters are designed to maximize the amount of power radiated from the antenna structure.
- Such equipment must process tremendous amounts of power in order to counteract the loss in field strength ($P = 1/R^2$) encountered as the signal radiates.
- The transmitter at Wardencllyffe was being configured to minimize the radiated power.

Global Wireless System Technology



- The energy of Tesla's steam driven Westinghouse 200 kW alternator was to be channeled into an extensive underground radial structure of iron pipe installed 120 feet beneath the tower's base.
- This was to be accomplished by superposing a low frequency baseband signal on the higher frequency signal coursing through the transmitter's helical resonator.
- The low frequency current in the presence of an enveloping corona-induced plasma of free charge carriers would have "pumped" the earth's charge.
- It is believed the resulting ground current and its associated wave complex would have allowed the propagation of wireless transmissions to any distance on the earth's surface with as little as 5% loss due to radiation.

Global Wireless System Applications



- The terrestrial transmission line modes so excited would have supported a system with the following technical capabilities:
 - establishment of a multi-channel global broadcasting system with programming including news, music, ...
 - interconnection of the world's telephone and telegraph exchanges, and stock tickers.
 - transmission of written and printed matter, and data.
 - world wide reproduction of photographic images.
 - establishment of a universal marine navigation and location system, including a means for the synchronization of precision timepieces.
 - establishment of secure wireless communications services.



Financial troubles

- By the Summer of 1902 Tesla had shifted his laboratory operations from the Houston street Laboratory to the rural Long Island setting and work began on development of the station.
- Construction had been made possible largely through the backing of financier J. P. Morgan who had offered Tesla \$150,000 towards the end of 1900.
- By July 1904, however, this support had run out and Tesla was compelled to pursue alternative methods of financing.
- In spite of valiant efforts to maintain the operation, income dwindled and his employees were eventually dropped from the payroll.



Financial troubles (cont.)

- A second mortgage in 1908 acquired again from the Waldorf-Astoria proprietor G. C. Boldt allowed some additional bills to be paid, but debt continued to mount.
- Between 1912 and 1915 Tesla's financial condition disintegrated.
- The property was foreclosed.
- The plant's abandonment sometime around 1911 followed by demolition and salvaging of the tower in 1917.
- Tesla's April 20, 1922 loss on appeal of the judgment completely closed the door to any further chance of his developing the site.

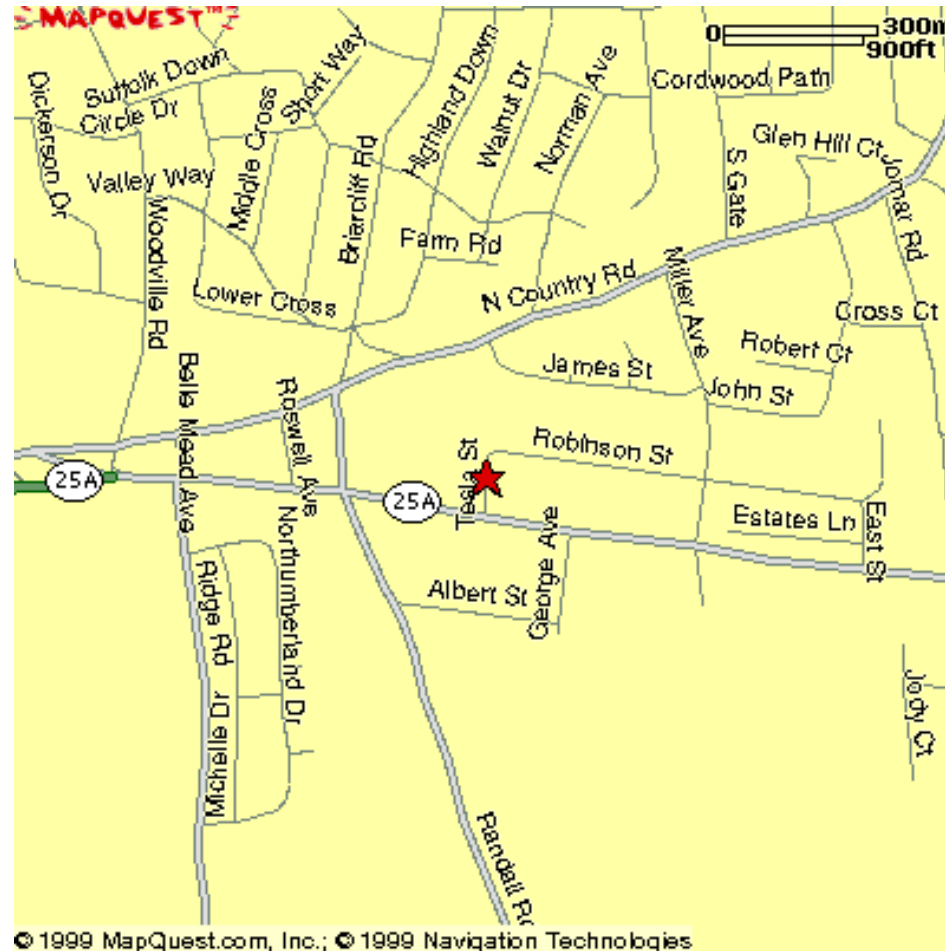
Warden today, Shoreham North shore of Long Island



THE TESLA WARDENCLYFFE PROJECT
P.O. BOX 990, SHOREHAM, NY 11786-0990 USA



Tesla street



A decorative graphic on the left side of the slide, featuring overlapping yellow, red, and blue squares with a black crosshair.

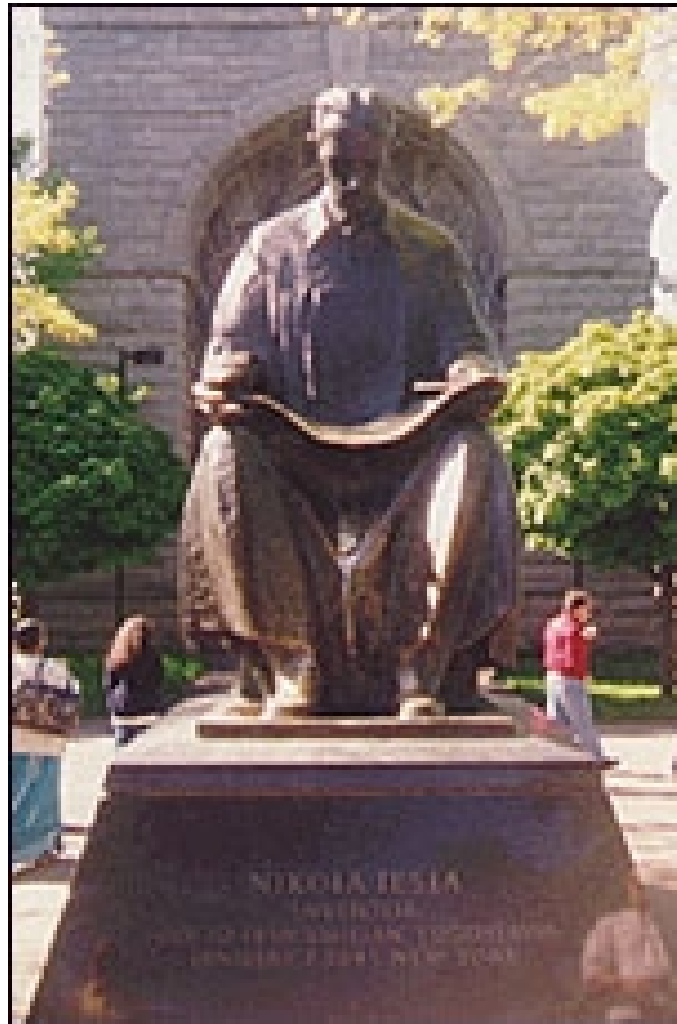
Legacy

"Nikola Tesla is the true unsung prophet of the electrical age without whom our radio, auto ignition, telephone, alternating current power generation and transmission, radio and television would all have been impossible. Yet his life and times have vanished largely from public access."

Kolmogorov-Smirnov Publishing

Legacy

Goat Island at Niagara Falls





Vision of wireless communications

"As soon as [the Wardencllyffe plant is] completed, it will be possible for a business man in New York to dictate instructions, and have them instantly appear in type at his office in London or elsewhere. He will be able to call up, from his desk, and talk to any telephone subscriber on the globe, without any change whatever in the existing equipment. An inexpensive instrument, not bigger than a watch, will enable its bearer to hear anywhere, on sea or land, music or song, the speech of a political leader, the address of an eminent man of science, or the sermon of an eloquent clergyman, delivered in some other place, however distant. In the same manner any picture, character, drawing, or print can be transferred from one to another place ..."

*Nikola Tesla, "The Future of the Wireless Art," *Wireless Telegraphy & Telephony*, 1908, pp. 67-71.*



Recent references to Tesla's patents

- US 5,548,819
Method and apparatus for communication of information
- US 5,908,444
Complex frequency pulsed electromagnetic generator and method of use
- US 6,104,107
Method and apparatus for single line electrical transmission

<http://www.delphion.com>



Tesla's writings

- *Nikola Tesla On His Work With Alternating Currents and Their Application to Wireless Telegraphy, Telephony and Transmission of Power*, L. I. Anderson, Editor, Sun Publishing, Denver 1992.
- *Tesla Coil Builder's Guide to the Colorado Springs Notes of Nikola Tesla*, Second edition, R. Hull, 1994.
- *The Problem of Increasing Human Energy. With Special References to the Harnessing of the Sun's Energy*, N. Tesla: <http://www.tfcbooks.com/energy.htm>
- My Inventions: The Autobiography of Nikola Tesla: <http://www.lucidcafe.com/library/96jul/teslaautobio.html>



Online references

- Nikola Tesla:
<http://www.mercury.gr/tesla/introen.html>
- Tesla's Teleautomation:
<http://www.mercury.gr/tesla/remoten.html>
- Wardenclyffe Project:
<http://homepages.nyu.edu/~jas4>
- Tesla Page, Tesla Coils (Bill Beaty's Homepage):
<http://www.eskimo.com/~billb/tesla/tesla.html>
- 21st Century Books: <http://www.tfcbooks.com>
 - Tesla Biographies:
<http://www.tfcbooks.com/biograph.htm>



Of interest

- L. D. Henderson, *Duchamp in Context, Science and Technology in the Large Glass and Related Works*, Princeton University Press, Princeton, NJ, 1998.
- T. West, *In the Minds Eye*, Prometheus Books, Buffalo, NY, 1997.
- D. G. Fraser, *Tesla Electric*, New Canadian Drama Series, Toronto, 1995.
- B. Degazio, 1958, "Nikola Tesla Overture," *Roads to Chaos*, Soundprints recording, 1996.
- "Brilliant! The Blinding Enlightenment of Nikola Tesla," The Edinburgh Fringe Festival, July 30 - Aug 24, 2003:
<http://www.electriccompanytheatre.com/brilltour.htm>

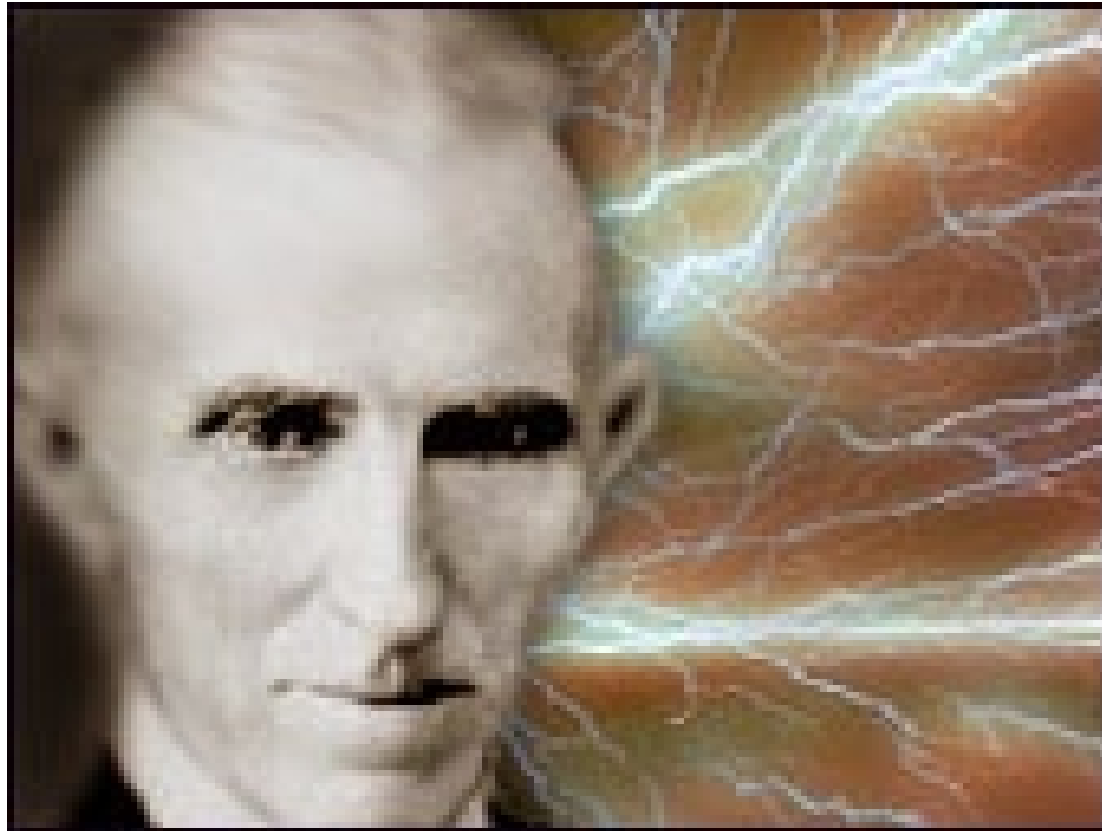
A decorative graphic on the left side of the slide, featuring overlapping yellow, red, and blue squares with a black crosshair.

Resources

- Public Broadcasting Service (PBS):
Life and Legacy Inside the Lab:
TESLA
Master of Lightning
<http://www.pbs.org/tesla/>



Tesla's dream



A decorative graphic consisting of overlapping yellow, red, and blue squares with a black crosshair.

This talk

UBC, Nikola Tesla:

Lj. Trajkovic, "Tesla's vision of the wireless global communications," *Famous People of Serbia*, UBC, January 2005.

<http://www.ensc.sfu.ca/~ljilja/cnl/presentations.html/>