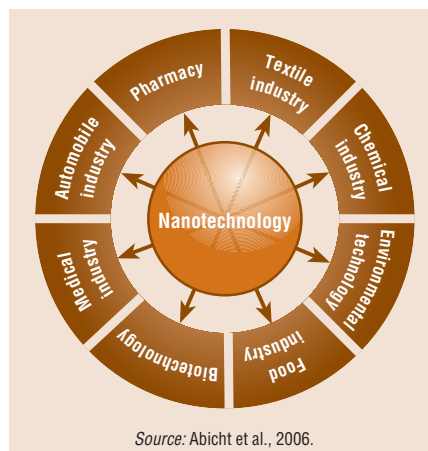


### When small is really small ... Nanotechnology

Originating from the Greek word meaning 'dwarf', in science and technology the prefix 'nano' signifies  $10^{-9}$ , i.e. one billionth ( $=0.000000001$ ). One nanometre (nm) is one billionth of a metre, tens of thousands times smaller than the width of a human hair. Accordingly, nanotechnology refers to nanometerscale science and technology. It involves the control of materials at the nanoscale, deals with extreme miniaturisation and with creation of materials with a nanoscale fine structure.

**1 nm (nanometer) =  $10^{-9}$  m = 0.000000001 m**

Nanotechnology is a cross-sectional discipline that has a large range of applications; almost all aspects of life are influenced by it, for example: automobile industry, pharmacy, textile industry, chemical industry, etc.



Source: Abicht et al., 2006.

### The 'revolutionary character' of nanotechnology

The fast development of nanotechnology is often described as a fundamental revolution in technology and compared to the invention of antibiotics, television, nuclear weapons, or computer technologies. It is expected to have a major impact on global economies this century. The European Union has recognised nanotechnology to have an important role in achieving the Lisbon strategy of making the EU 'the most competitive and dynamic knowledge-based economy by 2010'. Nanotechnology offers enormous potential for Europe to create new knowledge-based enterprises and has a

'revolutionary' potential that can open up new production routes.

Nanotechnology provides great opportunities not only for sciences but also for the everyday life of individuals. Even the most modest predictions estimate over 30% average growth rate per year, overtaking both bio- and information technologies. Europe holds a significant share of the growth potential. Such potential creates new jobs at different occupational levels: not only researchers and scientists holding university and post-graduate degrees, but also a range of technicians and specialists with secondary, post-secondary and non-university tertiary education. Therefore, it is crucial to ensure the future availability of potential workers with the right skills and competences to fill the jobs in nanotechnology. However nanotechnology education is only supported by the EU, India and the US, and no European country makes major investments. This is alarming, considering the expected increase in demand for adequately educated and trained staff.

The European nanobusiness survey, carried out in 2004 among representatives from various business industries, revealed the following:

- 90% of companies believe that nanotechnology will have an influence on their business;
- 55% think this will happen within three years;
- 84% believe that nanotechnology will have a significant effect on their competitiveness.

Source: ENA, 2004, p. 2.

### Public opinion of nanotechnology

The European network NanoForum conducted an online survey in 2004 on opinions and attitudes towards nanotechnology. Some findings were that nanotechnology will exert a strong impact on European industry (90% agreement) and European citizens (80%) within the next 10 years. The rising influence of nanotechnology is particularly expected in the chemistry and materials branches, information and telecommunication technologies, health service and security/defence. There is an urgent need to develop nanotechnology education and training for 90% of respondents

indicated that interdisciplinarity is crucial.

An important outcome of this survey is a general concern among respondents about the shortage of trained staff in nanotechnology. About 75% of respondents expect a shortage of nanotechnology personnel within the coming 5 to 10 years. This is an important consideration for education and training policy.

**34% of employers prefer hiring a graduate with a first degree in any traditional natural science, complemented with nanotechnology knowledge during graduate studies.**

Source: ENA, 2004.

**A lack of skilled staff is placed third as an obstacle to the development of nanotechnology (16%), after inefficient public funding (23%) and the lack of well-defined markets (21%).**

Source: ENA, 2004.

**62% of employers have reported recruitment difficulties in nanotechnology.**

Source: ENA, 2004.

### Emerging technologies: new skill needs in the field of nanotechnology

International workshop 11 and 12 July 2005, Stuttgart, Germany

The workshop, that took place in Stuttgart, July 2005, attempted to address some of the main concerns of skill needs in the field of nanotechnology. It was organised by Cedefop's network on early identification of skill needs 'Skillsnet', jointly with the Fraunhofer Institute for Industrial Engineering (Fraunhofer IAO), the German Federal Ministry of Education and Research (BMBF), and the Institute of Structural Policies and Economic Development (isw). Participants and speakers from 13 countries came to discuss and share their knowledge and experience on new skill needs in nanotechnology from different backgrounds: research, business, education and training.

#### ► Shortage of qualified personnel

The workshop gave a clear message that nanotechnology is still in a development phase. It has a multidisciplinary character and,

therefore, it is difficult to identify future skill needs, especially at the intermediate level. Europe has already a shortage of specialists and scientists with tertiary education, and this shortage is expected to increase in the future. There is a need for monitoring intermediate skill needs and lessons could be learned from the past experience of other new and emerging technologies, such as information and communication technologies. As soon as nanotechnology goes into mass production, the shortage of skills in intermediary level occupations will become obvious. Experts predict that in three to five years the need for workers with related skills at intermediate level education and training will grow significantly. In particular staff for nanotechnology production, sales, management, clerical and office work will be required.

### ► Emerging skill needs in nanotechnology

Based on the perceived trends of emerging skill needs, employers will need people who possess broad interdisciplinary skills. To satisfy future demand, a new approach to education and training for nanotechnology is necessary. As discussed in the workshop, the preferred form of education would be a theoretical background of natural sciences (mathematics, physics, chemistry, biology), integrated with applied sciences. Prospective nanotechnology workers should possess interdisciplinary knowledge, supplemented by some entrepreneurial and management skills.

Due to the importance of teamwork in nanotechnology research and development, employees need to be able to communicate effectively with specialists in related nanotechnology fields, even if they are not experts in the sectors themselves. Employees with intermediate-level qualifications will need particular interdisciplinary knowledge, high level social competences, and be able to carry out tasks such as quality assurance and documentation previously carried out by staff with higher qualifications.

Apart from these specific professional skills, experts also identified intercultural communication skills, self-management, analytical, critical and 'out of the box' thinking as important skills for performing successfully in the nanofield.

### ► Issues to work on

Participants agreed that an effort should be made to develop a road map for new skill needs in close collaboration with industry, science and education. This could help establish a system for technology monitoring and identifying occupational profiles, complemented by regular

surveys and data collection. To tackle rising skill shortages, a modular qualification system could help integrate nanotechnology and nanosciences into existing educational programmes, including vocational training.

Nanotechnology will continue to develop rapidly and be highly dynamic. It is imperative to develop a concept of lifelong learning and training for it, as current skills will be fast outdated when the technology develops further. All participants agreed that public awareness of the role and character of nanotechnology should be constantly raised to ensure its leading role in future technological development. Some experts observed that the young generation is not very interested in technologically-oriented studies. If this trend does not change, it could create a serious lack of qualified staff for nanotechnology in the future. Therefore, it is also important to increase young people's motivation to enter this field.

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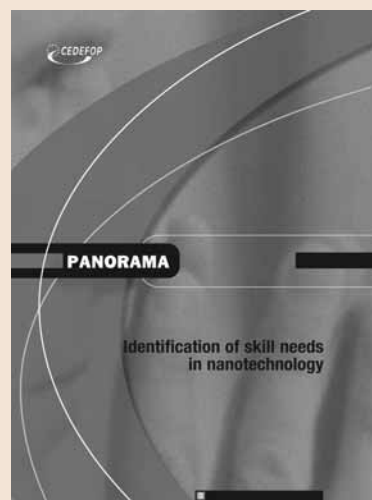
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## International network on early identification of skill needs

The international network Skillsnet, established in 2004 by Cedefop, focuses on the early identification of skill needs in Europe and beyond, and attempts to detect, anticipate and monitor new and changing skill needs in economy and society. Skillsnet brings together highly qualified researchers, policy-makers, practitioners and social partners to present and discuss outcomes and methods of research and analysis. Particular attention is paid to skill needs in regions, sectors, companies and occupations and among specific target groups. Skillsnet aims at fostering cooperation and exchanges between countries on methods and results of research and particularly at transferring findings into policy and practice. Regular activities of the network include thematic workshops and conferences organised by Cedefop and partner institutions in the network and publication of the proceedings.



## Identification of skill needs in nanotechnology

(Cedefop Panorama series, 120)

Abicht, L.; Freikamp, H.;  
Schumann, U. (eds)

The publication can be downloaded from the Skillsnet website  
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