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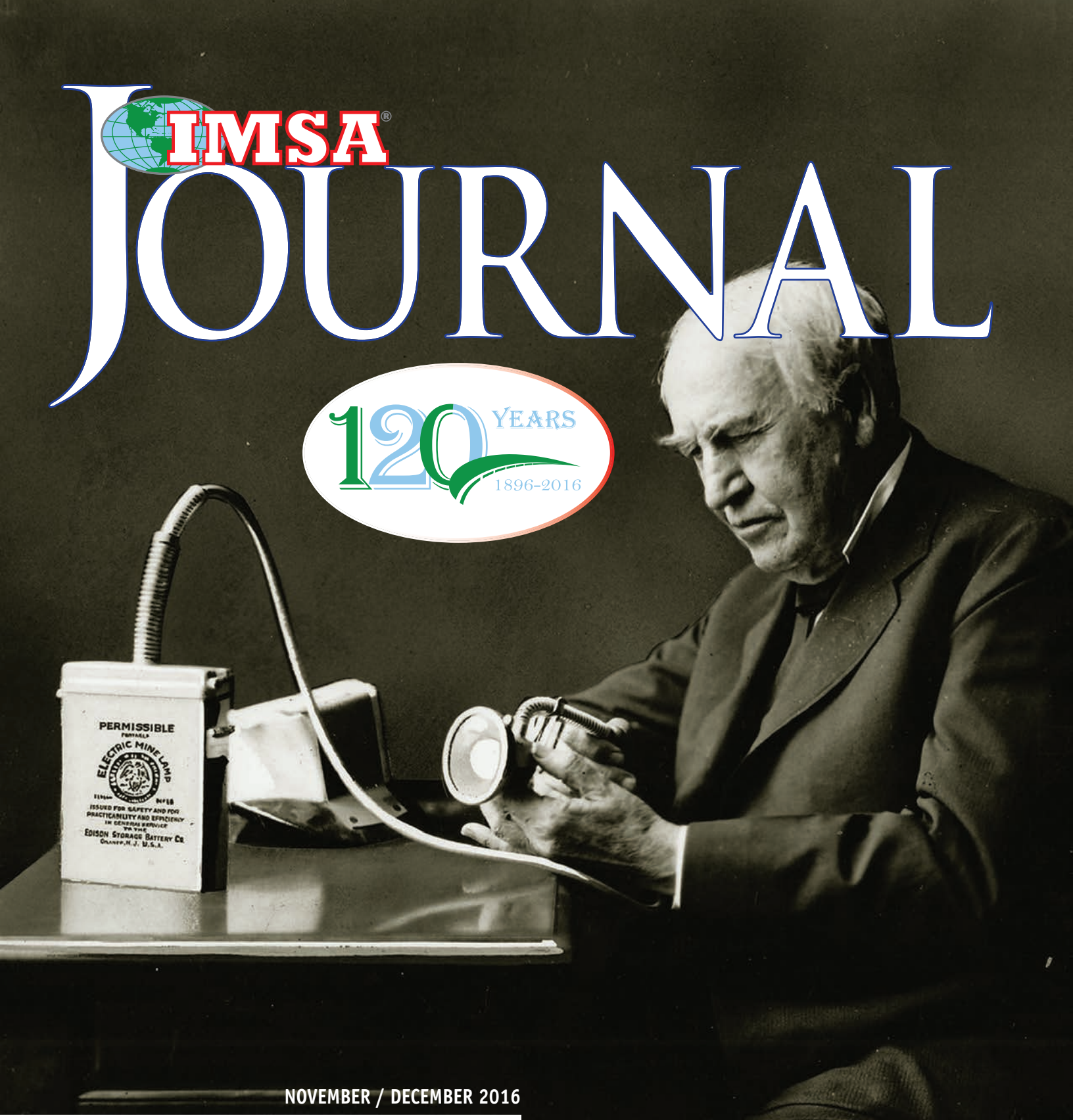

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I.A.M.E. member, Thomas Alva Edison.
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BACK TO THE FUTURE WITH IMSA'S MOST FAMOUS MEMBER

100 Years Later, Thomas Edison's Experiments With Batteries Are Keeping the Power On at Intelligent Transportation Systems Across North America

By Daniel Sisson, VP Research & Development/ Co-founder of ZincFive, Inc.

In the movie, *Back to the Future*, time traveler Marty McFly proclaims, "If you put your mind to it, you can accomplish anything." That can-do attitude is woven throughout the 120 year history of the International Municipal Signal Association and now, with the drive toward intelligent transportation systems. This is one of those exciting pivot-point moments in transportation history. We're turning all the buzz words — automated vehicles, connected highways and vehicle-to-infrastructure communications — into really cool innovations and IMSA is playing a big role.

Few people realize that an early IMSA member, who personified the organization's can-do spirit, was also one of the world's biggest celebrities. Today, one of the dream technologies he was unable to commercialize is finally playing a key role in intelligent transportation and public safety systems.

So, sans the Delorean, let's travel back in time to 1901!

1901 — ROCK STAR INVENTOR JOINS I.A.M.E.

That probably wasn't a news headline but it must have been a proud, back slapping moment for members when the "Wizard of Menlo Park," Thomas Edison, joined the International Association of Municipal Electricians (I.A.M.E., as it was known then). Edison had already amassed a record number of patents, forever altering the way the world communicates: the incandescent light bulb (1879), phonograph (1877, "Mary Had a Little Lamb" were the first words recorded), quadruplex telegraph (1874, allowed four separate signals to be transmitted on a single wire), phonograph cylinder (1877) and a version of the film projector (1888, the kinetograph and kinetoscope).

The five-year-old I.A.M.E. was prolific, too. Members met annually in the New York area, discussing products and equipment and sharing best procedures for construction and maintenance of signal systems. They developed all kinds of safety standards for fire alarm boxes, wire, cable and even specifications for manhole covers. Many of these standards are still in use today! They also created the Underwriters Laboratory and National Electrical Manufacturers Association.

THE FATHER OF R&D

Dr. Paul Israel, director of the Thomas A. Edison papers and professor at Rutgers University, is widely considered the world expert on Thomas Edison. He was delighted to learn Edison was an IMSA member. He says Edison was unusual in that he was both an inventor and a businessman. He succeeded not just by inventing, but also manufacturing, commercializing and continuing to develop his products.

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The sprawling West Orange manufacturing facility and laboratory in 1928.
U.S. Dept. of the Interior, National Park Service, Thomas Edison National Historical Park.

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"Edison led the shift to a more team based laboratory approach to invention. He was basically the father of research and development," says Dr. Israel. "What also set him apart from so many inventors in the 19th and 20th centuries was that his resources from several successful companies, enabled him to always have several projects going on at one time and employ large staffs of experimenters. He was able to focus on commercializing his technology."

That's key to understanding Edison. He knew that initial ideas and patents are only the beginning of a process.

IN SEARCH OF THE PERFECT BATTERY

The year Edison joined I.A.M.E., he was working out of his vast West Orange Lab complex. It was one of the world's largest industrial facilitates and home to the Edison Storage Battery Company.

The great inventor seemed obsessed with battery technology, specifically creating storage batteries for the transportation darling of its day — the electric automobile.

Edison had a long interest in batteries, dating back to his years as a telegraph inventor. He was the first to design consumer-friendly batteries in connection with his electric pen copying system and his electric phonograph.

"With the advent of the automobile in the late 1890s, Edison and his Edison Storage Battery Company focused on creating a battery perfect for high-demand, high-energy usage, for applications in the automobile industry, but also for industrial uses. He envisioned a lighter-weight, more powerful, reliable and robust storage battery, rather than the heavy and unreliable lead-acid batteries," says Dr. Israel.

Edison began dabbling with all different kinds of battery chemistries including Nickel-Zinc. He was intrigued by the potential of Nickel-Zinc electrochemistry because of its high energy density, high efficiency rating and temperature tolerance advantages, compared to traditional battery chemistries.

His persistence paid off. In 1901, Edison was awarded US patent 684,201 for a rechargeable Nickel-Zinc battery system. It seemed like the perfect battery.

THE PROBLEM

"Remember," says Dr. Israel. "Edison was all about R and D — moving a product to commercialization. But it turns out his Nickel-Zinc battery had a lower number of charge and discharging cycles than other chemistries of that era. He was never able to overcome this problem. He couldn't bring the promising Nickel-Zinc battery to market."

It took more than 100 years — and a few Edison disciples — to solve Edison's Nickel-Zinc problem.

BREAKTHROUGH

Nickel-Zinc cells are compact and completely sealed.

An exciting breakthrough arrived in 1993. Stanford lecturer and chemist, Morris Eisenberg, created a new electrolyte solving the problem that bedeviled Edison. Eisenberg's electrolyte enabled a significant increase in the Nickel-Zinc battery cycle life. Unfortunately, Eisenberg's company, Next Century Power, failed but his new electrolyte became the core technology for PowerGenix, a US battery company founded in 2003.

PowerGenix founder, Dr. Jeff Phillips, advanced Eisenberg's work, becoming the first to finally commercialize the Nickel-Zinc battery. Specifically, Phillips used Eisenberg's concepts to develop a Nickel-Zinc technology with improved energy and power density that could be manufactured on modern high-speed manufacturing equipment — a necessary requirement in

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Thomas Edison and one of his Nickel-based battery technologies.
U.S. Dept. of the Interior, National Park Service, Thomas Edison National Historical Park.

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the cost-driven environment of today. By leveraging the positive electrode technology from nickel metal hydride batteries and the separator advances made in lithium ion batteries, the Edison technology could finally compete with the performance of the latest lithium ion batteries — all at a price point closer to the ubiquitous lead-acid battery. The technology offered big advantages in areas of energy power density, maintenance, cost savings, environmental safety and recyclability.

In 2008, my company, EnSite Power (earlier this fall EnSite Power changed its name to ZincFive, Inc.), began collaborating with PowerGenix. We saw an opportunity to blend Edison's experiments with PowerGenix's technology and create our own dream battery for intelligent transportation systems and other mission-critical applications. It took us several years, but that technology is now at work in more than 80 transportation agencies and 700 installations across North America, including the City of Longmont, Colorado.

IMSA member Debi Sadar, Longmont's senior lead traffic signal operation technician, says the Nickel-Zinc UPS has eliminated the additional cost of piggyback cabinets and concerns about safety.

Edison's battery factory.
U.S. DEPT. OF THE INTERIOR, NATIONAL PARK SERVICE, THOMAS EDISON NATIONAL HISTORICAL PARK.

WHAT WOULD EDISON THINK?

Edison's own dream of a lighter weight, powerful, robust and reliable battery has finally been realized. And it's fun to imagine what the great inventor would think of today's transportation milestones and goals for smarter intersections and cities, including those championed by IMSA.

"I'm fascinated by Edison's membership in the IMSA and his work on the Nickel-Zinc technology," says Dr. Israel. "It speaks to how much knowledge we now have of materials that didn't exist when Edison was doing his work on storage batteries.

Edison might be amazed at the high volume plate manufacturing process for today's Nickel-Zinc battery, with sizes ranging from 1Ah, 1.65V, up to 84Ah, 13.2V.

The Edison inspired, Nickel-Zinc UPS slides inside the existing traffic cabinet at Main Street and Ken Pratt Blvd. in Longmont, CO, keeps traffic safely moving, even if the power goes out.

With storage battery research, in terms of configuration of materials, Edison conducted more than 10,000 different experiments, using combinations of metals, solutions and designs of batteries. It's nice that more than 100 years later, his technology is finally at work."

As Marty McFly says, "If you put your mind to it, you can accomplish anything." Just ask IMSA and other ambassadors working hard to make mobility more efficient, accessible and safer for everyone — now, and in the future.

Daniel Sisson, VP of Research and Development, ZincFive, Inc.

Daniel Sisson has 34 years of experience in manufacturing and new product invention and development. Mr. Sisson lectures about new battery technologies and high intelligence inverter and power systems. He's also a Thomas Edison aficionado, finding inspiration from reading the great inventor's patents. Mr. Sisson is one of the inventors of the world's first Nickel-Zinc uninterruptible power supply systems.