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Better Bodies

Bionics

Bionic devices replace or improve normal human body functions. Since the beginning of human history, those people left disabled by wars, accidents, or birth have used artificial body parts to overcome their disabilities. Until the 1500s, anyone losing a limb had their wounds painfully sealed and were given simple wooden "peg" legs or metal hooks to replace them. French surgeon Ambroise Paré helped to change this by designing mechanical limbs to help disabled soldiers get back to a full life, rather than just get by. Since then, prosthetic—or artificial—limb technology has advanced rapidly. Bioengineers have not only built fully functioning bionic limbs, but have succeeded in restoring hearing and heart function with electronic implants.

HELPING HAND

Ambroise Paré (1510–90) was surgeon to four kings of France and a founding father of modern surgery and anatomical science. He was also a gifted inventor who designed prosthetic devices far in advance of anything else available at the time. His masterpiece was an artificial hand with movable fingers operated by gears, springs, and catches.

Bionic leg

When we walk or run, we constantly adjust the way we move to keep balanced. The latest bionic legs use electronic sensors and computers to detect changing loads on the foot, ankle, and knee and make the adjustments automatically.

Stepping out *Hydraulic components extend the leg as it swings through the air ready for the next step.*

Bionic foot *The best prosthetic feet do not rely on computers or motors—they are carefully crafted springs that return energy at the end of each step.*

Bionic arm

Standard prosthetic arms are not connected to nerves, so are difficult to control and awkward to use. Bionic arms, however, can be controlled using the user's own nervous system. With this design, nerves leading to the missing arm are redirected to the chest, where electrodes attached to the bionic arm can pick up impulses and use them to direct arm movements.

Thought that counts *Although this man has lost an arm, the part of the brain responsible for movement still functions as if it were there. When he thinks about moving his left arm, nerve impulses are sent out just as they are when he wants to move his healthy right arm.*

Nerves *The nerves that would normally run toward the left arm have been surgically redirected to the muscles in the chest.*

Electrodes *Electrodes detect the nerve impulses where they connect with the chest muscle and relay them as electrical signals to the bionic arm.*

Movement *A computer processes the signals and directs the arm to perform certain movements such as bending the elbow, opening and closing the hand, and extending the wrist.*

Radial nerve

Median nerve

Ulnar nerve

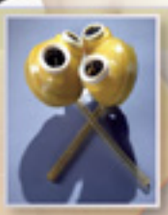
TIMELINE

BIONICS

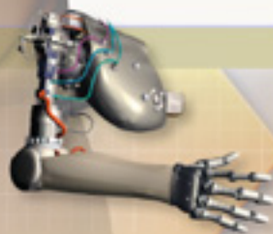
c. 300 BC Prosthetic limb
The oldest known artificial limb is a Roman wood and bronze leg dating from about 300 BC. Until recently artificial legs simply bridged the gap between stump and ground.

1923 Electric hearing aid
Austrian doctor Ferdinand Alt invented a crude electric hearing aid in 1906. His design was improved by adding vacuum tube amplifiers. Portable hearing aids were available from 1923.

1960 Cardiac pacemaker
American engineer Wilson Greatbatch built the first cardiac pacemaker. His invention delivers regular pulses of electrical current to the heart, keeping heart condition sufferers alive and well.



1969 Artificial heart
The first totally artificial heart was implanted in a patient in 1969. Even with current technology, they are a poor substitute for a transplanted donor heart.



1993 Bionic arm
Biomedical engineers in Scotland built the first robotic prosthetic arm in 1993. Now bionic arms can be precisely controlled, and even a sense of touch restored to the patient's existing nerves.

Quick Thinking

Computer

In many ways, the digital computer is the ultimate human invention. Much as telescopes extend our eyes and radios our ears, computers allow us to process information faster and more accurately than we could ever hope to do ourselves. The first computers were simple counting and calculating devices like the abacus. The first mechanical calculators appeared in the 1600s. Computers were improved—or rather, reinvented—during the last century, alongside developments in electronics. Within 10 years of the first, room-size electronic machines, smaller, faster devices based on transistors became available. Within 20 years, computers had powerful microprocessors. Today, computers are part of almost every home, school, and business in the developed world and are built into machines that keep the modern world functioning.

Compact computing

Laptop computers house all the essential elements of the first electronic computers, but are over 200 times smaller and thousands of times more powerful. Through clever design, a laptop packs computer circuitry, keyboard, display screen, memory drives, and power supply into a single, lightweight, portable package.

Central processing unit (CPU) *At the heart of the computer is the CPU—a data-crunching printed circuit on a tiny chip of silicon.*

Keyboard *The keyboard has its own microprocessor chip, which handles signals from switches beneath each key.*

Touch pad *The touch pad senses finger movement and pressure and converts it into an electrical signal. This avoids the problem of finding a flat surface for a mouse when on the move.*

Hard drive *Huge amounts of data are stored magnetically on the spinning, mirror-like disk of the hard drive. This allows the computer to store data even when switched off.*

Fan *Microprocessors get hot as they work. Small fans keep them from overheating.*

OLED screen *Pixels within thin films of colored organic molecules light up as they are supplied with electricity, producing a bright, colorful screen display.*

Battery *Laptops are powered by lightweight batteries that can last up to eight hours between recharges.*

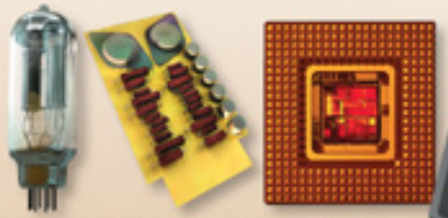
CD/DVD Drive *Text, audio, image, and video files stored on CDs or DVDs can be accessed by a reader head and transferred back and forth between the hard drive and DVD drive.*

Motherboard *The motherboard houses the microprocessor and other computer circuits, connecting them to one another, to the power sources, and to input and output devices.*

Mouse *A light-emitting diode (LED) and sensor tracks the movement of the mouse across a surface.*

LOGIC SWITCHES

All electronic computers are based on electronic switches or gates. Each one processes information using three basic logic operations—AND, OR, and NOT. When these switches are arranged into huge, interlinked circuits, they can process many kinds of data very quickly. Early computers used lightbulb-size vacuum tubes (or valves) to build these logic circuits. Later models used smaller and more powerful electronic transistors, and eventually thousands of microscopic transistors were combined on the surface of one silicon chip.



Vacuum tube | Transistor circuit board | Silicon chip

TIMELINE

THE COMPUTER

c. 2500 BC Abacus
The ancient Babylonian abacus was little more than a set of pebbles shifted between marks on the ground or on a wooden board. Later, the Chinese developed more advanced counting devices using wires and beads.

1642 Mechanical calculator
French mathematical genius Blaise Pascal built the world's first adding machine to help his father calculate taxes. Using mechanical gearing, it could add numbers up to eight digits long, but could not subtract, divide, or multiply.

1849 Difference Engine No. 2
Englishman Charles Babbage designed several "engines" that could perform complex calculations to 30 decimal places. These had many elements of the modern computer, such as memory, processors, and programs.

1951 UNIVAC electronic computer
UNIVAC was the first commercially sold multipurpose computer. Its thousands of vacuum tubes, circuits, and magnetic memory drums took up an entire room, and it often broke down.

1971 Microprocessor
Microprocessors cram thousands of circuits onto tiny silicon chips. They led to computers that were vastly smaller, cheaper, and more powerful than previously thought possible.