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2000년대의 "나노 테크놀로지"

Nano-Technology after the Year 2000

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Just as the transistor changed the face of electrical engineering and heralded the electronic and microprocessor era, a new technology, still in its infancy is likely to have an even larger impact on industry and society alike. This new technology which has already begun to make its impact on modern technology is called nano-technology. Nano-technology, derived from the Greek word, meaning - Dwarf, is related to the ability to manufacture, fabricate and measure in the nanometre precision range, which is 10^{-9} parts of a metre, a dimension which makes the diameter of a human hair appear huge by comparison.

The subject of nano-technology was originally coined by a Californian futurist, Eric Drexler who created a Utopian vision of a future technology so small that it could not be detected by the human eye, and where the trend towards miniaturisation to its ultimate extreme, the size of single atoms. Drexler forecasts that early in the next century, we will have developed the technology to manipulate individual atoms, either by removal or by addition. In fact the products made in the nano-technology industry will be little more than assembly of products in a similar way that children now build models using Leggo blocks. In other words bottom up manufacture were components and products will be completely engineered from the inside out, including their interacting surfaces, rather than manufactured by conventional methods where the materials are whittled away to produce their final shapes.

This technology may seem far fetched but progress is being made already. Initially the main force towards miniaturisation occurred in the microchip industry. Being the basic component of computer memory, manufacturers demanded higher chip storage density(greater miniaturisation), so that greater computer power and faster computer speeds were achievable. Computer speed for example is governed currently by the speed which electricity flows(the speed of light), hence the more densely packed, the faster the chip could be made to operate. More recently a new technology has been introduced, the scanning tunnelling microscope.(STM) which was designed to allow measurement of surfaces on the nanometre scale, recently this device has been employed in a way which enables atom by atom assembly or disassembly of materials. As the technology is developed complex structures will begin to be constructed.

The possibilities are almost endless with nano-technology, and the mind can range free on the edge of the impossible as it dreams up achieve-

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ments which can be realised in the future.

Consider the medical field, today's surgery may in as little as twenty years seem archaic. Then in the majority of cases the surgeons knife will be replaced by non traumatic techniques of medicine. The development of remote controlled sub-microscopic robots will facilitate such devices being inserted into arteries and they will be directed to "crawl" to various parts of the body to scrape away the fatty deposits which cause heart desease. Micro biological devices will be implemented with these robots designed to devour the removed fat and convert into basic ingredients which can then be carried away by the blood stream to be finally processed in the kidneys and liver by the normal mechanisms for disposal. A further type of artery submarine will be developed, to hunt down and destroy cancer cells and other hostile organisms which invade the body. The advantage of this will be to avoid using drugs such as antibiotics which may one day be regarded as primitive health remedies.

Other devices, probably called assemblers will create diamond and diamond like structures which will have special properties such as high strength durability and low weight which are constantly being demanded in the aerospace industries. Aeroplanes made largely of diamond type materials will soon leave the realm of fiction and enter the world of reality.

How fast will this technology come upon us? In real terms scientists have been exploring miniaturisation for more than a decade already, and as a result some applications of the technology are already reaching the market place. By the turn of the millennia significant progress will have been made in 'pushing' atoms around so that it is possible to produce atomic scale components.

How big will the industry become? Well for the far sighted company, the entrepreneur, and the investor, fortunes are possible. Two recent studies commissioned by the European Commission and a private think tank, suggest that the development of nano-technology will be very rapid and will become the second largest manufacturing sector, behind the computer industry itself. In reality it will be the computer industry which will be partly responsible for driving forward this technology. It is probably realistic to project that the nano-technology market will be worth approximately £40bn by the year 2010. Already multinational corporations such as IBM, BAe, GEC, Thorn EMI are already either interested in this technology or are already working towards it. But even though these multinational companies can provide very large investments in the research many major successes will come from smaller companies which will be developed as a result of university research programmes. It is predicted that in the European Community alone over 10,000 companies, many of them small will participate in the production or use of nano-technology.

How will nano-technology impinge on the society we live in? In simple terms products will be smaller, more pure and will allow more complex engineering on the microscopic scale. For example the development of nano scale gear boxes which are virtually friction free and capable of rotating at speeds of over one billion revolutions per second before failing. With this technology in place coupled with the developments in computing which will become significantly smaller and faster accompanied with the development of biological computers, a development which is already being pioneered in some large companies.

The way forward in biological computing seems to be the development of Bacteria Redoxin. This bacterial protein, it has been discovered, changes

shape on exposure to light. The researchers are currently separating the bacteria with the intention of placing the refined substance in a data cube. The cube will then be selectively subjected to a light source to activate the protein, hence the data cube will become a memory device which will enable the construction or the ultimate computer. Such a computer will be part chip and part biological, comprising semiconductors, data cubes and precisely controlled light sources. Such a technology will enable the development of intelligent micro machines which will be used not only in the medical fields mentioned previously, but also in the area of pollution control and pollutant removal.

The prospect of non intrusive surgery, the development of intelligent medicines in the form of capsules which will meter their release of chemicals will improve patients health. The elimination of some of the current ageing mechanisms which afflict the aged may in addition lead to a significant increase in healthy life for the world's population. This development alone will bring along its own problems of resource production which nano-technology will help to solve.

It is difficult to predict just how much nano-technology will affect the world, but the areas which will be significantly affected by the subject are physics, chemistry, measurement, micro equipment control medicine and the environment.

It is my opinion that the achievements as a result of the original development of the transistor, and later the microchip, will one day be recognised as having less significance on the world than the coming of age of nano-technology.

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