Philips Vision of the Future (1996) - technologies in prospect

Predicting the potential of a technology is difficult because its success depends not only on its intrinsic value as an innovation but also on a wide variety of 'real-world' variables. These include commercial viability, social need, governmental policies, international standards, and often other technologies which may boost its widespread acceptance. In reviewing technologies which now exist or look extremely promising, we decided to concentrate on those which have the most realistic chance of success and which are most relevant to Philips' field of operations: electronic engineering, software, materials, lighting technology, telecommunications and medical systems. We concluded that the most far-reaching changes in the next decade are not likely to be the result of dramatic new innovation. Rather, they will almost certainly result from the focusing, refining and merging of existing technologies and their extension to more areas of our lives.

computing power

Silicon chips - small pieces of silicon on which large numbers of electrical circuits are integrated - have been doubling in power every eighteen months for the last two decades. Exactly how long this process can continue is uncertain, but many people believe that it will go on at this rate at least until the turn of the century, and probably beyond. Indeed, it is possible that by the year 2000 we will be able to store more information than we currently either want or need. In addition to this massive processing and memory capacity, chips are also becoming physically smaller and more functions can be accommodated on the same surface area.

voice recognition and synthesis

The recognition and synthesis of human speech requires vast amounts of memory and computing capacity because everyone's voice is different and every utterance is acoustically unique. Recognition systems currently available can only cope with either limited vocabularies (as with some telephone information services) or input from a limited number of users (as with computer instruction programs and speech-to-text dictation systems). As chip capacity increases, these limitations will be overcome. Speech-synthesis chips which turn text into speech will soon be possible and could, for example, be incorporated into fax machines to read messages aloud to blind or partially-sighted recipients.

software agents

Software developments are increasingly enabling systems to 'think for themselves'. Artificial intelligence is now reaching the stage where systems can be programmed to predict situations and outcomes based on previous experience, and then take action accordingly. By using 'fuzzy logic' (reasoning and acting on the basis of approximate data), systems can continue to operate efficiently where accurate data is either not available or not strictly necessary - in much the same 'rough and ready' way we ourselves often work. Currently, computers and other devices only respond to direct commands or instructions from the user. Nothing happens unless these commands are entered by keyboard, mouse, touch screen or button. The device is passive and offers us no help unless we ask for it. However, software companies are currently developing what are called software agents.

These are software programs which 'know' what the user wants to do and can act autonomously on his or her behalf. The user will put a problem to the agent, and the agent will then monitor events and perform tasks which meet the user's goal. It will search for information the user needs regularly. It will monitor changes, and even represent the user where necessary. It will learn from experience, automating regular patterns. At any one time we may have a number of these agents working for us: they will be able to expand their knowledge base by learning about us from each other.
It will be rather like having a small community of personal 'helpers'. This is a development which is almost certain to change the way we interact with other devices around us. We will begin to view them in a more personal way, as devices which work together with us. And this, in turn, will make it increasingly natural for us to communicate with them through human channels, such as speech and gesture.

virtual reality
In combination with sensors which detect our movements and devices which convey the sensation of touch to our bodies, software programs can rapidly generate computer images and reactions which give us the experience of being in another, 'virtual' reality. There are many applications in the area of games and amusement. And virtual-reality devices can also be used to allow us to experience dangerous or otherwise difficult activities in a realistic way, such as training people to cope with hazardous situations or perform complex operations.

smart materials
Seemingly inert materials will become intelligent and start interacting with their surroundings. They will develop their own 'senses' and, chameleon-like, change their characteristics depending upon their environment. Old materials will combine their individual strengths to create powerful new materials. But as well as 'improving' on nature, we are also discovering how much we still have to learn from it. Smart materials modify their behaviour under specific circumstances, changing their shape, stiffness, position, natural frequency or other mechanical characteristics in response to changes in temperature or electro-magnetic fields. Such materials are already in use in the aerospace and engineering industries.

There are several different types of these materials. Shape-memory alloys, for instance, are metals which, at a certain temperature, will return to their original shape after having been stressed. Piezo-electric materials ex-pand and contract in response to an applied voltage, while magneto-strictive materials expand in particular magnetic fields. There are also liquids which increase in viscosity in response to a stimulus. These materials display a kind of intelligence which makes them seem 'alive'.

plastics become active

Once plastic was only used as an insulator. However, by creating a structure made up of several layers of plastics, each with a different electrical charge, it will be possible to simulate the effect of touch. In this way, a robot's hands could be made much more sensitive; or we could develop sensitive protheses for disabled people. It is also possible to make materials alternate between being transparent and opaque. We are all familiar with the sunglasses which become darker as the sunlight becomes stronger. The same principle can now also be built into windows or textiles.

The colour or transparency of materials can also be made to change under the influence of an external stimulus such as touch, temperature or light of a specific frequency. The handle of a toothbrush, for instance, can be made to change colour after being held for two minutes, encouraging children to brush their teeth thoroughly by introducing an element of 'magic' into the process and providing parents with a way of checking.

advanced composites

Much research is being done at the moment on combining materials to produce others with improved properties. These are known as advanced composites or hybrid materials. Glass, for example, has certain excellent properties, but is very brittle. Some plastics, on the other hand, are very flexible, but lack the hardness of glass. It is now possible to make molecular matrices into which the best characteristics of a number of different materials can be embedded. Advanced composites which are as strong as steel but are one-fifth of the weight are already being used in the construction industry.

back to nature

Natural materials change under the influence of use and age. In comparison, plastics change very little. Yet the ageing of natural materials, although detrimental for the functioning of objects made of them, is nonetheless often perceived as imparting a certain beauty - the noble patina of age. Old plastic, on the other hand, is rarely admired. It would be ideal if plastics could be enhanced by giving them certain properties of natural materials. One line of experimentation in this area is to make new 'plastics' from natural materials such as cellulose.

In another development, known as 'biomimicking', scientists are increasingly looking to nature to find new ways of improving artificial materials. They are building into them extra properties or functions, in much the same way that nature builds many functions into a single material. Human skin, for example, incorporates sensation (nerves), cooling (perspiration glands and pores), heating (hair), protection from the sun (melanin formation), and so on.

sensing the world
Important advances are also being made in manufacturing. Using 'nano-technology', the micro-electronic techniques developed in chip technology, researchers are creating a variety of microscopic devices which go beyond merely switching electronic circuits. New technologies make it possible to produce what are known as micro-electromechanical systems (or MEMS, for short). These are constructions built on the scale of chips, one-millionth of a millimetre thick. They make it possible to link up micro-electronics (both hard- and software), mechanics and chemistry. One type of microelectromechanical system consists of a pillar on which a tiny beam is mounted. This beam can move or vibrate in response to some external stimulus. By measuring that microscopic movement, we can'sense' the presence of the stimulus.

MEMS are already used to detect the degree of deceleration that a car undergoes during a collision to make the airbag inflate at the right moment. The deceleration sets the beam in motion and the extent of the motion is what is'sensed'. But this application, significant as it is, is only the beginning. MEMS also make it possible to sense smell. Smell consists of molecules, and if a molecule of a particular weight settles on a beam which is continuously vibrating, the rate of vibration will change due to the weight of the extra molecule. Detect the extent of that change and you have detected the smell.

new light technologies
The field of lighting will see exciting new developments in the near future. These include technologies for the transmission of light over considerable distances, along glass fibres or light-reflective tubes. Light will also become flexible, with the introduction of light-emitting polymers.

remote-source lighting
Remote-source lighting allows light to be produced at one location, transmitted along a pipe with minimum loss, and then released at particular points. An entire underground car park, for instance, could be illuminated from a single source using this system. Besides offering the possibility of 'tapping off' light anywhere, it also facilitates maintenance.

light-emitting foils and polymers
A quite different type of lighting currently under development is one which allows thin, flexible 'sheets' of light. These involve the use of phosphorescent layers on polymer foil to which electrical charges are applied. This flexible light 'sheeting' could be used to provide backlighting for control panels and could also be used in emergency contexts, being incorporated into clothing, for instance. It is completely safe and can be touched without danger.

Another development is light-emitting polymers which involve multiple layers of 'doped' plastics (plastics which have been made conductive). Light is created by electrons jumping from one layer to another.

fibre optics
The technique of transmitting light along glass or plastic fibres is known as fibre optics. It can be used for applications as diverse as exploratory surgery and animated billboards. In more familiar realms, we will soon see fibre optics appearing in the car, with lighting generated at a single source and relayed through the entire lighting system - headlights, rear lights, interior lights, and so on. Not only will this make maintenance easier, it will also save space.

faster data transmission
The principles of fibre optics also allow a highly efficient method of signal transmission using a rapid series of light pulses. Fibre-optic networks are now used to transmit voice, video images and data. They are up to a hundred times faster than traditional copper wiring. The voice, video and data are translated into digital signals (in this case, light signals).

Fibre-optic transmission can be made even faster. Every time a light signal has to be converted into an electronic signal for intermediate switching or processing purposes, the rate of transmission is slowed down. To solve this problem, fully optical networks are currently being developed. These eliminate all such conversion moments, so that the only time light signals are converted into electronic signals is at the very end of their 'journey', when they enter a computer for final processing.

Speeding up the transmission process will create greater capacity for data. But increasing speed will not be enough to cope with all the signals we will want to send. Real-time video with realistic movement, for videophoning or video-conferencing for instance, requires a lot of signals to be transmitted in an uninterrupted stream. New ways of compressing data and of sending more at one time will therefore be needed. One method that is currently being investigated involves treating the light signals rather like radio signals, transmitting them on a particular frequency and then receiving them by tuning in to the same frequency. Non-video data, which does not need to be transmitted in a continuous stream, can be transmitted in 'packets', i.e. messages can be split up into small parts which can then be transmitted separately along whichever route is available and reassembled at the receiving end.

telecommunications
Global telecommunications is big business, and wireless telecommunications is its fastest-growing segment. Analysts' predictions made in 1983 as to how many Americans would be using cellular phones by the turn of the century have already been exceeded twentyfold. Annual growth in North America is now running at 50%, and the figure is even higher in Western Europe, Australia, Asia and parts of South America. This great demand is forcing regulatory bodies to make more spectrum available.

digital assistant
The first development beyond the mobile phone is the personal digital assistant. This is a wireless handheld computer which can handle text, graphics and audio. It is essentially an enhanced mobile phone with extensions for video and fax. It is quite possible that within ten years, faxing and videophoning from handheld equipment will become commonplace. Such sophisticated operations need not be difficult, since much of the work will have been incorporated into the network and will be done for us automatically. Calls will be forwarded to us in the car, the office, or wherever we may be. Numbers will be linked to people rather than places, and satellite positioning systems will pinpoint our location.

medicine
New developments in electronics and telecommunications are already having a considerable impact in the medical field, and this trend is likely to accelerate as the technologies are applied more widely.

networks
Medical computer networks will become more sophisticated, so that patient data will be available immediately, not only within the hospital, but also, via local, national or international telelinks, to doctors in other hospitals or paramedics attending the scene of an emergency. Specialists will be able to diagnose, treat and even operate on patients at a distance. Historical data will also be more accessible for analysis, so that medical staff can learn from each other's experience.

imaging systems
Digitalisation of medical imaging systems will become cheaper and more widespread, permitting more accurate analysis and teletransmission of images. By linking imaging to computer systems, surgeons will be able to plan surgery more accurately and then be guided interactively through the operation itself. Miniaturisation will result in the development of small dedicated scanners which can complement and relieve the pressure on expensive full-body scanners. The next step will be portable equipment for use in the field, linked by communications networks to a base hospital.

ethical implications
Many new technological developments will raise ethical questions. Take the smart card, for instance. For people, these are mainly used for identification purposes in banking. But, in the form of electronic tags, they are used to identify cattle and pets. Electronic tagging is also used to keep track of, for example, prisoners on parole. But the next step is implantation of an electronic identification device into the flesh. This is already being done with animals. Could we accept implantation into humans?

The increase in personal computing power, access to the information superhighway, and so on, all have the effect of spreading knowledge much wider than it has been spread before. Until now, those with knowledge have had power. Companies have had hierarchical structures, with those at the top having access to all the information and able to make the decisions. New developments may change all that. Corporate structures are set to become more horizontal and more 'democratic'.

Similarly, the rise of software agents will provide many more people with the equivalent of an extensive support staff, hitherto the prerogative of those in power or with the resources to pay for them. This may lead to a considerable 'democratisation' of power structures. Also, we should not forget that, despite price erosion, technology does not come cheap. The question is: How much is the consumer prepared to pay for new developments? Will people be prepared - or even able - to pay the extra to have a fibre-optics line enter their living room for a videophone or hundreds of channels on their cable TV? Will manufacturers, for their part, be prepared to put vast sums of money into research, development and production if they cannot be sure of recovering their investment?

And finally, the issue of the impact particular technologies have on the environment has to be faced. Will we, as producers and consumers, be able to resist the temptation to avail ourselves of benefits provided by technologies which are less than eco-friendly? To what extent will governments take a hand in guiding development? To what extent will well-intentioned companies be supported by the consuming public?

Predicting answers to such questions is every bit as difficult as predicting other social attitudes. Yet these answers will be crucially relevant to the success of any technological innovation: ultimately, it is social acceptability, not technology, that determines what happens.

More material in
www.design.philips.com/about/design/section-13482/index.html