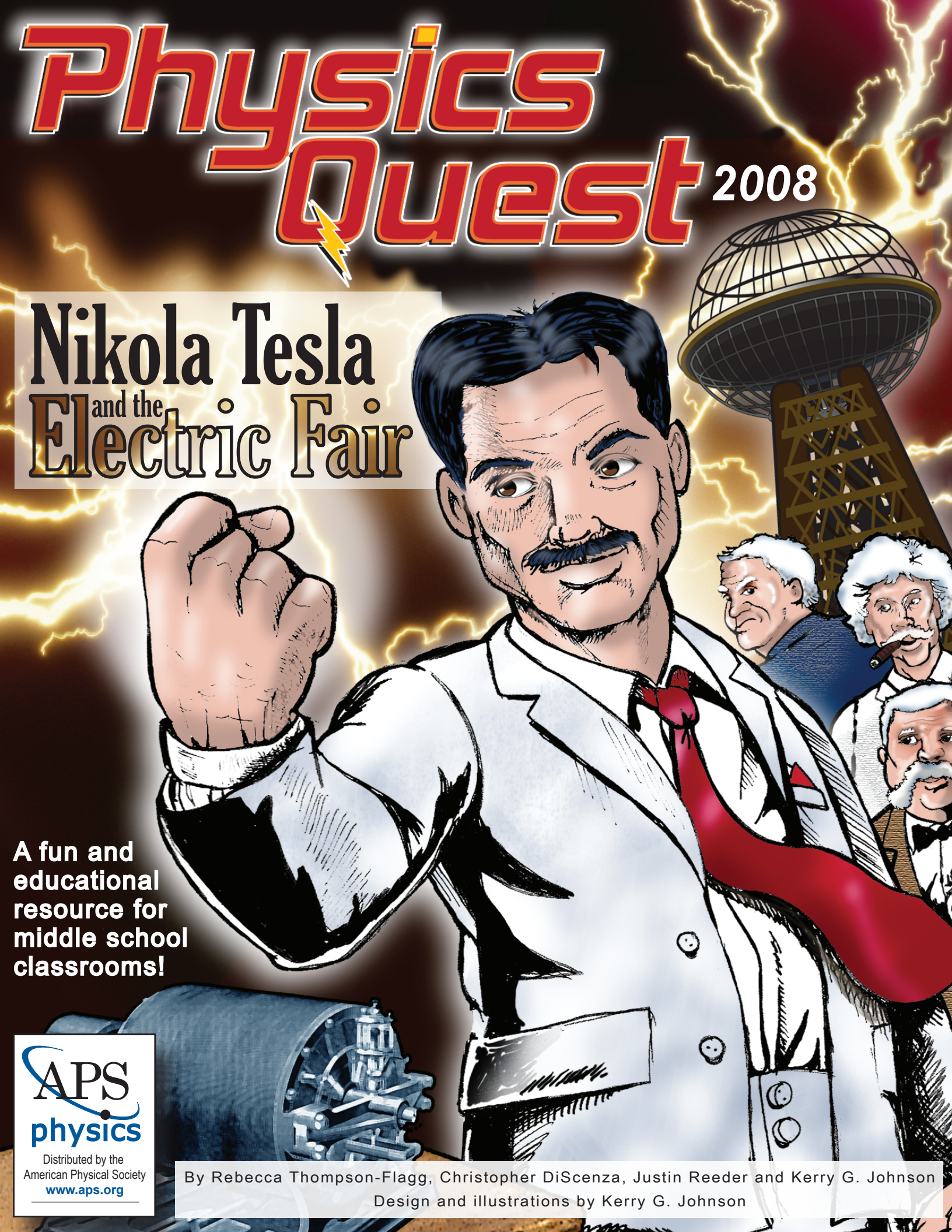
Physics Quest 2008

Nikola Tesla and the Electric Fair



A fun and educational resource for middle school classrooms!

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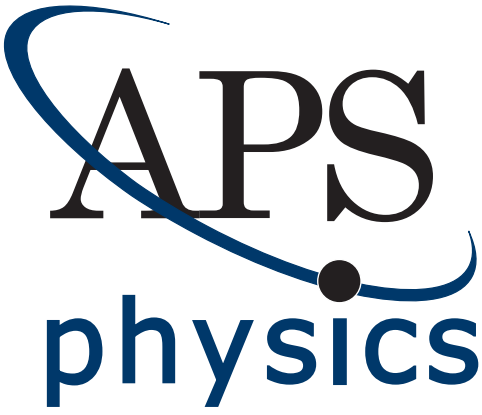
By Rebecca Thompson-Flagg, Christopher DiScenza, Justin Reeder and Kerry G. Johnson
Design and illustrations by Kerry G. Johnson



Copies of this comic book and the entire PhysicsQuest manual may be downloaded at **physicscentral.com/physicsquest**

Feedback and comments may be e-mailed to **physicsquest@aps.org**

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Physics Quest 2008

Nikola Tesla *and the* Electric Fair

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APS physics

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About the comic book

Before writing the comic book section, the PhysicsQuest team did extensive research into the life and inventions of Nikola Tesla. Though much of the comic is historically accurate to the best of our knowledge, parts of it needed to be fictionalized for a middle school audience and suited to fit within the PhysicsQuest mystery. We hope that no one is upset with our additions. We are also well aware that Tesla did much more than what is presented on the pages of the comic book. We would have loved to create a more extensive history of his life, but we were limited by space.

This program is created for a younger audience, so we glossed over some of the more "colorful" aspects of Tesla's life. We hope that the large contingent of Tesla fans enjoys the pigeon references. The PhysicsQuest team has great respect for Nikola Tesla's life and accomplishments and we hope that you find this to be a fitting tribute to his life.

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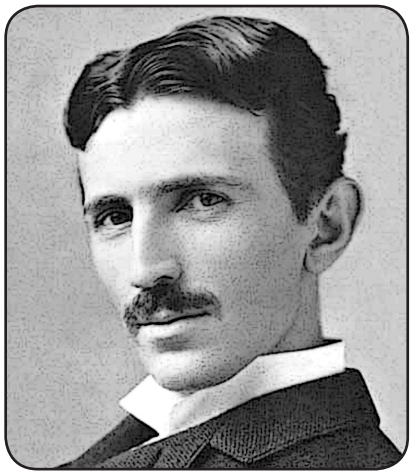
The PhysicsQuest 2008 Team

About Nikola Tesla



Born in 1856 in Smiljan Croatia of Serbian heritage, Nikola Tesla was a true genius. As a child, he was fascinated with physics and mathematics. This fascination transformed into an obsession with electricity. He studied Electrical Engineering at the Austrian Polytechnic in Graz and the Charles Ferdinand University in Prague. Then in 1881, he worked in Budapest and Paris on the new telephone and electrical systems. At that time, all electrical motors were powered by direct current (DC) with brushes that transferred the electrical current to the rotating shaft. These primitive motors had many problems. The brushes created friction in the motor and DC was an inefficient means of transporting electricity. However, Tesla conceived of a brushless motor that used alternating current (AC). He was walking with a friend through a park when the concept of the rotating magnetic field flashed through his mind. He stopped and sketched a diagram in the sand with a stick while explaining the principle to his friend. This vision was to lead him to many great inventions and success later in his life.

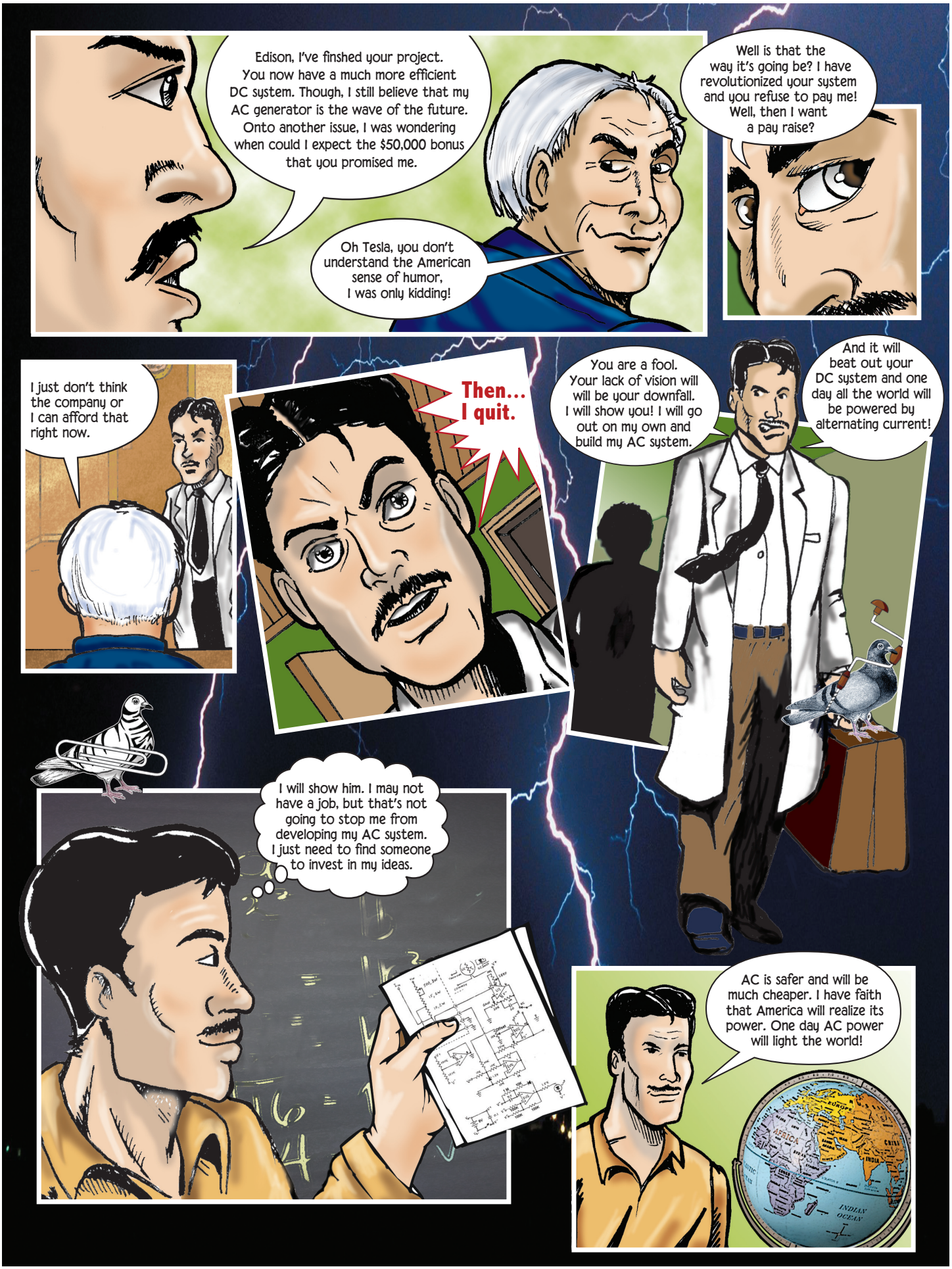
In 1884, he arrived in America looking to develop his ideas with the successful inventor Thomas Alva Edison. Tesla handed Edison a recommendation letter from his former supervisor, Charles Batchelor. The letter said: "I know two great men and you are one of them; the other is this young man." Edison hired Tesla immediately to work for his *Edison Machine Works*. Tesla made significant improvements to Edison's power generator designs. However, Tesla fought with Edison over the use of AC in the electrical systems. Edison had invested too much time and money into his DC system. Tesla knew that AC was more efficient and it would allow for more electrical innovation in the future. Switching to Tesla's AC system would be too expensive in the short term and it would also cost Edison his pride. Tesla left Edison's workshop to work for one of Edison's rivals, George Westinghouse Jr. Thus began a personal as well as scientific battle between Tesla and Edison over Alternating Current AC versus Direct Current DC. This conflict was known as the "War of the Currents."

The battle quickly shifted onto the political stage. It involved public events and demonstrations with the media. Edison was a successful businessman and a celebrity. He would publicly demonstrate the harmful effects of AC on livestock. To further his political war, he attempted to coin the phrase for electrocution as "getting Westinghoused". These cruel demonstrations were intended to frighten the public and have shivers run down their spine upon hearing the words "Alternating Current." Ironically today, Edison's Direct Current is generally considered more dangerous because electricity can remain stored long after the power has been shut off.

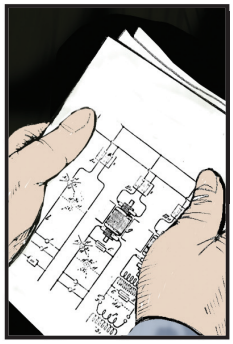
The Chicago World's Fair of 1893 was the symbolic end to the "War of the Currents". The fair resembled a great white city that was designed to glow with electric light. Tesla and Edison competed for the chance to provide electrical power for the first time to such an event. Edison's inefficient DC design required a heavy price compared to Westinghouse and Tesla's AC generators. The winning design would light the white city.

Nikola Tesla, with Ruder Boskovic's book *Theoria Philosophiae Naturalis,* sits in front of the spiral coil of his high-frequency transformer at East Houston St., NY. (Public domain image)

*** Charles W. Batchelor was an inventor and close associate of Thomas Edison. He was involved in some of the greatest inventions and technological developments in history.**

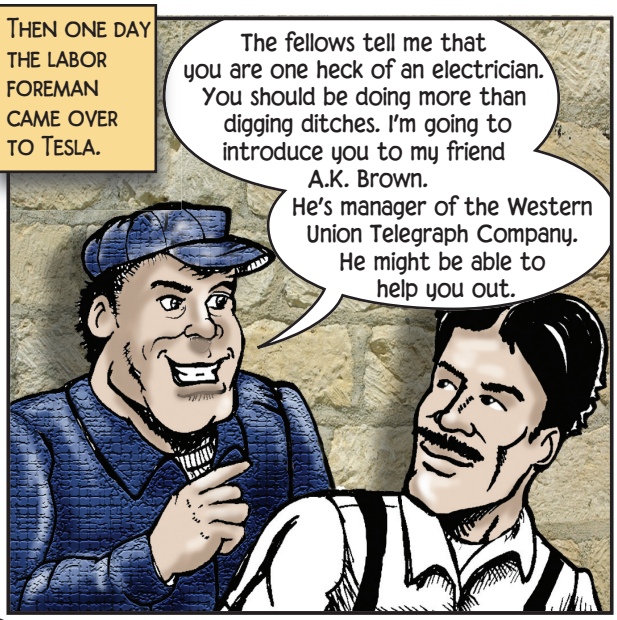

Edison, I've finshed your project. You now have a much more efficient DC system. Though, I still believe that my AC generator is the wave of the future. Onto another issue, I was wondering when could I expect the $50,000 bonus that you promised me.
Oh Tesla, you don't understand the American sense of humor, I was only kidding!
Well is that the way it's going be? I have revolutionized your system and you refuse to pay me! Well, then I want a pay raise?
I just don't think the company or I can afford that right now.
Then... I quit.
You are a fool. Your lack of vision will will be your downfall. I will show you! I will go out on my own and build my AC system.
And it will beat out your DC system and one day all the world will be powered by alternating current!
I will show him. I may not have a job, but that's not going to stop me from developing my AC system. I just need to find someone to invest in my ideas.
AC is safer and will be much cheaper. I have faith that America will realize its power. One day AC power will light the world!
EUROPE
AFRICA
CHINA
INDIA
INDIAN OCEAN

TESLA CONTINUED TO WORK ON HIS AC POWER SYSTEM WHILE DOING MANUAL LABOR ...

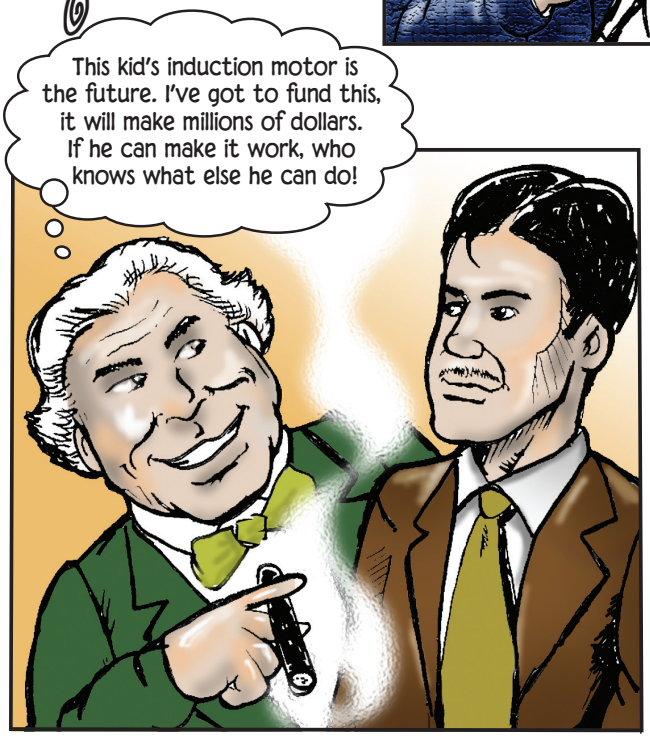


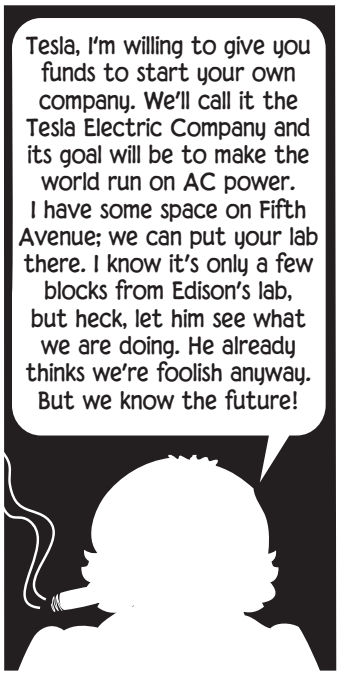
... AND IN 1887 HE WAS GRANTED 7 PATENTS FOR HIS AC SYSTEM. THESE TURNED OUT TO BE THE MOST VALUABLE PATENTS SINCE THE TELEPHONE.

THEN ONE DAY THE LABOR FOREMAN CAME OVER TO TESLA.

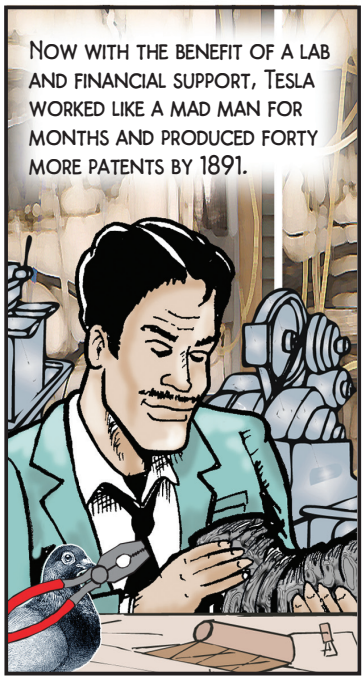


TESLA MEETS MR. BROWN AND HE EXPLAINS HIS IDEAS FOR A FUNCTIONAL AC SYSTEM.

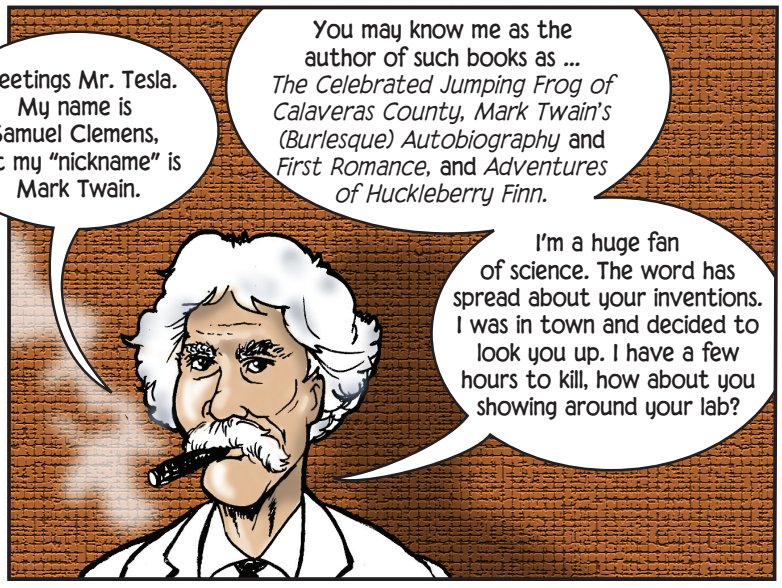


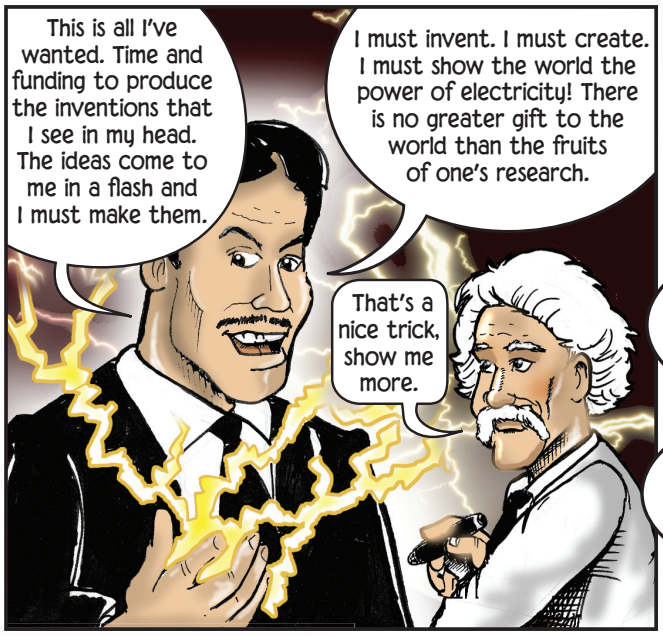


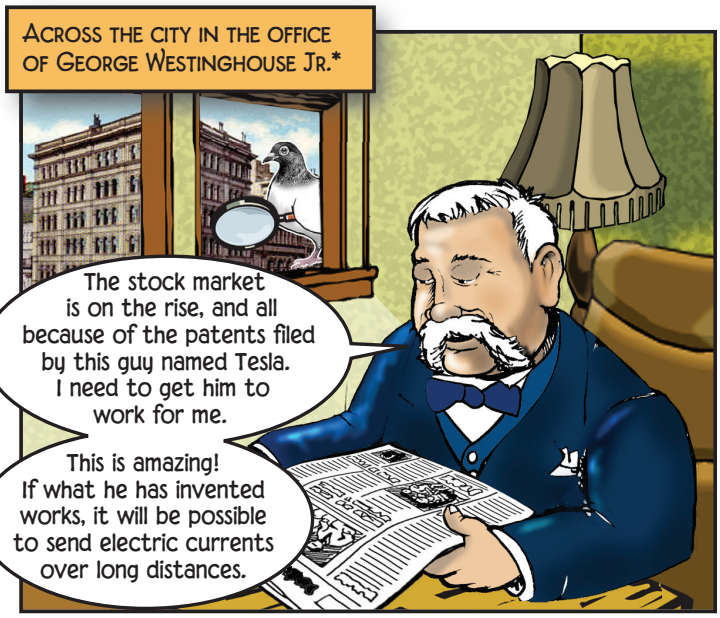
NOW WITH THE BENEFIT OF A LAB AND FINANCIAL SUPPORT, TESLA WORKED LIKE A MAD MAN FOR MONTHS AND PRODUCED FORTY MORE PATENTS BY 1891.



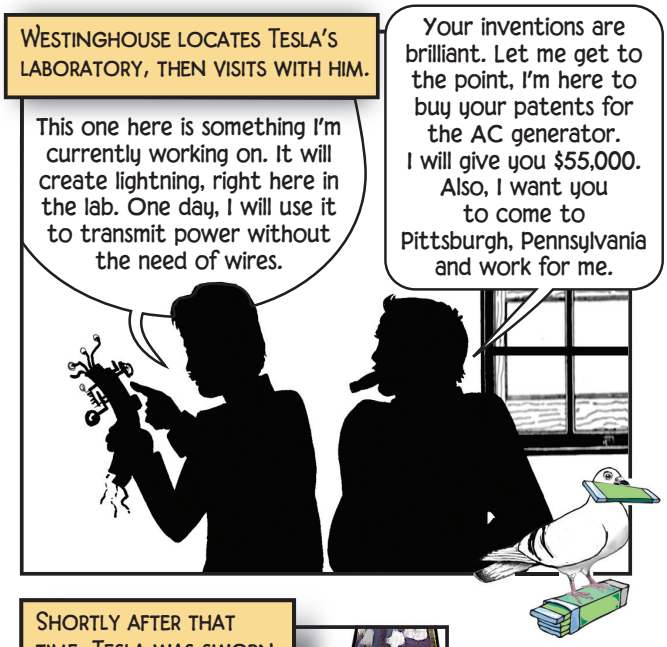
THEN ONE DAY, HE GOT A VISIT FROM A SURPRISE GUEST.

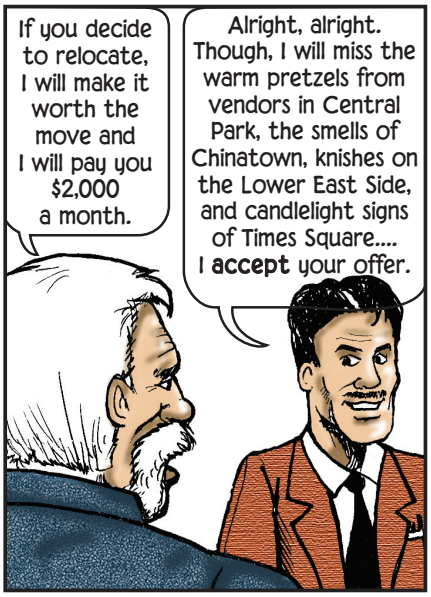


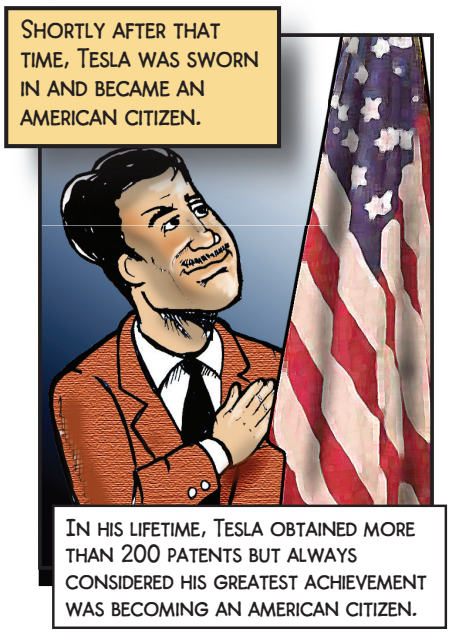


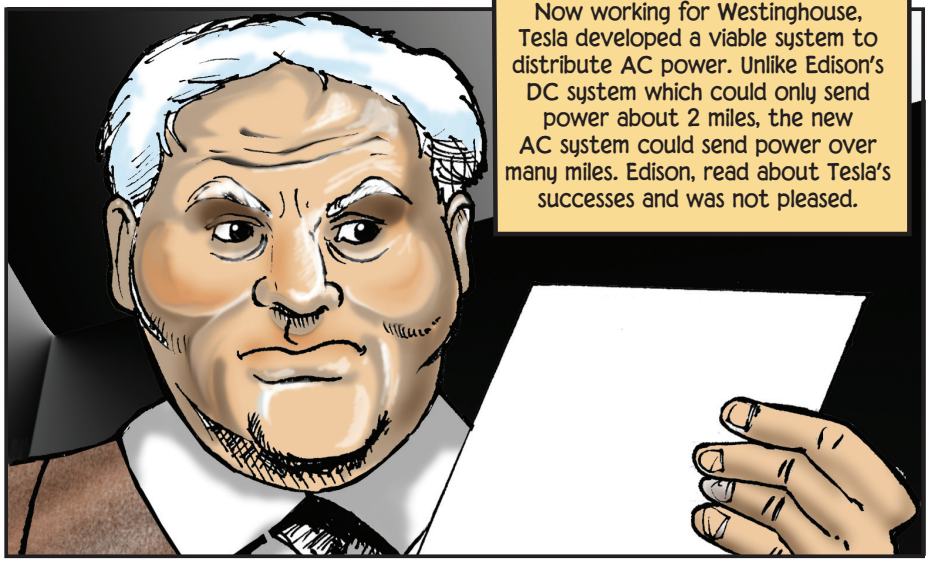


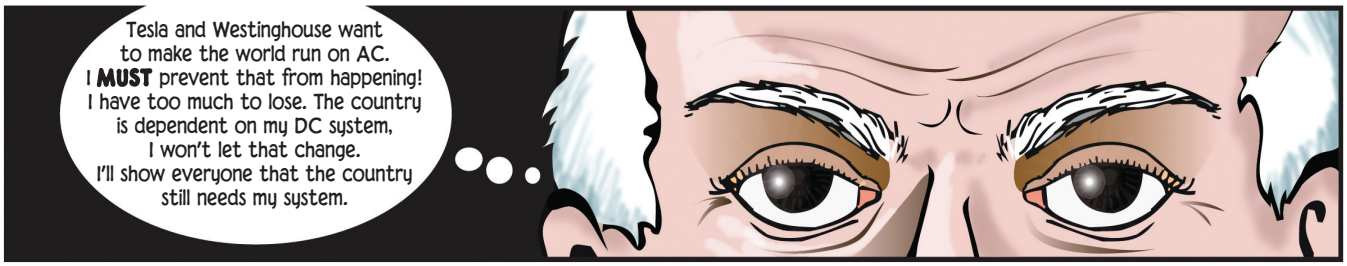
* George Westinghouse Jr. was an American entrepreneur and engineer who invented the railroad air brake and was a pioneer of the electrical industry. Westinghouse was one of Thomas Edison's main rivals.

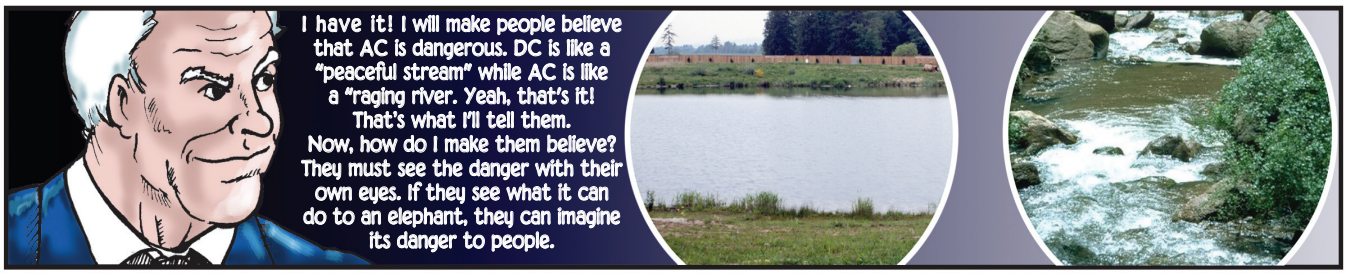


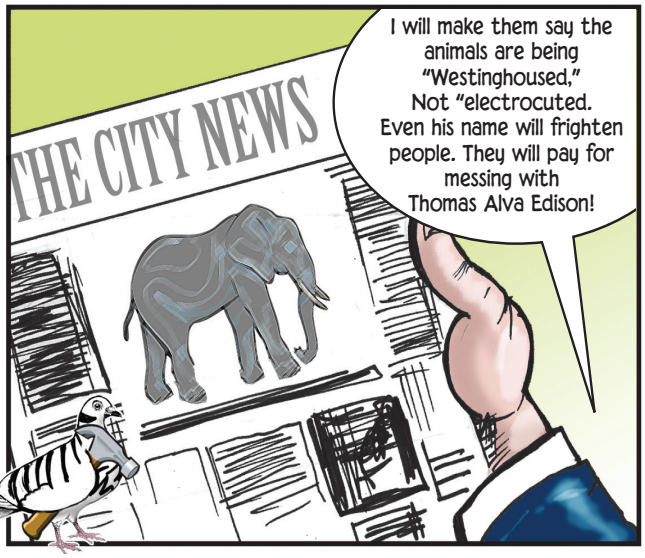




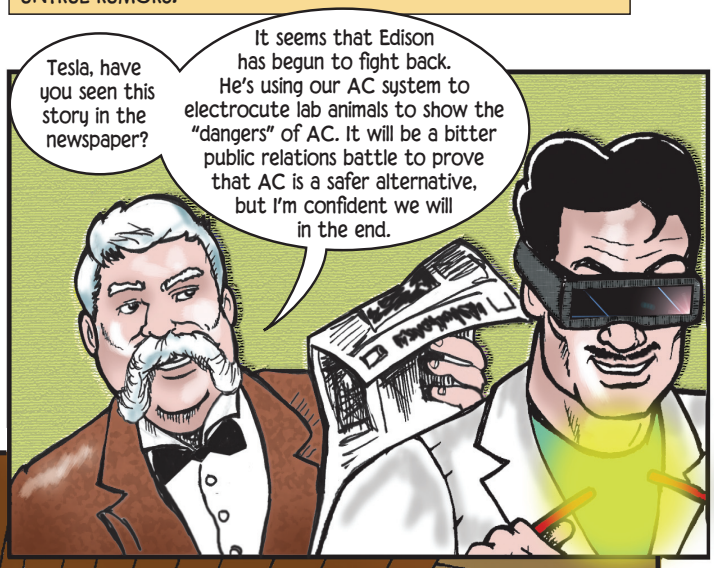


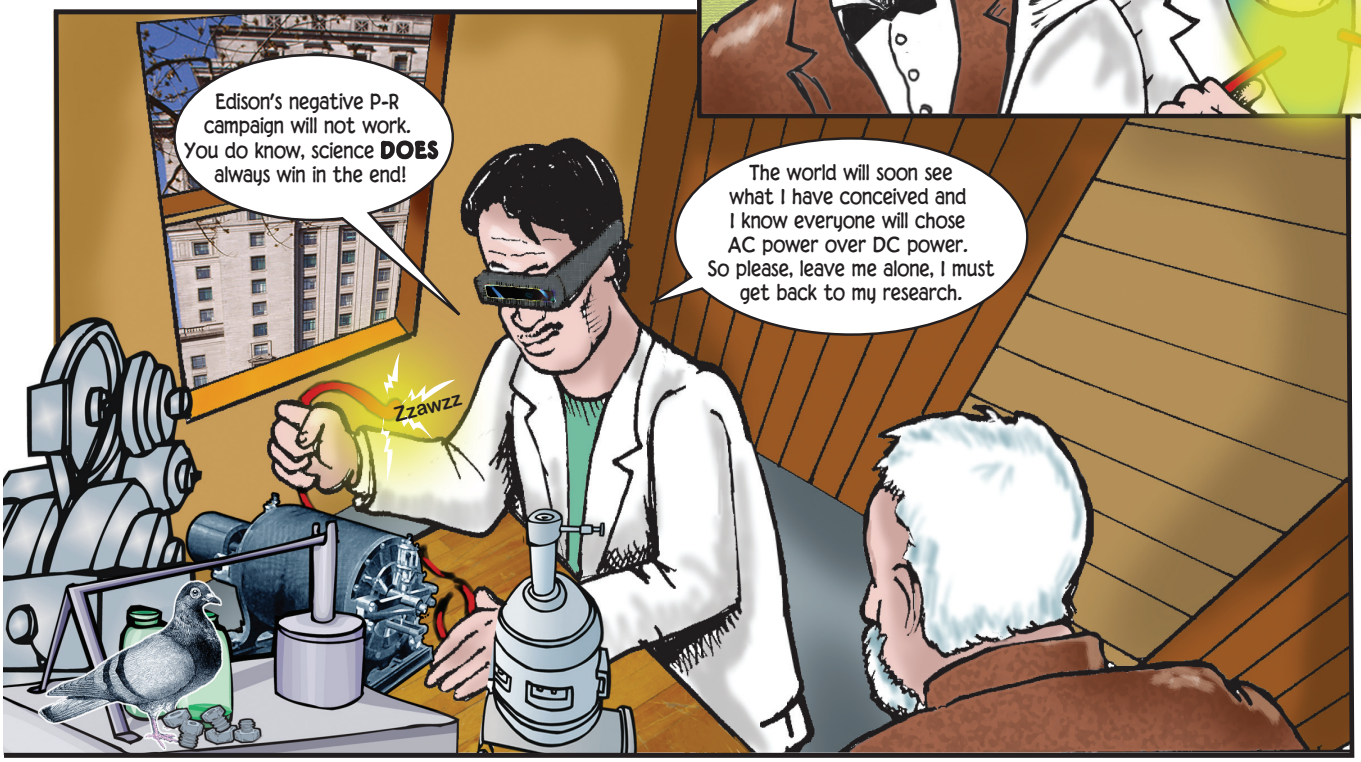






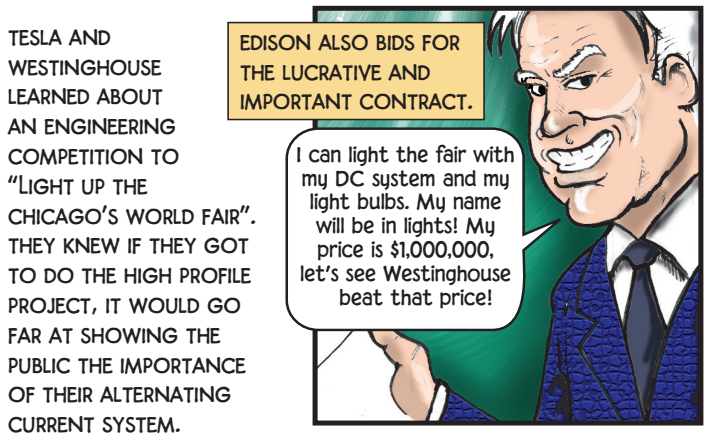
EDISON GRADUALLY STARTS TO PLANT NEGATIVE STORIES IN THE NEWSPAPERS AND BY WORD-OF-MOUTH CONVERSATIONS. EVENTUALLY, WESTINGHOUSE HEARS AND READS ABOUT THE UNTRUE RUMORS.

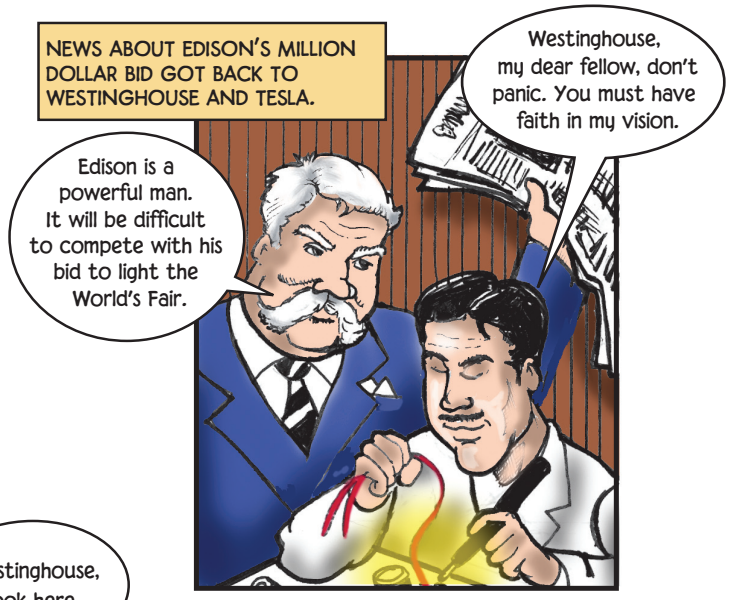


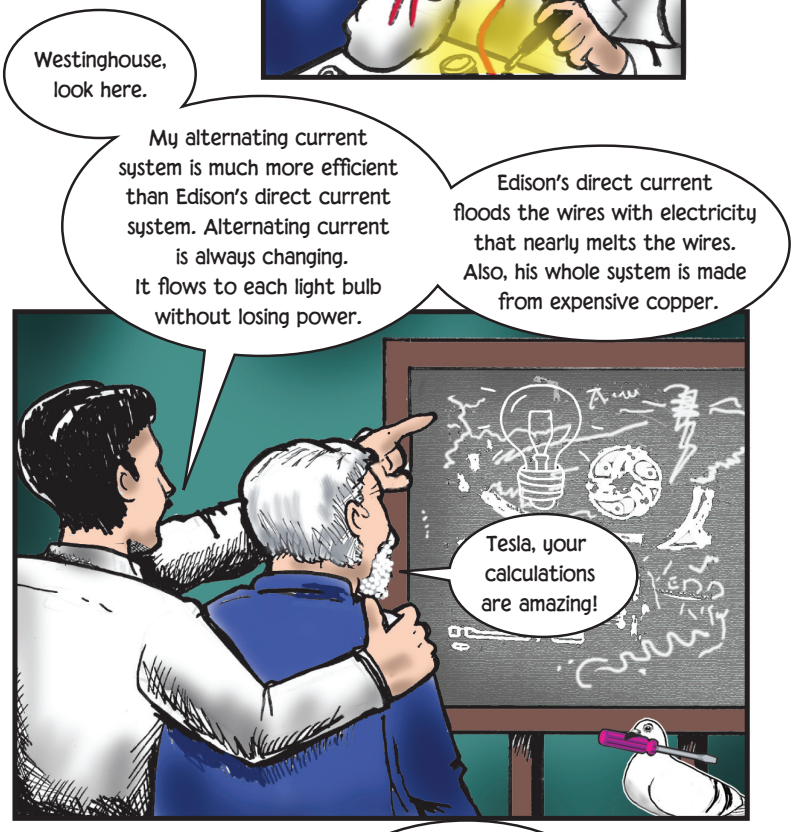


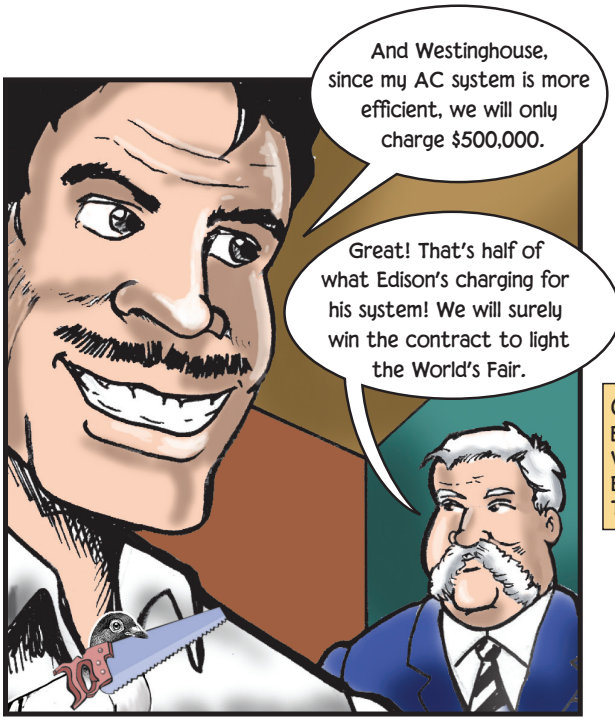
THE WORLD'S FAIR WAS HELD IN CHICAGO IN 1893. IT WAS THE FIRST WORLD'S FAIR TO USE ELECTRICITY. DURING THE LATE 1800S, IT WAS A COMING-OF-AGE ERA FOR THE ARTS AND ARCHITECTURE OF THE "AMERICAN RENAISSANCE". AT THAT TIME, MOST OF THE DOWNTOWN BUILDINGS IN THE CITY WERE BASED ON NEOCLASSICAL ARCHITECTURE AND MADE OF WHITE STUCCO, THIS GAVE CHICAGO THE NICKNAME "THE WHITE CITY."

TESLA AND WESTINGHOUSE LEARNED ABOUT AN ENGINEERING COMPETITION TO "LIGHT UP THE CHICAGO'S WORLD FAIR". THEY KNEW IF THEY GOT TO DO THE HIGH PROFILE PROJECT, IT WOULD GO FAR AT SHOWING THE PUBLIC THE IMPORTANCE OF THEIR ALTERNATING CURRENT SYSTEM.





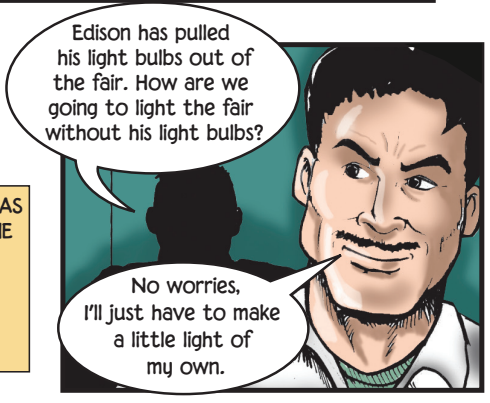




ON THE OTHER SIDE OF TOWN, EDISON'S LEARNS ABOUT WESTINGHOUSE AND TESLA'S BEING AWARDED THE CONTRACT TO LIGHT THE WORLD'S FAIR.

HE WAS ANGRY THAT HIS BID WAS NOT ACCEPTED, SO HE TOLD THE FAIR OFFICIALS ...

"Since my DC system will not illuminate the World's Fair, then neither will my bulbs!"



Tesla my boy, what do you have churning in that brain of yours? Surely, we are doomed. We are out in the field without an ox ... so to speak.

Here's what I'm thinking; Edison can keep his oxen. We will use the "field" to light up Chicago!

Tesla, are you crazy? I was only making a farmer's analogy. What are you talking about?

"The Electric Field! Michael Faraday* described the electric field as the 'Lines of Force' created by electric charge. The electric field emanates throughout space and fills each of us with a potential to create light."

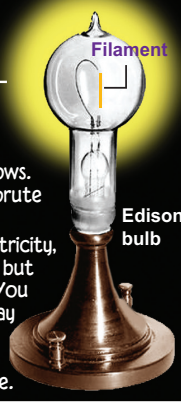
* Michael Faraday was an English chemist and physicist who pioneered experiments in electricity and magnetism. He established the basis for the magnetic field concept in physics.

Direct current only creates a short pulse in the electric field.

However, my alternating current creates waves in the electric field that carry energy through space and time to each light bulb.

Edison's light bulbs create light by heating a carbon filament until it glows. This is clearly the brute force method.

Given enough electricity, anything will glow, but very inefficiently. You know what they say about Edison, the light is on upstairs but no one is home.



My light bulbs contain gases that will harness the electric field and ionize it to form glowing plasma.

The alternating current will excite the gas 60 times in one second. This is faster than the eye can detect and the most efficient frequency for the generators.

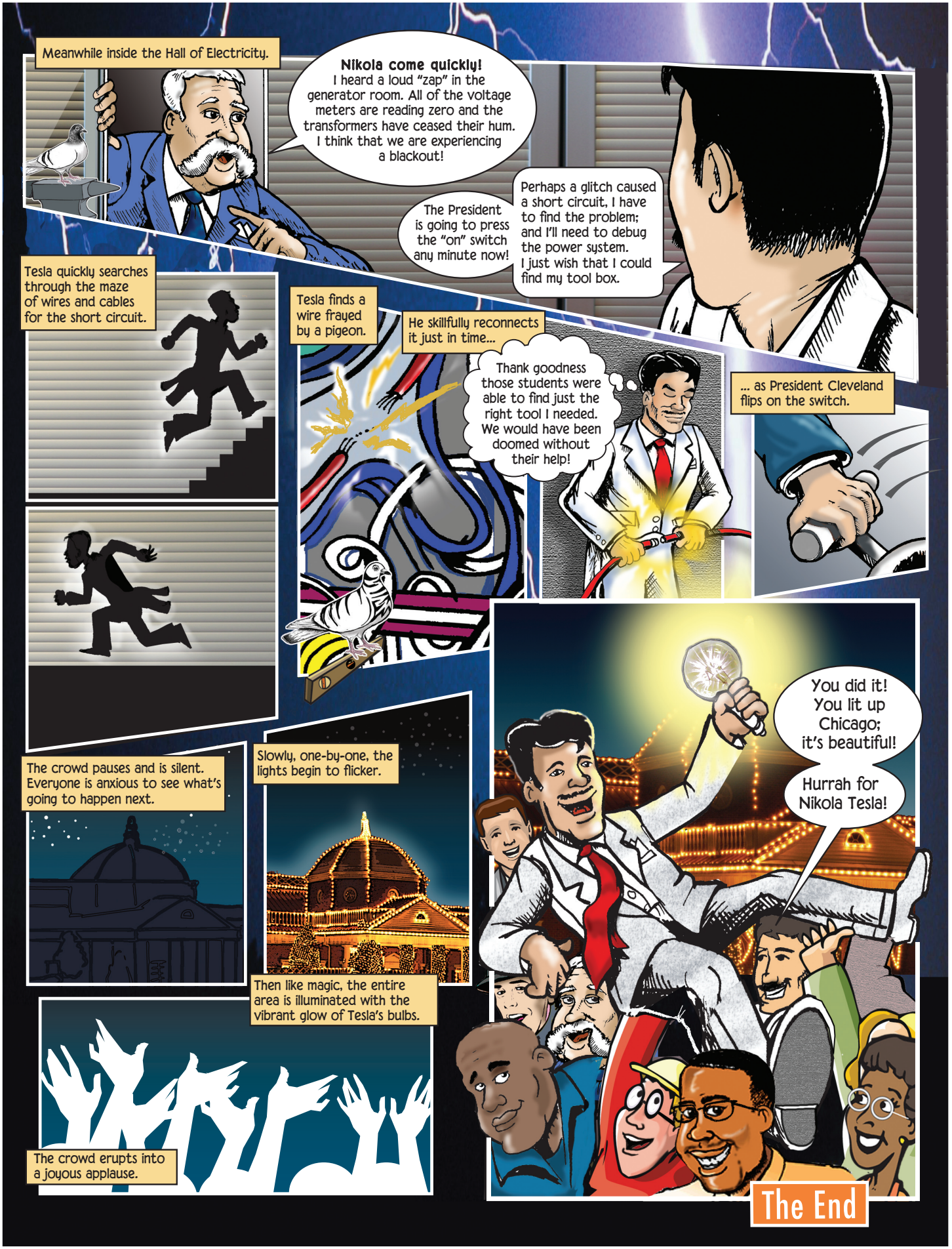
We now fast forward the story to the 1893 Chicago World's Fair, Where Tesla's AC electrical system is in place. President Grover Cleveland* is at the main stage giving a speech.

If a passenger on a train carries a charged balloon then the person on the embankment will observe a magnetic field but the passenger won't. How can this be? As your president, I will strive for equality among all observers! Today we are embarking on a new era of humanity that will lead us toward this goal.

Today, you're about to see the future of electric power. A young immigrant named Nikola Tesla followed the American dream and constructed the electrical system that will bring light and the modern world to our cities and homes. Imagine riding on a quiet elevated electric train, or lighting your house with the flip of a switch and turning it off with the clap of your hands.

Ladies and gentlemen, let's light up this city!

** Stephen Grover Cleveland was both the 22nd and 24th President of the United States.


Meanwhile inside the Hall of Electricity.
Nikola come quickly! I heard a loud "zap" in the generator room. All of the voltage meters are reading zero and the transformers have ceased their hum. I think that we are experiencing a blackout!
The President is going to press the "on" switch any minute now!
Perhaps a glitch caused a short circuit, I have to find the problem; and I'll need to debug the power system. I just wish that I could find my tool box.
Tesla quickly searches through the maze of wires and cables for the short circuit.
Tesla finds a wire frayed by a pigeon.
He skillfully reconnects it just in time...
Thank goodness those students were able to find just the right tool I needed. We would have been doomed without their help!
... as President Cleveland flips on the switch.
You did it! You lit up Chicago; it's beautiful!
Hurrah for Nikola Tesla!
The crowd pauses and is silent. Everyone is anxious to see what's going to happen next.
Slowly, one-by-one, the lights begin to flicker.
Then like magic, the entire area is illuminated with the vibrant glow of Tesla's bulbs.
The crowd erupts into a joyous applause.
The End

Physics Quest 2008

Nikola Tesla and the Electric Fair

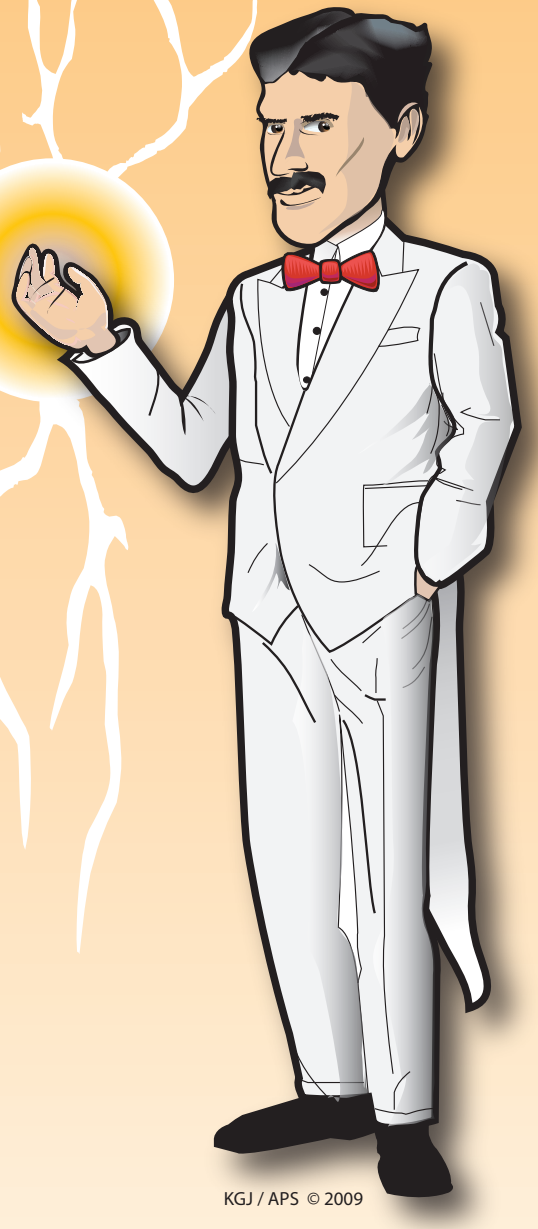
Born in 1856, inventor and scientist Nikola Tesla was a true genius.

As a child, he was fascinated with physics and mathematics. This fascination transformed into an obsession with electricity.

This vision led him to create great inventions and have successes later in his life.

Tesla was a close friend of writer Mark Twain and a bitter rival of inventor Thomas Edison.

In 1893,Tesla was hired to “light up” the Chicago World’s Fair, the first electric fair in the world.



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ISBN: 978-0-9823238-0-9
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