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HUMAN 2.0

THE EVOLUTION OF BIONICS

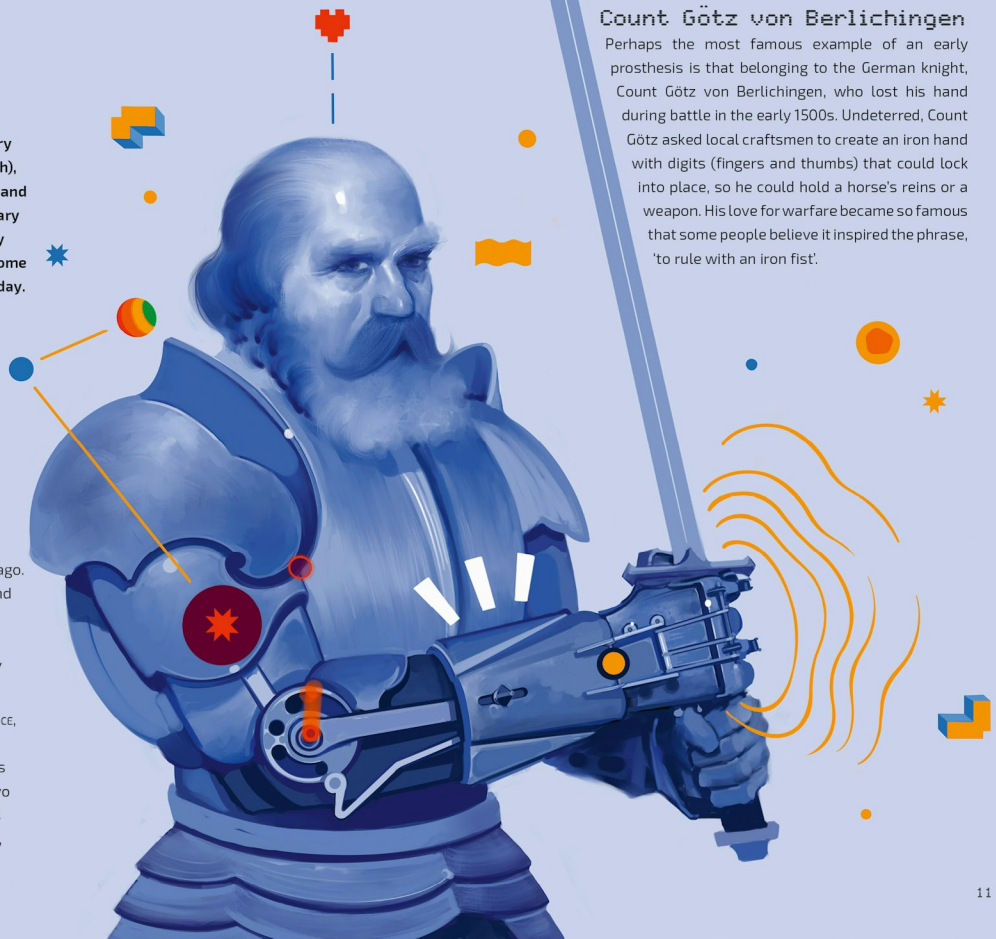
BIG PICTURE PRESS

THE FIRST PROSTHESES

For as long as humans have been around, we have been losing limbs, or are born without them. Whether due to an injury or congenital impairment (a condition that is present from birth), people have been trying to replace missing arms, legs, fingers and toes for thousands of years. Early prostheses were revolutionary for their time, yet their inventors did not having the technology needed to provide better functionality and comfort. Even so, some of these early prostheses closely resemble those that exist today.

The earliest-known example of a prosthesis (an artificial body part) belonged to an Egyptian noblewoman almost 3,500 years ago. This wooden prosthesis replaced the big toe on her right foot, and even had a ridge in the shape of a nail carved into it to make it appear more realistic. It would have been strapped onto her foot with string, and scientists believe that it would have greatly aided her balance.

The earliest-written mention of a prosthesis dates to around 77 CE, and describes the iron hand belonging to the Roman general Marcus Sergius. Sergius was said to be one of the finest generals of his time, especially because of his bravery in battle. Across two campaigns he was wounded 23 times, resulting in the loss of his right hand. Sergius's replacement hand was strapped to his arm, perhaps allowing him to hold a shield for future battles.



Count Götz von Berlichingen

Perhaps the most famous example of an early prosthesis is that belonging to the German knight, Count Götz von Berlichingen, who lost his hand during battle in the early 1500s. Undeterred, Count Götz asked local craftsmen to create an iron hand with digits (fingers and thumbs) that could lock into place, so he could hold a horse's reins or a weapon. His love for warfare became so famous that some people believe it inspired the phrase, 'to rule with an iron fist'.

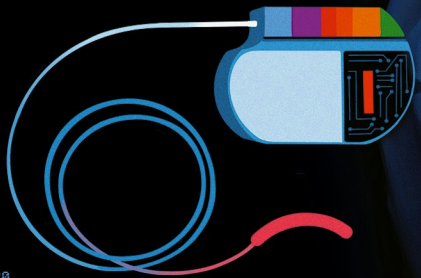
HOW PACEMAKERS WORK

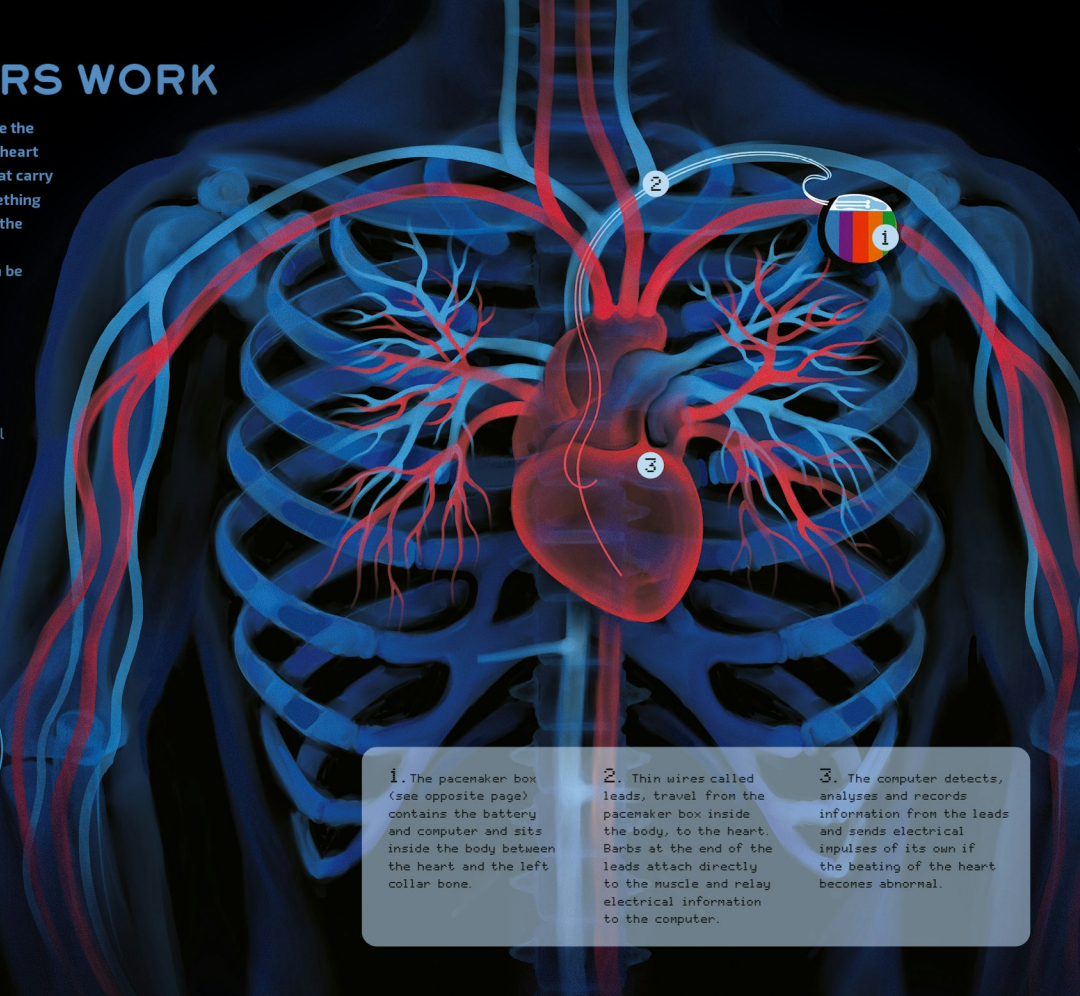
Pacemakers are small devices that monitor and regulate the electrical impulses controlling the heart. Normally, the heart regulates its own beating through a network of cells that carry electrical currents. These cells are coordinated by something called the sinoatrial node, which is often referred to as the 'natural pacemaker'. Medical conditions that affect the sinoatrial node, or any of the cells under its control, can be dangerous and require a pacemaker to correct them.

There are different types of pacemaker for different heart issues, but the basic idea behind them is the same. By sending electrical impulses only when irregular beats are detected, pacemakers mimic the role of the sinoatrial node and keep the heart functioning as it should.

Inside the pacemaker box

The battery lasts about six years. It gives plenty of warning when it is running low, and doctors monitor it closely.





1. The pacemaker box (see opposite page) contains the battery and computer and sits inside the body between the heart and the left collar bone.

2. Thin wires called leads, travel from the pacemaker box inside the body, to the heart. Barbs at the end of the leads attach directly to the muscle and relay electrical information to the computer.

3. The computer detects, analyses and records information from the leads and sends electrical impulses of its own if the beating of the heart becomes abnormal.

PROSTHETIC HANDS THROUGH THE AGES

Hands are one of our most valuable and versatile body parts. We use them to pick up objects, use tools and feel textures, but also to communicate and bond with others through touch and expressive gestures. It comes as no surprise that humans have been desperate to replicate hands for those who were born without them, or lost them through accidents, injury or disease. Because of the huge variety of tasks we use our hands for, this has been incredibly challenging, but it is fascinating to look back on over 500 years of advancement.

Early History

For almost as long as humans have roamed the Earth, there is evidence of tools being used as early prosthetic hands, including hooks, clamps and knives, which were strapped to the body. These were limited to performing just one function and did not come close to the complexity of a human hand.

Götz von Berlichingen, 1500s

The most notable attempt to mimic nature was the iron arm worn by the German knight Götz von Berlichingen who lost his right hand in battle (see page 11). This advanced early prosthesis could bend at the knuckles, allowing Götz to hold the reins of a horse, or even a weapon. However, it was so heavy it would have needed to be strapped to his body.

Ambroise Paré, 1575

French military surgeon Ambroise Paré popularised amputations as a means to save a soldier's life on the battlefield. He drew designs of a spring-loaded hand that could be locked to hold an object. Early in the next century, prostheses began to be designed for everyday use.

Bowden Cable Control System, 1948

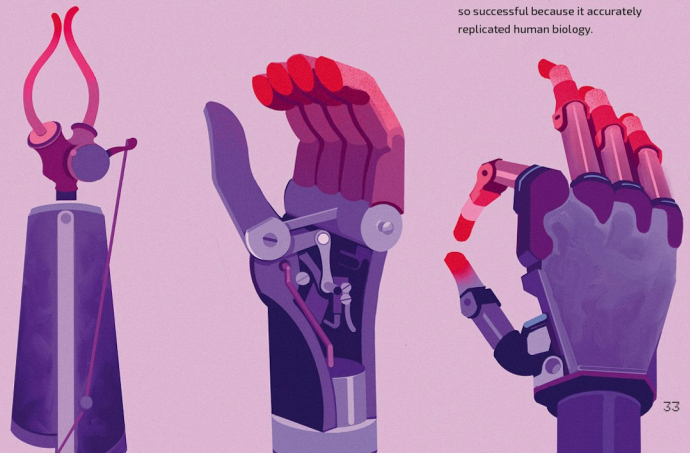
Both the First and Second World Wars resulted in a large increase in the population of people with arm amputations, so prosthetic hands began to receive more attention and investment. The first big success was the Bowden prosthesis, which was an affordable and reliable device that used cables to open and close a three-pronged hook. The cables were tied around the wearer's torso. Because of their simplicity and durability, these devices are still used around the world.

Myoelectric device, 1948

Myoelectric devices are the most common type of lower arm prosthesis today. Scientists developed them to introduce electrical signals to control the prosthetic hand more naturally. The first myoelectric device was invented by German physics student Reinhold Reiter and had motorised fingers. However, the device was bulky and couldn't be used for everyday situations. It wasn't until 1990 that myoelectric sensors were suitable for fitting inside prosthetic sockets.

i-LIMB®, 2008

Technology evolved to make prostheses, and the sockets they attach to, lighter, more durable and more realistic. In 2008, tech company Touch Bionics released the i-LIMB®, the first prosthetic hand to have five independently powered digits that could bend at the joints. This revolutionary device became so successful because it accurately replicated human biology.

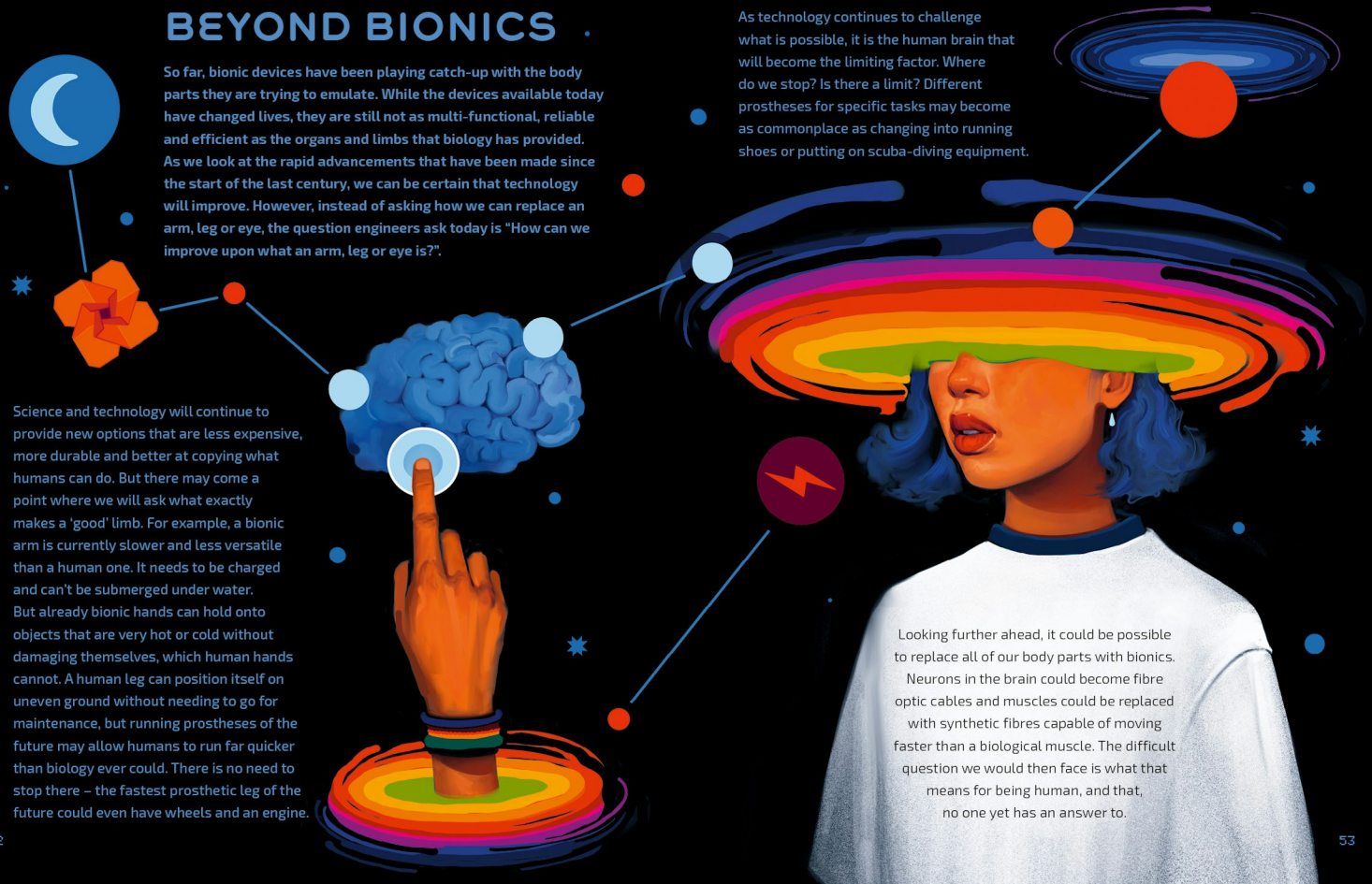


BEYOND BIONICS

So far, bionic devices have been playing catch-up with the body parts they are trying to emulate. While the devices available today have changed lives, they are still not as multi-functional, reliable and efficient as the organs and limbs that biology has provided. As we look at the rapid advancements that have been made since the start of the last century, we can be certain that technology will improve. However, instead of asking how we can replace an arm, leg or eye, the question engineers ask today is "How can we improve upon what an arm, leg or eye is?".

Science and technology will continue to provide new options that are less expensive, more durable and better at copying what humans can do. But there may come a point where we will ask what exactly makes a 'good' limb. For example, a bionic arm is currently slower and less versatile than a human one. It needs to be charged and can't be submerged under water. But already bionic hands can hold onto objects that are very hot or cold without damaging themselves, which human hands cannot. A human leg can position itself on uneven ground without needing to go for maintenance, but running prostheses of the future may allow humans to run far quicker than biology ever could. There is no need to stop there – the fastest prosthetic leg of the future could even have wheels and an engine.

As technology continues to challenge what is possible, it is the human brain that will become the limiting factor. Where do we stop? Is there a limit? Different prostheses for specific tasks may become as commonplace as changing into running shoes or putting on scuba-diving equipment.



Looking further ahead, it could be possible to replace all of our body parts with bionics. Neurons in the brain could become fibre optic cables and muscles could be replaced with synthetic fibres capable of moving faster than a biological muscle. The difficult question we would then face is what that means for being human, and that, no one yet has an answer to.