Public debate on nanoscience and nanotechnology

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Aims

- Identify the various actors implied in nanoscience and nanotechnology
- Understand the scientific and technological knowledge that contribute to the nanoscience and nanotechnology development
- Identify the epistemological questions in debate

Introduction

The module covers scientific contexts and socio-historical emergence of nanoscience and nanotechnology and presents the epistemological debates associated with them.

The birth of nanoscience theory and practice

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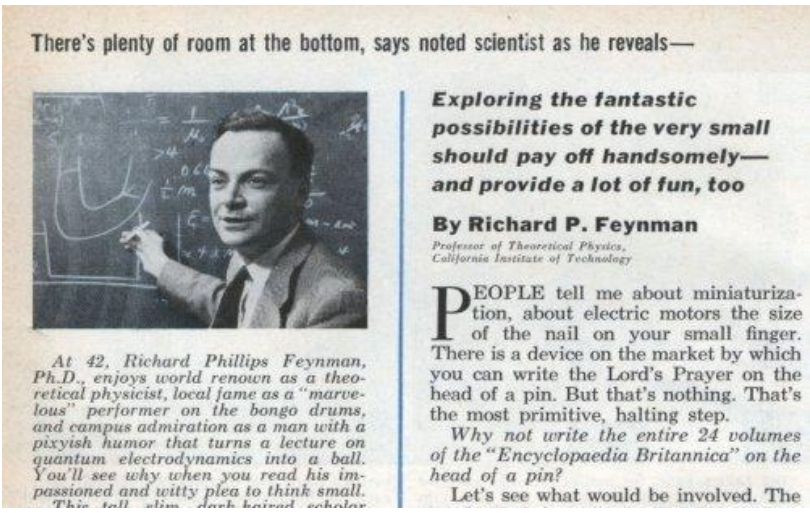
A. Birth of nanoscience theory and practice

Fundamental : Richard P. Feynman (1959)

The starting point of the most frequently mentioned event is the title of the talk given by Richard P. Feynman in 1959 at the annual conference of the American Physical Society at Caltech: "There's plenty of room at the bottom" announcing the symbolic birth of the "nanoworld".



There's plenty of room at the bottom, says noted scientist as he reveals—

Exploring the fantastic possibilities of the very small should pay off handsomely—and provide a lot of fun, too

By Richard P. Feynman

Professor of Theoretical Physics, California Institute of Technology

PEOPLE tell me about miniaturization, about electric motors the size of the nail on your small finger. There is a device on the market by which you can write the Lord's Prayer on the head of a pin. But that's nothing. That's the most primitive, halting step.

Why not write the entire 24 volumes of the "Encyclopaedia Britannica" on the head of a pin?

Let's see what would be involved. The

At 42, Richard Phillips Feynman, Ph.D., enjoys world renown as a theoretical physicist, local fame as a "marvelous" performer on the bongo drums, and campus admiration as a man with a pixyish humor that turns a lecture on quantum electrodynamics into a ball. You'll see why when you read his impassioned and witty plea to think small.

Engineering and Science, Vol. 23, n° 5, février, p. 22 36.

So what did Feynman say in this talk?
Accessible at http://calteches.library.caltech.edu/1976/1/1960Bottom.pdf

First, we can note that he did not refer to "nanotechnology". In 1959, the term was not yet on the agenda. However, in his own words, the physicist wanted to describe a field of research consisting in controlling and manipulating matter on a very small scale. According to him, at the time of his talk, this field of research remained largely unexplored and yet extremely promising

- first, due to the complex phenomena that occur when working with matter on a small scale
- second, due to its huge potential for technological application

Feynman began his talk with the idea of writing the entire content of the Encyclopaedia Britannica on the head of a pin. In terms of information storage, he used a short calculation to demonstrate that this was not physically impossible. The technological means by which to accomplish this feat remained to be found, however. Feynman ventured a few possible solutions, before going on to imagine some of the possibilities this would open up.
The entire talk was composed in this manner. Feynman discussed things that it was theoretically possible to do at the scale of atoms according to physical laws, or rather that it was not impossible to imagine. And the physicist underlined the technological challenges that this would present, challenging his audience to provide answers to the questions raised.

To back up his claims and show that the prospects of miniaturisation were not just words disconnected from the objects and concerns of the scientists he was addressing, Feynman took the example of biological systems:

- The information necessary for building an organism as complex as a human

being is contained in a tiny fraction of a cell.

- The human brain is more effective than the computers of the time were. He believed that if an attempt had been made in 1959 to create a computer as powerful as the organ we carry in our heads, there would have been four problems:
  - Finding the requisite quantity of semi-conductors.
  - Finding sufficient energy to make it work.
  - Dealing with cooling problems.
  - Finally, the speed of calculation of such a machine would have remained fairly limited due to its size and the finite value of the speed of light.

Feynman therefore concluded that miniaturisation was necessary.
But how? How should the changes in properties at such small scales be taken into account?
At the scale of an atom, weight and inertia would be relatively unimportant, however Van Der Waals forces would be extremely high. What happens regarding problems of lubrification? How should electrical circuits be redesigned on a very small scale? How can smaller and smaller machines be built?
Feynman laid out the questions and underlined that he did not have the answers, but did suggest a few possible paths to explore.
For example, in order to build extremely small machines and manipulate extremely small objects, he imagined a stage-by-stage approach. In atomic energy plants, devices existed that could be controlled at a distance. Feynman therefore suggested making machines that would seem small on our scale and that could each be controlled. Each machine would be more precise than us and able to build even smaller machines. In turn, these "slave machines" would make and control even tinier machines, and so on. Bit by bit, thanks to these tiny hands, Feynman imagined reaching smaller and smaller sizes.
The physicist also identified the many future prospects of manipulating matter atom by atom. Here again, he was very clear that he did not know exactly what would happen. In his view, though, materials would take on new properties and the quantum effects would no doubt open up new horizons for circuit design. He believed that tools would inevitably be developped allowing us to "see" what we were doing and to manipulate matter on an atomic level in a controlled manner.

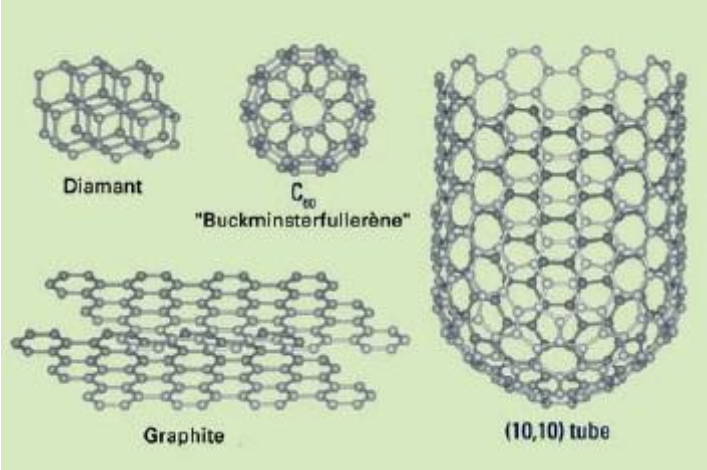
As Feynman drew towards his conclusion, he presented two challenges to his audience and offered a 1000$ prize for each. One prize would go to the first person who could take the information on the page of a book and put it on an area 25,000 times smaller. The second would go to the first person who could make an electric motor controlled from the outside that was no larger than $250mm^3$.

Although his talk ended here, the adventure did not. The talk was later transcribed and published in February 1960, first in Caltech's *Journal of Engineering and Science.* Today, it is regularly presented as THE founding talk on nanotechnology and Feynman is brandished as the figurehead of this technoscience.

Has Fenyman's talk been used consistently in this way since the 1960s? Or has this use increased over the years, as tools have progressively been devised to observe, control, and manipulate matter on a nanometric scale? The answer to both these questions is no (see module 3).

The Fullerenes

The discovery of fullerenes or "buckyballs”, molecules composed of 60 carbon atoms was also an important event in the development of nanoscience and nanotechnology. The fullerenes (C60) and other carbon structures such as nearly spherical C70 and substituted derivatives are collectively known as "buckyballs".

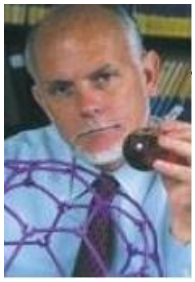


http://cohesion.rice.edu/naturalsciences/smalley/emplibrary/allotropes.jpg

Fundamental

The "buckyballs" are considered by many players on the nano as the "first nanomaterials".

The name buckyballs returns to American architect and inventor Richard Buckminster Fuller who created many geodesic domes whose shape is similar to C60. The buckyballs are as diamond and graphite, composed entirely of carbon, but their shape and molecular structure give them special properties.
In an experiment in 1984, chemists Richard Smalley and Robert Curl, students Jim Heath and Sean O'Brien at Rice University (United States of America) and Harold Kroto, University of Sussex (United Kingdom) were the first to identify and describe buckyballs. In 1996, Smalley, Curl and Kroto received the Nobel Prize in Chemistry for their work.

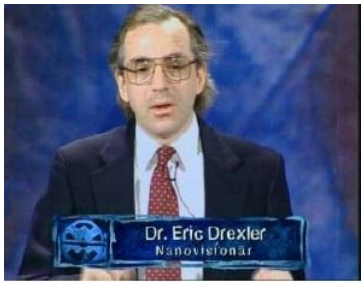


Richard Smalley
in 1985

Warning

At the time, there was no mention of nanotechnology (although the term was coined by Norio Taniguchi of Tokyo Science University in 1974) and this work on fullerenes was just qualified as chemistry.

The term "nanotechnology" was then popularized in a book by K. Eric Drexler, who describes himself as a nanovisionnaire (as you can see in the picture below). Drexler published in 1986 a book entitled "Engines of Creation" (see details in module 3).
Drexler used the word "nanotechnology" to describe how he saw a world where molecular manufacturing would allow humans to produce everything they need.



Drexler, K. E. 1986. Engines of Creation. Garden City, NY, Anchor Press/Doubleday.

Carbon nanotubes

- In 1991, S. Iijima, a chemist who was working in Japan for NEC, discovered another variety of buckyballs, the "nanotubes".

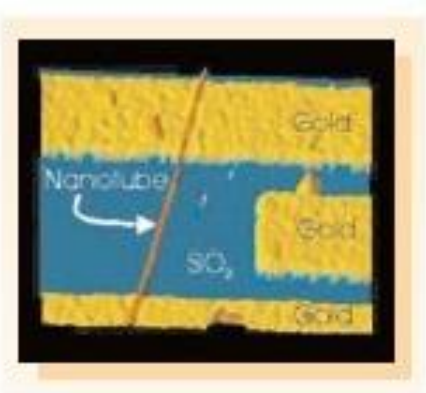
  These are formed by a sheet or several sheets, presenting primarily as a long cylinder of carbon with half a fullerene at each end.

Some experts believe that the "nanotubes" are the strongest material and in the same time are the most flexible ever developed.

- They also believe that the "nanotubes" have a very high electrical conductivity that makes them rivals of copper and gold, but with a much smaller thread.

- The "nanotubes" also have a high thermal conductivity.

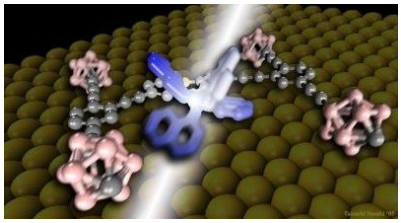
Transistor made by carbon nanotube



Composant électronique (transistor) réalisé à l'aide d'un nanotube de carbone
Applied Physics Letters, vol 73, p. 2447 (1998)

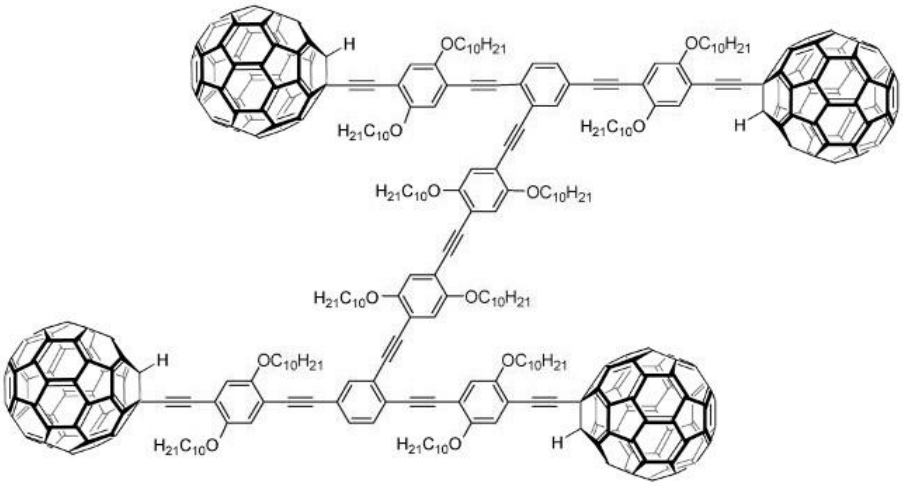
Nanorobots

During the year 1998, a molecular rotor was developed, ie it has been observed for the first time a single molecule rotation. This discovery gives hope to design artificial molecular motors. In the future, they are expected to become components of any nanorobots.



Molecular nanocar

In 2005, the team of James Tour (chemist at Rice University, Houston, Texas), created a molecule called molecular nanocar that advances through the tip of a scanning tunneling microscope. All wheels are in fullerenes, carbon spherical cages.



Nanocar. http://commons.wikimedia.org/wiki/File:Nanocar2.png?uselang=fr

- May 9, 2005: Motorola announces first prototype display made from carbon nanotubes.

B. Nanotechnology

Among the subjects who rushed in nanotechnology research was included polymer chemistry, which for more than 60 years focused on the study of the process of producing new materials, both natural and synthetic.
It was suggested that carbon nanotubes, in particular, would produce excellent materials for parts such as bumper cars or the wings of fighter jets. One of the first areas where commercial investments have been made (with all that this implies environmental and regulatory issues to solve) was the large-scale production of unilamellar nanotubes for experimental purposes in universities and corporate labs.

- In Japan, Mitsubishi, for example, has committed substantial resources to produce fullerenes in higher volumes (*« Tremblay, J. F. 2003. Fullerenes by the Ton: Mitsubishi's Frontier Carbon expects a big market for buckyballs. Chemical and Engineering News, Vol. 81, n° 32, p. 13-14 »*)

- In the United States in 1997, there was the creation of the company "Zyvex", the first company to invest in the field of "nano-mechanical" supposed to invent machines manipulating atoms in serial production chain in the future and create the first "nano-assemblers".

Example

In Europe, let's cite the society Nanocyl (founded in 2002), with a staff of over 45 people, six inventions declined by 51 patents and production capacity in constant growth. This company manufacturing carbon nanotubes, which ranks among the top five global players has become a leading company in Wallonia in the field of nanotechnology.

C. NBIC convergence (Nanotechnology, Biotechnology, Information Technology and Cognitive Science) and Converging Technologies for the European knowledge society (CTEKS)

NBIC convergence refers to the relationship between four areas: nanotechnology, biotechnology, information technology and cognitive science.
The convergence of these technologies would form large industrial interests and ambitions and raises major technological innovations that give greater hope than each area alone.

Is it a hybridization that occurs at all levels where these technologies complement and mingle?

Are we witnessing a growing unification of technology?

The idea of convergence is a mixture of understanding and manipulating at the atomic scale of matter, considerable knowledge of the molecular approach functioning of living and the development of information processing.

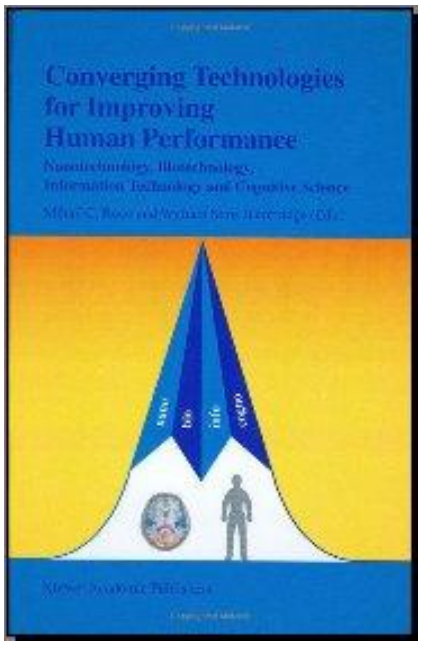
One can also wonder about the interests and aims of such a convergence:

_ Is it a reorganization of public research?

_ Is it the project of building a new human (transhumanism)?

National Science Foundation (NSF) : NBIC

The expression of NBIC convergence has its origins in a U.S. report of 400 pages published in 2002 and sponsored by the National Science Foundation (NSF) and the Department Of Commerce (DOF) of the USA. The report entitled "Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science" includes contributions from over fifty stakeholders from academia, industry and US government. The texts refer to the "convergence of technologies for improving human" and try to provide a comprehensive overview of the present state and progress of the four scientific technologies considered "most promising" for the future of "the humanity" and especially on convergence, combination and even the unification of these four sets of technologies.
(*http://www.wtec.org/ConvergingTechnologies/welcome.htm*)



Converging Technologies for Improving Human Performance:

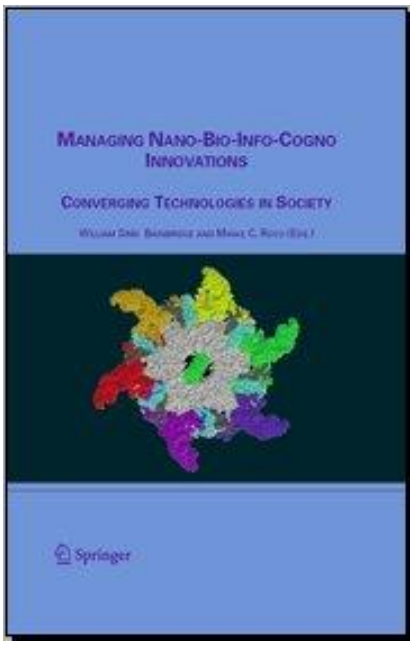
The report shows that the NBIC "is a unique moment in the history of technical achievement, improvement of human performance is made possible by the integration of technologies." At first, the NBCI allow the creation of new materials with properties "unprecedented." Ultimately, it is envisaged, for example the production of nanorobots capable, for example, to repair the damage caused by disease and aging of the human body.

This report is presented as a document that "provides a comprehensive overview of the status of the four most promising scientific technologies for the future of humanity."

Following 2002 National Science Foundation (NSF) report "Converging Technologies for Improving Human Performances", a second meeting (2003) deepened the theme of "converging technologies". This has resulted in a publication in the "Annals of the New York Academy of Sciences", comprising seventeen articles with such general title: "The coevolution of human potential and converging technologies" (Roco and Montemagno 2004).

A second report was sponsored also by NSF in 2005 on the management of innovation in nanotechnology, biotechnology, information technology and cognitive science as converging technologies in society "MANAGING NANO-BIO-INFOCOGNO INNOVATIONS CONVERGING TECHNOLOGY IN SOCIETY ".

(*http://www.wtec.org/ConvergingTechnologies/welcome.htm*)



Managing Nano-Bio-Info-Cogno Innovations : Converging Technologies In Society (http://www.wtec.org/ConvergingTechnologies/welcome.htm)

European Union : Converging Technologies for the European knowledge society (CTEKS)

In 2004, a group of twenty-five experts from, among others, the disciplines of nanotechnology, Humanities and Social Sciences was established to study the "convergence of technologies for a Europe of diversity."

Following the conference, which was held on 14 and 15 September 2004 in Brussels, the group produced several reports on the general theme of "Converging Technologies for the European knowledge society (CTEKS)".

The explicit goal was to share technoscientific knowledge to contribute to the construction of the "European Knowledge Society".

The report of the expert group is entitled "Converging Technologies - Shaping the Future of European Societies."

http://ec.europa.eu/research/conferences/2004/ntw/index_en.html

Composition of the *"Foresighting the New Technology Wave"* Expert Group

(Affiliation(s) and *Country*)

Chairperson	
Professor Kristine **Bruland**, Economic History, University of Oslo. *Norway*	
Rapporteur	
Professor Alfred **Nordmann**, Institut für Philosophie, Technische Universität, Darmstadt, Germany; Adjunct Professor of Philosophy, University of South Carolina, USA. *Germany*	
Members	
Dr. Jürgen. **Altmann**, Physicist and Peace Researcher, Universität Dortmund. *Germany*	
Professor Daniel **Andler**, Philosophy, Universite de Paris-Sorbonne (Paris IV); Director of Cognitive Studies, Ecole Normale Superieure. *France*	
Dr. Thomas Bernold, Communication and Policy Consultant, Visiting Research Professor at the School of Public Policy, George Mason University. *Switzerland*	
Professor Wolfgang Bibel, Intellektik, Darmstadt University of Technology and University of British Columbia. *Germany*	
Professor Jean-Pierre Dupuy, Philosopher, Ecole Polytechnique, Paris, and Stanford University, California, France, USA. *France*	
Professor Donald Fitzmaurice, Head of the Nanochemistry Group UCD; Chief Technology Officer NTera Group, Board/Advisor Draper Fisher Jurvetson. *Ireland*	
Professor Emilio Fontela; Universidad Autónoma of Madrid; Hon Prof of Economics, University of Geneva; Visiting Prof University of Seville; Chair of the Expert Group on Developing Foresight on Research/Higher Education Relation. *Spain*	
Eng. Thierry Gaudin, Président de Prospective 2100, Ingénieur général des mines, Membre du Conseil Général des Mines, Author, Futurist. *France*	
Professor Raoul Kneucker, Ret. Director General Research & International Affairs, Austrian Federal Ministry of Education, Science and Culture; Director of the "Gallery of Research" of the Austrian Academy of Sciences. *Austria*	
Dr. Günter Küppers, Physicist and Social Scientist, Inst. for Science & Technology Studies (IWT), University of Bielefeld. *Germany*	

Professor E.Barbieri Masini, Sociologist and Futurist, Professor Emeritus, Faculty of Social Sciences, Gregorian University, Rome. *Italy*	
Dr Ana Morato, Technical Director of the Spanish Observatory of Industrial Technology Foresight, OPTI. *Spain*	
Dr Michael J. Morgan, Chief Executive (Retired), The Wellcome Trust Genome Campus, Cambridge. *UK*	
Dr. Nebojsa Nakicenovic; Head of the Transitions to New Technologies Project, IIASA; Professor of Energy Economics at the Technical University of Vienna. *Austria.*	
Ian Pearson, Futurologist, BT, Author. *UK*	
Professor Darko Polsek, School of Law, Univ of Zagreb. Former Deputy Minister of Science and Technology. *Republic of Croatia*	
Dr. Gill Ringland, CEO and Fellow, SAMI Consulting. *UK*	
Prof. Dr. Arie Rip, Scientific Director: Graduate School of Science, Technology and Modern Culture; Head of Philosophy of Science and Technology , University of Twente. *Netherlands*	

Dr. Francoise Roure, Inspector General, Ministry of Economy, Finance and Industry, MINEFI, Conseil General des Technologies de l'Information. *France*	
Ottilia Saxl, Chief Executive, Institute of Nanotechnology. *UK*	
Dr. Jan Staman; Directeur, Rathenau Instituut of the Koninklijke Nederlandse Akademie van Wetenschappen,. *Netherlands*	
Dr Jean-Pol Tassin, Neurobiologist, Director of Research INSERM, Collège de France. *France*	
Prof. Walter van der Velde (to April 2004), former Director of Research at Starlab; Co-Director, AI-Lab VUB; Contributor, EC's Vision Book Project; Scientific Director, DISC. *Belgium*	

mwr

D. The new Eldorado or the Apocalypse ?

The "nanos", the idea of convergence of nanotechnology, biotechnology, information technology and cognitive sciences and the huge sums involved in this area by government economic policies lead to questions about the practices of research and innovations.

Nanosciences and nanotechnologies are they:

- **A decisive and irrecoverable break ?**

In the ways of knowledge production, such as blurring or eliminating the boundaries between the lifeless and the living, between knowing and doing, between the scientist and the engineer.

- **An inevitable mutation ?**

In research and innovation for a radical redefinition of human nature and society.

- **A continuous evolution ?**

In this perspective, research is planned to design future decades, and the laws of development are set out on an empirical basis.
It is considered here that the future is inherently uncertain and caution in order to achieve the knowledge that can be developed.

- **The invention of new possibilities ?**

For example the simulation of tactile feedback and visual nanomedicine and nanopharmacy for perfect health throughout life.

- **The redesign of the human race ?**

To push the limits of human intelligence, to make the human body a hybrid entity with a circulation of information remotely, new forms of coding and control.

E. Alignment of disciplines or radical epistemic change ?

Understanding at the atomic scale properties of matter, the considerable progress achieved by the molecular approach of the functioning of living and at the same time, the growth of information processing can lead to a growing unification of the sciences (physics, chemistry, biology, ...) to the nanometer scale, and is often mentioned about nanoscience and nanotechnology the idea of interdisciplinarity.

(Lacour,CNRS CECOJI, 2012)

- **But is it an effect of "ads" ?**

Can we consider that there is a mood of requalification as "nano" from research in traditional disciplines (eg, physics, chemistry, biology, ...) for grants?

- **Or rather the construction of a new field of research ?**

Or a new domain with real technical issues and practices?

- **The competition at the international level in the technoscientific areas also raises questions about a possible alignment of several countries?**

The rhetoric of France and Europe left behind in numerous documents and reports as well as institutional R & D budgets allocated to nanoscience and nanotechnology would tend to show such an alignment.

Fundamental

- Important Investments by the USA army.
- Progressive interest by multiple public and private actors (groups in biotechnology, electronics, chemicals, pharmaceuticals, cosmetics, university laboratories).
- Crossing knowledge of matter, life, treatment information (NBIC convergence).

To know more ...

Frameworks for scientific and technological policies

Recommendations from committees and experts groups in Europe

The European parliament

Web sites

Publications

A. Frameworks for scientific and technological policies

1. Reports from French senate

- Rapport du 25 juin 2008 sur « L'évolution du secteur de la micro/nanoélectronique » par Claude SAUNIER, sénateur. *http://www.assemblee-nationale.fr/13/rap-off/i0997.asp*
- Rapport du 5 février 2006 sur « Les nanotechnologies : risques potentiels, enjeux Éthiques » par Claude Birraux, Daniel Raoul et Claude Saunier, sénateurs. *http://www.assemblee-nationale.fr/12/rap-off/i3658.asp*
- Rapport du 6 mai 2004 sur « Nanosciences et progrès médical » par Jean-Louis LORRAIN et Daniel RAOUL, sénateurs. *http://www.assemblee-nationale.fr/12/rap-off/i1588.asp*
- Rapport du 22 janvier 2003 sur « L'évolution du secteur des semi-conducteurs et ses liens avec les micro et nanotechnologies » par Claude SAUNIER, sénateur. *http://www.senat.fr/rap/r02-138/r02-138_mono.html*

2. Recommendations from the European Commission

- Communication de la COMMISSION DES COMMUNAUTÉS EUROPÉENNES (Bruxelles 12-05-2004) [COM(2004)0338] "**Vers une stratégie européenne en faveur des nanotechnologies**". *http://ec.europa.eu/nanotechnology/pdf/nano_com_fr.pdf*[1]
- Communication de la COMMISSION AU CONSEIL, AU PARLEMENT EUROPÉEN ET AU COMITÉ ÉCONOMIQUE ET SOCIAL (07-06-2005) [COM(2005)0243] "**Nanosciences et nanotechnologies : un plan d'action pour l'Europe 2005-2009**", qui "*« définit une série d'actions articulées et interconnectées en vue de la mise en œuvre immédiate d'une stratégie des nanosciences et des nanotechnologies sûre, intégrée et responsable. »*" *http://ec.europa.eu/nanotechnology/pdf/action_plan_brochure_fr.pdf*[2]
- Communication de la COMMISSION AU CONSEIL, AU PARLEMENT EUROPÉEN ET AU COMITÉ ÉCONOMIQUE ET SOCIAL EUROPÉEN (Bruxelles 06-09-2007) [COM(2007)0505] "**Nanosciences et Nanotechnologies : un plan d'action pour l'Europe 2005-2009. Premier rapport de mise en œuvre 2005-2007**" *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0505:FIN:FR:PDF*
- Communication de la COMMISSION DES COMMUNAUTÉS EUROPÉENNES (Bruxelles 07-02-2008) |COM(2008)0424] "**Recommandation de la commission du 07/02/2008 concernant un code de bonne conduite pour une recherche responsable en nanosciences et nanotechnologies**" *http://ec.europa.eu/nanotechnology/pdf/nanocode-rec_pe0894c_fr.pdf*
- Communication de la COMMISSION AU PARLEMENT EUROPÉEN, AU CONSEIL ET AU COMITÉ ÉCONOMIQUE ET SOCIAL EUROPÉEN (Bruxelles 17-06-2008) [COM(2008)0366] " **ASPECTS RÉGLEMENTAIRES DES NANOMATÉRIAUX** "

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[1] http://www.ec.europa.eu/nanotechnology/pdf/nano_com_fr.pdf
[2] http://www.ec.europa.eu/nanotechnology/pdf/action_plan_brochure_fr.pdf

et le document de travail des services de la Commission qui l'accompagne [SEC(2008) 2036]. Cette communication établit que le terme «nanomatériaux» n'est spécifiquement mentionné dans aucun texte législatif de l'Union, mais que la législation en vigueur couvre en principe les risques potentiels des nanomatériaux pour la santé, la sécurité et l'environnement. *http://ec.europa.eu/nanotechnology/pdf/comm_2008_0366_fr.pdf*

- Résolution du Parlement européen du 24 avril 2009 sur les aspects réglementaires des nanomatériaux [P6_TA(2009) 0328]. Le Parlement Européen préconise entre autres l'introduction d'une définition scientifique exhaustive des nanomatériaux dans la législation de l'Union. *http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P6-TA-2009-0328+0+DOC+XML+V0//FR* . La définition visée dans cette recommandation devrait servir de référence pour déterminer si un matériau doit être considéré comme un «nanomatériau» aux fins de la législation et des politiques de l'Union. Il convient que la définition du terme «nanomatériau» dans la législation de l'Union se fonde uniquement sur la taille des particules constitutives du matériau, à l'exclusion de toute considération relative aux risques ou aux dangers qu'il peut présenter. Cette définition, fondée exclusivement sur la taille du matériau, couvrirait les matériaux naturels, formés accidentellement ou manufacturés.

2010 – Révision de la recommandation concernant le CBC en cours

Recommandation de la Commission Européenne concernant un code de conduite pour une recherche responsable en nanosciences et nanotechnologies (COM(2008)0424) ; *http://ec.europa.eu/nanotechnology/pdf/nanocode-rec_pe0894c_fr.pdf*

The NanoCode project

The NanoCode project is a european project funded in the framework of the 7th research and development european program with the aim of developing a strategic framework (MasterPlan) to guide the development of the good practices code for a responsible research in nanoscience and nanotechnology ; This Code is a recommandation of the European Commission on 2008 February 7.

NanoCode - Implementing the European Commission Code of Conduct for Responsible Nanotechnologies (http://www.nanocode.eu/)

B. Recommendations from committees and expert groups in Europe

Les avis du comité scientifique des risques sanitaires émergents et nouveaux (SCENIHR) sur les définitions des nanomatériaux et l'évaluation des risques qui y sont liés :

- Avis intitulé "The existing and proposed definitions relating to products of nanotechnologies", 29 novembre 2007 ;

http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scehnir_o_012.pdf

- Documents d'information de la Commission accompagnant l'avis du SCENIHR intitulé "The existing and proposed definitions relating to products of nanotechnologies" ; *http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scehnir_o_012.pdf*
- Avis intitulé "The appropriateness of the risk assessment methodology in accordance with the Technical Guidance Documents for new and existing substances for assessing the risks of nanomaterials" des 21 et 22 juin 2007 ; *http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scehnir_o_010.pdf*
- Avis modifié (après consultation publique) sur " The appropriateness of existing methodologies to assess the potential risks associated with engineered and adventitious products of nanotechnologies", du 10 mars 2006 ; *http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scehnir_o_003b.pdf*
- Avis intitulé "Opinion on: Risk Assessment of Products of nanotechnologies", du 19 janvier 2009 ; *http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scehnir_o_023.pdf*[3]
- Avis sur la sécurité des nanomatériaux dans les produits cosmétiques du 18.12.2007 ; *http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scehnir_o_023.pdf*[4]

Comité des produits de consommation (CSPC)

- Avis du Comité scientifique des produits de consommation (CSPC) sur la sécurité des nanomatériaux contenus dans les produits cosmétiques du 18 décembre 2007 ; *http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scehnir_o_023.pdf*

Groupe européen d'éthique des sciences et des nouvelles technologies (GEE)

- Avis numéro 21 du 17 janvier 2007du groupe européen d'éthique des sciences et des nouvelles technologies sur les aspects éthiques de la nanomédecine, élaboré à l'intention de la Commission européenne

C. The European parliament

- Le règlement (CE) no 1907/2006 du Parlement européen et du Conseil du 18 décembre 2006 concernant l'enregistrement, l'évaluation et l'autorisation des substances chimiques, ainsi que les restrictions applicables à ces substances (REACH) ; JO L 396 du 30.12.2006, p. 1.
- La directive 98/8/CE du Parlement européen et du Conseil du 16 février 1998 concernant la mise sur le marché des produits biocides ; JO L 123 du 24.4.1998, p. 1.
- La directive 89/391/CEE du Conseil du 12 juin 1989 concernant la mise en œuvre de mesures visant à promouvoir l'amélioration de la sécurité et de la santé des travailleurs au travail ; JO L 183 du 29.6.1989, p. 1.
- La directive 2001/95/CE du Parlement européen et du Conseil du 3 décembre

[3] http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scehnir_o_023.pdf.
[4] http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scehnir_o_023.pdf.

2001 relative à la sécurité générale des produits ; JO L 11 du 15.1.2002, p. 4.

- La directive 76/768/CEE du Conseil du 27 juillet 1976 concernant le rapprochement des législations des États membres relatives aux produits cosmétiques ; JO L 262 du 27.9.1976, p. 169.
- Le règlement (CE) no 178/2002 du Parlement européen et du Conseil du 28 janvier 2002 établissant les principes généraux et les prescriptions générales de la législation alimentaire, instituant l'Autorité européenne de sécurité des aliments et fixant des procédures relatives à la sécurité des denrées alimentaires ; JO L 31 du 1.2.2002, p. 1.
- Le règlement (CE) no 1333/2008 du Parlement européen et du Conseil du 16 décembre 2008 sur les additifs alimentaires ; JO L 354 du 31.12.2008, p. 16.
- La directive 2000/13/CE du Parlement européen et du Conseil du 20 mars 2000 relative au rapprochement des législations des États membres concernant l'étiquetage et la présentation des denrées alimentaires ainsi que la publicité faite à leur égard ; JO L 109 du 6.5.2000, p. 29.
- Le règlement (CE) no 1830/2003 du Parlement européen et du Conseil du 22 septembre 2003 concernant la traçabilité et l'étiquetage des organismes génétiquement modifiés et la traçabilité des produits destinés à l'alimentation humaine ou animale produits à partir d'organismes génétiquement modifiés, JO L 268 du 18.10.2003, p. 24.
- Le règlement (CE) no 258/97 du Parlement européen et du Conseil du 27 janvier 1997 relatif aux nouveaux aliments et aux nouveaux ingrédients alimentaires, JO L 268 du 18.10.2003, p. 24.
- Le règlement (CE) no 1272/2008 du Parlement européen et du Conseil du 16 décembre 2008 relatif à la classification, à l'étiquetage et à l'emballage des substances et des mélanges, modifiant et abrogeant les directives 67/548/CEE et 1999/45/CE et modifiant le règlement (CE) no 1907/2006, JO L 353 du 31.12.2008, p. 1.

D. Web Sites

- Site du programme américain : *http://www.nano.gov*
- Site du Foresight Institute : *http://www.foresight.org*
- Site du Ministere de la recherche français : *http://www.nanomicro.recherche.gouv.fr*
- Site Observatoire des nanotechnologies : *http://www.adminet.net*
- Site de l'Union européenne : *http://www.europa.eu.int* ou *ftp.cordis.lu/pub/nanotechnology*
- Site du CEA : *http://www.cea.fr*
- Site du Centre californien de nanosciences : *http://www.cnsi.ucla.edu*
- Site sur les applications : *http://www.nanotech-now.com*
- Site du Scientific american : *http://www.sciam.com/nanotech/*
- Site des nanotubes : *http://www.pas.msu.edu./cmp/scs/nanotube*
- Site de compilation de sites : *http://www.zyvex.com/nano*

E. Publications

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Conclusion

Nanoscience and nanotechnology are presented as an important scientific and technological policy since the speech of the U.S president Clinton in January 2000. Since then, a competition on nanotech has grown between several countries and big amount of money both from public and private funding have been invested. This competition seems to be without limits and several groups or individuals have raised questions and debate on the public sphere. Questioning the different definitions of nanotechnology, following their development, identifying the industrial interests, and the ways nanotech are politically managed, is important, to try to understand and identify the controversies about nanotechnology, about different issues on health risks, ethical implications or proposed solutions.