

innovation
by the nation
report



foreword

As an interactive bank, cahoot values change and innovation - our business was created to challenge tradition as a different type of bank with a different way of banking. The impact of online banking on the way many people manage and access their finances is evident. We strive to make banking convenient, safe and easy by constantly evaluating and evolving to meet our customer needs: for example, the facility to bank via the web 24 hours a day, 365 days a year; webcard™ (a secure solution to online shopping) and our flexible loan which offers a totally different approach to bank loans.

When commissioning the 'Innovation by the Nation' report, we were keen to find out which innovations, however small, have had the most practical impact on British lives. Developed by Professor David Harrison at Brunel University, the following report offers not just information about the top ten innovations and their origins but also draws some conclusions as to why British people voted this way.

One of the most interesting conclusions of the report is that we value safety, communication and convenience in our lives. This may be a result of the 'Information Age' or 'Second Industrial Revolution; a wave of digital networks, software and new media that has opened up the world to us and made us more aware of our need to protect ourselves, our families and our homes. Whatever the reasons, safety, communication and convenience have obviously influenced the way we voted, as the 'Top Ten' clearly shows.

Signed by

Deborah Cutler
Marketing Director, cahoot



introduction

Top Ten Innovations

1. Smoke alarm
2. Mobile phone
3. Microwave oven
4. Digital camera
5. DNA testing
6. Laser eye surgery
7. Air bags
8. Cash and debit cards
9. Long life, low energy light bulbs
10. ABS brakes in cars

The humble smoke alarm was voted the country's top practical innovation in a poll commissioned by cahoot, the Internet bank. The smoke alarm won 69% of the vote, from a nationally representative poll of 2000 people. The closest competition came from the mobile phone (61%) and the microwave oven (52%). The Top Ten Innovations poll asked individuals to choose their top ten practical innovations from a list of twenty-five which have come into common use over the last twenty years. (Design lecturers at Brunel University drew up the initial list of twenty-five.) The results reveal that what we really value in our innovations is safety, communication and convenience.

This reports examines the origins of the top ten innovations, explains briefly how they work, and considers the impact they have made on people's lives.

what our choices say about us as a nation

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Many of us live time-pressured lives, always on the move. In the poll we see people opting for a number of time saving, convenient innovations. The UK public is buying time to cope with the pressures of home and work. Four of the top ten choices can be linked to convenience: the microwave, cash and debit cards, the mobile phone, and long-life light bulbs.

There is also great interest in safety, reflected by the choices of smoke alarms, airbags, antilock braking systems (ABS) and to some extent, the mobile phone. Are we increasingly looking to technology for security and reassurance, as family and community support declines? Or are these innovations an inevitable result of our ability to make more intelligent, responsive products?

The poll reveals an interesting variation in attitudes across the regions. For example, the final choice of the smoke alarm might come as a surprise to many young Londoners. (Only 42% of Londoners voted for the smoke alarm). However, 83% of safety conscious East Anglians chose this life-saving technology over the more glamorous consumer products, such as mobile phones and digital cameras. This may be because if you live in a rural area, it can take far longer for a fire engine to arrive.

The smoke alarm was also a very popular choice with women, winning 76% of women's votes, compared with 63% of men's, highlighting its key role in keeping the home safe. Women generally voted for the more home related innovations such as microwave ovens, while men voted for gadgets such as MP3 players, DVD players and digital cameras. So why are men more attracted to these "boy's toys"? Perhaps in part it's about status. They're small enough to put on the table in the pub, while the car stays outside.

In picking the smoke alarm as a nation, we have gone for a product that fulfils one of our most basic needs, that of having a safe place to live. In contrast, the mobile phone is a truly multifunctional product that we use to communicate, access the Internet and store information. It meets a much wider range of needs, including safety, self-esteem and status.

Two of the top fifteen innovations came from Britain. When viewed in the light of the 193 countries in the world, this confirms Britain's predominant role in innovation. The US however, has been the dominant industrial power for the last century and the driving force behind much 20th Century innovation. In this poll, eight of the top ten have significant input from the US. So why do we produce a disproportionate number of designers and innovators? This has something to do with our education system, which values creativity above conformity.

differences in responses related to sex

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The poll showed clear differences in responses related to the sex of interviewee. The greatest difference (14%) was for ABS brakes, which were chosen as a good innovation by 39% of men but only selected by 25% of women. This difference may indicate that ABS is still seen as a "boy's toy", an expensive option on luxury cars favoured by those who like to push their car to the limit. However, it may simply indicate that women are less interested in the technology of cars. ABS is now a compulsory feature on cars made in Europe, so its association with high performance, high status, luxury cars is likely to eventually decline.

Another innovation that was significantly favoured by men was digital recording equipment (DVD and MP3 players in particular), with 29% of men in support, compared to 20% of women. This compares interestingly with the digital camera, where there was only a 4% difference between men and women, with 44% of men voting positively, as opposed to 40% of women. Perhaps not surprisingly there seems to be greater interest amongst women in products for recording images than in playing music. This may also be due to interests in recording family life in pictures.

In contrast, there was a difference of 13% in preference for the smoke alarm, with 76% of women voting for the smoke alarm, compared to 63% of men. This may be an example of women having a stronger focus on safety in the home. Also, 58% of women voted for microwave ovens, compared to 46% of men, doubtless showing a greater interest in convenience in cooking. This does suggest that sex roles are still not equal when it comes to preparing food.

difference in responses related to age

cash and debit cards were particularly popular in the survey with young people, getting a 36% return from 16-34 year olds

The greatest difference in response across the age ranges was 20%, for the microwave oven. 60% of over 65s voted for the microwave, compared to 40% of 16-24 year olds. The microwave meets the needs of older users for simple, convenient and economical preparation of meals, often for households with only one member. It is also necessary for the heating of some "meals-on-wheels" provided by Social Services. In contrast, many 16-24 year olds are still living at home (where prepared meals may still magically appear, courtesy of parents), or they may eat out in canteens, pubs and fast food halls. Another possibility is that they may simply not regard the microwave as an innovation. A twenty year old will have grown up during the diffusion of the microwave into British households, and for them, it will always seem to have been there.

Cash and debit cards were particularly popular in the survey with young people, getting a 39% return from 16-34 year olds, compared to 25% from over 65 year olds. Cash cards are all about convenience - instant money anytime, anywhere, and perfect for young people on the move.

There was also a significant difference (18%) between the 55% of 45-54 year olds who voted for the digital camera, compared to the 27% of over 65s. This indicates that people of middle age are early adopters of these high-tech products, perhaps largely because they have the disposable income to satisfy their interest and curiosity.

regional variations in response

DNA testing, which came fifth overall, was very popular in the east midlands, getting 60% of the vote. there could be an element of local pride in this, as DNA testing was invented in leicester

People from the East Midlands were generally the most positive about innovations, scoring the highest ratings for DNA testing (60%), laser eye surgery (53%), air bags (54%), cash and debit cards (47%), bulbs, (44%) and ABS brakes (46%). This contrasted strongly with Londoners who consistently seemed unimpressed, rating DNA testing at 30%, laser eye surgery at 28%, air bags at 26%, bulbs at 21%, and ABS brakes at 17%. Perhaps this is due to Londoners' greater exposure to waves of change and novelty, leading to "innovation fatigue" and scepticism.

DNA testing, which came fifth overall, was very popular in the East Midlands, getting 60% of the vote. There could be an element of local pride in this, as DNA testing was invented in Leicester. It may also be that we are a nation of sofa-bound criminal investigators, fascinated by the latest methods for fighting crime. Or the vote could be boosted by media interest in celebrity paternity suits. Most significantly though, DNA testing is the first technology to spin out from the huge advances in genetic science and really impact on our daily lives.

Long-life, low energy light bulbs were popular in the East Midlands, and got 33% of the vote overall. Does this mean that green issues are finally entering the British mind set - or is it that the low running cost, (up to six times less than conventional bulbs), combined with the attraction of them lasting ten times as long is finally winning round consumers? Consumer inertia is generally greater with more utilitarian products, with the diffusion of innovations taking longer. However, a number of energy saving campaigns have emphasised the benefits of low energy bulbs, and with an ageing population, replacing a light bulb may no longer be a trivial task.

no one ever has much of a relationship with their smoke alarm, yet the smoke alarm won out over the mobile in this poll, because it meets our most basic needs for safety and security

basic needs win out over relationships with technology

No one ever has much of a relationship with their smoke alarm, yet the smoke alarm won out over the mobile in this poll, because it meets our most basic needs for safety and security. In contrast, for many people the mobile is a trusted friend - a friend they'd rather not be without. A study by the Italian Consumer Association looked at the effect of depriving 300 volunteers of their phones for two weeks. Nearly one in six reported loss of appetite or depression, and a quarter confessed that being phone-less was a blow to their confidence that led to sexual problems with their partners.

So what builds our relationship with products like the mobile phone? Psychologist Susan Weinstein cites satisfaction of user needs, product behaviour that fits expectations and responsiveness to the user's actions as important factors. She identifies factors that inhibit a relationship as the user feeling a lack of control, the product failing to respond appropriately, or (in the case of a web site), asking for a commitment too early in the user's exploration.

Request for early commitment is not a common problem with the smoke alarm, but we rarely, if ever, get to see the product perform for real. Its responsiveness for most of us is limited to signalling that we've burnt the toast. This lack of interaction prevents us from forming strong bonds with this product. But we do have trust in this technology. This may be because of extensive government advertising - or perhaps because of the associations with the fire service, one of the most trusted of the emergency services.

1 origins & impact of innovations, the smoke alarm

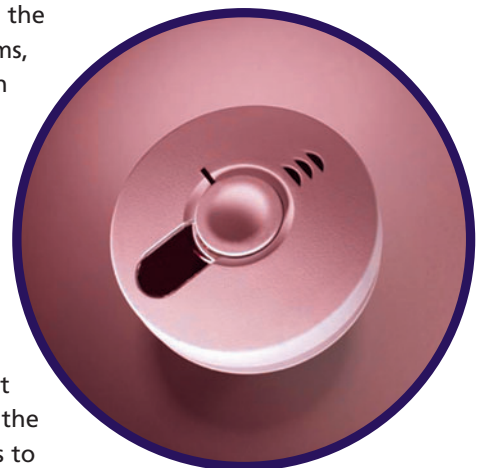
origins

Fear of fire runs very deep in all of us. It's something primal, a response that has evolved over tens of thousands of years. But cheap, mass-produced alarms for the home are a relatively recent innovation. In 1969 Randolph Smith and Kenneth House filed the patent for the first battery-powered alarms, allowing devices to be cheaply installed in the home. Domestic smoke alarms save hundreds of lives each year.



how they work

Smoke alarms consist of a device to detect smoke, and a loud horn or alarm to alert the user to danger. There are two approaches to smoke detection based on either a photocell or an ionisation chamber. The photocell approach is better for smoky, smouldering fires with large smoke particles. The ionisation chamber gives better detection of flash fires, which produce smaller smoke particles.



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there were an estimated 300,000 fires in UK homes in 2003

The photocell approach uses a beam of light shone into an L-shaped tube from a photoemitter. When smoke particles enter the tube they reflect some of the light round the "L" bend onto a photocell or photo-detector, and the light falling on the photo-detector triggers the alarm.

Detectors based on ionisation chambers are now more widespread, as they are better at sensing the smaller smoke particles from flaming fires. An ionisation chamber consists of two metal plates on either side of a small chamber, which are connected to a battery. A very small radioactive source is mounted inside the chamber. The alpha radiation from this source ionises oxygen and nitrogen atoms in the air in the chamber creating positively and negatively charged particles, which are attracted to opposite ends of the chamber, creating a flow of current. If smoke enters the chamber the smoke particles attach themselves to the charged particles, neutralising them and reducing the flow of current. This is detected by an electronic circuit, which trips off the alarm. (This approach has one big advantage for domestic alarms: as the battery starts to go flat, the flow of current is reduced and the alarm triggered, reminding us to replace the battery.)

impact

Domestic fires claim nearly four hundred lives each year in the UK, but smoke alarms give precious minutes to get to safety. (There were an estimated 300,000 fires in the home in 2003). However, statistics show that one in four smoke alarms fail to operate because they do not have a battery, or the battery is flat. Working smoke alarms save lives.

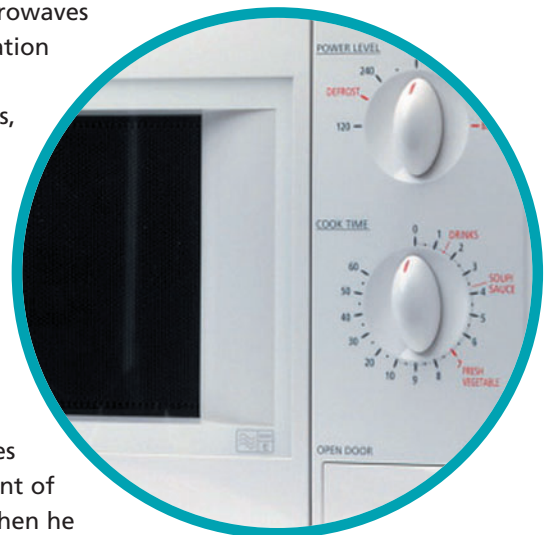
2 the microwave oven

origins

The microwave oven has its roots in the magnetron, a device that produces microwaves developed in Britain for radar systems during the Second World War. (Microwaves are a form of electromagnetic radiation with wavelengths of centimetres, which reflect well off metal surfaces, but pass easily through the atmosphere).



It was the American inventor Percy LeBaron Spencer who made the conceptual leap of using microwaves for cooking. He was standing in front of a magnetron while touring a lab when he felt a strange sensation in his pocket. It turned out that the chocolate bar in his pocket was melting. Realising this was due to the microwaves, he experimented with heating popcorn, and then an egg. The egg exploded, leaving his assistant with yolk on his face, and Le Baron Spencer with a valuable patent for microwave cooking.



Raytheon demonstrated the first microwave oven in 1947, calling it the "Radarange". It was over five feet tall and cost over \$2000.

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how they work

Microwave ovens use relatively high frequency electromagnetic waves to heat up water molecules in food, cooking the food from the inside out. Water molecules are "polar", that is, one end is positively charged and the other is negatively charged and because of this they tend to line up in a particular way in an electric field.

The microwave energy in the oven has an electric field, which reverses billions of times a second, flipping the water molecules backwards and forwards at 2.45 gigahertz or 2,450,000,000 times a second. As they rapidly rotate, some water molecules bump into each other and heat up, cooking the food. Plastic, glass plates and cups don't heat up in microwave ovens, because they don't contain polar molecules that absorb energy.

impact

The microwave has changed the way we cook. For busy, busy people, it's a domestic godsend - speed and convenience on a plate. Equally, for those who can't cook or won't cook it provides a handy 3-minute solution, usually in a box.

For the more 'traditional' kitchen goddesses, the microwave is possibly the worst modern gadget to be introduced to the kitchen. To quote Delia Smith:

"I truly have tried.... and we had a microwave to heat things in (during) filming but actually we mainly used it to keep the ashtrays in. I think it takes the soul out of food" (The Times 1990).

Soul-stealer or not, this was 14 years ago and technology has advanced, so even Delia may have changed her mind.

3 the mobile phone

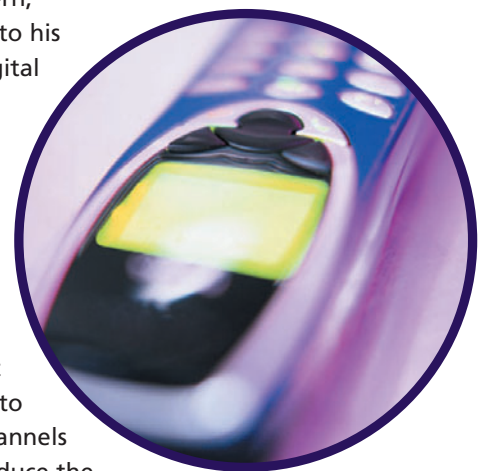
origins

The mobile phone is a very successful marriage between two technologies: the telephone, invented by Alexander Graham Bell in 1876, and radio patented by Marconi in 1896. Bell Labs introduced the idea of cellular communications for police car radio in 1947. However, Dr Martin Cooper of Motorola in the US is considered the inventor of the first modern, portable handset. He made the first call (to his rival at Bell labs) in 1973. The smaller digital phones that replaced the earlier "brick" phones were developed in Europe in the late 1980s.



how they work

A mobile phone is essentially a radio, but one which uses a cunning system of cells to reduce the total number of frequency channels required to operate the system and to reduce the power and therefore size of the equipment. An area is divided up into cells; in densely populated areas these may have a radius of only 50 to 300 metres. Each cell has a base station with a radio transmitter and receiver. Because the mobile phone is close to at least one of the base stations, the phone and base station can both use low power transmitters. The signals do not reach beyond adjoining cells, so the same frequencies can be used in



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non-adjacent cells across the city. This allows millions to use their phones, but take up relatively few frequencies. On the digital GSM phones used in Europe, clever signal compression packs even more conversations into the same bandwidth. One spin-off of the cell system is a service that allows parents to track their children via their mobiles. It is possible to tell which is their nearest base station and locate them to within 50m in some cases. The same approach has even been used to catch thieves using stolen mobiles.

impact

The mobile phone has radically changed the way we communicate. To business people, the mobile is an extra briefcase, to teenagers, a means for expression and to the rest of us...Love them or hate them, the mobile has the ability to evoke emotion in us all.

"Hello. I'm on the train." has come to symbolise the addictive relationship that we seem to have developed for multi-tasking and doing things on the move. Will we revolt and sever the 24/7 communication cord, or will we embrace constant communication, all day everyday?

The mobile has also gone some way to reducing fear of crime, but ironically is also a significant cause of street crime.

4 laser eye surgery

origins

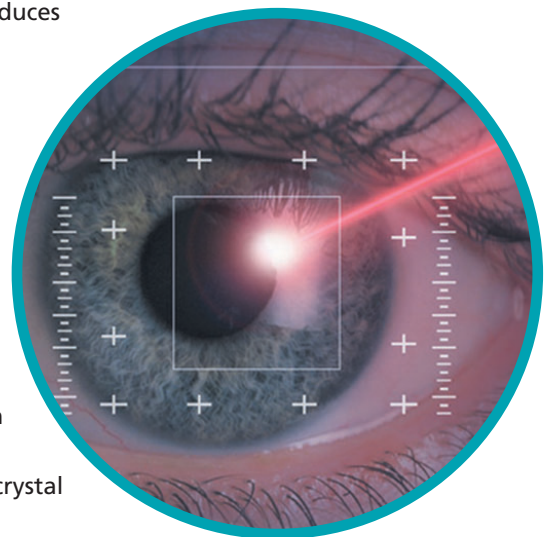
In 1981 Rangaswamy Srinivasan used an ultraviolet Excimer laser to etch living tissue. Two years later he collaborated with an ophthalmic surgeon, Dr Steven Trokel, using a laser to etch a cornea. This laid the foundations for today's procedures for laser surgery to correct short sight. The first patient to undergo laser vision corrective surgery was treated in Germany in 1988.

how they work

The laser is a device that which produces intense "coherent" light. In 1960 American physicist Theodore H Maiman built the first laser, using a crystal of ruby around which he wrapped a coiled flashlight tube.



Light energy is injected into the crystal. It is stored briefly, and then reflected backwards and forwards between the mirrored ends of the crystal until it emerges through the semitransparent area at one end of the crystal as an intense red beam. The type of laser used in eye surgery is an Excimer laser, which uses a mixture of argon and fluorine gases to produce ultra violet (UV) light. This UV laser beam breaks the molecular bonds between cells and vaporises tissue one layer at a time.



Lasers have a number of very valuable applications in eye surgery. One common

procedure is to repair a detached retina, the "screen" at the back of the eyeball. The laser is used to perform tiny "welds" to hold the retina in place. The patient suffers no serious discomfort and does not need anaesthetic. Before the advent of the laser this type of repair was very difficult to perform. Another procedure, which has become increasingly common over the last few years, is laser surgery to correct long or short sight.

The laser is used to cut a small flap of material in the cornea of the eye. The flap is then folded back and either the laser or another cutting tool is used to remove material from the eyeball beneath, reshaping the eyeball and reducing the visual distortion. Some 100,000 people underwent this procedure in the UK last year. Recovery times are very short and many people find that their sight is much improved.

5 air bags

origins

Airbags were invented by John Hetrick in the US, in 1952. Following an accident in which he ended up in a ditch, John felt there should be some sort of device which could reduce the interior impact. He is quoted as saying, "As I applied the brakes both my wife and I threw up our hands to keep our daughter from hitting the dashboard. There was soft mud in the ditch, so the car wasn't damaged and no one was hurt. During the ride home I couldn't stop thinking about the accident. I asked myself, 'Why couldn't some object come out, to stop you from striking the inside of the car?'" Whilst thinking about possible solutions, he remembered he had once seen a canvas cover over a torpedo inflate very rapidly with compressed air. This gave him the idea for his canvas air bag.



In his patent, the canvas bag was inflated by compressed air from a cylinder released by a valve triggered mechanically by the impact. Although Joe had foreseen the key elements of current airbag systems, his approach could not have triggered and inflated the bag within the forty microseconds required to be effective. It took thirty years of further technological development before effective, practical products were available.

In 1966 a new detonating valve developed by the US Army was applied to air bag design by researchers at Eaton, an automotive research centre. When a sensor was tripped, the detonation released nitrogen gas into a nine-foot nylon bag. Based on the success of this technology, Ford planned to launch an airbag in 1971, but it was scrapped due to concerns over child safety. GM carried out field trials of airbags in 1973, and offered them to the public in 1974. However, only 10,000 of the planned production run of 100,000 were bought, and the product was withdrawn. Airbags reappeared on the Mercedes in the early 1980s and have gradually become more popular.

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how they work

A sensitive accelerometer monitors the deceleration of the car. If this exceeds certain limits, it is assumed that a collision has taken place. Current is passed through a wire in the detonator, causing gas to be generated and inflate the air bag within microseconds.

impact

Over three thousand people in the UK were killed in car accidents in 2002 and almost 36,000 were seriously injured. Advances in airbag technology have allowed many drivers to escape death and regulations now require that cars made in the US have driver and passenger-side airbags. However, some accidents are attributed to drivers not taking sufficient care because they feel protected by their technologically advanced cars. This is potentially a problem, as safety innovation has been seen to provoke changes in driving behaviour.

6 ABS brakes for cars

origins

Conventional car brakes can "lock up" when you try to stop suddenly on a slippery road. The wheels stop rotating and the tyres skid and slide uncontrollably across the road surface. (The resistance to sideways motion from a skidding tyre is only 10% of one which is rotating). Some advanced drivers developed a technique of pulsing the pressure on the brake pedal to delay the onset of skidding - and a similar approach is taken in the anti lock brake systems first patented by German engineer Karl Wessel in 1928. However, Wessel's design was never built and it was not until 1970 that an ABS prototype appeared on a vehicle. (ABS is derived from the German word Antilockiersystem). The early prototypes were not very reliable and it required the development of miniaturised digital electronics before Bosch started the first series production in 1978.



how they work

A speed sensor monitors the rotation of the wheels, looking for the very rapid deceleration, which only occurs when a wheel has "locked up" and ceased to rotate.

When this is sensed, it indicates the car has started to skid. At this point valves in the hydraulic brake lines are opened briefly, reducing the pressure on the brake pads, and allowing the wheel to rotate and the car to stop skidding. A hydraulic pump is then triggered to make good the loss of pressure from the opening of the valve. This sequence then repeats automatically, braking the wheel as rapidly as possible without potentially dangerous skidding occurring.

impact

ABS brakes do provide the shortest stopping distances on slippery surfaces and they do allow you to steer until you stop. Advances have also meant that cars equipped with ABS are able to stop 10% quicker than non-ABS cars, which

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means that a non-ABS car braking from 60mph is still travelling at 18mph when the ABS car stops. This 18mph difference could mean life or death when a driver tries to avoid hitting a pedestrian.

However, several studies have shown that ABS systems do not significantly reduce the number of accidents. This is a classic example of "risk compensation". Just as school children pull riskier stunts when they have "bouncy asphalt" in their playgrounds, ABS seems to make drivers more confident about driving faster and braking later.

7 DNA testing

origins

DNA testing or genetic finger printing was invented by Sir Alec Jeffries in the UK, in 1984. It provides a method of identifying individuals from the unique DNA sequences in their blood or other body fluids.

By 1987 it had been used as key evidence in the conviction of a murderer. The technique uses "minisatellite" regions in the DNA, sequences that do not contribute to the function of the DNA but are repeated within it in a pattern which is unique for individuals.

DNA fingerprints may be also be used for paternity and maternity tests, as well as for identification purposes in forensic medicine.



how it works

To examine an individual's genetic fingerprint, a sample of DNA derived from cells from blood or body fluids is cut into fragments using enzymes. These fragments are separated using electrophoresis (where large fragments move more slowly than smaller ones under the influence of an electric field). A "probe" that detects minisatellite DNA is then used to construct the final DNA fingerprint. This is composed of a number of bands of different sized DNA fragments, containing minisatellite DNA, arranged in a unique pattern.

impact

DNA fingerprinting is a tool of great value for criminal justice. It has led to the conviction of murderers and rapists and just as importantly the release of many falsely accused. Yet it started with a pure science investigation driven by curiosity. Current capabilities are just the tip of the iceberg. Already we see that characteristics such as region of birth can be established. In the future we should even be able to read usefully accurate facial characteristics from DNA.



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8 long-life, low energy light bulbs

origins

Low-energy light bulbs are compact fluorescent lights (CFLs) that are four to six times more efficient than incandescent lamps and last up to ten times as long. Ordinary light bulbs are actually electric heaters. Like a fire, they glow because they are hot, and put out only 10% of their energy as light. Philips is generally credited with introducing the low energy light bulb in 1981. The main stumbling block for low-energy light bulbs was cost. The production techniques were complex and expensive, making commercially viable production a real challenge.



how they work

Ordinary strip lights pass an electric current through low-pressure mercury vapour. This generates invisible ultraviolet light that in turn is converted to visible light in a phosphor coating inside the tube. There are two main problems - the light requires a heavy and complex set of control circuits and there is a pronounced flicker. The compact fluorescent lamp works in a similar way, but with minaturised control circuits, which control the flicker.



impact

In most homes lighting makes up around 10% -15% of the electricity bill. UK households use £1.2 billion worth of electricity every year on lighting. Each low energy bulb will reduce lighting costs by up to £10 per year and cut greenhouse gas emissions at the power station. Replacing eight continuously lit incandescent bulbs with low energy bulbs would save enough fuel energy to run a small car.

in the mid 1980s cash cards became a worldwide phenomenon, facilitating and perhaps encouraging the move to a 24-hour society

9 cash and debit cards

origins

"It seems the only people using the machines were a small number of prostitutes and gamblers who didn't want to deal with tellers face to face".

So wrote the inventor Luther Simjian about his "hole-in-the-wall" machine for banks, which underwent trials in America in 1939, but was not a success.



British inventor John Shepherd Barron's idea for a 24/7 cash dispenser came one night in the bath in the mid 1960s. He needed to create a new product, or his business unit would fail.



He is quoted as saying "I remember being infuriated that I could not always get access to my money when I needed it, especially over the weekend when banks were closed". His breakthrough came at the end of a 90 second pitch to the General Manager of Barclays Bank - the response was "If you can make this device you are speaking about, I will buy it right now".

As a result, in 1967, Barclays Bank installed the first modern cash dispenser in North London. This machine relied on being fed paper vouchers, in return for which it coughed up a single £10 note. Lloyds Bank introduced plastic cards with a magnetic strip in the UK in 1972. These worked with the first online cash point machines, which were connected directly to the bank's central computers.

impact

In the mid 1980s cash cards became a worldwide phenomenon, perhaps facilitating and encouraging the move to a 24-hour society.

10 digital cameras

origins

Digital cameras have evolved from the video camera technology used for television. Both video cameras and most digital cameras use a CCD (charge coupled device) to sense light intensity and colour. The charge-coupled device (CCD) was invented in Bell Labs in the US in 1969 by William Boyle and George Smith. The CCD is an integrated circuit that converts light energy into an electronic charge and was originally thought up as a new type of memory circuit for computers. During the 1960s NASA developed techniques for sending digital images back to earth and digital imaging was also used in spy satellites. Kodak introduced the first 1 mega pixel CCD sensor in 1986 and Apple and Kodak also sold the first digital cameras aimed at consumers in 1994.

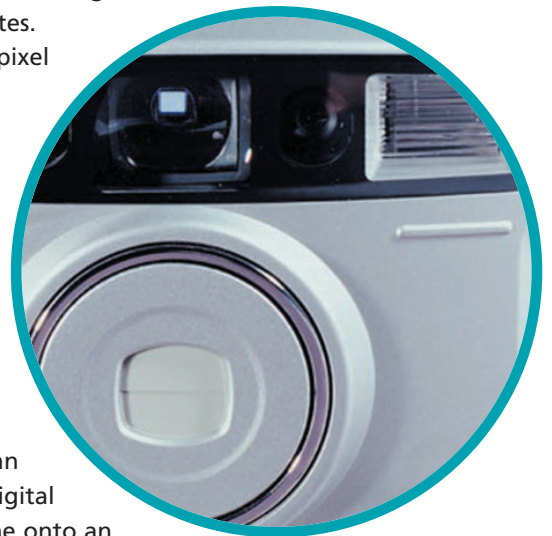


how they work

A digital image is a long string of 0s and 1s that represent all the coloured dots or pixels making up an image. A digital camera creates a digital image by focusing light from a scene onto an electronic sensor. This image sensor turns the light intensity information in the image into electrical charges. These charges are captured and converted into binary data that represents the levels of light, and can be stored and processed by the camera's computer.

impact

Digital cameras for most people are considerably more expensive than the film cameras they replace. What appeals to consumers is the instant feedback. Is it a good picture or not; if not, delete it and take another one - then e-mail to a friend.



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Digital cameras are part of a growing trend for people to record their lives in ever greater detail. Coming soon is a digital camera you wear all day, that can record up to 2000 images from your daily life. You download the images into a visual diary at night. Supporters say the images record family life, giving recall of every significant moment. They argue it could help fight crime and help you find things you have lost. Critics point out that all this image making can get in the way of living and experiencing real life.

future innovations, what can we expect?

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Innovation occurs where human needs and desires link together with new science and technology. But once an idea has sparked in the mind of the inventor, there is still a long way to go before it becomes a successful innovation. In many cases the original idea may take years or decades to develop (the computer took 100 years, aeroplanes even longer). During this time the idea takes on new forms as the technology develops and the market changes. With human knowledge doubling every 10 years and computer power doubling every 18 months, we can expect the C21st to throw up some exciting innovations. However, it is difficult to predict what will they look like and how they will change our lives.

Three great themes dominated science in the C20th - the atom, the computer and the gene. In the C21st it is likely that cross fertilisation between these three fields will result in new abilities to manipulate matter, life and intelligence. These advances in scientific understanding will underpin a wide range of new technologies, which will be put to work in products.

Nanotechnology and the human genome project are two areas where much effort is focused currently. In the longer term, advances in knowledge may lead to entirely new technologies - perhaps technologies based on quantum entanglement. This "spooky action at a distance" as Einstein called it, which links the states of two particles even though they may be far apart has already led to successful lab experiments in "quantum teleporting". Quantum computing is another area which shows much promise.

A number of observers have identified "waves of innovation", by looking back and mapping past technological developments. They define our time as the "Information Age", the "Second Industrial Revolution", or the "Fifth Wave", marked by a wave of digital networks, software and new media. However, others argue that technology is no longer the main driver of product innovation and that user requirements are now leading. A number of emerging trends have been identified, including the ageing population, changing work life balance and environmental pressures. By considering these trends and human needs we can predict some innovations: cheaper, cleaner energy, cures for colds and cancer, robust and abundant crops, faster, more efficient transport and communications. All these are being worked on by global businesses and, with such a large investment in terms of capital and research teams, we can expect a stream of innovations in these areas. (For example, the US government has recently tested a scramjet engine, which potentially could take an aircraft round the world in under 10 hours). More difficult to predict are the kind of innovations that people always "wanted", without knowing it. Examples of these might be the phonograph, the Walkman, and the mobile phone.

Some innovations which might take off in the near future are given as Case Studies on the Design Council website, (www.designcouncil.org.uk). One concept is an email pen from Cambridge Consultants, which enables users to read and write emails from home without a personal computer.

A related innovation is electronic paper, the dream of combining the flexibility, readability and portability of paper with the rewritability of electronic screens. There are a number of competing technologies, some use small particles suspended in fluids, some use variations on liquid crystal displays. Once they mature we may only need one electronic book or newspaper, onto which we download any book we want. Another visionary product is Cellpore, a self-contained cellulose sachet, which converts microbiologically unsafe water to safe water, using osmosis. A third concept is the Dyson DC06, a vacuum cleaner that can do the job on its own, charting a spiral course from the outside of a room to the centre, using fifty sensory devices to navigate around obstacles, and systematically clean the room. A fourth innovation, iris recognition, can match iris codes derived from iris patterns against a database, searching through up to 100,000 codes per second. This approach is increasingly being adopted for access control to military bases and US prisons, and with current concerns over security we may well see its widespread adoption soon.

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innovations that flopped

Innovations flop for many reasons. For example the original laser disc did not provide enough data compression, and so was too large. This was an instance of failure due to inadequate, premature technology. In contrast the Sony Betamax, which was technically superior to the VHS (and indeed achieved dominance in many markets world wide), flopped in the UK. This was because VHS got to the UK market first, there was then a large investment in this country in VHS rental videos, and nobody was willing to stock both. Very often with an innovation that flops, there is a correctly identified need, but the solution was inappropriate. An example of this was the C5 electric car. An electric car would have been a very fine thing, but in this particular car the passengers felt dangerously exposed.

The history of surround sound is an example of a succession of failures, which has finally come good with Dolby Digital surround sound. This has at last achieved the result that people wanted. It can steer the sounds to individual speakers, and works well, in contrast to earlier systems.

So rather like the story of the airbag, innovations that flop today may, with a small tweak of technology, become tomorrow's successes.

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what does the survey tell us about what innovations we want in the future?

The poll also asked interviewees what one innovation they would particularly like to see in the future. It is of course very, very difficult to predict what innovations we want in the future. This is something we'd all like to be able to do. For instance, nobody predicted that texting would be a big fashion, it was only included on phones as a sideline because the technology could do it.

However, 36% of respondents chose a washing machine that washes, dries and irons clothes as their preferred future innovation. Second choice was an instant weight loss drink (19%) and third choice was a time capsule for speedy travel to work (9%).

This shows that practical, everyday innovations that reduce the chores of everyday life are very popular. Many people today see themselves as "time poor" - they spend a large proportion of their waking hours working, and wish to enjoy their leisure when they are not.

This part of the survey shows that, surprisingly, people are more interested in practical everyday innovations than more exciting and revolutionary dreams.

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