THE ACADEMY OF ELECTRICAL CONTRACTING

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HOW TECHNOLOGY HAS DRIVEN CHANGES IN ELECTRICAL CONTRACTING

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In the very early days, man only knew about electrical phenomena by their effect on his world. Lightning strikes, St. Elmo's fire, static discharges, magnetic materials (loadstones), and such were things that could be observed. It remained that way until the 17th century when Dr. William Gilbert created the age of science with his brilliant De Magnete, a work composed of 6 books on his study of magnetism.

The 18th century brought increasing awareness of electrical phenomena and ushered in modern methods for studying it. Great minds like Oersted, Volta, Maxwell, and others made countless discoveries by observation and through experimentation. James Watt produced the first practical rotary steam engine in the mid 1700s and our own Benjamin Franklin developed his theory of electricity in 1746. Franklin's experimentation with the only available source of high voltage electricity led him to develop the lightning rod in 1752 and a new industry was born.

Forerunners of our modern electrical contractors adopted this new technology and quickly began to install lightning protection systems around the country. By the year 1782, there were over 400 installations of this protective technology in Philadelphia alone. This represents the first recorded history of electrical construction work. Incidentally, this may also have been the first electrical construction problem area that demanded safety codes. Unskilled installers sometimes caused more problems than they cured. Ultimately the fire codes and UL were challenged to produce some sanity in this area.

The Age of Communications

Technology was not to remain stagnant. Quickly Volta developed the concept of the battery and Oersted the Galvanometer. Then came the concept of communication over electrical wires. By 1832 the first practical electromagnetic telegraph system had been produced by John Henry and was refined by Webber and Gauss.

Early contractors saw this opportunity and began installing communications systems. By 1844 a Baltimore to Washington D.C. telegraph line was in operation — all based on the use of batteries and newly invented solenoids. That same year saw the commissioning of the first international telegraph line from Dover, England to Calais, France. 1856 marked the formation of our own Western Union Company employing thousands of men in the construction of a vast communications system through the western parts of the United States. This work spawned large construction and engineering companies to handle this very ambitious project. The Siemens & Halske Construction Co. completed a 6,800-mile telegraph project in 1876 called the Indo-European line that was in continuous operation until 1931. These early contractors were learning the techniques and concepts they would apply to long distance electrical transmission, soon to follow.

DC Power is King

With the advancement of the battery as a practical source of electrical power, a number of innovations were developed that paralleled those in the communications realm. George Ohm developed his principles of the relationships in an electrical circuit, Michael Faraday worked with electrical induction, and Humphrey Davy worked with electrical arcs. As it became apparent that electricity could be used for more than communication, experiments in electromagnet lifting devices resulted in a huge magnet that was able to lift 7.5 tons in 1833. Thomas Davenport patented the first electrical motor in 1837. Insulated wire was developed to allow close spacing between the wires installed on a solenoid magnet.

Even though these early technological advances were not completely practical, lighting systems based on the arc lamp were installed by early electrical contractors. All of this was winding the spring of technology that was soon to explode. 1879 saw the installation of the first practical electrified railroad by Siemens & Halske Co. as a demonstration line at the Berlin Trade Exhibition, an achievement repeated in America in 1884. Electrical contractors were again learning a new technology that was rapidly changing.

The development of the electrical dynamo in the late 1800s was, in my opinion, the single most important concept for the practical use of DC power. Chemical batteries were no longer required for power generation. This development, coupled with the steam engine, supplied power in appreciable amounts on a continuous basis. Soon electrical contractors were installing stationary DC generating plants and extending the wiring into their customer's buildings. Edison was ready with his new low-voltage incandescent lamp. He realized that the transmission of electrical power in an economical manner required a higher voltage so he designed his lighting systems with series lamps, much like today's Christmas tree lights (and also with their problems). One of Edison's dynamo generating plants — called "Jumbo" — had the capacity for 1,200 lamps. He designed and installed a number of street lighting systems and electrical contractors demonstrated again that they were flexible in their thinking and their installations.

Technology was soon to overtake Edison and the electrical contractors, however, with the introduction of a generating system that produced AC power. This development led to somewhat of a battle over the type of power that would be most appropriate for future use. Edison firmly believed that DC voltage had vast advantages over AC, the chief one being safety, due to the lower voltage of the DC systems of that time. The General Electric Company joined Edison in this "Battle of the Currents," as it was called.

Major Changes

On the opposite side of the "Battle" was the Westinghouse Corporation. George Westinghouse acquired the patent rights to a device that would transform the voltage of an alternating current. This device raised the voltage, therefore lowering the losses for long distance transmission of the current. At the user end of the transmission, voltage could be lowered back to a useable and safe level. This process had a unique advantage over the earlier DC systems in that it could transmit electrical power over very long distances with an acceptable loss ratio and still deliver that same power to a customer at a safe lower voltage. All that was needed to win this "Battle" was an AC motor: Nikola Tesla provided this when he received a patient covering the polyphase induction motor in 1888.

Both Westinghouse, using this new technology, and General Electric, which by this time had taken over Edison's interests in DC power, bid on the lighting system for the Chicago World's Fair in the spring of 1892. GE's bid was between $13.98 and $18.51 per lamp. Westinghouse was the low bidder at $5.25 each. The new technology was less expensive to install than the older, and modern technology had once again changed the course of the business of electrical contracting. Ultimately the transmission of electrical power for any distance was reserved for AC voltages and contractors settled down in the early 1900s to install this newer technology.

It is not fair to state that DC power was through, however. A number of electrical contractors used insulated wire and batteries to install lighting and doorbells in more remote areas not served by AC power grids. These innovative contractors pulled new wires through old gas pipes (used for lighting) and installed a battery plant and a dynamo to recharge them. Believe it or not, this was a practical installation for the first quarter of the 20th century. In fact, early intercom systems used in the more affluent homes of the times were based on the old speaking tube technology that continued to be used on ships during the Second World War. These systems underwent no substantial change until vacuum tube amplification systems became popular around 1940. Compare this to our modern "Smart House" of the 21st century.

Powering the Entire Country

Rural electrification projects and the TVA system of generating plants were destined to shape the contractor again. With inexpensive electrical power, our country entered a second industrial revolution. Operators of older factories that used a single "line-shaft" powered by a steam engine soon refitted them with electrical motors, and the installation of incandescent lighting brightened many workplaces of that era.

In the early 20th century, contractors experienced an explosion of new devices and innovations that shaped the industry for many years. "Real" safety fuses replaced hand made fuses; fully enclosed safety switches became common. Even the invention of Bakelite by Leo Hendrick Baekeland in 1909 played a major role in this revolution by providing the insulation for major switchboards and other devices. In addition, electrical codes and rules were instrumental in shaping the business practices of the contractors of that era.

Technology was still the major driving factor in any contractor's success. To take advantage, contractors developed a number of unusual markets. The incandescent lamp had a major problem with "burn-out," so some enterprising people bought the old glass envelopes for these lamps and reinstalled new filaments. Of course technology was not to remain static. A little over 15 years after the modern tungsten lamp was developed, the principle for a working fluorescent lamp was conceived.

Retrofit Enhances Modern Life

At this time (1920s & 30s) all of the technological action was in lighting advances. Early Edison-type street lighting was replaced with more modern and efficient mercury vapor lamps, and incandescent lamps that had replaced arc lamps were themselves replaced by fluorescent lamps. The electrical contractor was again on the spearhead point of the changing technology, discovering that retrofitting electrical and lighting systems could be a welcome addition to client services. This same era saw the demand for traffic signal systems, which developed into the familiar red, yellow, and green signals of today. These early systems were mechanically controlled by timing motors, and were somewhat primitive, but electrical contractors had found another market for expansion.

The large polyphase electrical motors that were so successful early in the century were joined by single phase motors and motors of smaller and fractional horsepower. Factory owners, who had previously relied on a single large electrical motor driving a line-shaft, replaced them with machinery operating on built-in motors. Our contractors were quick to develop the wiring systems for this retrofit. Modern electrical starters and relay controls were implemented and safety was a big factor in this distributed power system. Some of the machinery and motors of this era are still in service today. I recently had an opportunity to witness the operation of some very large open frame motors of the 1930s that were driving flood control pumps for a large metropolitan area. These units were quiet and reasonably efficient and the flood control people had no desire to replace them.

More efficient sodium vapor units, characterized by their familiar yellow glow, challenged mercury vapor lamps. Again, street lighting was retrofitted to this new lamp system — one that increased light output, yet had a smaller appetite for electrical power. Inside buildings, lighting advances prompted contractors to retrofit older fluorescent fixtures with newer, more efficient metal halide multi-vapor fixtures. As the ceiling heights of warehouses increased for high-pile storage, the lighting systems were changed to modern high bay fixtures and again contractors developed the expertise for his change.

Technology and Miniaturization

Often technology takes unexpected turns. The mid 20th century saw some surprising developments. IBM was working on what they called a sequence controlled calculator at the same time our government was working with some unusual applications for vacuum tubes in calculating operations. With the outbreak of the Second World War, development of the first true electronic digital computer was pushed. The outcome of these applications was ENIAC, a 30-ton device that consumed 150 kw of power and used 18,000 vacuum tubes. It could perform 5,000 additions per second, which was remarkable when compared with the older mechanical adding machine.

ENIAC's electrical power and air conditioning requirements severely limited its usefulness — only government agencies had the deep pockets required to support such costs. William Shockley, Walter Brattain, and John Bardeen suddenly changed all this. These gentlemen were working at Bell Labs in 1948, and they developed the transistor. This device allowed miniaturization to the point that the entire operation of ENIAC could be replaced with a small box called the modern computer.

IBM was quick to recognize the importance of these developments and provided computer technology to commercial businesses that didn't even know they needed it. IBM and a handful of other players were so successful that the development of computer technology spawned a new branch of electrical contracting: power quality. These new devices were very sensitive to the slightest deviation in electrical power. Our industry was forced to become knowledgeable in a new arena involving surges, sags, interruptions, and such. Again, technology drove the development of the Uninterrupted Power System (UPS) and its associated battery supply system. Oddly, in the late 1960s we were back to DC again. Those contractors who were quick to embrace this technology installed an enormous number of these large UPS systems.

But chance continued to act on this stage, and by 1971 Intel developed the forerunner of the microprocessor with their "4004" controller. This quickly led to the "8000" series, including the "8080" unit which was a computer on a chip. Not long afterward, the "Altair" personal computer, using this new "microchip" technology, appeared in a kit format, which was purchased and assembled by the thousands by electronic hobbyists. The modern age of the personal computer (PC) was born.

IBM, wanting to maintain its domination of the computer, decided to bring out the first modern PC in 1978. Corporate America was quick to recognize the usefulness of the new units and purchased them for desktop use. This prompted a need for inter-PC communication, thus the "ether-net" was developed (along with other networks). Again, the electrical contractor was in the midst of another technical revolution.

At this point, we seemed to have come around again to our humble beginnings: installing communications wiring. Communications was destined to become a major business for the contractor who invested the required time and materials. Network data cabling technology quickly changed from the basic telephone type cable (CAT-3) to higher and higher speed cabling (CAT-5, fiber optic, and CAT-6). Some old line electrical contractors now claim that about 30% of their business is data communications. Of course, just like the early days of contracting, many unskilled or incompetent people have jumped into this area, so again it is up to our industry to assure some sanity and quality through the development of codes and standards. (NECA is a leader in this field, along with BICSI, with the development of ANSI installation standards.)

Modern Developments

Office computers are not the only devices demanding data communications capabilities. Modern traffic signal systems are now communicating from intersection to intersection and are dynamically changing their timing to allow a greater flow of traffic during rush hours. Plant and machinery automation systems routinely communicate with one another using "Data Highways," an industrial version of these computer networks. This development encouraged power utilities to investigate the possibility that fiber optic links could be installed with power lines between buildings, and sold as communications channels. This technological development has spawned somewhat of a war over the placement of cables on utility poles that are owned by the deregulated power utilities. In some cases, utilities have refused to allow new cables unless installed and owned by them.

The upside of deregulation, however, is that electrical contractors are channeling some new effort at the arena of on-site power generation. With deregulation and new technology, the generation of power is being driven closer to the ultimate user. No longer can the utilities legally prevent co-generation, so the market for on-site power generation may be the boom of the 21st century. Already, windmill, photovoltaic, and fuel cell power generation systems are being installed. As electrical contractors enter these areas and grow in expertise, they could be in training for the work of the future.

As I write this, I am looking at the cover of the magazine EC&M (February 2002 edition) which states, "THE LAST DAYS OF CENTRAL POWER?" The subtitle to this enormous question is, "Distributed Generation is Poised to Replace Traditional Power Plants." Writers of this article predict, "Within a few years, homes and businesses could become energy producers as well as consumers." A second article in the same issue envisions that many businesses will outsource the service of emergency power systems to electrical contractors or other third party service organizations. With the huge installed base of emergency power systems now in place, and with the NEC demanding competent and timely maintenance of these units, this could develop into an enormous business for our contractors.

My Crystal Ball

Can anyone predict the changes that technology will make in our future business? Not with any accuracy. Still, we all must be aware of the changes that can occur and not be surprised by them. As an example, in 1986 Kari Mueller and Johannes Bednorz reported major developments in superconductivity. This technology could allow the transmission of electricity without any resistive (heat) losses. Several industries are developing new power cables and generation devices based on this principle. They are going to require electrical contractors with expertise in this field.

Another example: lighting systems are being developed that will operate on electro-luminous panels. Instead of a point-source of light, this technology will allow the soft lighting of an entire ceiling. Also on the lighting front, new, very long-life "LED" lamps have been created for retrofit installation in traffic signal and exit sign fixtures. The list goes on and on. There seems to be no limit to the creativity of man, and technology seems to be changing at an increasingly rapid rate.

Can the typical electrical contractor keep up with all of this? I hope so, but it will be a challenge. That is why I feel it is so important that we contractors contribute time to and belong as members to a competent organization that stays at the focal point of these advances in technology.

NECA can and must be that organization, and I am strongly suggesting that the excellent NECA Marketing Committee continue the study of the emergence of any new markets for our electrical contractors, and offer more avenues for reporting its findings. In addition, NECA should provide additional information to its membership on the development of any new electrical and electronic technologies that may, in the reasonable future, drive further changes in our industry. Clearly, one avenue for this information delivery could be a small section printed in our own Electrical Contractor Magazine. Another could be an association-wide movement toward closer affiliation with our manufacturer/suppliers, so that we may be in closer touch with their R & D efforts. A third avenue could be networking meetings that focus solely on technological innovations and updates so that advances on one coast can be anticipated on the other. Another could be the development of relationships with the sponsors of the University NECA Student Chapters in order to monitor new technology development.

Throughout our history, technology has driven the construction business. It will continue to do so into our future, and that of our grandchildren. Electrical contractors will be best able to advance the entire industry — to the benefit of all — by keeping abreast of the rapidly moving changes in technology.

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NECA History

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