The trend to build higher and faster continues. . . .

Buildings are now being completed never having used a building elevator for passenger service. We can see that this trend can reduce some of the hazards we work with by distancing us from the running high speed automatic equipment during construction but as IUEC members we also see the importance of pursuing hoist construction work as work we claim. At this writing there are no temporary hoists available to be used for construction in the country with under a six month wait. Factories operating at capacity cannot keep up with the demand. As the trend continues more and more well trained elevator constructors will be needed to take part in this challenging area of the business. Not unlike elevator construction along with hoist work go the same concerns for safety. Awareness of potential hazards and their avoidance may be the most important asset you can possess. The responsibility of working safely for your safety and of those around you falls on each member of your team.
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Being involved in education presents the opportunity to have a positive impact on the lives of students. The training that students receive enables them to enrich their knowledge level so as to acquire the skills needed to be successful in their careers. This success establishes financial security for elevator constructors, as well as their families, and has been emulated over and over for numerous generations. The IUEC has been providing skilled labor for its signatory contractors for over 100 years and the creation of the National Elevator Industry Educational Program in 1967 will ensure the industry with a constant supply of trained mechanics and apprentices well into the future. Recently, NEIEP became involved in a training endeavor that enabled the educational program to have a positive impact on the life of an unfortunate child.

As with all the craft specific material offered in the apprenticeship and mechanic’s continuing education programs, NEIEP remains committed to developing material that supports the many aspects of the elevator constructor trade. The latest addition to the program is the development of a chapter relating to Rack and Pinion Hoists. Current development projects include: creating web casts to support state licensing requirements, a web cast refresher regarding Safety for Elevator Constructors, and a text material chapter relating to Limited Use/Limited Access (LULA) residential lifts. It was during the research and development for the LULA residential project that NEIEP was able to provide some assistance to a family in need.

Creation of all NEIEP material requires input from a number of sources including NEIEP staff technical developers, NEIEP Instructors, suggestions from students and assistance from the employers in the form of product information, specific training requirements, training resources, and often times products and supplies. NEIEP relies heavily on the use of video, pictures, and illustrations to help students understand the information being delivered to them. The video and pictures are captured on actual job sites providing realistic footage to support training needs. Often times the arrival of a NEIEP film crew can cause quite a disruption to a job which can in turn create a problem in meeting completion deadlines.

Shortly after the initial steps began in creating the LULA project a request for assistance came to repre-
sentatives of the NEIEP by way of Representative Timothy Bishop of Coram, New York. The story of Justyn Kubik is:

**Justyn’s story**

**One determined family, one miracle boy**

By DREW CROUTHAMEL of the NorthShore Sun

MT. SINAI—Now, six years later, Justyn’s parents can look at his sonogram and see the signs of the severe muscle-wasting disease that forces their son to breathe though a tracheotomy, that limits his movement to a shoulder roll and that requires nursing care 24/7.

When he was born, there was nothing to prepare them for any of this. Justyn Kubik came into this world eight weeks premature, with broken bones and lifeless muscles from a rare disorder called arthrogryposis. Only one in 30,000 children are born with the disease and, in Justyn’s case, doctors here had never seen symptoms so severe. He needed tubes to eat and breathe. He required multiple surgeries. And, after months in the hospital, doctors at Schneider Children’s Hospital told Kurt and Diana Kubik not to bring him home. Place him in a long-term care facility, they were advised. You cannot take care of this child at home.

Other parents had essentially abandoned their children with this condition. “I couldn’t walk away from my child,” Ms. Kubik said.

When Justyn first came home to the split-level home on Mt. Sinai Avenue, he turned blue every other hour as his tiny body fought to breathe. Without any support group or foundation to give them direction, the Kubiks struggled to raise a severely handicapped child who is “trapped in a body that doesn’t work,” his father said.

The medical bills had buried them in a mountain of debt. There were no other couples they knew on Long Island with a child like Justyn. And they quickly learned that their home was not sweet at all for caregivers who had to carry the immobile boy up and down the stairs every time he needed to go to the bathroom or get bathed.

“This house is a mess, the worst possible for handicapped child,” Mr. Kubik said.

It has three levels, with a main level with kitchen and living room where the Kubiks have set up Justyn’s special bed right next to the TV. That way, the whole family, which includes three other children, can spend quality time with Justyn.

“He likes ‘Sesame Street,’ ” his father said. “He likes anything with music and, believe it or not, he loves game shows like ‘Wheel of Fortune.’”

Down four steps is the den, which has been turned into Justyn’s therapy room, with machines to work his muscles and a cabinet, stocked floor to ceiling, with medical supplies. Upstairs is the only bathroom with a tub. Because of the tube in his throat, Justyn cannot take showers.

The layout means that Justyn is constantly being carried from one level to another by the nurses who have struggled to lift the growing boy. Justyn, a kindergartner at a BOCES school, now weighs more than 40 pounds, since his stomach tube was removed during a special operation at a hospital in Cincinnati, Ohio, allowing him to begin eating ice cream, pudding and other soft foods through his mouth.

“I’m losing nurses because he’s getting too heavy to carry,” Mr. Kubik said. “We lost a nurse who loved him dearly.” She didn’t want to go, but the family realized it had become too dangerous for her to lift him up and down eight steps every time he needed to use the bathroom.

Justyn can understand language and can communicate on a basic level through grunts and facial gestures. There is a communications pad that attaches to a wheelchair like a tray. Some day, Justyn will be able to tap on the keys and make word sounds. For now, though, it sits in the garage unused because the house is not wheelchair friendly.

The family has looked at other houses with more open floor plans. But the Kubiks, who both work to pay the bills, said escalating home values have priced them out of the trade-up market. What they want to do is stay where they are, turning the den into Justyn’s room. They want to expand the room and add a bathtub to the shower. They want to make the house more handicapped accessible. They want it to be a place where Justyn will be able to spend the rest of his life.
When Mr. Kubik explored adding an addition onto his home, he learned that his property tax bill would soar after the town reassessed his home. He went to Congressman Tim Bishop, who helped lobby on his behalf for a waiver on the additional property taxes. Mr. Bishop wrote a letter to the Brookhaven Town assessor in the summer of 2003, stating that the family is “attempting to construct an addition to their home so that they will not have to resort to admitting Justyn into a nursing care facility. They would like to keep their son at home and care for him; however, the additional costs and taxes have become prohibitive.”

In the fall of that year, Mr. Kubik stood before the Town Board urging officials to amend the Town Code to offer tax relief to families like themselves who need to expand their homes to accommodate the disabled.

The town voted unanimously to adopt the code change. Handicapped advocates call it Justyn’s law.

Now, Ed Giuffrida of Mr. G’s Pizza in Wading River has organized a fund-raiser, with fliers going up asking residents to donate money to help the Kubiks pay for the addition. “We’re very private people; we don’t like asking for help,” Mr. Kubik said.

“My son is just extraordinary,” he continued. “We went into debt because of his medical condition. We’re in a lot better shape now than then. But if we do the extension, we are going to be in that shape again.”

Those who wish to help should send donations to the Justyn Kubik Trust, Box 241, Mt. Sinai, NY 11766.

“Kids like him really are a gift,” Ms. Kubik said last week at their home, while Justyn sat in a chair in the kitchen and tapped on a music machine that played Elmo’s voice from “Sesame Street.” “With this diagnosis, people run from it. But they shouldn’t.”

Installers on this project included former NEIEP Coordinator and current Business Representative Edward Krull from Local 1, New York as well as NEIEP Area Coordinator James McGoldrick of Local 1. On behalf of the family of Justyn Kubik, thank you to Edward Krull, James McGoldrick and ThyssenKrupp Elevator.

Sincerely,

James J. Higgins Jr.
NEIEP Director
Elevators have undergone many changes as the elevator itself has evolved. Door operation has moved from a basic counterbalanced wooden gate to a state-of-the-art Variable Voltage Variable Frequency (VVVF) AC drive with velocity and position feedback. Who knows where elevator doors will be in the future. The door motor will probably be replaced with a magnetic linear control much like the ones that today’s trains and roller coasters are using. The doors themselves will probably consist of some type of fire resistant lightweight plastics. The swoosh sound that you remember from the Starship Enterprise’s doors may be the sound of the doors opening on the elevator you ride in the near future.

Passenger safety has driven the development of door control. The earliest doors were manually opened and closed. Some early elevators that were run by operators with a car switch actually had a bypass switch for the hoistway door locks in case a hoistway door did not close correctly. If the elevator operator knew a certain door was giving him difficulty, he would just bypass the door locks until the problem was repaired. Sometimes, though, no repair was ever made. As you can see this could turn into a dangerous situation. These bypass switches were all removed by the mid-1970s.

Other safety items had to be implemented with the introduction of the fully automatic door operator. The first was the addition of a reversing edge to prevent passengers from being struck by the closing door. Early models were crude and unreliable. One of the next safety improvements was the addition of the photo electric cell. A light beam was shown across the door opening to a light sensitive photo cell. When the beam was blocked the photo cell would signal the controller to reopen the doors. As with the early mechanical edges the photo cells had problems. They required regular cleaning and alignment or they would fail. Also incandescent light sources could be interfered with by other artificial or natural lighting. By 1980 these were starting to be replaced by infrared light which is less affected by other light sources. Today’s doors use full-length infrared beams, motor torque limiting, and mechanical door restrictors. Also doors must have a 1 1/2 hour fire rating and fire gibs that can withstand heat on all hoistway and car doors.

Other early door operators could be quite intricate in their design. One type used air compressors in the machine room. Air lines were run down the hoistway to mid-shaft where an air hose was run along with the traveling cables to the car. In the cab floor was a foot-operated valve that would open to allow air pressure to the top of the car to a cylinder containing a piston that would move to open the doors. Once opened, the doors would latch in the open position. The operator would depress the pedal again and the latch would release.

Another type of operator consisted of a single speed AC motor with a V pulley on its shaft that rested on a V-belt secured to the top of the door on a spring-
loaded bar. This device was called a *walking stick*. The motor would turn to open or close the doors and if people were in the doorway while the door was closing the belt would slip. The idea was to limit torque due to slipping of the pulley to the belt. This sounds like a good idea until the belt wears and the doors do not move at all. Oh well, that’s just another night call!

Other door operators still used a single speed AC motor but tried to control the speed by installing oil checks to slow the doors at the final close and open. These worked fine for their era but were subject to oil leaks. This offered a unique advantage - you would never have to lubricate your door drive chains! Most of these early operators were set up to mechanically lift or drop a retiring cam which would unlock the hoistway door at the floor where the car was located.

An innovative door operator for the industry was the Otis 6970 saturable reactor type. Not only did it use a unique motor speed control system, but it also used a mechanical operator that was an industry standard for years. The saturable reactor control system used a winding in the transformer that was located in the machine room to control the current through the transformer. A three phase current of about 100 volts was sent through the transformer, rectified at its output, and applied to the door motor. Current through the control winding was controlled by door operator switches and rheostats for adjustment. When control winding current was high the output of the transformer and its rectifier that delivers current to the door motor was also high. Most mechanics are familiar with how the current in a hydraulic valve coil rises to high levels when a coil is removed from its solenoid. This is the same theory that applies to the saturable reactor. A simple example for demonstration purposes would be a hydraulic valve coil wired in series with a light bulb. When the core is in, the coil current is low and the lamp is dim. When the core is removed, inductance and reactance decrease, current goes up, and the lamp glows brightly. This doesn’t mean that the transformer core of the saturable reactor moves in and out of the coils. However, that would work and was a common method in other industries such as for stage light dimming in theaters. In this door system the control winding in the transformer is used to saturate the core making it unable to conduct more magnetic lines and therefore making it invisible to the coils. The same effect of removing the core is achieved without physical movement. This combination of the saturable reactor control system and the accompanying mechanical door operator worked together so well that they would probably be among the first nominees for the elevator equipment hall of fame. The traditional method of controlling the DC shunt motor was by controlling the speed with switches in the operator box on the car top. These switches inserted adjustable series and shunt resistances that could be manipulated in the circuit to control acceleration, speed, and deceleration. A simple example of this type of control system is found in figure 1. Usually a circuit such as this would be supplied with somewhere between 125 and 300 volts DC.
To control the direction of a DC motor, current through the armature needs to be reversed. In this circuit, when the open contacts O1 and O2 close they will supply DC voltage to the door motor armature terminal. A2 will be + and A1 will be -. When the doors are closing, C1 and C2 contacts will close, thereby causing the polarity to the armature terminals A1 and A2 to reverse.

Door speed becomes the next consideration and is controlled by the series resistors O1C and C1C. The speed of a DC motor is proportionate to the voltage applied to its armature. To slow the doors down, parallel checking resistances OC and CC provide a path for counter electromotive force. The CEMF that is generated in the motor armature needs to dissipate to effectively apply the brakes. The rate that the doors slow down to stop is regulated by the position of the resistor taps on OC and CC.

Although this simple circuit serves to demonstrate these principles to fine tune door operation, more elaborate circuitry is usually necessary. Figure 2 shows a complete door circuit for a permanent magnet DC motor. This diagram illustrates the presence of additional slowdowns that are mechanically operated in the door operator by cams at predetermined distances to slow the doors down smoothly. In the close direction, SDC1 closes first, followed by SDC2 contacts, introducing two separate steps of slowdown. SDO operates similarly in the open direction.

Also in the close there is an additional point on resistor R5, called NR, which is used for reduced speed closing such as nudging or fire service. The high speed closed (HSC) and the high speed open (HSO) are contacts that open when the slowdowns are initiated in either direction. R2 is used to control the overall open and close speed. R3 is another adjusting point for the closing speed. R4 is used to control the soft starting of the doors to allow the door clutch to engage the hoistway door pick up rollers smoothly. The early DC-controlled door operators were controlled fairly well electrically, but mechanically they were not a pretty.
Some were chain-driven with the use of sprockets and gears while others were airplane cable-driven. The mechanical end of the early operators used pulleys or gears to increase torque to the doors. The ratio of the motor speed to the doors stayed consistent throughout the complete open and close cycle. A harmonic drive wheel was added, which works like a piston driven by a crankshaft in a car engine; as the wheel revolves 180 degrees it will slow down the doors as the drive wheel approaches the point analogous to an automotive piston reaching top dead center (TDC). Here door travel slows and stops before it reverses—even though the drive wheel is still turning. This is the same action as an automotive piston slowing and stopping before reversing direction even though the crankshaft is still turning.

When a harmonic type door operator is adjusted correctly, its linkage driving point will be at the corresponding top dead center point when the doors are fully open. This will give the mechanical advantage of holding the doors open with enough force when they reach the opening limit to prevent the spring closer from overcoming the operator and allowing the doors to pull closed. When the doors are fully closed, the position of the linkage driving point will be just slightly before the corresponding point; 180 degrees away to prevent a mechanical lock in condition in the closed position.

The next generation of door operators used a combination of armature voltage for speed feedback and armature current for load feedback. This provided a
suitable amount of regulation in situations of tight or heavy doors. Later, as electronics progressed, a tachometer was implemented for velocity feedback to control the door speed. Some modern operators use an encoder that not only determines precise speed but is also capable of resolving the location of where the doors should begin slowing and stopping without the use of physical electrical switches. These operators are equipped with devices that communicate to the door control the motor speed and door location. Some are processor based control systems that can store several speed and slowdown switch profiles to address doors of any weight in a single installation. A DC motor is still used in most installations and is controlled electronically by turning transistors off and on in order to control the current flow to the armature. Recent types of DC control use a permanent magnet field instead of an electrical shunt field. They are low inertia motors that provide quick response to speed and direction change. DC door operator motors may soon become a thing of the past as recent trends are towards AC motors with VVVF controls. The cost of these sophisticated controls along with their performance makes them an acceptable alternative to versions using the more costly DC motor.

When a velocity encoder is used it can be installed on the motor shaft or any rotating part of the door system to sense speed. An encoder consists of a disc with slots cut in radial fashion along its circumference—much like a nicely sliced pizza pie. A light emitting diode is placed on one side of the disc and a photo transistor on the opposite side so that when the disc spins, the light beam from the diode to the transistor is interrupted. This generates a square wave or an on/off signal that is proportional to motor speed. Other types of encoders use several light beams through various sized slots to send a signal that can be decoded by the processor. Both types with support from the processor can be used to determine precise speed, direction, and location. This signal is fed back to the door control where it is compared to dictated speed. If a difference occurs between the demand speed (the programmed door speed) and the actual speed (the motor’s turning speed) an error voltage is generated that is processed by the controls which then sends speed correction to the motor.

Although some are still available, bulky resistance controlled operators with their array of maintenance-intensive switches are gradually being replaced by modern electronics—sometimes in the form of a single, small circuit board. When mechanical speed reduction is used it is done with belts and crank arms. However, the heavy oil filled gear cases that have performed well for over 50 years are finding it difficult to keep up with the demands of modern code inertia limits and competitive cost requirements. The simple linear operator that was usually belt or cable driven is making a comeback in low rise installations that are less demanding in the door performance area. These newer style operators are taking advantage of modern electronics to cover up the lumps and bumps in their operation that was handled so well with the steel constructed, high mass systems of the past.

Call for Submissions

NEIEP is looking for serious inquiries into preparing articles for the next issue of LIFT magazine dealing with the topic of Installation Techniques and Devices. Compensation will be provided for all articles published. Composition skills are not as important as a thorough knowledge of the subject matter. Willingness to allow your work to be edited is essential. Please submit article ideas by December 2006.

Please contact:

Jon Henson
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Attleboro Falls, MA 02763
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Reading through a web-based industry message board recently, I came across a discussion that went something like this: “Why is American industry falling behind other industrialized countries when it comes to building and maintaining a highly educated workforce?” An answer was immediately shot back from across the Atlantic. A British elevator man warned: “Watch out America, we have already lost the fight in defending our technical and engineering trades against foreign competition. You could be next!” In America it is not foreign competition which threatens our trades, but all too often the undercutting of non-union operators which compromise the industry.

The reality of the situation is simple: keep your workforce trained and up-to-date or lose out to the competition. Thankfully, the American labor movement is not taking this trend lying down. The doors of educational opportunity are wide open for the motivated worker. And the fact is, many are taking advantage of these continuing education programs in order to improve their individual skills and career paths while strengthening the backbone of U.S. industry for years to come.

In a recently released study by the U.S. Department of Education, 40% of the American workforce is involved in some kind of formal adult education.1 We are not talking about people simply going back to college. More than 33% of adults take part in work-related courses. The trend is obvious: In order to maintain a highly educated and well-trained technical workforce, we cannot be satisfied once that initial apprenticeship is completed or when the ink has dried on that mechanic’s certificate. Formalized education does not end when that graduation cap flies into the air -- it must be ongoing.

“40% of the American workforce is involved in some kind of formal adult education. 33% of adults take part in work-related courses.”


What’s My Motivation?
Continuing education takes time and energy and a real commitment to self-improvement which does not happen
over night. So workers may rightly ask: What’s my motivation here? The answers are many, but the point is simple. First, well-trained and up-to-date employees perform at the highest levels of safety and efficiency. This ensures not only the best possible work environment for everyone from the shaft to the machine room, but it also guarantees a quality product with which customers are pleased. All that training

“In a field where non-union companies are challenging at every turn, only top-rate employees can make the difference that will impress clients to choose the IUEC workforce over the competition.”

pays off with not only a better understanding of the technical problems workers face on a daily basis, but with actual solutions that make doing the job easier. Secondly, only in a technically sound and continually upgraded environment can apprentices learn the trade safely and with true expertise. These qualities are essential to the ongoing health of the industry. In a field where non-union companies are challenging at every turn, only top-rate employees can make the difference that will impress clients to choose the IUEC workforce over the competition.

These motivations should ring true from the first year apprentice to the mechanic nearing retirement. Without the most well-trained and competitively educated workers, no company can remain profitable, no worker can be secure in his or her job or in the future of his pension. Just as the elevator colleague from Great Britain commented, in order to preserve the quality of our technical and engineering trades in the U.S., we need to get on board with the highest degree of education possible. And we need to do it fast!

NEIEP’s Continuing Education Mission

NEIEP recognizes the need for ongoing worker education and hands-on training and provides members with a combination of text materials, videos, labs and other training aids to continually update their technical know-how. From traditional self-study classes to locally organized group study options, there is an ongoing education package to fit nearly everyone’s needs. One of the most promising and flexible programs is NEIEP’s online Computer Based Training (CBT) Programs. These CBTs not only offer comprehensive apprenticeship study programs, but also provide advanced training in further topics such as elevator machine room maintenance, elevator hoistway maintenance and hydraulic elevator maintenance. And there is more in the pipeline. Additional CBTs are continually being developed and added to the curriculum.

The CBT programs are filled with audio and visual aides that help the student grasp standard concepts and procedures while also checking their knowledge
with interactive unit tests. Each student’s progress can be individually monitored to ensure success, and completed course certificates, training units and coursework are maintained in a central database for future reference.

Cutting-Edge Technology Delivers Training to You

More and more, educational institutions across the country are recognizing the need to deliver content with the most convenient means necessary, and today that means utilizing distance learning technologies over the internet. Institutions like DeVry University and the University of Phoenix deliver degree programs entirely online or by offering a combination of online and traditional courses. Today, even the most traditional colleges and universities are offering distance learning courses designed to connect students and teachers over greater distances and with greater flexibility in time. Training and continuing education in the elevator industry is no exception to this trend. By partnering with Ivy Tech Community College in Indiana, NEIEP has devised several programs not only to help employees further their training and education, but also to pick up some valuable industry and non-industry credentials along the way. By enrolling in general online coursework offered through Ivy Tech and linked with local education programs offered by NEIEP, apprentices and journeypersons alike can earn Associate of Science and Associate of Applied Science degrees. Advanced mechanics are also eligible for degree work through Ivy Tech’s program in elevator technology leading to an Associate of Applied Science degree.

With several states already mandating and regulating ongoing education within the elevator industry and others likely soon to follow, it is important to respond quickly and effectively to newly emerging training and educational requirements. Frequently, CBTs in advanced topics can fulfill this need, but at other times, more individualized requirements must be met as well. NEIEP’s archived webcasts accomplish these goals by developing and distributing online video training modules needed to meet special state licensing requirements. These webcasts can also provide general and specific industry-wide training to the greatest number of participants possible. And the best part is, this cutting-edge technology is available to all employees covered by the NEII Standard Agreement and the Otis Elevator Agreement and is readily accessible through the Internet, from the comfort of your own living room, after work or during a work break or over lunch. There is literally no reason not to be involved in continuing education training if your job requires you to update your skills periodically. By taking advantage of these programs you not only help your company and strengthen your industry, you ultimately help yourself by acquiring the right tools for the job. Many of these resources are free and right at your fingertips, and they are continually being upgraded and improved to ensure your success in the field.

Keep the Doors Open – Keep Moving Forward!

Continuing education is a buzz word in many fields today because of the central role it plays in keeping workers well-trained, knowledgeable and ready to compete in the global market place. By taking advantage of a well-organized and goal-oriented program in your field you can both boost your own success in your career and do your part to keep your industry on the leading edge of international standards and ahead of the competition. So don’t let your skills stagnate in the corner. Keep those educational doors open and move forward. Look into the many continuing education possibilities available to you today!

More information on NEIEP’s education programs is available at: http://www.neiep.org/

Fred Yaniga Jr. teaches German at Butler University in Indianapolis and has been teaching students and teachers alike for over fifteen years.
NEIEP has partnered with Ivy Tech Community College of Indiana to offer the IUEC membership an opportunity to earn a college degree. Under this unique program, apprentices enrolled in our apprenticeship training program can earn an Associate of Applied Science (A.A.S.) Degree. The opportunity also exists for journeypersons, who can earn a two-year degree by enrolling in as little as 5 courses to earn residency status. And for those who wish to proceed further in higher education, students can transfer their degrees to the National Labor College and ultimately earn a four-year degree.

For More Information. To learn more about the degree requirements and other information, you can access the Ivy Tech’s web site: http://www.ivytech.edu/apprentice/ or you can contact Heather Higgs, Director Academic Support Systems, hhiggs@ivytech.edu, 317-921-4518 or toll-free 877-395-4378, or visit us on the web at: http://www.ivytech.edu/apprentice/elevator

Innovative Internet-based Program Offers NEIEP Apprentices and Mechanics an Opportunity to Earn an A.A.S. Degree

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68 Credits Total
RESISTANCE CONTROLLED DC DOOR OPERATOR

By: Jim Bunning
Local 25

When the trend in the industry turned toward power operated doors, it was no surprise that the DC motor was the choice for the job. It had been around for years and having the ability to deliver controlled door operation made it the best solution for the task. Control circuits for DC motors had some differences but they were very similar for controlling the shunt wound motor.

The concepts of operator circuits illustrated in this article and similar ones were used with relay logic controllers since the introduction of power doors. The operator in the drawing uses a fractional horsepower, shunt wound DC motor.

Basic Door Operator Circuit

V-Belt to Cable Drive Sheave

Cable Idler Sheave to Music Box Chain Drive

V-Belt Cable Drive
Some manufacturers used compound wound motors. The compound motor when used has a series field wired into the armature circuit. In some types the door direction circuitry changes current direction through the series field, therefore changing the polarity of the field. In the open direction the series field aids the shunt field and in the close direction the series field opposes the shunt field. This provides more torque in the open direction and reduced torque in the close direction. These operators provided good control, speed, and torque. With the use of cam operated contacts and resistors located in the door operator, power to the motor armature could be controlled.

This type of door operator circuit may have had a gear box with a worm and gear that controlled a link arm going down to the door. It may have had belts and sheaves linking the door to the operator. Variations of this type of circuit have been used to control door operation in most DC resistance controlled operators used in the industry over several decades. They required several large resistance tubes capable of handling up to 500 watts of power in the operator and on the controller. Linear varieties of door operators use a belt drive from the motor to a cable or belt that spanned the width of the car to drive the doors. The speed of the doors is in direct proportion to the motor speed at all times. This type of operator provided good door operation but lacked the finer control of modern solid state types. At very low speeds such as near full open or closed when motor RPM is low it was difficult to maintain enough torque to reach the limits without increasing torque at the mid travel point where less than 30 lbs. is required. Additional circuitry was usually added to the basic circuit to provide the motor with the extra torque to overcome the common high wind condition that affected final door closing in building lobbies and to overcome the tension of the door closer in the open. Other issues such as belt tension drastically affected torque and speed. As belts aged and stretched doors had a tendency to speed up and then reach a point to where slip was a factor.
These items still affect the operation of modern operators but the addition of speed feedback is very effective in covering up the occasional tight door and wind condition.

It would appear that when looking over various schematics of door operator circuits by different manufacturers that their circuits are totally different. This appearance is the draftsman’s choice when he sets up his drawing. You can take any one of these prints and rotate it 90 degrees and it takes on a different appearance but it still operates the same. Careful examination of these circuits reveals that in their basic operation they are not too much different.

The power to this basic type of operator is typically 125VDC. The motor field is constantly excited. However, when the operator is not opening or closing, the motor field will have reduced voltage. As the door opens or closes the motor field is made stronger by closing O-3 or C-3 to provide more torque and better control. So why not leave the motor field at full volt-
age? Many manufacturers did. The reason for lowering the voltage was to keep the motor cooler, and yet to remain warm enough to ensure a more consistent door operation and quick field buildup. A cold motor field will perform differently than a hot one.

The motor circuit in the basic drawing has four series resistors.

CA – close acceleration
C1C – close initial check
O1C – open initial check

OA – open acceleration

There are also two parallel resistors.
CC – close check
OC – open check

The following sequence describes the open operation. With the doors in fully closed position, O1C contact is closed while all other open contacts, OA, O2C, O3C, and O4C are open. The doors start to open with current flow through contact O1, the door motor
armature, part of O1C resistor and O1C contact, the entire OA resistor, and finally contact O2. The doors get a slow acceleration to get the door lock picked quietly due to OA resistor, and then door operator contact OA closes shorting out part of OA resistor.

This increases current to the motor and the doors accelerate to full speed. Full open speed is controlled by the position of the O1C resistor tap. When the doors are near mid travel the O1C contact opens inserting the entire O1C resistor in series with the motor armature. This is the first step in deceleration. This check reduces armature voltage to the motor, but does little to slow the inertia of the doors. Without parallel checks the doors would continue to coast at nearly high speed. As the doors approach a point about 16 inches from full open the O2C contact closes, this is the first parallel check. As this contact closes it provides a parallel path for the CEMF generated by the motor armature. This is called dynamic braking and is very effective at slowing the doors.

At this point kinetic energy is converted into electrical energy and the motor is generating current into a load. This is followed up by two more parallel checks O3C and O4C, each one putting less resistance in parallel with the armature producing more dynamic braking. The lower the resistance in parallel with the armature, the more dynamic braking occurs. The final check, O4C, slows the armature to almost zero speed for stopping the door in the full open. The parallel checks are much more effective than the first check that is in series with the armature and simply lowers voltage. The three parallel checks should be adjusted to provide a smooth slowdown. If the door is adjusted properly, speed changes introduced by each check should not be visible. When the doors are fully open an open limit will drop open-relay O, removing power from the armature. The close operation sequence is similar to the open. The close operation needs to meet code requirements for torque and kinetic energy.

There are several ways in which door close torque could be controlled. One way is to add extra resistance in series with the motor armature to reduce voltage and current to the motor armature. Another way is to add resistance in parallel with the motor armature to absorb CEMF current and provide dynamic braking. Motor torque could also be reduced by weakening the motor field.

Six dry contacts are all that is required from the elevator controller to the operator for this simple motor control. Contacts O-1, O-2, C-1, and C-2 command the operator to open or close; contacts O-3 and C-3 control the motor field. As more features are added to this basic operator more circuits and contacts are required. Other features that may be used on this type of operator could include reduced torque and speed when nudging operation is activated. This could be accomplished by adding resistance in series with the motor armature. If the safety edge was activated while on nudging, the doors could be adjusted to stall by inserting a small resistance in parallel with the motor-armature bringing it to a stop. When features such as Fire or Hospital Service are mixed in, the simple door circuit becomes more complicated. It’s important to keep in mind when working on logic and control circuits that they all started out simple on the drawing board. As features are added the circuits become more and more complex. The simple circuit we started with soon may become unrecognizable. Good troubleshooting practice requires that a mechanic can isolate the portion of the circuit related to the problem at hand and focus on that area alone for a solution. Circuits that appear to be complex are generally just more simple circuits layered one upon another. Identifying these layers is a talent that is acquired with an understanding of circuit fundamentals and on-the-job experience.
In the late 1800’s, elevator doors were opened and closed manually by the attendant or the passengers riding the unit. There were no electric safety devices on the doors to prevent the car from operating with the doors opened. If a rider would forget to close the hatch doors, there would be a potential for occupants of the building to fall down the hatch, or get hit by the elevator passing their floor if they were too close to the opening.

In 1877, Alexander Miles improved the method of opening and closing of elevator car doors. He also created an automatic mechanism that closed the hatch doors even when the elevator was not on that floor. This device, although never implemented under his patent, proposed doors that were operated by the motion of the car as it approached a floor. Cams in the hoistway engaged levers on the car and opened the doors. Door operation has come a long way since this time. Original designs used an open loop system where motor velocity was not critical and actual positioning was not necessary. An open loop system uses no feedback to monitor position and velocity. It ran at a single speed and simply stopped as it reached end of travel similar to a garage door opener. Demands for high speed doors were met with resistance controlled, multi speed operators. As time went on and technology improved, closed loop systems have entered the door operator industry. These types of controls compare actual velocity with the desired velocity of the doors at any position in the opening. The difference between the actual and desired speed generates an error signal. When a closed loop system senses an error, it produces a command to compensate, reducing or eliminating errors in speed.
The solid performing mechanical operation of the familiar GAL operator has been coupled to one of their most innovative door operators named the “MOVFR”. This is a closed loop high performance operator that uses a variable voltage variable frequency (VVVF) drive without an encoder. The operator uses cams that are rotated by the operator drive shaft. The cams swing through optical sensors that are mounted on the same circuit board that contains all of the electronics for motor control including inputs and outputs to the controller. The sensors have lights indicating the door’s speed and location. This single board solution affords a quick and easy remove and replace operation.

One of the notable features of the MOVFR operator are a one-half HP, 230 VAC motor with heavy duty chains sprockets belts and sheaves. Although the horsepower is higher than many door operator motors, the extra power can be appreciated in the quick reversals and effortless operation of even heavy doors. The incoming power can be 200 to 240 VAC fused with either a 3 amp time delay or 6 amp fast acting fuses. The VVVF drive is programmed to provide varying power to the door motor and compensates for load changes such as heavy wind, and worn rollers to provide consistent smooth operation at all floors without the use of a speed sensing device such as an encoder.

Wiring the door operator has been made easy. There are only three control inputs needed: door open, door close, and nudging along with an optional input for buildings that have a heavier decorative door on one of their floors. These input signals can be either wired with a dry contact, or voltage signals ranging from 12 to 230 volts AC or DC. The contacts for the output signals such as the door close
and open limit are rated for 230 volts, 10 amp AC.

The operator has test switches for cam set up and adjusting speeds, nudging, and manual door open and close. When the Automatic/Manual switch is in the manual position, the doors can be operated using the Open/Close switch provided. This helps to adjust the performance of the doors. Activating the nudging switch allows the doors to close at a reduced speed when in the manual mode. When the cam set up switch is activated, power is removed from the door motor, and the doors can be moved manually. As the door position changes, the cams enter and exit the optical sensors lighting a red light-emitting-diode (LED) for the close-positions that are actuated, and a green LED for the open-positions that are activated. Inputs and outputs have an LED indicator as well as speed zones during the open and close cycle. These optical sensors have replaced the mechanical contacts and pivoting arms, reducing the number of moving parts and contacts to wear. The cams can be easily adjusted by spinning them on the rotating shaft for speed changes at required door positions. Once the position cams are set, the operator can have its speeds properly programmed. Programming instructions are provided in the manual provided with the door operator and also written on the back of the programming unit.

The MOVFR operator uses a hand held programming unit with a digital display to change the factory pre-set

Handheld Programmer
speeds, and to adjust the acceleration, deceleration, and torque of the doors. The speeds are changed through a drive, by entering values into the handheld tool as opposed to adjusting resistors. The values for speeds in the tool are represented in hertz. This programming unit also has the ability to store several door profiles. When doing a bank of multiple elevators, the door operator on the first elevator can be adjusted and its speeds programmed. The first car’s operating parameters can be easily uploaded into the programming unit. The information can then be downloaded into the operators of the other cars in the group for consistent door operation throughout the bank of elevators. The hand held programmer is capable of holding up to 5 different programs in its memory. This provides a quick means for comparing an adjustment change.

Another feature included in the MOVFR is an adjustable door obstruction re-open feature. If the system senses something preventing the doors from closing, it will automatically re-open them without an external open input. Another interesting feature is that a door detector unit, available from a variety of vendors, can be ordered through GAL and plugged directly into the door operator control box eliminating the need to locate a power supply and mount a control box for the door detector.

When first looking at a GAL MOVFR door operator, it looks like the dependable, low maintenance product mechanics have been familiar with for years. The main difference is the control box, which at first may seem a bit intimidating, but becomes quite user-friendly with a little experience. The duties of the mechanic have gone from lubricating pivot arms, replacing worn contacts, and adjusting resistors to maintaining original door speeds, troubleshooting, and replacing components within the door operator control box.
Throughout the many years since the inception of the elevator, passengers have always needed a way to enter and exit the car. From the time when door operators were actual human operators that would personally open the doors for you, to the present when everything is automatic, doors and the opening of these doors have changed quite a bit.

Automatic operation of doors is common place now and there are many versions of operators on the market today. The operators have many components that are similar with all manufacturers. Sheaves, belts or chains, and linkage arms are all a part of automatic operation. While many operators are similar, let’s focus on the MAC operator for this topic.

While the mechanical parts of the operator have remained the same, the controls have changed quite significantly. In the beginning the controls were located in the machine room and inside the controller itself. Controlled with relays for opening and closing, resistors for speed and torque control. Since solid state has come on the scene the controls of this operator have changed. A board has been added on the operator and the controls have been removed from the machine room.

Taking a look at successful door operators over the years makes it apparent that the link arm system has been the obvious choice for good high speed door operation. It circumvents a motor and its control systems weak points and exploits the areas of their best qualities. These are the ability to run the motor at a speed nearer to its ideal speed when the doors are in their nearly full closed or open position. With resistance type motor control used on linear style operators, it was necessary to increase speed to maintain torque at a high enough level at these slower speeds to overcome tight doors and wind in the final stages of opening and closing. Maintaining the 30 lb. force requirement became a fine line between proper force, adequate door time and sufficient torque for a sluggish door in the near full open or closed position. Resistance control did not lend itself well to maintaining a steady available torque over this wide RPM range. As long as a motor is selected properly, modern solid state controls can help cover up these shortcomings. Link arm operation by virtue of the driving force being obtained from the outside portion of a rotating wheel requires far less RPM change for elevator door operation. With linear operation zero door speed is zero motor speed. With link arm or harmonic operation zero door speed can be several hundred RPM. When drive wheel travel is perpendicular to the link arm, the doors attain a natural zero speed with the motor still rotating at a speed that can deliver consistent torque.
With all of this said it is apparent that the best operation is attained when the doors are in their full open or closed position and the link arm connecting point travel is perfectly perpendicular to it. The problem arises that the door cannot be opened by hand from inside the car in an emergency because of the resulting mechanical locking nature. The result is that most operator manufacturers stop the doors somewhere before this mechanical lock-in condition exists by operating the close limit before the drive wheel motion is perpendicular to the link arm. This results in a harder than desired stop in the close.

The MAC door operator takes advantage of the pendulum like movement of the harmonic operator to its limits. It maintains full opened and full closed positions with the link arm perpendicular to the load. This is accomplished by using a split link arm that disengages from the connecting arm if the door is forced open from inside the car. The need to stop the link arm short of perpendicular is eliminated. With this operation the door can be fully driven to open and closed positions in a continuous motion and never contact a stop block at either end of travel. The drive wheel can virtually be rotated at a constant speed and good door operation without speed step transitions is the result. When some electronic control is mixed in, door operation is fast and smooth.

Most elevator mechanics can attest to the fact that well designed equipment stays around the industry for a long time. Usually it becomes a victim of cost, weight, or code restraints. The MAC operator is no exception to this. It uses heavy gauge track, link arms, and door hangers that are up to the task of daily use and abuse. There is very little lost motion between the motor and the door that makes for solid operation with smooth reversing doors. There is a price to pay for the increased mass of the system; however, that will be addressed later.

Kone Elevator is the now the proprietor of the MAC door operator and supplies parts, changeover equipment, and upgrades to the original operators. They have even developed a newer version that uses a double speed reduction arrangement from the motor.

Although several control systems have come and gone, the mechanical operation of the MAC operator has remained unchanged. The coupling from the motor to a pillow block mounted idler shaft is a single V-belt. In this area speed is high and torque is low. On the opposite side of the idler shaft is a double belt arrangement to the drive wheel. Two belts are necessary here to provide higher torque but at reduced speed. The natural clutching ability of V-belts help smooth out remaining lumps and bumps in operation. A disadvantage to
using V-belts is that with all else being constant the code required 30 lb. door force changes as the belts age and stretch. Rubber belts cannot hold the tolerance and maintain the consistency in this area as similar chain driven operators. As in all solid state operators door force is measured by monitoring motor current. With the inherent losses in V-belts much of the power delivered by the motor may not make it to the doors. Consequently door force increases as new belts age and wear, commanding that door force be monitored more closely.

With litigation involving elevator accidents increasing in this country, manufacturers have been striving to reduce mass of a door system without sacrificing operation. Remember when a passenger is struck by a door he is struck not only by the force of the door but by every moving component of the system including the stored energy of the rotating motor. Low inertia motors entered the scene and were applied to the MAC operator improving the inertia situation. They came packaged as the familiar small circumference permanent magnet motors we use almost exclusively today on modern operators. Reducing overall weight also has other obvious advantages and soon aluminum link arms and sheaves appeared throughout the industry, some with questionable integrity. The MAC has retained its original heavy gauge link arms and sheaves.

Ease of installation is also a MAC high point. The operator can be set to operate over a predetermined length of door travel. The pivot point on the crank arm mounted on the drive wheel is pre drilled to swing the...
doors through the proper width of an opening. Connecting the drive arm to a higher or lower point on the door adds some fine adjustment to this distance. If the opening is 42 inches you may set the drive arm fastening on the door to yield about 43 inches of travel to allow for open and close overlap. Once this dimension is set the operator can be moved into precise position to allow the door to close to within 1/16 of a door close bumper and return to the full open plus about 1/2 inch. Once in position a simple but effective locking system prevents further movement. Most mechanics however prefer to pin the operator to prevent any change in its position. Cams mounted on the output wheel shaft and locked in place by set screws operate micro switches. The switches pass along low current information to the control board to indicate door position. As the doors reach a point of about 6 inches from full open or closed, the related micro switch operates and places the motor in its final speed. The amount of motor speed change necessary at this point on a link type operator compared to a linear operator is minimal. The transition in speed is seldom noticeable even on a poorly adjusted operator.

Speed and torque control are managed on the board located on the operator. The speeds are controlled with potentiometers. The group of potentiometers allow for the setting of speeds in open high speed, open slow speed, close high speed, close slow speed, and initial open speed. The initial open speed is used to allow the clutch on the car doors to be completely engaged with the pickup rollers on the hoistway door and raise the locking hook before accelerating to full speed.

Door force is set by a current limit pot that is adjusted to the 30 lb. maximum in the center 1/3 of door travel. The operator contains another pot to set the nudging speed for use on fire service or if the door edge has been blocked too long. There are no learning capabilities on this type of operator. This operator is adaptable to many different controllers and requires only an open and close signal. A fuse and other solid state current limiting are also provided.

The door force can easily be adjusted within the required maximum of 30 lbs. with the doors in their center 1/3 of travel. Stalling the doors and then slowly releasing pressure with the gauge applied should yield less than 30 lbs. at the point the doors begin to creep. The setting holds fairly consistent at the midpoint of travel of the doors but as the link arm approaches perpendicular position of the drive wheel point, things can change. The motor RPM stays constant as the door travels to within 6 inches of the closed position but the nature of the drive wheel causes the door to slow. Door force can be higher here. The effect is about the same as shifting to a lower gear in your car. The distance traveled per motor RPM decreases and available torque goes up. This change can produce a variance in door force depending on the operator and width of the opening. Check door force at various locations within the center 1/3 of the opening to be certain 30 lbs. is not exceeded. It may be necessary to adjust door force below 30 lbs. near the open and close limits to avoid exceeding it in center 1/3 of travel position. Keep in mind that as new belts stretch the door force can increase. Open door force adjustment is not required but is fixed to limit current in the stalled condition such as debris in the sill or a door lock hang up. Maximum available power in the open direction assures a quick door reversal when requested by door protective equipment.

The longevity of the MAC operator in the industry is testimony as to its familiarity with many elevator Mechanics. In many cases he might arrive on a job where the equipment is totally new to him. The one component recognizable to him may be the time tested MAC operator.
Most elevator men are no longer surprised at the rapid pace that new equipment comes and goes in the industry. However once in a while something comes along that is new and completely different. Not being a stranger to the Linear Induction Motor, Otis applied the technology to the door operators of their most performance demanding installations.

Known as the HPLIM, the HP is for High Performance, it avoids all of the mechanical linkage, rotating sheaves, drive wheels, belts, and chains of other typical high performance operators. Gone is all of the lost motion, due to torsional stress of multiple link and drive arms. Flexing pivot points causing sling shot like operation on reversals is non-existent. Wear of chains, belts and pivot bearings causing lost motion adding to rough operation is eliminated. The only moving parts is what the passenger sees, the doors.

This may sound a little unusual to those not familiar with the product, but a simple explanation of the technology may bring it to light.

The magnetic forces that generate attraction and repulsion to rotate an AC motor come from current in the stator and from magnetic flux generated in the rotor through induction. There are no brushes or mechanical links between the two other than the bearings. The bearings are critical in an AC motor to hold the close clearance between the rotor and stator for maximum efficiency. The larger the gap between them the lower is the efficiency. Modern AC motors operate with only a few thousandths of an inch clearance. This minimizes the air gap that the magnetic field has to jump to produce rotation.

What makes the LIM unique is that it is in effect a flat motor. Its stator and rotor are along a flat plane to create horizontal or vertical motion instead of rotational. In the case of the HPLIM, the stator is located above the door rollers and moves with the hanger assembly. A copper plate about 6 inches wide and slightly over 1/16 inch thick called a reaction plate is used as the rotor. The reaction plate is mounted to the door header. As the door travels the stator mounted to the door and the reaction plate on the header pass in close
proximity. Guides on the stator ride the edges of the plate to maintain a clearance of about 1/16 inch between them.

Three phase power controlled by an AC drive is applied to the stator as it would be in a rotating motor. As current passes through the stator windings, a magnetic field cuts through the copper plate creating a voltage and therefore a magnetic field that pulls the stator along the horizontal plane of door travel. Three Hall effect sensors that sense a series of holes above the door rollers accurately resolve speed, position and direction of the doors. Critical operation points such as limits and slowdown locations are memorized in the microprocessor during a learn run. Depending on the opening width and type of doors (SSSO, SSCO or others) two profiles are in memory available for selection by the mechanic. The first selection is for fast operating doors and the second selection is for very fast operating doors. The HP in the name of this operator means exactly that. It can produce some very impressive door times such as 1.5 seconds open and 2.2 seconds close on standard 42 inch center opening doors with ease. And remember all of this is without the traditional belts, chains, cables and sheaves. The preprogrammed profiles are merely suggestions from the factory as to provide smooth operation. These properties can be changed by the Mechanic with a hand held tool to meet the demands of the installation.

Performance like this does not come without a price and the operators are only available by special request from the customer. When it comes to meeting the demands of high price prestigious office space, performance of this operator is certainly up to the task.
NEIEP continues to update and improve the curriculum taught to apprentices and in expanding its training for classroom instruction. In addition to those changes, NEIEP instructors now have the opportunity to refine their teaching and presentation skills by attending a new round of advanced training designed specifically to meet the needs of veteran instructors.

These changes have been developed by NEIEP “Train the Trainer” instructors Drs. Andy DiPaolo and Ron Boehm. Building from the Basic Train the Trainer Course (BTTC), the new Advanced Train the Trainer Course (ATTC) provides NEIEP instructors with sophisticated teaching skills in order to deliver the NEIEP curriculum in more interesting, lively, and dynamic ways. In addition, the ATTC is designed for instructors to gain a better understanding of how to add powerful enrichment activities to the classroom by sharing their own real world experiences. The result is an instructional presentation that better matches the needs and interests of today’s apprentice.

“On the job training is often an effective and interesting way to learn, but it can be inefficient and costly. Now new instructional technology is helping NEIEP instructors bring the real world into the NEIEP classroom resulting in more effective and meaningful learning” according to Dr. Ron Boehm.

This is being accomplished by ensuring the advanced course offers instructors training in the newest techniques to design and deliver attention-grabbing, instructionally-sound classroom presentations. For example, with the new advancements in digital photography instructors can easily document certain “teaching points” on the job—whether it is a safety reminder or new methods for installation or repair. Digital media like this, added to the existing NEIEP curriculum and materials, can help instructors deliver a powerful, customized learning experience—but first they need to learn how to do it.

NEIEP instructors are being taught how to integrate their own digital materials into existing NEIEP PowerPoint demonstrations. These additions will make classroom instruction more interesting and relevant resulting in a stronger apprenticeship training program. The technology to bring real world exami-
ples into the classroom does require new skills and considerable investment in computer technology. This commitment from NEIEP is an important part of both the basic and advanced instructor training programs.

In another example of how the training is changing, NEIEP instructors attending both the BTTC and ATTC programs are also learning how to use the power of the Internet to improve their teaching and in turn, improve the learning of their students. Besides the use of the NEIEP website at www.neiep.org to download the latest teaching materials, instructors are learning how to quickly find important information on the Internet made available by manufacturers and other sources. Once found, the challenge for the NEIEP instructor is to integrate that information into classroom presentations. Boehm, director of a pioneering Internet educational organization started in 1996, leads the effort in helping instructors to become confident and adept in the use of computer technology in support of instruction. A few attendees in the recent advanced classes shared their thoughts about the importance of the new skills they acquired:

“What I liked most about the seminar was learning how to use the Internet to get images, etc., to add to the PowerPoint presentations. Also I appreciated learning new ideas to make my classes more interesting for the apprentices.”

“I enjoyed learning how to ask questions that encourage class participation.”

“I learned some new ways of trying to motivate students. I found through this course that I was getting stagnant in my teaching.”

“We know that computer and presentation technologies presents new challenges for NEIEP instructors. But when done well, these new tools will help create a positive and productive learning situation for students,” related Andy DiPaolo, who leads Stanford University’s Center for Professional Development. He continued “NEIEP’s commitment to the advanced training of its instructors and the integration of new technology and techniques into the student learning experience has positioned NEIEP to be a leader in offering one of the best apprenticeship training programs in the country.”
ThyssenKrupp Elevator along with all other manufacturers in the past has used door operators that included multiple resistors, switches, and cams to control the speed and torque of the elevator doors. This was very tedious time consuming work to set up, most of which had to be done bent over the crosshead in an uncomfortable fashion. I know everyone that has adjusted this type knows what I am talking about! This type of control had to be readjusted soon after turn-over due to the belts and linkage loosening up and changing the door operation. The Universal Door Operator has eliminated the need for any mechanical devices in the operator but instead uses a Variable Voltage Variable Frequency closed loop system to control speed and torque much the same as we control elevators today. It is basically a small motor-drive for the doors.

The ThyssenKrupp Elevator Universal Door Operator can be adapted to either an AC or DC powered motor. This makes it quite versatile for modernization jobs with the ability to use the existing door motor.

Harmonic Drive is a term used to describe the natural mechanical speed control of a link arm connection to a drive wheel without the means of electrical energy. This relationship is between the center of the drive wheel and the two mechanical pivot points of the door operator linkage. As the drive wheel rotates from its fully closed position (figure 1) the natural mechanical speed increases to maximum when the drive wheel is rotated 90 degrees and the intermediate arm pivot point is at the bottom of the drive wheel. As the drive wheel continues to rotate the doors will start to slow down mechanically then to a stop as the center of the drive wheel and the intermediate pivot point are horizontal to each other. The Harmonic Drive uses a single drive arm for side opening doors (single and two

By: Donnie Bacak
Local 18
speed), and two drive arms for center parting doors (figure 2).

The TKE UDO utilizes an aluminum drive wheel and intermediate wheel to minimize rotational inertia as well as to provide good corrosion protection. Code limits the closing kinetic energy of elevator doors, so using aluminum wheels helps reduce the “flywheel effect” of using heavier materials. It does not require a weight on the drive wheel to prevent the car doors from drifting closed when stopped in the open position. The elimination of rollback in the open is prevented by the mechanical or harmonic stop position of the drive wheel to the link arm, the switch must be adjusted properly. In the closed position the center of the drive wheel to the pivot point must be adjusted slightly lower than horizontal to allow for opening the doors from inside the cab with power removed. This is a code requirement assuming the car is not in the door restrictor zone.

On the center parting door arrangement it utilizes two independent drive arms to each panel, which minimizes the loads in each drive arm and eliminates the need for relating devices.

The Harmonic Drive system uses belt(s) from the motor to the intermediate sheave and from intermediate sheave to drive sheave. A 3V cross-section motor belt is less prone to stretch and with advanced control or encoder feedback does not require a spring tensioning means or floating motor.

The proven wedge configuration of V-belts assures stability when heavy shock loads are encountered. Clutching is smooth, with no grabbing or jerking. The belts deliver an ideal balance between controlled power transfer and slippage.
The most demanding installations with very high speed doors will require the harmonic drive type system. Other installations where performance is not as critical will use the newer linear type operator system.

The Belt Drive linear type system uses a drive motor and gear reduction box directly mounted on the end of the rotating axial shaft at one end of the door header.

The belt idler sheave is mounted on the opposite end of the door header. One end of the drive belt connects to the belt hitch assembly on the master door. It loops around the circumference of the drive sheave, stretches across the door header to loop around the idler sheave then back to the belt hitch assembly. On center opening doors there is a belt clamp that connects the slave door to the drive belt. The direct coupling of the doors to the belt eliminates the need for relating.

The open and close limits are provided via a hall-effect proximity sensor mounted at either end of the door track, and a magnet mounted on the door hangar assembly.

To open and close, the door’s controller signals OD or CD is sent to the Universal Door Operator then voltage and current is supplied to the door motor armature. Power is removed from the door armature when
the doors are at their fully opened or closed positions. Due to the balance of the doors and the lack of mechanical-linkage-weight as with the harmonic type system, there is virtually no roll-back of the doors in the open or closed positions. The same capability to open the doors from inside the cab with power removed is achieved with the linear type system provided the car is not located within the door restrictor zone.

**PERFORMANCE**
The Universal Door Operator uses field adjustable parameters to customize motion profiles.

1) Acceleration and deceleration rates
2) Top speed (limited in part by kinetic energy limits in the close)
3) Final approach speed
4) Closing torque limit (limited to 30 lbs. by code)
5) System gains (smoothes the transitions from deceleration to final approach speed)
6) Auto learn travel profile (encoder pulses from door close limit to door open limit)
7) Automatically adapts to any belt wear or slip (using the closed loop feedback from the encoder to compensate)

8) Low system inertia allows for a faster door panel velocity for the same kinetic energy (kinetic energy is a combination of door panel and linkage weight total, speed, and torque)

**CONTROL**
The TKE UDO works with AC or DC motors, VVVF–Flux-Vector Control. Flux Vector drives use a mathematical model of the motor to calculate and control the rotor flux position and magnitude based on stator currents and motor shaft position.

Closed loop motion control is used for determining position, speed, and current. Two high current transducers or sensors integrated on board are used to sense motor load. The UDO also uses a motor encoder for flux vector control that provides position and speed feedback.

The controller can provide 5 different motion profiles that can be activated as necessary on a per floor per door basis. The different profiles are useful for special situations. For example:

If the lobby has a heavier door than the other floors, one profile can be used to run the lobby
A door with a slower closing speed and another profile would run the doors for the rest of the building at a higher closing speed.

Each profile has adjustments for both open and close. The adjustments are the same with the same default, maximum and minimum values, but may be adjusted for a different purpose within a profile. Adjustment values can relate to one another only within the same profile. For example, Open-Backlash Time, of Profile 1 and Open-Backlash Speed, of Profile 1 relate to each other, but only within Profile 1. Backlash is the term given to the initial open speed and distance allowed for the clutch to engage the door drive rollers prior to acceleration into high speed.

The UDO synchronizes the position system with integral door open and door close limit inputs and provides complete independent profile adjustments for open and close.

Adding to the versatility of the operator, it will also interface to any control system via one of these interfaces. Universal asynchronous transmitter/receiver, RS 485 serial communication (UART) and serial controller area network (CAN), and discrete inputs and outputs. Most elevator companies use one or several of these types of communication interfaces for hall calls, drives, brakes, etc.
USER INTERFACE
The Universal Door Operator has two means of interfacing for adjusting and diagnostics: the on-board UIT (user interface tool) or Windows PC and Palm PDA (personal digital assistant) tools.

The on-board UIT (user interface tool) stores adjustments and parameters to local FLASH non-volatile memory, and provides for easy software updates via FLASH memory using Z-Modem. It uses a simple 4 button, 2 line LCD user interface. Z-Modem is a communications protocol that provides faster data transfer rates and better error detection, it also supports larger block sizes and enables the transfer to resume where it left off following a communications failure.

The Windows PC and Palm PDA based user interfaces provides a more advanced diagnostic for tuning and adjustments.

SAFETY FEATURES
Provides direct door control in response to door protective devices (i.e. electric eye, safety edge). The electric eye or safe edge is wired directly to the Universal Door Operator instead of to the elevator controller. Any electronic edge can be used with this operator as the signal uses only a contact closure to activate the door reversal.

It also protects against encoder signal loss and over-speed conditions. Just as with a motor drive the Universal Door Operator detects a fault condition under these circumstances and removes power to eliminate the possibility of a passenger being struck by the doors.

Another safety feature is the over-current protection of power IGBTs. Isolated Gate Bipolar Transistors are high-speed switching transistors used primarily for motor control. If a fault condition is detected, the IGBTs would be turned off. A command is available to reset the IGBTs through the interface tools.

The ThyssenKrupp Universal Operator is as its name implies, suitable for new construction and with its built in versatility features adaptable to many control systems for the modernization market.
Elevator Constructors Annuity and 401(k) Retirement Plan

Elevate Your Retirement Dreams Today

One of the most compelling reasons why you should consider participating in the Elevator Constructors Annuity and 401(k) Retirement Plan is the tax advantage of 401(k).

By participating, you will be able to defer, or postpone, paying Federal income taxes on your contributions and your investment earnings. This can mean big current tax savings that directly impact your retirement savings.

Start making your pre-tax contribution by following these simple steps:

2) Complete the Elective 401(k) Contribution Rate-Suspension-Resumption Form and return it to your employer.
3) Complete the Investment Election Form and return it to MassMutual.

If you’re already contributing, consider increasing your deferral rate to save even more!

The Tax Advantage of 401(k)

The following example shows estimated Federal income tax savings when saving through a 401(k) versus a traditional bank account.

Assumptions are: $80,000 annual salary, 6% contribution, 28% flat tax rate

<table>
<thead>
<tr>
<th>Bank Account</th>
<th>401(k)</th>
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</thead>
<tbody>
<tr>
<td>Annual Salary</td>
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<tr>
<td>401(k) Contribution*</td>
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<tr>
<td>Taxable Income</td>
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<td>You Saved</td>
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</table>

Estimated Current Federal Tax Savings*

Hypothetical example for illustrative purposes only. Tax information is estimated and shown only to demonstrate the potential current federal tax savings of pre-tax contributions to a retirement plan. No other sources of income are considered in the example.

The information contained in this example is not intended or written as specific legal or tax advice and may not be relied on for purposes of avoiding any federal tax penalties. Neither MassMutual nor any of its employees or representatives are authorized to give legal or tax advice. You must rely on the advice of your own independent tax counsel.

*Subject to taxation at time of withdrawal.

Important Reasons Why You Should Consider Participating in the Elevator Constructors Annuity and 401(k) Retirement Plan

• Your contributions are automatically taken out of your paycheck before you can spend them or Uncle Sam can tax them.
• You pay no Federal income taxes on contributions and earnings until you take money out of the plan. Take a look at the chart on the other side for more details.
• You owe it to yourself! For most people, Social Security and the Annuity portion of your Plan only provide a partial retirement income. Your 401(k) savings can help make up the difference.
• Your plan offers a variety of ways to invest your money with a choice of 16 investment options, so you control the amount of risk you take.
• You can take it with you. If you leave employment, MassMutual’s Retirement Specialist Group can help you keep your retirement savings working for you.

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