
Executive Summary



The Technological Revolution of the 21st Century

In 1959, in a paper entitled "There's Plenty of Room at the Bottom", physicist Richard Feynmann proposed a new field of study for science: technology at an atomic and molecular scale. "The principles of physics, as far as I can see, do not speak against the possibility of manoeuvring things atom by atom", Feynmann told the American Physical Society, opening the way to any interested investors. His talk sparked an interest in developing technology at a minute scale, which has continued to the present day, and which will probably result in a silent revolution which will have an impact on many different areas of our everyday life.

Nanotechnology is a series of multidisciplinary techniques used to manipulate matter at the scale of atoms and molecules. The prefix nano- denotes a billionth part. A nanometre is a billionth of a metre. In order to understand the potential of this technology it is essential to know that the physical and chemical properties of matter change at nano scale: electrical conductivity, colour, resistance, elasticity and reactivity, among other properties, behave differently than at a larger scale.

Nanotechnology can be applied in various fields, including materials, electronics, biomedicine and energy. Materials of much greater hardness and resistance, much faster computers with greater capacity, more effective medical research and diagnoses, capable of responding faster to new diseases and abundant low-cost environmentally-friendly energy are just some examples of how nanotechnology will revolutionise the potential of many common fields today.

Nanotechnology is already here, however; nanoscale materials are used in a range of consumer products: Some of the applications already to be found on the market include much more effective cosmetics offering better protection, more flexible and resistant tennis rackets and non-scratch glasses. Researchers consider it to be just a matter of time before nanotechnological products start entering our everyday lives. Indeed, they estimate that sales of products incorporating nanotechnology will increase from 0.1% of the total manufactured at present to 15% by the year 2014.

The development of new products and processes and entry into new markets requires large-scale investments that will be of key importance in the successful development of nanotechnology. To date, it has been public initiative that has enabled the early take-off of nanotechnology, but the private sector is now beginning to take the reins, playing an increasingly important role. The current position varies from region to region, however: in America and Asia, the business sector already contributes more than government, but in Europe we will still have to wait some time before we see the

private sector leading investment in nanotechnology.

Conclusions of the Future Trends Forum on the development of the nanotechnology

The FTF experts forecast that developments in nanotechnology will begin to have a major impact over the next five to ten years, though to a different extent from one industry to another. Because nanomaterials can be applied in a range of sectors, it is predicted that they will be the first to enter the market, opening the way for the subsequent penetration of nanotechnology into electronics and energy. The experts consider that nanotechnology will take longest to emerge in medicine, which is heavily conditioned by statutory considerations.

The development of nanotechnology can be studied in three phases:

- The present: nanotechnology is at investigation phase and scientific knowledge is beginning to take shape in solid applications.
- The next five years: during this period many different applications are expected to be developed and to begin to be produced on an industrial scale.
- Ten years and more: nanotechnology will be consolidated as an industry and consumers will enjoy a wide range of products using nanotechnology.

These trends will depend on a series of key factors which the FTF experts have identified from amidst the uncertainty surrounding nanotechnology. These factors will play a determining role in its success. The existence of suitable tools to allow study at a nanometric scale, the search for practical applications to attract private investment, a reduction in the costs of processes and equipment, and a government policy that encourages the development of nanotechnology –these will all help speed up its entry into the market.

Although the experts consider that it is very likely that these conditions will be fulfilled, they have also identified a series of obstacles which might slow nanotechnology down. A lack of investment, for example, would mean a much longer take-off period for nanotechnology, while a lack of coordination between research centres and business could hinder industrialisation of the applications.

Nonetheless, the FTF tends to feel that nanotechnology will gradually emerge in the medium term, with the incorporation of many elements using nanotechnology in our lives. The experts believe that some of the most revolutionary changes in everyday life will come in hygiene and communications. Other lifestyle changes that nanotechnology has in store for us will come in the areas of food and transport: for example, thanks to nanoparticles, we will know when food has gone bad by colour of the wrapping; vehicles powered by hydrogen stored in tanks incorporating nanotechnology

will allow us to tap into a source of renewable, non-polluting energy. These are just some of the many advances that nanotechnology will bring to practically all aspects everyday of our everyday lives.

Like all new incipient technologies, there are uncertainties about the potential of nanotechnology. Here it is the scientific community and the government –with specific regulation– that must work to minimise possible risks. The FTF experts think the primary risks that might cause most public unease will be uncontrollable nanoparticles representing an environmental hazard and the use of nanosensors that violate an individual's right to privacy.

In conclusion, nanotechnology is destined to play a lead role in the twenty-first century with applications that will improve our quality of life. It will have a huge impact on the economy, generating new business opportunities and offering new opportunities for developing countries to catch up technologically with the major powers if they train their professional personnel appropriately.

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