I N D I N E W S

Newsletter on Science & Technology & Innovation Indicators

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In this issue

This edition focuses on two different issues: First a technology which is expected to play a key role in the 21. Century: nanotechnology. The scientific and technological development and the positions of European countries are analysed.

Second the mobility of highly qualified personnel and of researchers is considered a brain drain for some countries, and a brain gain for others. The report analyses whether it it is really that easy to make such statements. Both reports will be further outlined and developed in the 3rd edition of the European Report on S&T Indicators.

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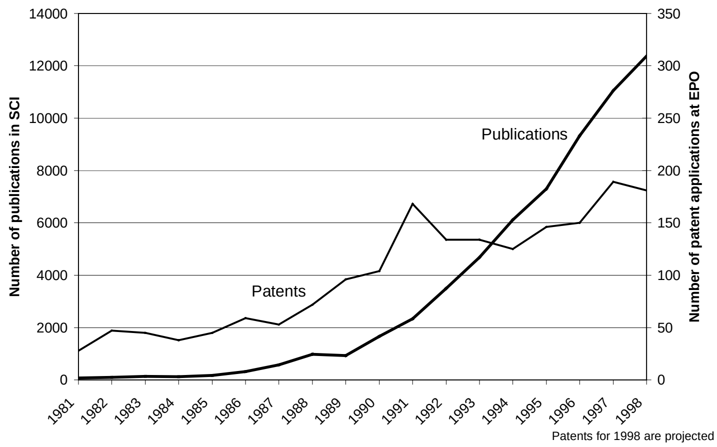
Nanotechnology: Europe on Top in Nanoscience

Nanotechnology is expected to become one of the major key technologies of the 21st century. This report analyses the status quo of nanotechnology by using sophisticated indicators of scientific and technological development. At the country-level, it also identifies the main actors. A more detailed analysis will follow in the Third European Report on S&T Indicators.

Scientific and technological research activities related to nanotechnology have been ongoing for decades. In the 1980s, a common understanding was developed following Taniguchi's baptism of the new "nano-technology" in 1974. Figure 1 shows the development of publications and patents in nanotechnology from the beginning of the 1980s up to 1998.

Fig. 1: Publications and Patents in Nanotechnology from 1981 to 1998, worldwide



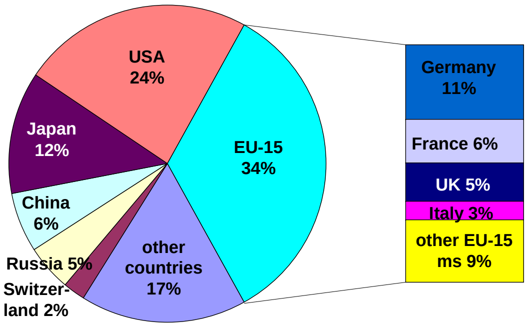
(Sources: SCI, EPAT and own calculations)

The time slope of publications as an indicator for nano*scientific* development shows only small numbers in the 1980s and a take off in the early 1990s. Between 1989 and 1998, the number of publications increased from 1,000 up to more than 12,000. In this period, we find growth rates from 10 to 80 % per year (average: 27 %). The data for 1999 and 2000 suggest the continuation of this trend. Nano*technological* development, expressed by the number of patents in nanotechnology at the European Patent Office (EPO), is much more moderate. Between 1987 and 1991, the total number of patents increased from 53 up to 168, but stagnated in the following years between with 125 and 189 patents per year. The average growth rate in the 1990s amounts to 7 %.

These indicators of nanoscientific and nanotechnological development show similarities to the typical development patterns of new technologies. After significant progress in basic research, as be seen in the end of the 1990s, the technological development will follow with a time lag. So these data prove the novelty of nanotechnology as well as its potential for growth; the take-off of nanotechnological patents can be expected for the next years.

Which countries undertake nanoscientific research? Figure 2 shows the distribution of publications in nanotechnology between 1997 and 1999 in the SCI database.

Fig. 2: Publications in Nanotechnology between 1997 and 1999 by Country

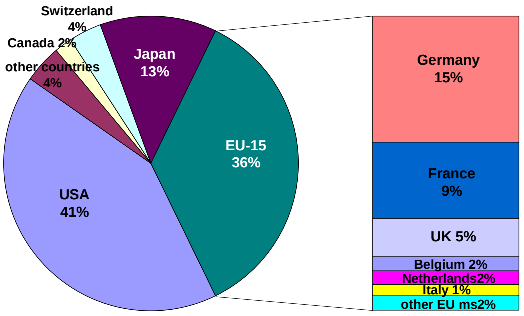


(Sources: SCI and own calculations)

Regarding single countries, most active in nanoscientific research is the US with almost one fourth of all publications. Japan, Germany and – with greater distance – China, France, UK and Russia follow. These seven countries have published about two thirds of the world's nanoscientific papers. But the rest of the publications are broadly distributed between a great number of countries including European and Asian countries as well as Canada, Israel and Australia. Taking the EU-15 member states altogether, they are responsible for about one third of the world's nanoscientific activities. Besides the large EU-15 countries shown in Figure 2, it is mainly the Netherlands, Sweden, Belgium and Austria, which are very active. In relation to their general presence in the SCI database, the shares of China and Russia are outstanding and show the relative strong significance of nanoscience in their research systems.

The distribution of nanotechnological research expressed by countries of inventors is more exclusive. Figure 3 shows patents in nanotechnology at the EPO and the Patent Cooperation Treaty (PCT) for the 1990s.

Fig. 3: Patents in Nanotechnology between 1991 and 1998 by Country



(Sources: EPAT, PCTPAT and own calculations)

Again, the US is the major actor with more than 40 % of the patents. Germany, Japan and France follow. Other inventor countries within Europe are the UK, Switzerland, Belgium, the Netherlands and Italy; but also Russia, Sweden or Spain. Regarding the triad, the USA is still in the lead, but the EU is the second important player. Japan follows with greater distance.

Nanotechnological research resulting in patents is only taking place in a few countries, because of the preconditions of costly instruments and other expensive equipment for high quality nanotechnological research and related questions of critical mass. In contrary to nano-scientific research, which relies mainly on excellent education in natural sciences, especially physics or chemistry, only wealthier research systems can offer the necessary frame conditions for advanced nanotechnological research. Many scientists, mainly from Russia, but also China and India are undertaking their inventions during guest stays mainly in the US or in Germany.

Political support to nanotechnology has increased in the last years. In 1999, the USA has launched the National Nanotechnology Initiative (NNI) which, with other programmes, amounts to about 270 million US Dollar per year. In the EU, the Fifth Framework Programme includes several subprojects, mainly dedicated to collaboration and networks for nanotechnology in Europe. Altogether, estimations of most recent Commission support to nanotechnology are about 30 million Euro per year, with the national programmes of the member states this sums up to about 200 million Euro. In the Framework Programme 2002-2006, the Commission's support to nanotechnology will increase considerably.

For nanotechnology in Europe we can draw several conclusions. Nanotechnology is emerging, but still in the state of mostly scientific progress. Nevertheless, technological achievements can be observed and new products based on nanotechnology are already conquering the markets. Several EU-15 member states belong to the most important actors in nanoscience and nanotechnology, leaded by Germany and France. Efforts to support nanotechnology should not only rely on scientific excellence but also on co-operation between scientists and industrial researchers in order to strengthen the whole innovative process. Co-operation should not be limited to the EU and Switzerland – important partners are in Asia and America as well as in Eastern European countries and Israel. The countries mentioned have a great potential for technological and economic competitiveness in nanotechnology in the future. Europe will have to defend its good starting position.

-- ***A.H***

Mobilité intra-européenne : quelques résultats préliminaires

La mobilité du personnel scientifique et technique à l'intérieur de l'Union européenne est devenue, au cours de ces dernières années, un sujet d'actualité. Du point de vue de la politique européenne scientifique et technologique, ce sujet est important parce qu'il est à la fois un facteur et une conséquence du développement de l'espace européen de la recherche et de l'innovation. D'un point de vue plus général, la mobilité intra-européenne est également importante pour contribuer à la diminution des tensions croissantes sur les marchés du travail du personnel hautement qualifié de certains États membres, qui sont apparues sous les effets conjugués des besoins dus à la transition vers l'économie de la connaissance et du vieillissement démographique des populations européennes qui oblige à un fort renouvellement des effectifs.

Parallèlement aux travaux engagés avec les experts pour mesurer l'exode des cerveaux, l'unité K-2 a entamé des travaux internes pour évaluer sur le plan quantitatif le développement de la mobilité internationale du personnel hautement qualifié aussi bien en Europe que dans le monde. Nous présenterons ici quelques résultats préliminaires de ce travail, fondé essentiellement sur l'exploitation des données des enquêtes communautaires sur la force de travail effectuées par Eurostat.

La population active ayant un niveau d'études universitaire ou équivalent est d'environ de 36 millions de personnes dans l'Union européenne (hors Irlande qui n'est pas couverte par l'enquête communautaire). Parmi cette population qualifiée et ayant un emploi en 2000, on retrouve 1,33 millions de personnes qui ne sont pas de la nationalité du pays dans lequel ils travaillent. Environ 604 000 sont des ressortissants d'autres pays de l'Union européenne et 725 000 sont originaires des pays du reste du monde.

En valeur absolue, l'Allemagne est le pays européen qui attire le nombre le plus élevé de ressortissants de l'Union européenne (165 000) dont une grande majorité sont des ressortissants de l'Autriche (34 000), du Royaume-Uni (30 000), de l'Italie (22 000) suivis de la France (17 000) et de la Grèce (15 000). Avec respectivement 127 000 et 91 000 personnes, le Royaume-Uni et la France sont également des pays de destination préférés des Européens hautement qualifiés.

En valeur relative[1], le Luxembourg (41 %), l'Autriche (4,5 %) et la Belgique (4,3 %) occupent les trois premières places. 16 000 Allemands et 15 000 Français hautement qualifiés travaillent respectivement en Autriche et en Belgique. En revanche, les pays scandinaves attirent très peu d'autres européens hautement qualifiés, mis à part la mobilité intra-scandinave traditionnellement élevée.

Une analyse par pays d'origine de ces 604 000 européens hautement qualifiés qui travaillent dans un autre pays membre de l'EU révèle qu'ils sont essentiellement composés de Britanniques (83 000), d'Allemands (78 000), d'Irlandais (72 000) suivis des Français (61 000) et des Néerlandais (42 000). En termes relatifs, la mobilité intra–européenne semble être en revanche plus élevée surtout parmi les Irlandais et les Autrichiens suivis des Finlandais et des Portugais ayant suivi des études supérieures.

Si l'on s'intéresse maintenant au personnel étranger occupant des postes de responsabilité scientifique et technique, on s'aperçoit qu'au total 230 000 Européens travaillent dans un autre pays membre que celui de leur origine. 29 % des emplois scientifique et technologique au Luxembourg, 6 % en Irlande et 5 % en Belgique sont occupés par des expatriés des autres pays membres de l'Union. Á l'inverse, les trois pays membres dans lesquels le pourcentage d'expatriés européens est très faible sont la Grèce (0,1 %), l'Italie (0,3 %) et la Finlande (0,4 %).

L'enquête communautaire permet aussi de savoir si des nationaux expatriés reviennent dans leurs pays d'origine. Pour cela, on a considéré le nombre de personnes ayant un emploi qui se sont déplacées ces trois dernières années vers un des pays de l'Union européenne. La situation la plus remarquable est celle du Portugal, où les « retours au pays » concernent près de 1 % de la population ayant un emploi, soit quatre fois plus que les Portugais qui se sont déplacés dans d'autres pays de l'Union européenne pendant la même période. L'Irlande vient ensuite avec 0,5 % de la population ayant un emploi, ce qui dénote une amélioration remarquable des conditions économiques dans ce pays. Citons aussi l'Allemagne qui, en valeur absolue (un peu

[1] Si l'on considère l'ensemble de la population résidant dans un pays, ayant suivi des études supérieures et ayant un emploi, part des ressortissants d'autres pays de l'Union européenne de mêmes caractéristiques.

moins de 100 000, le double du Portugal, trois fois plus que d'Allemands qui se sont expatriés vers d'autres pays de l'Union européenne), est le pays européen qui vit le plus grand nombre de retours (environ 0,3 % de la population), suivi par la Suède (0,3 % de retours, plus que de départs vers d'autres pays membres).

Les résultats complets de ce travail interne sur les indicateurs de mobilité effectués à partir des données des enquêtes communautaires sur la force de travail seront présentés dans le prochain Rapport européen sur les Indicateurs de S&T dont la publication est prévue en 2002.

--- **J.B. et T.H.**

Internal News

- K-2 is co-organising a workshop with the Belgian Presidency on:
  ***IN SEARCH OF SCIENTIFIC EXCELLENCE: research performance by disciplines*,** Palais des Congrès, Brussels, 13 November. It is planned to present first results of the mapping of economics exercise and discuss the outcome in a broader context. For further information see:
  http://www.cordis.lu/belgium/12112001workshop.htm

- Eurostat held ***the 11th EEA Working Party Meeting on R&D and Innovation Statistics*** in Luxembourg, 13-14 September 2001. This special meeting was devoted to the indicators for the benchmarking of national research policies, and highlighted the importance attached to this work by the Member States. In a very constructive discussion, the statistical offices from the MS, associate and EFTA countries examined possible methodological improvements for increasingly the comparability and accuracy of some of the existing indicators, and planned the next round of data collection, as well as the work needed to develop the new indicators.

- K-2 will be on line by end of September. You will find the web site about **Science and Technology Indicators for the European Research Area (STI-ERA)** on http://www.cordis.lu/indicators. Comments are appreciated.

External News

Upcoming Conferences

The OECD is announcing a series of conferences, e.g.:

- ***Leadership in the Knowledge-creating Society***, co-organised with the Research Institute of Economy, Trade and Industry (RETI), 16 October in Tokyo.
- ***Knowledge Management Applied to Industry/University Relationships*** Co-organised with Fuji/Xerox, 15-16 October in Tokyo.
- ***Network and Cluster-oriented Policies***, 15-16 October, in Vienna, Chamber of Commerce.

From 15 until 18 October 2001, RICYT - the Iberoamerican Network on Science and Technology Indicators - will organise its ***Fifth Workshop on Science and Technology Indicators*** together with the Science, Technology and Innovation Office of the Ministry of Education and Culture of Uruguay. This conference will be held in Montevideo, Uruguay. Within the framework of the conference, a **First Workshop on Gender, Science and Technology Indicators** will be held. This Workshop is organised by SEGECYT - the Gender, Science and Technology Secretariat for Latin America - and will be entirely dedicated to gender issues. K-2 will present a paper on ***Patent and Publication Indicators by Gender***

Conference report

News from the ***8th International Conference on Scientometrics & Informetrics*** which took place in Sydney, Australia, July 16-20, 2001. This biannual conference brought together some 150 participants from all over the world. A focus was given to impact factors and webometrics. Especially the latter (aka cybermetrics), was thought to be an emerging subdiscipline of scientometrics. However, the research of webometrics so far, e.g., web impact factors, trying to measure ingoing and outgoing links, hits, downloads etc., are very unlikely to be of a real useful and valid S&T indicator in the near future. It became very clear that all "research" based on the web, depends on when and where downloads of data to be analysed etc. are taken place, and that due to the incredible fast changes within the web, the research performed has only exploratory character and a limited value. It seems that the analysis of web sites ("sitation analysis") can assist as a qualitative means, but certainly not as a quantitative indicator.
