

Eng 24 Nikola Tesla: The Genius Who Lit the World

Prof. Jasmina Vujic

Freshman Seminar for Spring 2006

The 150th Anniversary of Nikola Tesla's Birth (1856 - 1943)

*Nature and Nature's laws lay hid in night:
God said, "Let Tesla be", and all was light.*

B.A. Behrend, AIEE annual meeting, New York City, May 18, 1917.

On February 22, 2000, in his speech at the National Press Club, Neil Armstrong, the first man on the Moon, presented "The Twenty Greatest Engineering Achievements of the 20th Century" organized by the National Academy of Engineering (NAE). Widespread electrification was chosen as the greatest feat of the century because "its impact is vast and it has touched the majority of people on the planet." The name of Nikola Tesla was omitted from the NAE's justification of this decision. Nikola Tesla was one of the most accomplished inventor-scientists of the late nineteenth and early twentieth centuries. He created the polyphase alternating current system of motors and generators that powers our world. Without his inventions the widespread electrification that "touched the majority of people on the planet" would not have been possible. He gave us every essential of radio, and laid the foundation for much of today's technology. He is most known for his "Tesla coil," a high voltage, high frequency transformer originally used in radios. However, Tesla's greatest contributions, A.C. power transmission and fundamentals of radio, are either not known or challenged bitterly. Tesla's great inventions include: a telephone repeater, rotating magnetic field principle, polyphase alternating-current system, induction motor, alternating-current power transmission, Tesla coil transformer, wireless communication, radio, fluorescent lights, and more than 700 other patents. Tesla is one of only two Americans to have a unit of electrical measurement named in

his honor. In this seminar we will talk about Tesla's life and his greatest inventions, as well as about famous "War of the Currents" and "The Great Radio Controversy" which is still going on among Tesla's "followers" on one side and Edison's and Markoni's "followers" on the other side.

Outline of the Freshman Seminar

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There are no prerequisites required, and the seminar is open for engineering and non-engineering freshmen. Grading is P/NP.

The short outline of the course is presented below:

EARLY LIFE OF NIKOLA TESLA

Tesla was convinced that his childhood experiences were decisive for his future work. In his autobiography, Tesla explains his traits and qualities by heredity and attributed them to the influence of his parents and ancestors. The circumstances of Tesla's youth were very hard. His father was a country priest in a very poor region of Lika, who struggled to give his son an education, the cost of which was extremely high as compared with his income. Tesla was torn between his strong desire and actual opportunities, and this left an imprint on his whole life.(1,2)

TESLA'S FIRST EFFORTS IN INVENTION

Being born in poverty, Tesla often, as a young boy, had to invent his toys and tools. In his autobiography, Tesla talks about his frog-catching "apparatus", his first "motor" powered by May-bugs, his "pop-gun" made of hollow wooden tubes, and many others.(1)

THE DISCOVERY OF THE ROTATING MAGNETIC FIELD

Tesla's discovery of the rotating magnetic field produced by the interactions of two and three phase alternating currents in a motor winding was one of his most significant achievements, and formed the basis of his induction motor and polyphase system for the generation and distribution of electricity. Large amounts of electrical power could be generated and transmitted efficiently over long distances. To this day, the three-phase form of Tesla's polyphase system is still used for the generation and transmission of most electricity. Moreover, the conversion of electricity into mechanical power is made possible by updated versions of Tesla's three-phase and split phase motors.(3)

THE DISCOVERY OF THE TESLA COIL AND TRANSFORMER

His experiments with high frequency and high potential alternating currents resulted in the development of the "Tesla coil" which is still used as a major component in numerous electronic devices. This device is a transformer with an air core that has both its primary and secondary tuned in resonance. As part of other experiments Tesla also developed the precursors of modern neon and florescent lights. He constructed these lights, elongated glass tubes filled with gas and coated with phosphor, excited in his high voltage experiments. He also discovered that high voltage current could be made harmless by using alternating current scheme at very large frequencies.(3)

Outline of the Freshman Seminar

- WAR OF THE CURRENTS In May 1885, George Westinghouse, head of the Westinghouse Electric Company in Pittsburgh, bought the patent rights to Tesla's polyphase system of alternating-current dynamos, transformers, and motors. The transaction precipitated a titanic power struggle between Edison's direct-current systems and the Tesla-Westinghouse alternating-current approach, which eventually won out. A similar media blitz is responsible for Thomas Alva Edison becoming a familiar household name. In reality Mr. Edison did not create or develop our system of alternating current electricity. History of "The War of the Currents" shows how he fought its adoption bitterly, choosing instead to promote a system of direct current that had already been invented by others. In short, Mr. Edison's brief role in the electrical power industry was that of an entrepreneur who failed, rather than an inventor. It was Nikola Tesla's discovery of the rotating magnetic field principle in 1882 and patented in 1888 that gives us our modern day system of electrical power distribution. (2, 4)
- THE GREAT RADIO
CONTROVERSY Marchese Guglielmo Marconi was the first to send a message across the ocean and, as a result of his business interests later, he is partly responsible for 'developing' radio...but he did NOT invent it. Tesla did. Most people are unaware of what happened June 21, 1943: The United States Supreme Court made a landmark decision that essentially settled the long dispute between Marchese Guglielmo Marconi and Nikola Tesla. The court's decision, Case No. 369, identified as "Marconi Wireless Telegraph Company of America vs. United States," rendered invalid Marconi's basic patent No. 763,772 dated June 28, 1904. Tesla's patent No. 645,576 of March 20, 1900, and its subdivision patent for apparatus No. 649,621 dated May 15, 1900, had priority. (2,4)
- REMOTE CONTROL AND
AUTOMATION In the development of receivers and transmitters Tesla applied them in remote ship control, and he was granted a patent in 1898 for "The Method of and Apparatus for Controlling Mechanism of Moving Vessels or Vehicles ". This invention made Tesla an originator of remote control.(1,2,4)
- THE GREAT SMITHSONIAN
CONTROVERSY The Smithsonian Book of Invention is a prodigious 3/4 inch thick book of America's greatest inventors and their inventions. Tesla's name does not appear anywhere in that publication. One wonders how such an august institution with all the learned historians in their employ could possibly ignore Tesla's contributions in their chapter depicting the evolution of electric power and radio. Further evidence of history gone amuck is seen in the Smithsonian's publication, "The Beginning of the Electrical Age." The curator meticulously traces the history of electricity from Volta to Edison, naming 43 significant contributors, yet Nikola Tesla's name is missing. Instead, the curator shows pictures of the Niagara Falls Power project, and readers are carefully guided into believing that this was the work of Edison. Yet it was Tesla's polyphase AC system that the power commission adopted and licenses had to be issued to use Tesla's patents. Money for this publication came from the Thomas Alva Edison Foundation. (5,6)
- REFERENCES (1) Nikola Tesla, "My Inventions," Skolska Knjiga, Zagreb, 1990
(2) Margaret Cheney, "Tesla, Man Out of Time," New Jersey: Prentice-Hall, Inc., 1981
(3) Encyclopedia Americana, Vol 26, Grolier Inc: Connecticut, 1997, Pp. 527-528.

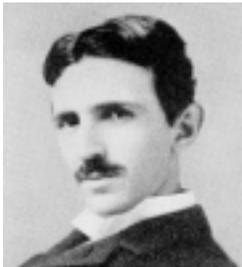
Nikola Tesla: Short Biography

(4) Marc J. Seifer, "Wizard: The Life and Times of Nikola Tesla: Biography of a Genius," New Jersey: Carol Publishing Group, 1996.

(5) John Wagner, personal communication

(6) Z. Herskovits, "To the Smithsonian or Bust: The Scientific Legacy of Nikola Tesla," Yale Scientific Magazine, Volume 71, Issue 4 (1999)

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(b. July 9/10, 1856, Smiljan, Austro-Hungary--d. Jan. 7, 1943, New York City), Serbian-American inventor and researcher who discovered the rotating magnetic field, the basis of most alternating-current machinery. He emigrated to the United States in 1884 and sold the patent rights to his system of alternating-current dynamos, transformers, and motors to George Westinghouse the following year. In 1891 he invented the Tesla coil, an induction coil widely used in radio technology. Tesla was from a family of Serbian origin. His father was an Orthodox priest; his mother was unschooled but highly intelligent. A dreamer with a poetic touch, as he matured Tesla added to these earlier qualities those of self-discipline and a desire for precision.



Training for an engineering career, he attended the Technical University at Graz, Austria, and the University of Prague. At Graz he first saw the Gramme dynamo, which operated as a generator and, when reversed, became an electric motor, and he conceived a way to use alternating current to advantage. Later, at Budapest, he visualized the principle of the rotating magnetic field and developed plans for an induction motor that would become his first step toward the successful utilization of alternating current. In 1882 Tesla went to work in Paris for the Continental Edison Company, and, while on assignment to Strassburg in 1883, he constructed, in after-work hours, his first induction motor. Tesla sailed for America in 1884, arriving in New York, with four cents in his pocket, a few of his own poems, and calculations for a flying machine. He first found employment with Thomas Edison, but the two inventors were far apart in background and methods, and their separation was inevitable.

In May 1885, George Westinghouse, head of the Westinghouse Electric Company in Pittsburgh, bought the patent rights to Tesla's polyphase system of alternating-current dynamos, transformers, and motors. The transaction precipitated a titanic power struggle between Edison's direct-current systems and the Tesla-Westinghouse alternating-current approach, which eventually won out. Tesla soon established his own laboratory, where his inventive mind could be given free rein. He experimented with shadowgraphs similar to those that later were to be used by Wilhelm Röntgen when he discovered X-rays in 1895. Tesla's countless experiments included work on a carbon button lamp, on the power of electrical resonance, and on various types of lighting.

Tesla gave exhibitions in his laboratory in which he lighted lamps without wires by allowing electricity to flow through his body, to allay fears of alternating current. He

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was often invited to lecture at home and abroad. The Tesla coil, which he invented in 1891, is widely used today in radio and television sets and other electronic equipment. That year also marked the date of Tesla's United States citizenship.



Westinghouse used Tesla's system to light the World's Columbian Exposition at Chicago in 1893. His success was a factor in winning him the contract to install the first power machinery at Niagara Falls, which bore Tesla's name and patent numbers. The project carried power to Buffalo by 1896.

In 1898 Tesla announced his invention of a teleautomatic boat guided by remote control. When skepticism was voiced, Tesla proved his claims for it before a crowd in Madison Square Garden. In Colorado Springs, Colo., where he stayed from May 1899 until early 1900, Tesla made what he regarded as his most important discovery-- terrestrial stationary waves. By this discovery he proved that the Earth could be used as a conductor and would be as responsive as a tuning fork to electrical vibrations of a certain frequency. He also lighted 200 lamps without wires from a distance of 25 miles (40 kilometres) and created man-made lightning, producing flashes measuring 135 feet (41 metres). At one time he was certain he had received signals from another planet in his Colorado laboratory, a claim that was met with derision in some scientific journals.

Returning to New York in 1900, Tesla began construction on Long Island of a wireless world broadcasting tower, with \$150,000 capital from the American financier J. Pierpont Morgan. Tesla claimed he secured the loan by assigning 51 percent of his patent rights of telephony and telegraphy to Morgan. He expected to provide worldwide communication and to furnish facilities for sending pictures, messages, weather warnings, and stock reports. The project was abandoned because of a financial panic, labour troubles, and Morgan's withdrawal of support. It was Tesla's greatest defeat.



Tesla's work then shifted to turbines and other projects. Because of a lack of funds, his ideas remained in his notebooks, which are still examined by engineers for unexploited clues. In 1915 he was severely disappointed when a report that he and Edison were to share the Nobel Prize proved erroneous. Tesla was the recipient of the Edison Medal in 1917, the highest honour that the American Institute of Electrical Engineers could bestow.

Tesla allowed himself only a few close friends. Among them were the writers Robert Underwood Johnson, Mark Twain, and Francis Marion Crawford. He was quite impractical in financial matters and an eccentric, driven by compulsions and a progressive germ phobia. But he had a way of intuitively sensing hidden scientific secrets and employing his inventive talent to prove his hypotheses.

Tesla was a godsend to reporters who sought sensational copy but a problem to editors who were uncertain how seriously his futuristic prophecies should be regarded. Caustic criticism greeted his speculations concerning communication with other planets, his assertions that he could split the Earth like an apple, and his claim of having invented a death ray capable of destroying 10,000 airplanes at a distance of 250 miles (400 kilometres).

Bibliography



After Tesla's death the custodian of alien property impounded his trunks, which held his papers, his diplomas and other honours, his letters, and his laboratory notes. These were eventually inherited by Tesla's nephew, Sava Kosanovich, and later housed in the Nikola Tesla Museum in Belgrade. Hundreds filed into New York City's Cathedral of St. John the Divine for his funeral services, and a flood of messages acknowledged the loss of a great genius. Three Nobel Prize recipients addressed their tribute to "one of the outstanding intellects of the world who paved the way for many of the technological developments of modern times." (I.W.H.)

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Bibliography

1. CHENEY, MARGARET. *Tesla, man out of time* / Margaret Cheney. Englewood Cliffs, N.J. Prentice-Hall, c1981.
2. HUNT, INEZ. *Lightning in his hand; the life story of Nikola Tesla*, by Inez Hunt and Wanetta W. Draper. Denver, Sage Books [1964].
3. MUZEJ NIKOLE TESLE. *Tribute to Nikola Tesla. Presented in articles, letters, documents*. Beograd, Nikola Tesla Museum, 1961.
4. O'NEILL, JOHN JOSEPH, *Prodigal genius; the life of Nikola Tesla*, by John J. O'Neill. New York, N.Y., I. Washburn, inc. [1944].
5. TESLA, NIKOLA, *The complete patents of Nikola Tesla* / edited by Jim Glenn. New York : Barnes & Noble Books, 1994.
6. TESLA, NIKOLA, *The fantastic inventions of Nikola Tesla* / by Nikola Tesla & David H. Childress. Stelle, Ill. : Adventures Unlimiteds, [c1993]. Series title: Lost science series.
7. TESLA, NIKOLA, *My inventions : the autobiography of Nikola Tesla* / edited, with an introduction, by Ben Johnston. 1st Hart Bros. ed. Williston, Vt. : Hart Bros., 1982.
8. TESLA, NIKOLA, *Nikola Tesla on his work with alternating currents and their application to wireless telegraphy, telephony, and transmission of power : an extended interview* / Leland I. Anderson, editor. Denver, Colo. : Sun Pub. : Breckinridge, Colo. : Distributed exclusively in the USA by Twenty First Century Books, 1992.

Bibliography

9. VIDEORECORDING The Mechanical universe and beyond. Part 37-38. Electromagnetic induction ; Alternating currents / a co-production of the California Institute of Technology and the Corporation for Community College Television. Santa Barbara, Calif. : Intellimation [distributor], c1987.1 videodisc (60 min.) : sd., col. ; 12 in.Laserdisc. UCB Media Ctr VIDEO/D 97
- The above listed books and materials are available form the UCB Libraries. Listed below are newer books and materials that we would like to obtain:
10. VUJOVIC, IWONA *Tesla Bibliography, 1896-1920*, Publ. Tesla Project (1998)
11. HULL, RICHARD L.. *The Tesla Coil Builder's Guide to the Colorado Springs Notes of Nikola Tesla*, Publisher:Twenty First Century Books, Date:July 1999
- 12.STEWART, DANIEL B. *Tesla: The Modern Sorcerer*, Publisher:Frog, Limited, Date:Aug. 1999
13. SEIFER, MARC J. *Wizard: The Life and Times of Nikola Tesla*, Publisher:Carol Publishing Group, Date:March 1998
14. CHENEY, MARGARET. *Tesla*, Publisher:Doubleday, Date:Nov. 1998
15. TESLA, NIKOLA. *Nikola Tesla - Lecture Before the New York Academy of Sciences*, April 6, 1897; The Streams of Lenard & Roentgen: a Novel Apparatus for Their Production, Publisher:Twenty First Century Books, Date:Dec. 1994 T
16. TESLA, NIKOLA *Nikola Tesla on His Work with Alternating Currents & Their Application to Wireless Telegraphy, Telephony, & Transmission of Power*, Publisher:Sun Publishing, Denver, Date:May 1992
17. CHENEY, MARGARET AND ROBERT UTH *Tesla: Master of Lightning*, Barnes and Noble Books, 1999
18. PBS DOCUMENTARY *Tesla: Master of Lightning*, <http://www.pbs.org/tesla/>