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Introduction:

Animation:

Animation is the rapid display of a sequence of images of 2-D or 3-D artwork or model positions in order to create an illusion of movement. The effect is an optical illusion of motion due to the phenomenon of persistence of vision, and can be created and demonstrated in several ways. The most common method of presenting animation is as a motion picture or video program, although there are other methods.

Computer animation encompasses a variety of techniques, the unifying factor being that the animation is created digitally on a computer. The individual frames of a traditionally animated film are photographs of drawings, which are first drawn on paper. To create the illusion of movement, each drawing differs slightly from the one before it. The animators' drawings are traced or photocopied onto transparent acetate sheets called "cels", which are filled in with paints in assigned colors or tones on the side opposite the line drawings. Today, animators' drawings and the backgrounds are either scanned into or drawn directly into a computer system.

Electronics:

Electronics is the branch of science and technology that deals with electrical circuits involving active electrical components such as vacuum tubes, transistors, diodes and integrated circuits. The nonlinear behaviour of these components and their ability to control electron flows makes amplification of weak signals possible, and is usually applied to information and signal processing. Electronics is distinct from electrical and electro-mechanical science and technology, whic h deals with the generation, distribution, switching, storage and conversion of electrical energy to and from other energy forms using wires, motors, generators, batteries, relays, transformers, resistors and other passive components. This distinction started around 1906 with the invention by Lee De Forest of the triode, which made electrical amplification of weak radio signals and audio signals possible with a non-mechanical device. Until 1950 this field was called "radio technology" because its principal application was the design and theory of radio transmitters, receivers and vacuum tubes.

Animatronics History:
The roots of modern animatronics lie in the middle Ages, when entertainers used mechanized puppets in shows. The first major animatronic attraction, however, was in 1939, when Westinghouse presented an exhibit featuring a robot, Electro, and his animatronic pet Sparko.

Long before digital effects appeared, animatronics was making cinematic history. Who can forget the scare of the Great White coming out of the water in "Jaws"? Or the tender otherworldliness of "E.T."? Through the precision, ingenuity and dedication of their creators, animatronic creatures often seem as real to us as their flesh-and-blood counterparts.

What exactly is an animatronic device? Basically, an animatronic device is a mechanized puppet. It may be preprogrammed or remotely controlled. The device may only perform a limited range of movements or it may be incredibly versatile.

Animatronics is a cross between animation and electronics.Basically, an animatronic is a mechanized puppet. Animatronics reached mass appeal during the 1964 World's Fair in New York. Walt Disney presented a robotic Abraham Lincoln as part of its "Great Moments with Lincoln" exhibit. However, the technology for creating animatronics was still complicated and expensive, so not many amusement parks incorporated them. It took a decade for animatronics to gain popular appeal in Hollywood as opposed to amusement parks. Steven Spielberg's blockbuster flick "Jaws," featuring an animatronic killer shark, ushered in a new favorite special effect for films.

One of the ongoing refinements in animatronics technology concerns the nature of motion. Engineers and artists strive to create figures that move in ways that appear humanistic as opposed to robotic. The more broken and mechanical the motion appears, the less the appeal for animatronics. These days, computers operate animatronics as opposed to human operators, so the result is more exact and refined. Among the recent innovations in the field is Japan's development of a robot, Asimo that climbs stairs. However, like the early experiments in animatronics, these contemporary robots come at a high price, beyond many people's budgets.

Animatronics technology is constantly changing to keep up with consumer trends and the needs of the market. These days, innovators are working on creating animatronics that can interact with people one-on-one. Another trend is toward the burgeoning market of created haunted animatronics. Halloween and haunted house rides are popular, driving a need for darker attractions such as electric chairs and torture devices.

Famous Ties:
Animatronics have had the starring role in several movies. In the 1980s, muppet creator Jim Henson produced "The Dark Crystal," a fantasy movie populated with mechanized puppets. "Jurassic Park" was another noteworthy film, starring a roster of animatronic reptiles integrated with computer animations.

Audio-Animatronics technology features heavily in many of the attractions at Disney parks around the world. Imagine Pirates of the Caribbean ride without all of the Audio-Animatronics figures, or the Haunted Mansion without its ghostly residents. But where did it all begin?

It was in the early 1950s that Walt Disney purchased a mechanical bird while he was on vacation in Europe. That souvenir spurred Walt on to give life-like movement to 3D figures, just as he’d given life to the characters in his animated films.

The first true Audio-Animatronic technology was used for the birds in The Enchanted Tiki Room at Disneyland, which opened in 1963. For this the Imagineers had devised a system to control the actions by means of magnetic recording tape and solenoid coils. The signals recorded on the tape triggered solenoid coils inside the figures, producing action.

By 1964 the first fully animated human figure had debuted at the New York World's Fair. That figure was Abraham Lincoln, and it incorporated 57 moves, including 22 different head movements. But the work had been painstaking and involved animator Wathel Rogers being rigged up with a harness-like device and his every movement captured and recorded. The programming harness was a precursor of the motion capture systems that are used today. A duplicate of that Abraham Lincoln Audio-Animatronic figure went on to be used in the Disneyland attraction Great Moments with Mr. Lincoln which opened in 1965.

The 1964 film "Mary Poppins" saw the appearance of two Audio-Animatronics birds, Robin and Umbrella, and the profits from that film were used to invest in an organization, MAPO, set up to create Audio-Animatronics figures.

The Digital Animation Control System (DACS) came into being in 1969, making use of the now rapidly developing computer technology. DACS involves the movements being recorded onto computer disk, which animators then use to manipulate the figures' movements via a console. Using this system the animators are able to adjust or delete actions at the touch of a button. DACS technology has moved on a long way since then, and a more sophisticated version is now used to control all of the Audio-Animatronics figures we see at the parks today. All of the Audio-Animatronics figures in Epcotand Magic Kingdom at Walt Disney World are controlled from a system composed of multiple DACS from a single remote location in the Magic Kingdom.

1989 saw the first A-100 Audio-Animatronic figure in the form of the Wicked Witch of Oz at Disney Hollywood Studio's Great Movie Ride. The A-100 figure enables movements and gestures that the figure makes to be more realistic than ever before, and it takes around eight hours to animate just one second of movement.

Meeko was the first portable, all-electric Audio-Animatronics figure, and made his debut in 2002 in Animal Kingdom'sPocahontas and Her Forest Friends show.

2004 saw a huge step forward with Lucky the Dinosaur, the world's first free-roaming Audio-Animatronics figure. Lucky made his debut at Disney's California Adventure park and was able to roam around interacting with guests. This technology continued to evolve with the appearance of the Muppet Mobile Lab at Epcot, which saw much smaller versions of the free-roaming Audio-Animatronics characters, that were not only able to move around, but could also converse with each other as well as with guests.

These days Audio-Animatronics figures can be found in many Disney rides and shows, including an A-100 Captain Jack Sparrow in the Pirates of the Caribbean attraction, an 18 feet tall yeti in Animal Kingdom's Expedition Everest, and the most complex A-100 figure to date in the form of Stitch at Magic Kingdom's in Stitch's Great Escape.

Audio Animatronics:

The first use of Audio-Animatronics was for Walt Disney's Enchanted Tiki Room in Disneyland, which opened in June, 1963. The Tiki birds were operated using digital controls; that is, something that is either on or off. Tones were recorded onto tape, which on playback would cause a metal reed to vibrate. The vibrating reed would close a circuit and thus operate a relay. The relay sent a pulse of energy (electricity) to the figure's mechanism which would cause a pneumatic valve to operate, which resulted in the action, like the opening of a bird's beak. Each action (e.g., opening of the mouth) had a neutral position, otherwise known as the "natural resting position" (e.g., in the case of the Tiki bird it would be for the mouth to be closed). When there was no pulse of energy forthcoming, the action would be in, or return to, the natural resting position.

This digital/tone-reed system used pneumatic valves exclusively--that is, everything was operated by air pressure. Audio-Animatronics' movements that were operated with this system had two limitations. First, the movement had to be simple--on or off. (e.g., the open and shut beak of a Tiki bird or the blink of an eye, as compared to the many different positions of raising and lowering an arm.) Second, the movements couldn't require much force or power. (e.g., the energy needed to open a Tiki Bird's beak could easily be obtained by using air pressure, but in the case of lifting an arm, the pneumatic system didn't provide enough power to accomplish the lift.) Walt and WED knew that this pneumatic system could not sufficiently handle the more complicated shows of the World's Fair. A new system was devised.

In addition to the digital programming of the Tiki show, the Fair shows required analog programming. This new "analog system" involved the use of voltage regulation. The tone would be on constantly throughout the show, and the voltage would be varied to create the movement of the figure. This "varied voltage" signal was sent to what was referred to as the “black box.” “The black boxes” had the electronic equipment that would receive the signal and then activate the pneumatic and hydraulic walls that moved the performing figures. The use of hydraulics allowed for a substantial increase in power, which was needed for the more unwieldy and demanding movements. (Hydraulics was used exclusively with the analog system, and pneumatics was used only with the tone-reed/digital system.)

To illustrate the voltage regulation system, take for example the movement of the narrator's (Father) head. If the resting position was for the head to be at the far left position, then during the show the voltage would need to be controlled, by a tone, so that the head would be in the natural middle (e.g., looking forward at the audience). If the tone signalled the voltage to increase, then the head would move toward the right, if the voltage was decreased then it would move toward the left. When there was no voltage, the head would once again return to the resting position (far left). All of the actions that were variable (not just "on or off") for the figures were controlled in this way. All of the actions that were "on-and-off actions" (e.g., eye blink, simple finger movements, etc.) were controlled using the digital system. With the two systems working together, Walt had the technology he needed to program the figures in a lifelike manner.

Most people's conception of how the figures were programmed dates back to the May 17, 1964, Wonderful World of Color episode, "Disneyland Goes to the World's Fair." In that TV program, Walt is seen working on an act from the Carousel show. As Walt explains the Audio-Animatronics figures, he makes a path to Wathel Rogers, Disney's principal Audio-Animatronics programmer for the Fair shows. Wathel, who is programming the Father figure, is strapped into a control harness that resembles something out of a medieval torture chamber. As Wathel moves and gestures, so does the AA figure; Walt comments that, "The operator of the harness has to be a bit of a ham actor." It was also learned that in order to make the figure talk, the operator would have to synchronize his lip movements to a pre-recorded dialogue track, although this is not demonstrated in the show. This same film, with additional footage, was also utilized in an early progress report to G.E.

While the show is enlightening, it leaves one to believe that the programming of the figures is something that was done with relative ease. In actuality, the me

thods of programming the figures were infintely more complex--and impressive--than Walt would have us believe.
There were two basic ways of programming a figure. The first used two different methods of controling the voltage regulation. One was a joystick-like device called a transducer, and the other device was a potentiometer (an instrument for measuring an unknown voltage or potential difference by comparison to a standard voltage--like the volume control knob on a radio or television receiver). If this method was used, when a figure was ready to be programmed, each individual action--one at a time-- would be refined, rehearsed, and then recorded. For instance, the programmer, through the use of the potentiometer or transducer, would repeatedly rehearse the gesture of lifting the arm, until it was ready for a "take." This would not include finger movement or any other movements; it was simply the lifting of an arm. The take would then be recorded by laying down audible sound impulses (tones) onto a piece of 35 mm magnetic film stock5. The action could then instantly be played back to see if it would work, or if it had to be redone. (The machines used for recording and playback were the 35 mm magnetic units used primarily in the dubbing process for motion pictures. Many additional units that were capable of just playback were also required for this process. Because of their limited function these playback units were called "dummies.")

Formation of Animatronics:
Following are the process involved in the formation of Animatronics:
1. Design Process
2. Sculpting
3. Mold making
4. Armature Fabrication
5. Costuming
6. Programming.

Design Process:
During the design process, the client and the company developing the animatronics decide what the character will be, its appearance total number of moves, quality of moves, and what each specific move will be. Budgets, time lines and check points are established. Many years have been spent to ensure that this critical step is as simple as possible. Once this critically important stage is solidified and a time line is agreed upon, the project moves to the sculpting department.

Sculpting:
The sculpting department is responsible for converting two-dimensional ideas into three-dimensional forms. This team can work from photos, artwork, videos, models, statuettes and similar likenesses. Typically, the client is asked to approve the sculpting before it goes to the molding department.

Mold making:
The molding department takes the form created by the sculptor and creates the molds that will ultimately produce the character skins. Molds can be soft or hard, single or multiple pieces, and reusable or non-reusable. To get the sculptorâ„¢s exact interpretation, mold making is both an art form and an elaborate technical pro

cess. The process can be very time-consuming and complicated. It can be so unnerving that some animation mold makers even refer to it as black magic.

After the mold is finished and cured, it is ready for skin making. Fiberglass shells are simultaneously being laid up to form the body and limb shapes. Some of these shapes are reusable stock pieces, but the majority of shells are custom made for each character.

Armature Fabrication:
Meanwhile, various body armatures are being created and are assembled in the welding metal-fabricating areas. Each of the robotâ„¢s movements axis points must have an industrial-rated bearing to provide action and long life. Each individual part requires a custom design and fabrication. These artisans are combining both art and technology to achieve realistic, lifelike moves.
As the armature takes shape, the actuators, valves, flow controls and hoses are installed by the animation department. The technicians select those components carefully in order to ensure the durability and long life. As itâ„¢s assembled, each robotic move is individually tested and adjusted to get that perfect movement.

Costuming:
The costume, if there is one, is usually tailored to the character and its movements. Animation tailoring can be a very difficult tedious process considering the variables. The outfit has to allow for easy acces to the characterâ„¢s operating mechanisms. It must also look normal after movement has taken place. The costume must be designed to provide hundreds of thousands of operations without wearing out and without causing the skin areas (i.e. around the necks or wrists) to breakdown as well.

Programming:
Finally, if it is an animated character the electronic wizard moves in to connect the control system into valve assembly in the preparation for programming. Programming is the final step, and for some animations it is the most rewarding. Programming can be done either at the manufacturing facility or at the final installation site. In programming, all the individual moves are coordinated into complex animated actions and nuances that bring the character to life.

10 Laws of Animatronics:
The animatronic characters that perform successfully are almost always in alignment with some fundamental notions. After years of studying and analyzing applications and characteristics, it has been assembled the findings into ten basic laws that govern animatronics success and failure in the entertainment and educational arenas.

1. The law of distance. The greater the distance between the audience and an animatronic character, the more you can get away with in terms of believability. Distance will determine everything from the quality of make-up and hair to how many character movements are necessary to be convincing. In the early Disney animatronics, Walt would never let audiences within 30-40 feet of a life-like human character. Consider the early Lincoln attractions. Abe was located high on a stage – far removed from direct audience contact. Disney knew that Lincoln’s early animatronic movements were not technically sophisticated and distance would help masquerade those limitations – thus increasing believability. More recently, the Madame Tassauds attraction in the Venetian Hotel in Las Vegas has installed an Elvis animatronic utilizing the Law of Distance – hoping to increase the believability of that character.

2. The law of time. The shorter the time animatronics are viewed the less sophisticated a character needs to be. Consider a typical animatronic dark ride application – if the audience is traveling in a moving car at a fairly rapid rate of speed, eye blinks and eye turns would not be a character requirement. Those kinds of movements wouldn’t be seen, appreciated, or add to the experience. On the other hand, the longer a character is seen by an audience, the more sophisticated it needs to be – if the audience is watching a historic animatronic figure tell a two minute story, the audience is going to notice if the eyes do not blink or the arms never move.

3. The law of numbers. The more animatronics performing and/or the more movements each character has increases the total audience “attention” holding time. A single character can only hold an audience for a short period of time without revealing additional movements (surprises). However, multiple animatronics allow interaction between each other and the variety of personalities generally increases the effective performance time. With multiple animatronic characters interacting, it is easier to set up good/bad or right/wrong relationship. That relationship generally helps with Law #7.

4. The law of non-human. Non-human animatronic characters are not judged as critically as human life-like ones. No one really knows what a talking beverage bottle, animated garbage can, or singing chicken is supposed to look like. Hence their movements aren’t judged consciously or even unconsciously by your audience. You can get away with fewer movements and take some real risks with what they do and say!

5. The law of surprises. Revealing surprises helps keep audience attention. Those surprises can be additional animatronic moves, special effects, or just some unusual animatronic act. Life Formations applied this technique on the award winning IAAPA "rapping clown" with his pelvic thrust and cigar that actually lit up and emitted smoke. Disney’s Will Rogers animated figure that performed a lasso trick is another example of this technique.

6. The law of singing. Audiences are addicted to animatronic characters that sing. There is something mesmerizing about things that sing that aren’t human. We have witnessed these phenomena consistently in various venues. For instance, Honeywell had Life formations design and build an animated hospital operating room for a medical administrator’s trade show – a relatively conservative audience to say the least. The booth stopped visitors’ dead in their tracks and the message was burned into their brains with music and singing by the animatronics. People were leaving the hall singing the songs while humming Honeywell’s praises. A side note – Honeywell gathered over 100 qualified sales leads during that show compared to 5 the previous year!

7. The law of personality. Scripting, voice talent, and personality are critical to animatronic character believability. All of these components go hand-in-hand to form a character’s soul. We urge clients to think first in terms of a distinguishable personality when concepting an animatronic character. If the personality is not a given inherent quality, we then urge them to think in terms of famous personalities to reference. We often ask, “If your character could be a film or television star – who would it be?” That identification generally helps set the character design process in motion and makes both the scripting and voice talent selection easier. Be sure to use a script writer who understands the animatron

ic medium and a voice talent that can bring life and personality to the narration.

8. The law of brevity. Brevity in performances is your best friend - leave audiences wanting more. We encourage clients to limit any presentation to a minute or less per animatronics character. This law is simply the most difficult for client's to understand. They typically have an hour of content to share. We constantly remind clients that audiences don't remember much and the secret to being a bore is to tell everything. Note: The law of brevity can be broken by carefully and skillfully incorporating laws 4, 5, 6, and 7. remember – if the audience stays around for an additional performance – you just received the equivalent of an Academy Award for Animatronics Performances.

9. The law of scale. Changing the size and proportions of things helps create audience interest and grabs their attention. For instance, make things that are small, big. For example we designed and built an animatronics talking house for Honeywell's Trade Show booth that stole the Homebuilder's show. The six foot long house came alive and talked about all of the places in a typical home that Honeywell products can be utilized.

10. Law of the edge: If it's appropriate and possible – go over the top with your character – push the edge. The beauty of animatronics characters is their ability to do things that other media cannot and repeat that ability over and over – flawlessly. We encourage clients to push the limits. Show people something they've never seen. Be audacious! Have the spirit of P.T. Barnum! It's show business. Make it funny. Make it crazy. Get their attention! Deliver the message! Risk nothing – gain nothing! Joan Rivers once said"Most stars play it safe because they have too much to lose. Superstars are the ones who throw caution to the wind; improvise impulsively; go for the high note. Superstars give it everything they've got and hold back nothing at all. In a word, the difference is guts." Have guts – get edgy!

How Animatronics works?

1. Creating Animatronics figures:

The first thing that happens with any animatronic figure is that an artist creates preliminary sketches of the creature. The sketches are analyzed and changes are suggested. Eventually, the artist creates a detailed illustration of the creature. The paper sketches are vital. Everything else relies on the accuracy of these designs.

2. Build a Maquette:

From the final paper design, a miniature scale model called a maquette is created. Fashioned out of clay, the first maquette SWS made of Spinosaurus was one-sixteenth scale. This initial maquette is used to verify that the paper design is accurate. If there are any problems, they are corrected and a new paper design is made. The larger maquette allows the designers to add more surface detail.

3. Build a Full-Size Sculpture:

Once the sketches and models are done, the full-size building begins. The maquette is taken to Cyber F/X, where it is scanned by a 3-D digitizer. This is nothing like a normal computer scanner. There are a variety of methods used in 3-D digitizers, one example is laser scanning.

Laser scanning takes precise measurements of the maquette by bouncing beams of laser light off its surface. As the laser scanner moves around the maquette, it sends over 15,000 beams per second. The reflected light from the beams is picked up by high-resolution cameras positioned on either side of the laser. These cameras create an image of the slice (cross section) of the object that the laser is scanning. A custom computer system collects the cross sections and combines them to create a perfect, seamlesscomputer model of the maquette.

Cyber F/X then used the computer model to mill the life-size model of the Sculpture from polyurethane foam. This very rigid foam is cut to the correct shape through a proprietary process called CNC-Sculpting. This process, developed by Cyber F/X, takes the data from the full-scale computer model and divides the model into manageable chunks. The data for each chunk is then sent to the foam-sculpting machine, where a life-size section of the dinosaur is created by whittling away pieces of foam from a large, solid block using tiny spinning blades. Once all the sections are done, now we will assemble the pieces like a giant 3-D jigsaw puzzle. This creates a very basic full-sized model.

4. Molding and Casting:

A set of molds are made of the full-sized sculpture. The molds are made from an epoxy that is very durable and has strong bonding characteristics.

Once the components of the animatronic device are ready, much of the frame work is test fitted inside the molds before the foam rubber skin is cast. In conjunction with this step is the fabrication of the foam-running core, which is created by lining the inside of the mold with precise layers of clay to represent the skin thickness. When the clay lay-up is completed, the surface of the clay is fiberglassed to create the foam-running core. After the clay is cleaned out, the foam-running core is bolted into the mold and creates a negative space between the foam-running core and detailed surface of the mold. When filled with foam rubber, this negative space becomes the skin.

The purpose of this process is twofold:

- It makes the skin movement seem more natural
- It controls the skin's thickness and weight

5. Creature Creation:

Building the various components used in the animatronic device usually takes the longest time. Most of the creatures that are developed require parts that you're not going to find at your local hardware store. Basically, there are four main categories that the work splits into, with development happening simultaneously across the categories:

- Mechanical - SWS engineers design and build the mechanical systems, which include everything from basic gears to sophisticated hydraulics. An interesting fact about the animatronic Spinosaurus is that nearly all of the mechanical systems used in it are hydraulic.

- Electronic - Another group develops the electronic control systems needed to operate the animatronic device. Typically starting from scratch and creating their own custom circuit boards, these engineers are essentially building giant remote-controlled toys. Almost all of the movement of the Spinosaurus will be manipulated by specialized remote-control systems known as telemetry devices. We discuss the specific telemetry devices used in the next section.
- Structural - All of the electronic and mechanical components need something to attach to and control, and the skin must have a frame to maintain its shape. This is done by building a plastic and steel frame. To increase the realism, and because it is the natural way to design it, the frame of the Spinosaurus, as well as most other creatures made by SWS, resembles the actual skeleton of the beast. This skeletal frame is largely comprised of graphite, a synthetic material known for its strength and lightness.
- Surface - The "skin" of the Spinosaurus is made from foam rubber, which is a very light, spongy rubber that is made by mixing air with liquid latex rubber and then curing (hardening) it. While there are other compounds, such as silicone and urethane that are stronger and last longer, foam rubber is used because it is much easier to work with. The solution is poured into each mold and allowed to cure. As mentioned earlier, parts of the frame are embedded with the foam rubber at certain points. To further strengthen the skin, a piece of fabric is cut to size and embedded in the foam rubber after it is poured into the mold. Once cured, each piece of skin is pulled from its mold.

6. Assembling:

When all the components are done, it's time to build the Creature. The frame is put together and then the mechanical systems are put in place. As each component is added, it is checked to ensure that it moves properly and doesn't interfere with other components. Most of the electronic components are then connected to the mechanical systems they will control. The controls have been tested with the mechanical systems prior to final assembly, but the systems are checked again. Parts of the skin that have embedded pieces of the frame in them are put in place when the frame is assembled. The other skin pieces are fastened in place on the frame once the mechanical and electronic components are installed. Assembling the skin is a very laborious process. As each piece is added, the team has to check to make sure there are no problems, such as:

- Unwanted folds
- Buckling
- Stretching
- Too tight

Whenever one of these problems occurs, the skin must be adapted or attached differently. Also, there are places where you do want the skin to fold or hang loose or travel in a certain way, and it must be adjusted to achieve that effect. One of the tricks that SWS uses to make the Spinosaurus and other dinosaurs seem more realistic is to attach bungee cords between areas of skin and the frame. During movement, these bungee cords simulate tendons under the skin, bunching and stretching.

The skin is mostly "painted" before it is attached to the frame. Stan Winston Studio does not use actual paint, though. Instead, a specially formulated mixture that is akin to rubber cement is used. Tints are added to the mixture to get the correct color. Rosengrant says that they use this mixture in place of traditional paint because it bonds more strongly with the foam rubber and stretches with it as the animatronic moves.

Once the animatronic device is complete, the team has to test it and work out any problems.

7. Making it move:

The people that control the animatronic figure are called puppeteers, because th at is all that an animatronic device is -- a sophisticated puppet. These puppeteers are skilled actors in their own right and will spend some time with the animatronic figure learning its range of movements. Rosengrant calls this "finding the performance." The puppeteers are determining what movements make the animatronic figure look angry, surprised, hungry or any other emotions or moods that are called for in the script.

Eight puppeteers operate the Sculpture:

1. Basic head/body – swivels head, opens and closes jaws, moves neck back and forth, makes body sway from side to side
2. Tongue slide levers – moves tongue up and down, side to side and in or out
3. Eye joystick control – eyes move, eyelids blink and eye ridge moves
4. Front arms – full range of motion; hands open and close
5. Cart/body – moves creature back and forth on track
6. Breathing potentiometer – inflated bladder inside chest cavity simulates breathing
7. Tail – full range of motion
8. Body raise slider – raises and lowers body

The coordinator makes sure that all of the other puppeteers are working in concert to create a realistic and believable motion. The telemetry devices used to control the Sculpture range from simple handheld units, reminiscent of a video-game joystick, to bizarre contraptions you wouldn't find anywhere else. For example, the puppeteer who controls the arms has a device that he straps onto his own arms. He then acts out the movement he wants the Sculpture to make, and the telemetry device translates his motion into a control signal that is sent to the circuit board controlling the mechanical components that comprise the arm system of the Sculpture.

Case Study:
Disney Theme Park:

Role of Animatronics in Theme Park:

The development of animatronics began with the development of automata. These were devices that could mimic life-like creatures using clock-work-like devices. The most famous examples include small birds that could move and sing when wound up, and human-like creations that could write entire sentences. The earliest automata may have been created around 520BC, capable of breathing and moving their feet. The most astounding examples were created in the 1700's and 1800's. It is reported that Walt Disney encountered some of these automata and quickly put his imagineers to the task of creating even better examples. Some early creations that resulted from these efforts include Great Moments with Mr. Lincoln, the Enchanted Tiki Room, and Pirates of the Caribbean, The Carousel of Progress, and the Jungle Cruise. Soon, other theme parks latched onto the technology to bring all sorts of characters to life... and the rest is history.

Early animatronics were called "audio-animatronics". Their motions were recorded on magnetic tape as tones. When the tones were played back, they would vibrate reeds, which would close a circuit, operating a relay, which would fire a pulse of electricity to the pneumatics, resulting in motion. Modern animatronics are controlled via computer, and servos are often used instead of pneumatics or hydraulics. Lucky, shown below, is one of the most recent jumps in technology. Lucky, showcased at Disney's Animal Kingdom for a brief time, can walk around on his o wn, fueled by a pile of batteries. Although some puppeteering is involved, Lucky also has some extremely complex programming under the hood helping him to move and react. Force feedback (a.k.a. compliance) has allowed modern animatronics to make faster and more naturalistic movements. In the case of Lucky, the result is wonderful.