

European Commission
Directorate-General for Research

Women in industrial research:

A wake up call for European industry

A report to the European Commission from the High Level Expert Group on Women in Industrial Research for strategic analysis of specific science and technology policy issues (STRATA)

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Science and Society
Women in Science

Women in Industrial Research

A wake up call for European Industry



<http://europa.eu.int/comm/research/wir>

A report prepared for the European Commission by the independent High Level Expert Group on Women in Industrial Research (WIR) – for Strategic Analysis of Specific Science and Technology Policy Issues (STRATA)



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Foreword

I very much welcome this report on women in industrial research.

Previous work undertaken at European level to promote the participation of women in science has clearly shown that information concerning the situation of women in industrial research is scarce, to say the least.

Business is a pivotal player in transforming the results of scientific research into benefits for society as a whole. It is a crucial partner for achieving the competitive, knowledge-based society that was called for at the Lisbon Summit in 2000 by the Heads of State and Government. The target of 3% investment of GDP in R&D, by 2010, will mainly come from the private sector.

Against this background, we cannot afford to ignore the situation of women in industrial research, which is why I have taken the initiative of inviting this group of experts to review and investigate the situation and provide strategic advice.

This report succeeds in bringing together information about women researchers in industry from a variety of sources and presents a first analysis of the context. It constitutes a starting point in terms of outlining actions to be taken and identifying areas for further investigation. Indeed, we will not succeed in making the most of scientific research if women scientists continue to leave scientific careers in disproportionate numbers.

Leading R&D companies, as well as innovative SMEs, are aware that fundamental changes in working culture are required to stay ahead in a competitive environment. This report reveals how they are implementing new structures and instruments to promote gender equality and diversity.

As Commissioner for Research, I will pay close attention to the conclusions of the report and will ensure a proper follow-up. Furthermore I invite all stakeholders (among them companies, national governments, higher education institutions and professional associations) to take heed of the advice, examples and recommendations put forward here.

Finally, I would like to thank all the members of the high-level expert group for their work and especially Professor Helga RübSamen-Waigmann and Dr. Ragnhild Sohlberg, who co-chaired the expert group, and the rapporteur, Professor Teresa Rees. I am impressed by the involvement and commitment of all those who have contributed.

The Commission intends to play its part in the promotion of gender equality in industrial research and in the European Research Area as a whole.



Philippe Busquin
Commissioner for Research

Preface

The issue of women and science is at the core of the idea of a European Research Area (ERA). Indeed, the under-representation of women in science is preventing the full realisation of the ERA's potential and the achievement of the Lisbon objectives. Furthermore, the exclusion of women from science, in particular in senior positions, is an unacceptable and unaffordable waste of human resources and a distortion of the relationship between science and society.

Industry plays a leading role in research, innovation and development. About 56% of research and technological development investment in the EU Member States – Research and Development (R&D) expenditure – is funded by industry. The Barcelona Council of Ministers (2002) agreed that R&D investment in the European Union Member States should approach 3% of the Gross Domestic Product (GDP) by 2010. This represents an increase from 1.9% in 2000. By 2010, it is anticipated that about two thirds of this R&D investment will be financed by industry.

The Communication Women and Science: Mobilising women to enrich European research was adopted by the European Commission in February 1999 (CEC, 1999), and backed by the Council Resolution on Women and Science in May 1999 (Council of the European Union, 1999). It was also supported by a Resolution of the European Parliament in February 2000 (European Parliament, 2000). On the basis of this, the Commission acknowledged the severe under-representation of women in science and set out an action plan. The ETAN report *Science policies in the European Union: Promoting excellence through mainstreaming gender equality* (Osborn et al, 2000), drew attention to problems in the situation of women in research but mainly focused on the public sector. It pointed to the paucity of information available on women in industrial research.

It is therefore opportune that the Commission launched the Women in Industrial Research (WIR) expert group in January 2002 at a time when the problems of recruiting sufficient numbers of highly qualified researchers and engineers had already been identified as a policy concern .

The work was organised in plenary sessions, subgroups (young scientists, good practices, women entrepreneurs, top women, communication and changing the public image of industrial research) and by electronic exchange of data and views, proceeded with lively and free discussions, great enthusiasm and concentration. About 50 senior experts from leading R&D companies, universities, research institutions and professional organisations from Europe and North America have contributed to this report.

The situation of women in industrial research in Europe has never been analysed before. The results are alarming. The first official statistical data show that the participation of women in industrial research is less than half that of the higher education sector. There are remarkable differences between countries in the mechanisms enabling the reconciliation of family responsibilities with research careers and hence in the inclusion of highly qualified women in the innovation process. In terms of entering such education, up until now, not one country has really been successful in

attracting enough young girls to careers in natural and computer sciences, engineering/technology or mathematics. However, there is a positive trend. Concerted actions at European, national and regional levels are now needed to keep women with a completed science education active in scientific careers and to allow newcomers to enter. If visible changes are to be reached by 2010, such activities have to start immediately.

Some positive examples already exist and will be discussed. Leading companies are going ahead and a few countries are setting good examples. However, if a real difference is to be made, concerted efforts will be needed from policy-makers, industry and women themselves. Europe needs to be transformed into a region where combining children with a career is no longer so difficult to reconcile, for either women or men.

Professor Helga Rübsamen-Waigmann

Dr Ragnhild Sohlberg

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We should like to acknowledge the hard work, support and advice received from a range of companies and individuals listed at the end of this report.

In addition, we are most grateful to the European Commission services, in particular Helga Ebeling, who so ably co-ordinated the project, and her tireless colleague Vera Fehnle, from the Women and Science Unit of the Directorate-General for Research. Other members of the Commission services also provided invaluable information, statistics and support, in particular Marge Fauvelle, Mary Dunne, Dr. Angela Hullmann, Lieve van Woensel, Nicole Dewandre and Dr. Rainer Gerold. We thank them all for going far beyond the call of duty.

Executive summary

Chapter 1: Introduction

- This report has been prepared by a group of leading representatives from research-based companies in Europe and the US, at the request of the European Commission's Directorate-General for Research. It is one of a series of initiatives from the DG Research to foster better use of the talent pool of women in science and in science policy. While data exist on the participation of women in publicly funded academic research, relatively little is known about their role in industrial research.
- This report on Women in Industrial Research (WIR) is concerned with Europe as a whole, but concentrates on the 15 European Union (EU) Member States in the year 2002.
- The European Council agreed at the Barcelona summit that the proportion of Gross Domestic Product (GDP) spent on R&D in the European Union (EU) should increase from 1.9% in 2000 to 3% by 2010. This will mean substantially increasing the numbers of researchers: indeed, investment in industrial R&D is expected to double by 2010. Given that it plays the leading role in R&D, this is a major challenge for industry.
- In this report, the position of women in industrial research is analysed and recommendations as to how this talent pool could better be used are presented. At present, women constitute only around 15% of industrial researchers in the EU. As significantly more women are graduating in science and engineering, they are an obvious source of new recruits. In addition, the disproportionate loss of women from scientific careers needs to be overcome. Old-fashioned ideas and practices still impede women's careers in industrial research. Their input into innovation, and creativity of science does not reflect their buying power or their growing role as decision-makers.
- There is a need for more statistics, for monitoring, for scoreboards and for the position of women in industrial research to be benchmarked. This will allow informed policies and practices to be developed. For companies to succeed in recruiting, retaining and promoting women in industrial research, 'special measures' are not enough. There will have to be organisational and cultural change for industry to be competitive. Governments need to support such changes through concerted actions.
- The recommendations are aimed at companies, but also at national governments (who are responsible for creating the necessary framework conditions), at universities and at the European Commission. Concerted action is required at the European level, from companies, governments and from women themselves. Examples of good practice from some of the major industrial research companies that have made a commitment to gender balance and diversity are showcased to show the way forward.

Chapter 2: Why focus on women for science and development?

- Women constitute about 50% of the population world-wide, and they constitute the majority of new graduates in most Western industrialised countries, however, with major differences among disciplines. As they are becoming more significant as consumers, both as individuals and as purchasers and procurers for public and private sector organisations, they need to be better represented in product design and development teams.
- The labour supply in Europe is getting smaller and is ageing: there will be more competition for qualified staff. Multi-skilled, highly creative and innovative inter-disciplinary teams are needed for a globally competitive industrial research: diversity is good for business and for generating new ideas. Companies are increasingly concerned to become not only the supplier, but also the employer of choice, for men and women. Companies in the process of downsizing particularly need to ensure employment of best employees to achieve their goals in the market. Recruiting and retaining good quality industrial researchers as well as other qualified staff is vital in the context of skill shortages.
- Young people are making different lifestyle choices from that of their parents. When choosing a company for whom to work, young people consider which companies offer compensation and benefits that allow flexibility (work/life balance) and have other related policies and supportive structures.
- Different countries offer very different framework conditions for employment, such as parental leave, childcare, eldercare and so on. European companies and their employees therefore operate in a wide range of sets of circumstances. While in the Nordic countries, for example, many support mechanisms are in place, in others, eg Germany, companies may have to compensate for a lack of provision. The lack of harmonisation of policies has clear and significant negative consequences for the mobility of researchers in Europe (compared with the US) and inhibits the ability of companies to recruit the best staff.
- The 'leaky pipeline' in academic life, where qualified women disappear in disproportionate numbers from every stage in the hierarchy and as a consequence, are under-represented in senior decision-making positions, is well documented. There are proportionately even fewer women scientists working in the private sector – in either large companies or in small and medium size enterprises. However, major differences exist among different European countries and among companies. There are some successful examples of companies that have retained female members of the European talent pool for research and development.

Chapter 3: Women in industrial research – an overview

- Cross-national statistics on women in industrial research are presented in this report for the first time. There are significant national differences. While women make up between 18% and 28% of industrial researchers in eight out of ten Member States, in Germany and Austria, the figure remains below 10%. This is despite the fact that German companies contribute a major share to the European R&D budget in industry.
- The statistics show the untapped potential of women in industrial research. More girls need to be attracted to science and engineering to widen the recruitment base. The fact that high potential people are systematically being lost to industrial research is a major cause for concern. Structures to

support a healthy work/life balance need to be in place. Equally, the needs of people returning to industrial research after a career break need to be addressed much more effectively.

- The student body has expanded considerably in recent years and within it, there has been a significant increase in the numbers of women studying at degree level in Europe. Indeed, across all disciplines, women are now the majority of new graduates in every EU Member State except Austria.
- The proportion of women among science and engineering students has grown. In the EU Member States in 2000, women made up 41% of undergraduates in science, mathematics and computing and 20% of those studying engineering, manufacturing and construction subjects.
- Women in the EU Member States are obtaining nearly 40% of all new PhDs (2000). In science, their share is highest in life sciences (50%) followed by mathematics (30%), physical sciences (27%), engineering (20%) and computing (19%).
- As well as better statistics, indicators and bench marking are needed for monitoring progress in retaining and promoting women and men, and to compare the effects of national and industrial policies.

Chapter 4: A vision for 2010 – opportunities and approaches

- Based on the business need for diversity and gender balance, the vision for 2010 set out in this report is one where companies value and develop human talent, and ensure that both women and men have a sensible work/life balance. There should be a gender balance of men and women in laboratories and in senior management, which reflects their roles in society, as decision-makers and as consumers.
- Work cultures and organisations will need to change to embrace researchers with a whole variety of characteristics. This approach fits in with the EU agenda of equal treatment for groups on a range of dimensions such as age, disability, sexual orientation and race and ethnic origin. More women will need to be recruited, retained and promoted. Good practices will need to be fostered in order to develop democratic, inclusive and innovative work cultures in industrial research to release the spark of creativity.
- To promote diversity and gender balance, companies need to treat the individual as a whole person. This involves work/life balance policies that allow employees to accommodate family and caring responsibilities and, if they wish to engage in cultural, religious, community, trade union or other activities. Secondly, there is a 'democratic' principle that entails building a listening culture, where systems and structures are transparent and open. This puts an end to patronage, the 'old boys network' and nepotism and allows for recruitment and promotion based purely on merit.
- The tools to put these principles into practice are different for each equality dimension. For promoting gender equality (known as the 'gender mainstreaming' approach) 'visioning' is important. The company takes a hard look at itself to identify customs and practices that (however inadvertently) have the unintended consequence of structurally disadvantaging women or indeed excluding them from the organisation.

- Other tools to develop a gender balance throughout the organisation are using sex-disaggregated statistics as a management tool, developing equality indicators, and conducting gender impact assessments for new policies.
- Most importantly, commitment from the top is required; incentives to build ownership of the agenda, reporting mechanisms and monitoring. Diversity measurements must be reviewed as an investment and consideration must be given to the cost of not undertaking such measures.

Chapter 5: Entrepreneurs: The lifeblood of the EU economy

- The number of women-owned businesses in Europe is growing but not at as fast a rate as in the US. Women entrepreneurs in Europe tend to have companies in the service sector. Their businesses tend to be smaller and younger than those of men. They are more likely to be sole traders and to use informal means of acquiring start-up capital.
- Information and communication technologies (ICTs) are a top growth business and employment area. Despite the fact that 19% of new PhDs in computing in the EU area are awarded to women, few have so far started an ICT business enterprise.
- The biosciences might seem to be an obvious area for women entrepreneurs, given that the majority of lifescience graduates are women. However, there are very few women among those starting new companies in this field and very few women among senior managers of existing companies.
- The challenges facing women entrepreneurs include the fact that they are likely to start with less finance than men, have fewer business networks and less business experience. As a consequence, their businesses have a slower growth rate. Women find it difficult to access venture capital but at the same time, they are less likely to apply for it.
- Recommendations focus on: creating a better understanding of the challenges faced by women entrepreneurs; measures designed to help meet some of the challenges already identified (business training, incubators, access to capital) and direct or indirect support for women entrepreneurs (mentors, coaches and role models, and publicising successful case studies).

Chapter 6 Conclusions and recommendations

- If the 3% Barcelona goal is to be reached, the number of researchers in both industry and academia in Europe must be increased drastically. Women who are already highly qualified are obviously the richest untapped potential. Several leading R&D companies are already changing their human resource policies in order to recruit and retain women in science and engineering more effectively. Some European nations are clearly ahead of others in successfully educating women and keeping them involved in the innovation process.
- Companies are one of the key movers in R&D. In order to raise their attractiveness as employers to women, the report provides a checklist of good practices giving examples of corporate level initiatives on implementing a diversity management and gender mainstreaming approach. Being an 'employer of choice' reflects an awareness of societal and cultural changes: this enables companies to become the 'supplier of choice' in a globalised world - another business need!

- The other key movers are governments. In the past in Europe, attempts to include women in the innovation process have been fragmented and limited to individual companies or governments. Hence, on a European scale, success is modest. Public policies must therefore support and/or push company policies. Supportive measures at government level include whole-day schools and tax laws supporting parents – men and women – independent of the classical ‘male bread-winner/female homemaker’ family model. Pushing measures include laws that encourage companies to provide supporting structures for working parents.
- Concerted actions are a ‘must’ at the European level to promote changes in social and organisational culture, to foster media awareness and to create new public/private partnerships of companies, universities, schools and other stakeholders at European and regional levels. This report calls for further research into the different national European governmental and company policies, which have led some European nations and companies to lead the way in maximising returns from a broad and diverse talent pool in the innovation process.
- To ensure Europe’s competitiveness and the competitiveness of its companies in the future, however, this report also calls upon the European Parliament and the European Commission bodies to adopt and implement good practices, monitoring procedures, and ‘buy-in from the top’. This first analysis has identified all of these as crucial for success.

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Introduction

A wake up call

Science, engineering and technology are vital to developments in most industrial sectors. However, social, economic and demographic changes in Europe mean that skill shortages in industrial research are likely to worsen, unless there is active intervention. Significantly more investment will be needed in research and development (R&D) in future years. Considerable effort will have to be expended in attracting and retaining additional researchers. Europe needs to address the chronic shortage of industrial researchers¹ and mobilise that most neglected reservoir of talents – women – in particular. Companies especially will need to take an active role in expanding a highly qualified workforce; other stakeholders will need to ensure that there are suitable framework conditions in place for this growth to occur.

¹ By industrial researchers we mean qualified people working in Science, Engineering and Technology Development in the business enterprises. OECD (1993) *Proposed Standard Practice for Surveys of Research and Experimental Development: The Frascati Manual*, Paris: OECD: 'Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and in the management of the projects concerned.'

Box I.1: R&D financing by main sources of funds, latest available year (%)		Business Enterprise	Government	Other national sources	Abroad	Total
	Belgium	66.2	23.2	3.3	7.3	100
	Denmark	58.0	32.6	3.5	5.3	100
	Germany¹	66.9	30.7	0.4	2.1	100
	Greece	24.2	48.7	2.5	24.7	100
	Spain²	49.7	38.6	6.8	4.9	100
	France	54.1	36.9	1.9	7.0	100
	Ireland	64.1	21.8	1.6	12.4	100
	Italy³	43.0	50.8	–	6.2	100
	Netherlands	49.7	35.8	3.4	11.2	100
	Austria	40.1	40.3	0.3	19.3	100
	Portugal	21.3	69.7	3.7	5.3	100
	Finland²	70.3	26.2	0.9	2.7	100
	Sweden	67.8	24.5	4.2	3.5	100
	UK²	49.3	28.9	5.5	16.3	100
	EU⁴	56.3	34.2	2.1	7.4	100
	US^{2,5}	66.8	27.3	4.4	–	100
	Japan²	72.4	19.6	7.6	0.4	100

Source: DG Research Key Figures (2002)

Data: OECD.

Notes:

¹ 2001;

² 2000;

³ 1996;

⁴ EU average does not

include Liechtenstein;

⁵ excludes most or all capital expenditure.

Box 1.2: The European Union goal set at the Lisbon Summit, March 2000

'To make the European Union by 2010 the most competitive knowledge-based economy, capable of sustainable economic growth with more and better jobs and greater social cohesion.'

Box 1.3: Presidency conclusions: Barcelona Summit, March 2002

'In order to close the gap between the EU and its major competitors, there must be a significant boost of the overall R&D and innovation effort in the Union, with a particular emphasis on frontier technologies. The European Council therefore: agrees that overall spending on R&D and innovation in the Union should be increased with the aim of approaching 3% of GDP by 2010. Two-thirds of this new investment should come from the private sector.'

Women are the most obvious source for increasing the numbers of highly trained scientists, engineers and technologists because this talent pool already exists and can be expanded. Currently, women represent over 50% of university graduates but they remain under-represented in the natural sciences, engineering, technology and computer sciences: indeed, in 2000, women graduates doing those subjects comprised of fewer than 20% of all women graduates in all the European Union (EU) Member States, except Ireland. By comparison, men taking science, engineering and computing subjects range from 29% to 55% of all new male graduates across the EU (EC, 2002a, p 70). In 2000, 166,734 women graduated in natural and computing sciences and engineering in the EU (see Table 3.1 in Chapter 3).

Europe has not really been successful in attracting women into industrial research. Too many bright young women avoid natural sciences and computing or engineering, but more importantly, those who begin careers in these fields are all too often prematurely lost to the profession. Precious few women scientists, technologists and engineers manage to reach the upper echelons of careers in industrial research. Europe is in effect, trying to run a marathon without two working lungs! In turn, however, this situation means that there are exciting opportunities for tapping into women's potential for industrial research in Europe.

So, for Europe to achieve the necessary increase in highly qualified research personnel, women must be a major part of the enlarged band of industrial researchers. This will be crucial to the promotion of excellence and quality and for ensuring competitiveness. However, at the moment (based on the first official data from ten EU Member States (see Chapter 3, Table 3.3), less than 15% of industrial researchers (50,789) in the EU are women. For the Barcelona goal to be achieved, this number would have to be quadrupled by 2010.

This report was requested by the European Commission

The subject of this report is at the core of the European Commission's concept of building a 'European Research Area' (ERA). It is also crucial to the European Commission Directorate-General for Research's (DG RTD) Sixth Framework Programme (FP6). Its Science and Society Action Plan (2001)² has a focus on developing a science policy for the EU that is 'closer to the citizens': this includes promoting gender equality in science.

Action 26, Women in industrial research, is a new topic of European Commission research policy. However, the issue of women and science has been a live one in the EU for some years. The Commission's Communication Women and Science: Mobilising women in order to enrich European research (CEC, 1999) was followed by a Resolution from the Council of European Union (1999). The Council invited Member States to gather statistics and information, to collect data, produce indicators and take part in a dialogue on women and science. It asked the Commission to provide EU-level indicators, promote the participation of women in the Fifth Framework Programme, suggest initiatives to promote women in research and report on progress³.

² See <http://www.cordis.lu/rtd2002/science-society/home.html>

³ Hence, the Women and Science Unit in DG Research commissioned the influential European Technology Assessment Network (ETAN) report on women and science (Osborn et al. 2000). It co-ordinates the Helsinki Group of national delegates from countries associated with the Fifth Framework Programme to exchange information about national policies (Rees, 2002), and national statistical correspondents to work towards the harmonisation of sex-disaggregated statistics and development of equality indicators. It commissioned reports on the gender dimension in research projects funded by the Fifth Framework Programme (Laurila and Young, 2001). It has also organised a series of conferences drawing attention to the chronic under-representation of women in science, engineering and technology (Logue and Talapessy, 1994; EC, 1999, 2001, 2002). See <http://www.cordis.lu/science-society>.

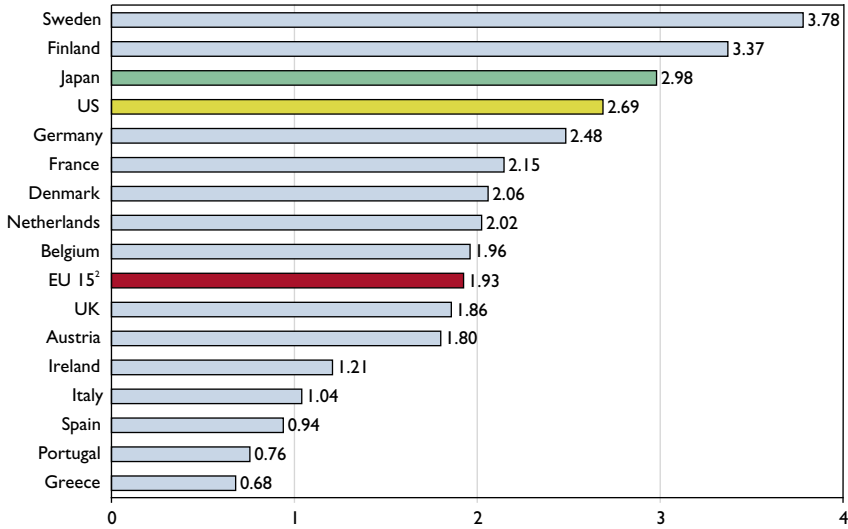
Box 1.4:
R&D intensity
(GERD as % of GDP),
latest available year¹

Source: DG Research Key Figures (2002)

Data: Eurostat, Member States

Notes: ¹ Figures for Greece, Ireland, Italy, Belgium, Netherlands, Denmark and Spain are 1999; all other countries and EU are 2000.

² EU average is estimated and does not include Luxembourg.



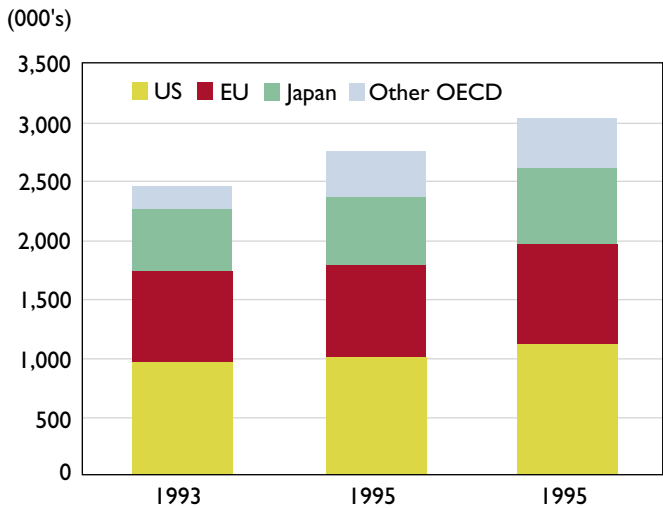
This report calls for action on women in industrial research (WIR). It is a wake up call to industry in Europe, designed to alert companies of the need to focus on recruiting, promoting and expanding the potential of women in industrial research as a matter of urgency. It has been prepared by a group of senior individuals from leading research-based companies from numerous EU Member States and associated countries, and from North America, where similar challenges pertain. While the report is aimed primarily at all those stakeholders engaged in industrial research, it also concerns those involved in generating and providing the necessary supporting structures and policies. They include the European Commission (especially concerning ERA and FP6), national governments, universities, venture capital, employers' organisations, trade unions and professional associations, the media and of course women scientists, engineers and technologists themselves. The report also addresses schools, colleges and universities.

Most of the initiatives of the Commission and the Member States on women in science have so far focused on the public sector where statistics are more readily available. For the industrial sector, statistics are much more difficult to find and there is no institutional focal point (especially at a trans-national level) to examine the issue. This report tries to fill that gap through an analysis by the expert group, supported by the Women and Science Unit of DG RTD and the ideas and experiences of leading companies.

Box 1.5:
Total researchers in
OECD countries

Note the
stronger increase
in all areas
compared to EU!

Source: OECD Main S&E Indicators (2002)



Box 1.6: What's in it for women?

The implications of the recommendations of this report for women are more and better career opportunities in industrial research, the excitement of working in research at a level more commensurate with competence, and the satisfaction of realising personal potential. It should also lead to opportunities to take part in high-level decision-making that affects what products and services are developed.

Box 1.7

'Member States should remove disincentives to female labour force participation and strive, taking into account the demand for childcare facilities and in line with national patterns of provision, to provide childcare by 2010 to at least 90% of children between 3 years old and the mandatory school age and at least 33% of children under 3 years of age'

Source: Presidency conclusions – Barcelona, 15 and 16 March, 2002-10

We present what is available on the participation of women in industrial research, including some new statistics. Promising ideas and good practices in companies as well as the public sector, governments, the EC, and women themselves are showcased.

The need for concerted action to speed up changes

Employing women in research in the private sector enlarges the population of researchers and is likely to offer a greater pool of excellence which, in turn, will translate into supporting the development of an economic competitive edge. Policies that will allow women to develop careers in industrial research must be implemented and monitored. They involve both cultural and organisational change. Women in the child-bearing years need to be retained or reintegrated after a career break, developed, promoted and matured as researchers and leaders.

The report outlines a vision for creating organisations and cultures where women and men in all their diversity flourish in scientific careers. Changes necessary to allow European research-based companies to make the most of women as a talent pool are defined. The report calls for concerted actions and an action plan for industry, national governments and the European Union (EU).

Chapter 2 makes a case for developing women as a talent pool. An overview of the present situation, drawing upon available statistics and research follows in Chapter 3. The need for better data on the use of women's talent in industrial research cannot be overemphasised. In Chapter 4, a vision is described to open companies up to women. A strategic approach to enable this vision to become reality is outlined: one that fosters an exciting, diverse culture, enabling companies to become employers and suppliers of choice. The next chapter focuses on entrepreneurs, so essential to the development of innovation in Europe. Chapter 6 presents ideas for delivering the vision in an action plan: it is a catalogue of recommendations drawing upon initiatives and good practice in organisational and cultural change from numerous countries and industries.

Concerted action is needed. A wide range of partners is called upon to deliver the action plan. Observations about delivering the vision and its vital role in assisting the EU to achieve its goal for science and society to become a highly competitive internationally leading force, conclude the report. The aim is to inform, to persuade, to change. We have to start now...



Why focus on women for science and development?

Global business needs diversity!

Why should women be targeted as the main source of new industrial researchers? The answer is simple – while inequalities waste potential, excellence requires diversity. The under-utilisation of women in science and technology is demonstrated all too clearly in the statistics. Equity policies are needed to ensure transparency and openness and to promote diversity. Diversity, in turn, releases potential, fosters innovation, creates markets and reaches diverse consumers – diversity is good for business. Diversity in the global market assists employers to become both the employer and supplier of choice.

Significant changes affecting Europe are throwing the spotlight on the business imperative to develop and support women's careers in industrial research. Changing demographic patterns mean that there is a smaller potential workforce to draw upon over the next decade, just as the number of industrial researchers will need to grow! The workforce is also ageing. Employers will need to become more competitive by investing in and developing staff for research and development, and using them wisely and more effectively.

Many employers in industrial research face the prospect of downsizing and are taking the decision to outsource some of their research functions. This makes it even more important to ensure effective and creative use is made of human resources, in particular that of industrial researchers. There can be no waste of potential in lean companies. A flexible and agile response to market needs, while retaining expertise and developing additional skills is essential, both within the company and with regard to outsourcing teams.

Ironically, while downsizing, companies are also facing skill shortages. This means fishing in a wider pool. Moreover, new ways of working are shifting more emphasis onto different combinations of skills. 'Hybrids' are increasingly in demand, combining technical skills in several areas with management skills and interpersonal skills (including a capacity in languages). To recruit such new breeds of industrial researchers and to build up multi-skilled teams means opening the doors wider and accepting candidates from less traditional routes.

Box 2.1:

'In 1999 when we started on our current journey, just 8% of our top team – our top 450 people were women. Of the top 40 – the Executive and Group Vice Presidents who run the company – none were women.

Just 9% of the top team came from countries other than the US or the UK.

That was the starting point.

....

By the end of this year (2002) we'll have almost twice as many women in our global leadership team – our executive cadre – as we had three years ago.

Four years ago, as I said, there were no women on my top senior team – our top 40. Now we have five.

And we have increased by 50% of our university recruits from some 25 different countries beyond the Anglo-Saxon world.

And we are beginning to develop a rich feeder pool talent – people in their 20s and 30s who are gathering experience through the company and across the world.'

Source: Lord Browne, Group Chief Executive BP in his keynote speech at the 'Women in Leadership Conference', Hotel Intercontinental, Berlin 19th June 2002 (www.catalystwomen.org)

Box 2.2: The Sunday Times Report on the '100 best companies to work for'

... the companies that make it on to the (100 best companies to work for) list have fared better than most during a bumpy year on the stock market. Whereas the FTSE All-Share index fell 15.6% in the year to January 31st 2002, the listed companies among our top 100 fell a more modest 5.9%. A study of performance over the five-year period is even more instructive. Share and dividend returns for these companies have shown 25.4% growth year on year over this period, compared with 6.3% for the rest of the All-Share index. Being a great place to work clearly pays in the long run.

Source: *The Sunday Times*, March 24th 2002

Box 2.3

Several major US corporations have moved ahead in the past decade to develop policies to retain and promote the women in their ranks. Fear of legal action has been a strong motivating factor. But the fight for talent, particularly during the Internet boom, made companies realise their best talent was in-house, but in danger of leaving if adequate policies were not put in place.

Source: http://www.pwn.link.be/bestpractices/p_tht_corp_bpract.html

Many are likely to be women. Science has demonstrated that monocultures are not sustainable.

Information and communication technology developments have changed everything – including progress in research. Research is now faster and, in a sense, more democratic: it is easier for companies, wherever they are based, to have access to new techniques and data. Projects are no longer constrained by participants having to be geographically close. This puts an additional emphasis on the use made of human resources in order to gain a competitive edge. The benefits of diverse, international teams and the range of experiences and perspectives that members bring to them will be crucial to success in the markets of the future.

Very importantly, recent social and economic changes have enhanced women's position as consumers. More women are in paid work; there are more households now headed by a woman. Women are increasingly important in determining consumer choices. More women are setting up their own businesses and are responsible for business procurement in big companies.

Just as major companies are now seeking to have international teams in their product development and process departments to tap into global markets, so the enhanced role of women as consumers means that they need to be recruited as members of the teams inventing and developing new products. Companies that ignore the growing power of women as consumers by not enhancing their participation in R&D will miss significant opportunities. Some private sector employers in Europe are beginning to address the issue, including those represented in the WIR expert group, as are US companies.

Lifestyle choices of new entrants to the workforce are clearly different from those of their parents' generation. Younger people are choosing different options, reflecting a desire for a better work/life balance. Demographic changes mean that eldercare will become almost as important an issue for many employees as childcare in the future. A myriad of new household arrangements and 'reconstituted' families increasingly characterise modern western society. This means that company policies based on the outmoded notion of a white nuclear family with a breadwinner husband and a homemaker wife will fail and not be as attractive for recruiting and retaining staff, or for offering appropriate products. Companies need to reflect changing patterns of households and families, as well as emerging lifestyle choices in their employment policies as well as their product design.

There are significant national differences among European countries in childcare provision. Often childcare facilities do not meet the needs of working mothers and fathers. This is especially the case for young scientists whose working lives are characterised by international mobility and long or variable working hours.

Very importantly, diversity policies combat nepotism and patronage and privilege merit as a discriminator, over 'who you know'. Hence, such policies are crucial for competitiveness. Business organisations, equality agencies and the media are constructing league tables of the 'best' and 'worst' companies for which to work. In the US, being listed (or not listed) among the 'best' companies on diversity can affect the quality of applicants for posts and, eventually, influence consumer choices.

Women are clearly interested in science and scientific careers, although there are significant differences across countries and by discipline⁴. However, as the ETAN report on women and science highlighted, in universities and research institutes in the public sector, women fall off the academic hierarchy, in disproportionate numbers, at every rung of the ladder (Osborn et al, 2000). They fail at every stage to be selected proportionate to their numbers in the recruitment pool. The obverse of this of course is that men are consistently selected in numbers greater than their proportionate share of the recruitment pool. This is the case across disciplines, across countries and irrespective of whether women comprise the majority or minority of undergraduate students, in that subject, in that country (Osborn et al, 2000). Structural barriers systematically exclude women from developing their careers in academia, and thereby from the contribution they are able to make to the industrial research that is carried out in universities and research institutes. Moreover, while the statistical base is not as developed, similar patterns of frustrated careers appear to characterise industrial research too (see Chapter 3). Assuming an equal distribution of talents among women and men, existing selection processes do not appear to recruit efficiently.

In the UK alone, there is a pool of approximately 50,000 women graduates in science, engineering and technology not in the labour force (Greenfield et al 2002, p xvi). Hence, there are potentially tens of thousands more qualified women in science and engineering in Europe, many of whom may be interested in careers in industrial research and development. This represents a huge untapped potential. However, women in science and engineering are still more likely (proportionately) to be employed in the public sector than in industrial research (in most countries). It is evident that there are very few women researchers or engineers in top jobs in major companies. Small and medium sized enterprises can be described as the ‘engine house of the economy’ but here again, there is a very similar pattern of under-utilisation. Clearly, well-qualified women are not having a significant influence in decision-making in the industrial sector in Europe.

In some companies R&D is regarded as a starting place for employees on trajectories to other disciplines and management. Recruiting and retaining more female industrial R&D workers in these cases will produce a more balanced workforce in senior positions. Multi-disciplinary project teams increasingly carry out industrial research. Gender-balanced teams have been shown by management studies to score better.

Very few women are named as inventors in patent applications – a much smaller proportion than one would expect given the number of trained women industrial researchers in the working population. Women’s powers of innovation are not reflected in the numbers that apply for patents or are mentioned as co-inventors.

Which companies are the drivers of innovation, growth and diversity? Where are women in research valued, where do they flourish? Which policies work in attracting, retaining and promoting women? There is a severe problem here not just of lack of statistics but also a shortage of documented case studies. This report aims to help fill that gap through the ideas and experiences of several companies.

Box 2.5

‘The country with the highest distribution of female inventors is Spain followed by France and Italy. Germany has the lowest percentage of female inventors (4.6% versus 15.8% of Spain). Since Germany produces about 50% of the patents the low German percentage of female inventors influences significantly the global statistics.’

Source: European Commission (2002) ‘Scientific and technological performance by gender: A feasibility study on Patents and Bibliometric Indicators’, vol 1 *Statistical Analysis*, Luxembourg: Office for Official Publications of the European Communities page 21

⁴ See Chapter 3 and the statistics in the ‘Helsinki Group’ report for data on women and science in 30 European countries (Rees, 2002) and Meulders et al (in press).

It argues for routine monitoring of the position of women in industrial research. It also makes the case for a comprehensive approach to releasing their potential through recruitment, retention and promotion – by adopting best practice. Scoreboards and benchmarking should measure the improvement in the participation of women in industrial research to address this serious management concern.

Very importantly, this report is not advocating ‘special measures’ to enable women better to fit in with the dominant culture. Rather, the key to releasing potential – of both women and men – is organisational and cultural change. The questions should no longer be ‘where are the women?’ but rather – ‘what’s wrong with the culture?’

Obviously, there are significant differences across countries and sectors. Part of our task in this report is to bring these to light, and, in particular, to make comparisons. Countries, where there are good institutional frameworks, such as Norway, Finland and Sweden and sectors, where women constitute a much higher proportion of industrial researchers, such as the life sciences are highlighted. Recommendations of this report are built upon this awareness of diversity of situation and context.



Women in industrial research: an overview

Setting the scene

In the context of international R&D development, this chapter reviews the potential of highly qualified women and female participation in industrial research. The field is very diverse and complex, data are often incomplete, and little analysis is available. The following overview draws on data from different sources, in particular Eurostat¹, DG Research², OECD and US databases and publications. The review also includes material from companies, national governments, as well as data, literature and preliminary results from a study³ on women in research in the private sector commissioned by the European Commission.

The rising proportion of women in higher education and employment in recent decades has been one of the major structural changes affecting labour markets and society. However this phenomenon has not yet been translated into a substantial participation of women in industrial research. There are large national differences in Europe, because of traditions and cultural backgrounds and in framework conditions to support work/life balance.

This chapter concentrates on the 15 EU Member States, but also includes data for other European countries and for the US.

World-wide trends in industrial research

The Capex scoreboard on research and innovation indicates that R&D is dominated by IT hardware (25%) and automotive (17%), closely followed by pharmaceuticals and biotechnology (16%). Five sectors (electronic and electrical, health, IT hardware, pharmaceuticals and biotechnology, software

¹ New Cronos database.

² WIS database.

³ A full report on this study, outlining the methodologies used and a full summary of results and raw /data will be available early 2003 (Meulders et al: in press). It was conducted by DULBEA (the Department of Economic Analysis at the Université Libre de Bruxelles) and by la Fundació CIREM (Centre d'Iniciatives i Recerques Europees a la Mediterrània), Barcelona.

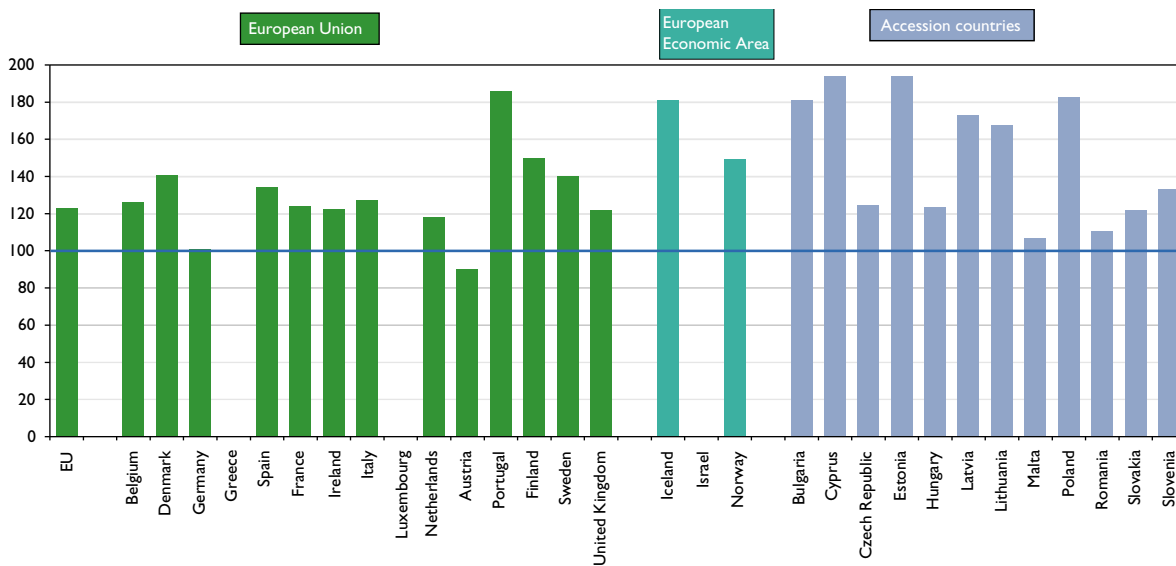
and IT services) have the highest R&D intensity and account for over 60% of all R&D⁴. The Business Enterprise Sector⁵ accounts for 56.3%⁶ of all European R&D financing and 65.3%⁷ of R&D performance.

Major increase in women’s qualifications

There has been a spectacular rise in women’s educational attainment in the EU Member States over the last 20 years. In the 18–21 age group, women are more likely than men to be enrolled in tertiary education programmes in every EU Member State. For the 22–24 and 25–28 year old age groups, this is already true in the case of 8 countries⁸.

In 2000 there were on average more than 120 women graduates for every 100 male graduates in Europe (55% female graduates, see Figure 3.1). Only in Austria did the proportion of women graduates remain below 50%. In Scandinavian countries by contrast, women now constitute about 60% of graduates. In seven of the 12 Accession Countries (right hand side of Figure 3.1) the dominance of women graduates is even higher – more than 150 female per every 100 male graduates.

Figure 3.1: Women graduates in Europe per 100 men graduates (ISCED 5 and 6) (2000)



Source: Eurostat

Data: Eurostat, UOE. Includes all first and advanced degree programs in higher education⁹.

Exceptions to the reference year: Denmark, France, Italy, Ireland, Finland, and Cyprus (1999).

Netherlands, Poland, and Romania: Excludes ISCED level 6.

Luxembourg does not have a complete university system, most students study abroad, breakdown by sex is not available.

Austria: ISCED level 5B refers to previous year.

Cyprus: Excludes 12,448 tertiary students studying abroad which represents 53% of the total number of Cypriot tertiary students.

Romania: Excludes second qualification.

⁴ Capex scoreboard on innovation of the Department on Trade and Industry (DTI), United Kingdom http://www.innovation.gov.uk/projects/capex_scoreboard/capexscoreboard_fr.htm#score2

⁵ OECD (1993).

⁶ See DG Research, Key Figures 2002, Table 1.1.1

⁷ Provisional estimate from OECD data, DG Research, Unit K3

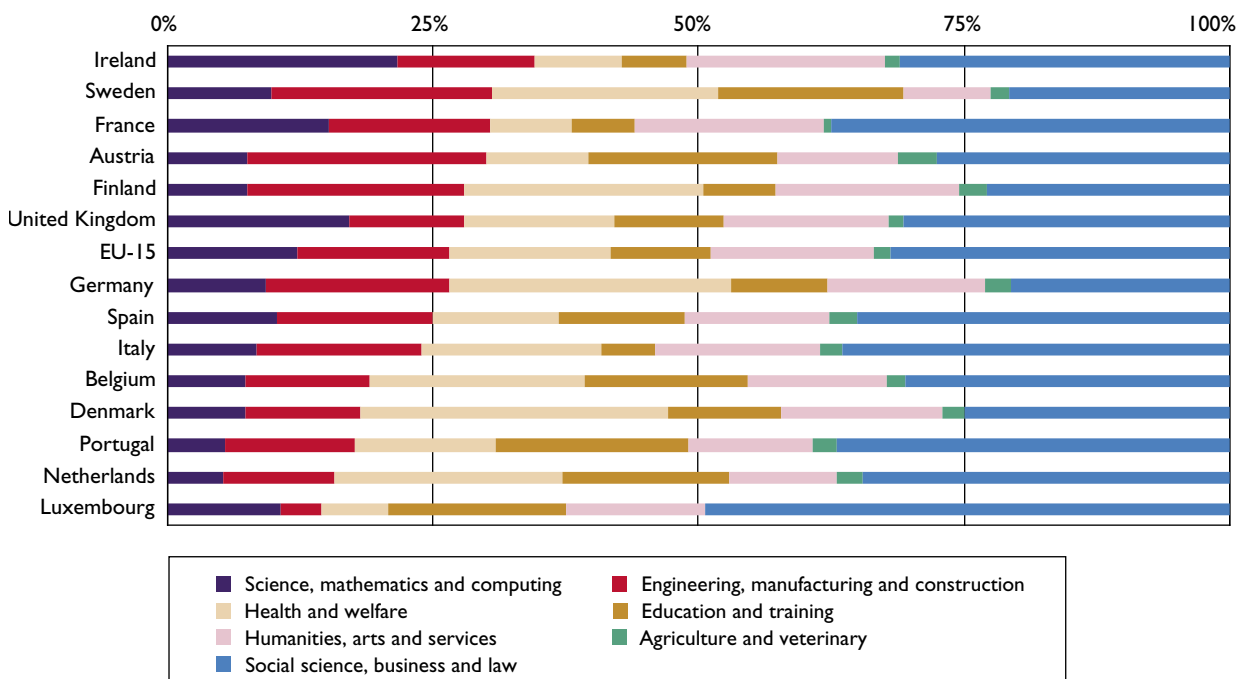
⁸ See Table 3.1 in annex. Source: Eurostat (2002) The life of women and men in Europe: A statistical portrait, ISBN 92-894-3569-2, Luxembourg.

⁹ The number of female graduates per 100 males is calculated by dividing the total number of female graduates by the total number of male graduates and multiplying the result by 100.

Distribution across fields of study

Regardless of the gender dimension, there are some common patterns in the distributions of all higher education students by field of science in Europe, as Figure 3.2 reveals¹⁰. Social science, business, and law together tend to attract most students in all countries. By contrast science, mathematics and computing together with engineering, manufacturing and construction only recruit a third or less graduates, ranging from 34.5% of all graduates in Sweden to 16% in the Netherlands and 15% in Luxembourg.

Figure 3.2: Distribution of all graduates (ISCED 5 and 6, male and female), by broad field of study, (2000)



Source: DG Research, Unit C5

Data: Eurostat, New Cronos (see Annex Table 3.2).

Ranked by the summed proportions of graduates in the two main fields of science, mathematics, computing (ISCED 42-48) and engineering (ISCED 52-58).

Missing data: Greece.

However, these figures hide deep disparities in educational subject choices between the sexes (Figure 3.3, Annex Table 3,2).

In the year 2000, in the EU 166,734 women graduated in science, mathematics and computing and engineering as Table 3.1 indicates – about 10% more than the year before. In science, mathematics and computing 41% of all graduates were women in 2000, compared with only 20% of all graduates in the field of engineering, manufacturing and construction.

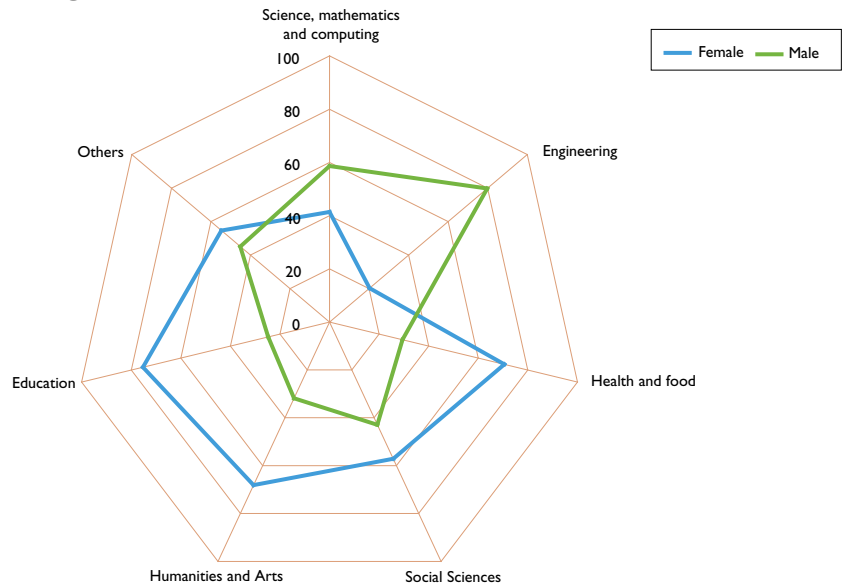
Box 3.1

By 1999 20% of all Masters and 27% of all Doctorates in the US were foreign born. With 52% their percentage was highest in Civil engineering, followed by Mechanical engineering (49.2%), Electrical engineering (47.2%), and Computer sciences (46.4%).

Source: NSB (2002, pp 3-30)

¹⁰ The fields presented are drawn from the ISCED classification of broad groups and fields of education and include broad groups 1-7 only [Education (1); Humanities and Arts (2); Social sciences, business and law (3); Science (4); Engineering, manufacturing and construction (5); Agriculture (6); Health and welfare (7)]. 1997 (ISCED)

Figure 3.3: Proportions of male and female graduates in tertiary education, in selected fields of study 2000, EU-average



Source: DG Research, Unit K3

Data: Eurostat, UOE

Health and Food = Health and Agriculture: ISCED fields 62 (Agriculture, forestry and fishery), 64 (Veterinary)+72 (Health)

Box 3.2

In Israel, women make up 28% of students in engineering studies. A National Institute for Technology and Hi-Tech Training report argues that women will avoid entering domains where they will be in a distinct minority.

There are strong variations in the proportion of women (in % of all graduates) in the different fields of study between the EU Member States. There is no evidence that those countries with a high female proportion of all graduates also have a high proportion of women graduates in science and engineering as Table 3.1 shows. By the same token, a strong position in science does also not necessarily indicate an equally strong position in engineering and vice versa.

In science, mathematics and computing we find the highest proportions of women graduates with 50% and more in Italy and Ireland – and the lowest in the Netherlands, Belgium and Germany with about 30%. In engineering, manufacturing and construction, Portugal has the highest proportion of women graduates with 35% and again the Netherlands the lowest with only 13%.

It seems that in most European countries strategies to encourage women to study engineering have not yet been sufficiently successful. This is also true for computing and physics.

European women are obtaining more than a third of new PhDs

In 2000, 39% (27,027) of all PhDs in the EU were awarded to women. This proportion is slightly higher than the average of 30 OECD countries (38%)¹¹

¹¹ Source: OECD, 2002, Education at a Glance. OECD Indicators 2002

Table 3.1: Women graduates in tertiary education (ISCED 5 & 6) in the EU, by all fields, Science and Engineering, (absolute numbers and %) 2000

	Total (all fields)		Science, mathematics and computing		Engineering, manufacturing and construction	
	Number	%	Number	%	Number	%
EU	1,184,530	55.3	105,798	41.4	60,936	20.4
Belgium	38,121	55.9	1,510	30.1	1,716	21.7
Denmark	21,667	56.7	966	32.5	1,337	26.3
Germany	152,064	50.3	8,755	31.4	8,542	16.4
Spain	149,182	57.3	11,267	42.5	9,327	23.9
France	277,082	55.4	31,813	41.8	14,072	18.7
Ireland	23,133	55.1	4,556	50.3	930	17.2
Italy	106,555	56.0	8,718	55.0	8,179	27.5
Netherlands	43,006	54.2	1,162	27.5	1,039	12.6
Austria	11,855	47.5	656	35.2	840	14.9
Portugal	38,017	65.0	1,450	45.7	2,476	34.6
Finland	22,298	61.7	1,265	46.4	1,494	20.3
Sweden	24,739	58.4	1,969	47.5	2,192	24.8
UK	276,801	54.9	31,711	41.5	8,882	18.1

Source: Eurostat, UoE, including ISCED 5 and 6

Missing data: Greece

Not applicable: Luxembourg

France, Italy: 1999 data

Denmark: In 2000 no data for ISCED 6; indicator on basis 1999.

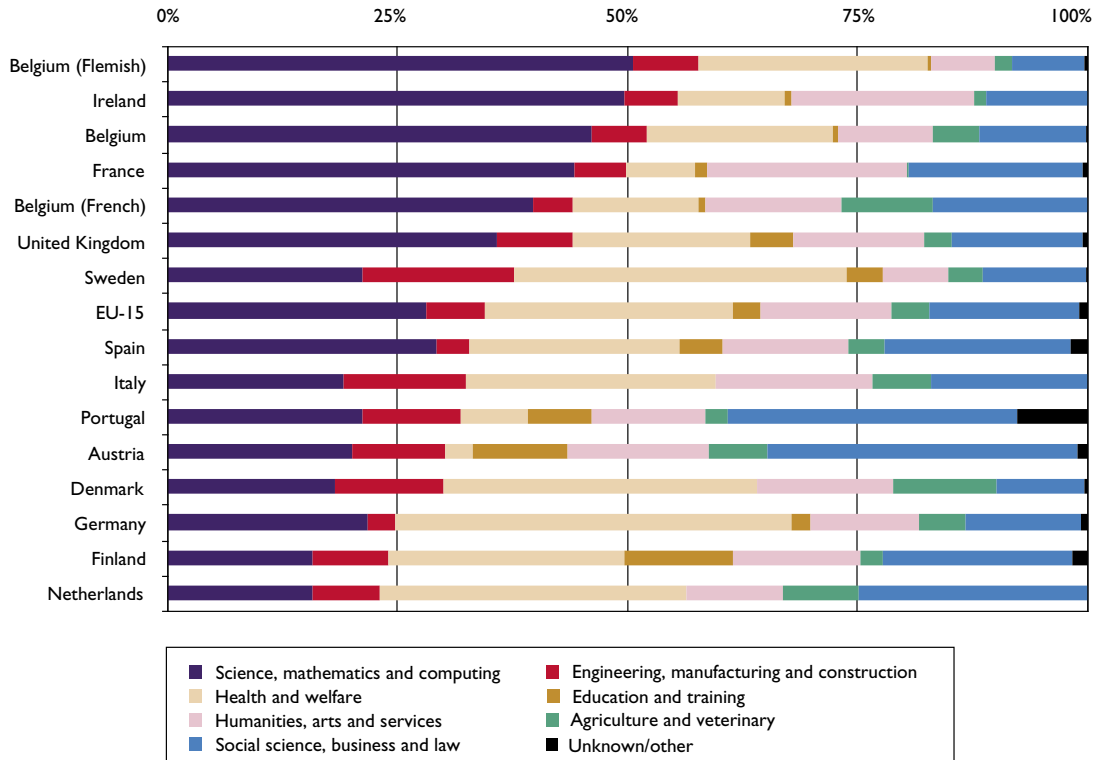
but lower than in the US (44%)¹². Of these women, 7,593 women earned a PhD in science, mathematics and computing, which equals 34% of all PhD graduates in this field. The share of women PhDs in life sciences is 50%, followed by mathematics (30%), physical sciences (27%) and computing (17%). In engineering, manufacturing and construction women's share of PhDs was 20% (1,744 women PhDs). By comparison, in the OECD countries the share of women PhDs was 47% in life sciences; 30% in mathematics and computing and 23% in engineering in 2000.

There are, distinct national differences. In science, mathematics and computing women PhDs, in % of all PhDs, constituted about 50% in Ireland, Portugal, and Italy and have been lowest in Germany and the Netherlands with less than 30%. In engineering, Italy is a little ahead of the other countries with 35% women graduates, followed by Portugal and Ireland with almost 30%. The countries with the lowest proportions of women graduating in engineering are Germany, the Netherlands, and Belgium with only 15% or less).

As Figure 3.4 indicates, more or about 50% of all women PhDs in Ireland, Belgium and France are in science, mathematics, computing and engineering. On the other hand, women doctorates in Netherlands, Finland, and Germany are more likely to have studied health and/or social sciences.

¹² Source: National Science Board, 2002, Science and Engineering Indicators 2002

Figure 3.4: Distribution of women PhD graduates (ISCED 6), by broad field of study, 2000



Source: DG Research, UNit C5
 Data: Eurostat, New Cronos (See Annex Table 3.3)
 EU15: estimated, excludes Greece.
 Denmark, France and Italy: 1999 data.
 Luxembourg does not have a complete university system. Most students study abroad.
 Ranked by the aggregated proportions of graduates in the two main fields of science, mathematics, computing (ISCED 42-48), and engineering (ISCED 52-58).

Box 3.3

“Today just as many women as men graduate from university, so the difference in the number of suitable candidates for (leading) positions is expected to increase quickly.”

Source: Klomp, Luuk, Meinen, Gerhard, Meurink, Andre, and Martje Roessingh, 2000, Knowledge-based economy 2000 – R&D and innovation in the Netherlands, Statistics Netherlands

Women in industrial research are still invisible

In 1999, a total of 935,222 researchers were employed in the EU (see Figure 3.2). Forty nine per cent worked in industry (Business Enterprise Sector) and 49% in the public sector (Governmental and Higher Education Sector)¹³. The proportion of researchers, who work in industry was highest in Ireland and Austria (64%), followed by Germany (59%), Sweden (57%), UK (56%), and Belgium (55%). In all other countries less researchers are working in industry than in the public sector: only 13% in Portugal and 16% in Greece.

About two thirds of all researchers in the EU are employed in Germany, France and UK (Table 3.2). The concentration of researchers in these three countries is even more pronounced if one considers only researchers in industry: nearly one third of all EU researchers in industry are working in Germany alone.

There are remarkable differences in the number and proportion of female researchers in the EU. The proportion of women among researchers among

¹³ The Governmental Sector includes publicly supported research institutes. The private non-profit sector is not included here.

Table 3.2: Total number of researchers and percentage distribution by sector, EU, US, Japan, 1999

	Total number	Business enterprise %	Governmental %	Higher education %
Germany	255,260	59	15	26
UK	165,105	56	9	30
France	160,424	47	16	35
Italy	76,796	35	16	47
Spain	61,568	25	19	55
Netherlands	40,623	48	20	31
Sweden	39,921	57	6	37
Belgium	30,219	55	4	40
Finland	25,398	42	16	41
Austria	20,222	64	5	31
Denmark	18,438	47	21	31
Portugal	15,752	13	22	52
Greece	14,828	16	13	71
Ireland	10,668	73	3	24
EUI 5	935,222	49	14	35
US	1,219,407	83	4	11
Japan	658,910	66	5	27

Source: DG Research

Data: Eurostat, Member States, OECD; Notes: (1) Researchers in full-time equivalents (FTE) (2) EU-average does not include Luxembourg

all researchers is highest in Portugal (43%) and Greece (41%) and lowest in Austria (19%) and Germany (14%) (Figure 3.5). In all other EU countries women constitute more than 25% of all researchers.

By comparison, in Iceland women have a share of 33%, Norway 28%, Switzerland 21%, and in the US 24%.

Industrial research relies mostly on researchers, who are qualified in the fields of science, mathematics, computing and engineering, where participation of women in higher education, especially in advanced studies, is still lower than that of men. It is not surprising, therefore that the proportion of women among industrial researchers is lower than in other sectors (Table 3.3), which have researchers from a broader spectrum of disciplines. However, this does not explain why the proportion of women in industrial research amounts to only 15% (for 10 EU countries, see Table 3.3).

Indeed, women do not even constitute 30% of industrial researchers in any individual EU Member State. This, despite the fact that their overall participation in R&D thus ranges between 26% and 43% in eight Member States (see Figure 3.6).

Women make up between 18% and 28% of industrial researchers in eight of the 10 countries that provide sex-disaggregated statistics. In the two remaining countries, Germany, and Austria, the share of women among all researchers is even below 10%. Germany with its dominant position in European industrial R&D, lowers the European average to 15%. This average is distinctly lower

Table 3.3: Numbers and proportions of female researchers in industrial research (BES), EU, 1999

Countries	All researchers ranked by total number	Number of women	% of women
Germany*	150,149	14,414	9.6
Denmark	11,292	2,218	19.6
Greece	3,931	940	23.9
Spain	17,310	3,353	19.4
France	86,215	17,787	20.6
Ireland	1,900	536	28.2
Italy	29,706	5,490	18.5
Luxembourg**	1,217	No data	No data
Austria	13,966	1,258	9.0
Portugal	3,328	793	23.8
Finland	22,515	3,999	17.8
Sweden**	39,921	No data	No data
UK**	98,587	No data	No data
EU (10)	340,312¹⁴	50,789	14.9

Source: DG Research, Unit C5

Data: Eurostat, New Cronos; DG Research, WiS database

Exceptions to the reference year: Austria (1998); France, Italy (2000); Ireland (2001)

* = Full time equivalent; ** = No gender differentiation data available

No data for Belgium and the Netherlands

than women's share of all graduates in science, mathematics and computing (41%) or than the already low share of women in engineering (20%).

Box 3.4

A survey of 162 life science researchers who had worked in both academia and industry identified career development opportunities and financial rewards as the key attractions of the latter.

Source: Grimwade, A. (2001) 'Working in academia and industry', *The Scientist*, vol 25, no 8, at http://www.the-scientist.com/Yr2001/apr/prof2_010416.html

Around three-quarters¹⁵ of all researchers in the business enterprise sector are employed in countries whose main economic activity¹⁶ is in the more R&D intensive manufacturing. The other domain in which both men and women are concentrated is "real estate, renting and business activities", which are especially important areas for Denmark (40%) and Greece (25%). These two domains comprise companies whose main economic activities are in IT or in R&D.

The overall proportion of all researchers in these two domains – manufacturing (D) and "real estate and business activities" (K) – amounts to 76% (70% for women) in Greece and exceeds 84% in all the other countries. Only in Denmark does the proportion of women researchers in manufacturing – 53% – exceed the proportion of men researchers.

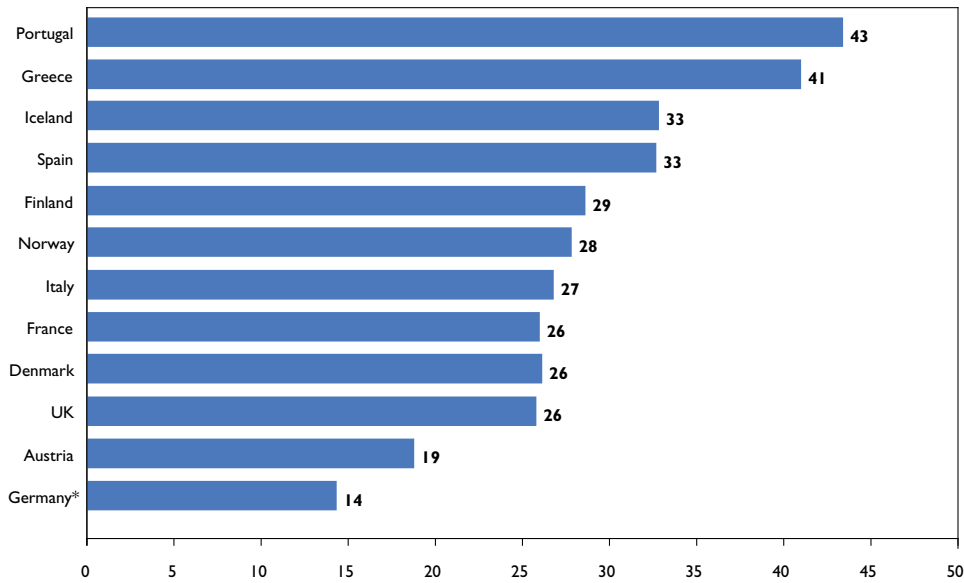
Although women researchers are generally distributed across domains in a similar way to men, the only domains where women participate substantially in industrial research are health and social work (N) and financial intermediation (J).

¹⁴ 480,037 if Luxembourg, Sweden and UK are included.

¹⁵ The overall for the 9 countries (A, D, DK, EL, E, FIN, F, I, P), which were able to provide data is 78.6%.

¹⁶ These data have been reported by Member States to DG Research; data are structured by ISIC/NACE classification of main economic activity.

Figure 3.5: Female researchers (head count) as a percentage of all researchers at the national level, 1999



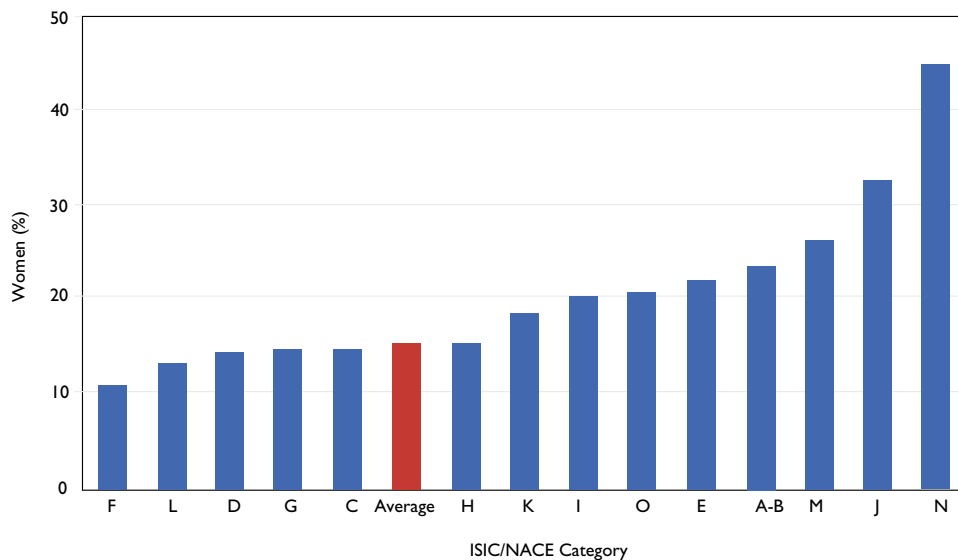
Source: DG Research, Units C5 and K3

Data: Eurostat, Member States

Exceptions to reference year: P: 2000, A: 1998

*= Full time equivalent

Figure 3.6: Percentage of female researchers (head count) among all reserachers by domain of economic activity (ISIC/NACE category)¹⁷, EU, 1999



Missing data: Belgium, Ireland, Luxembourg, Netherlands, Sweden, United Kingdom. Exeptions to the reference year: Austria (1998), France and Finland (2000)

¹⁷ A+B = Agriculture, hunting and forestry + Fishing; C= Mining and quarrying; D= Manufacturing; E= Electricity, gas and water supply; F = Construction; G = Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods; H = Hotels and restaurants; I = Transport, storage and communication; J = Financial intermediation; K= Real estate, renting and business activities; L= Public administration and defence; compulsory social security; M = Education; N= Health and social work; O = Other community, social and personal service activities.

It is of special interest to compare the situation between France and Germany, because they are the countries with the highest numbers of researchers in the EU¹⁸. In France women researchers in industry play a far more important role than in Germany, their share amounts to 21% of all researchers in industry but only to 10% in Germany. Even though Germany has nearly twice as many industrial researchers as France, France has over 3,000 more female researchers working in industry than Germany (Table 3.3).

The following trends are results of a survey, which was conducted in the public and private research sector in France, and published in March 2002¹⁹. The survey covered 11,200 companies and 50 research centres.

The trends identified were:

- Female participation is higher in public research than in industrial research,
- There is a remarkable increase in the number of women in all scientific fields – especially in health and also in self-employment.
- The proportion of women is larger in life sciences and chemistry (49%), and lowest in mathematics, physics or engineering (only 8%).

Sex disaggregated data have been available in France since 1993. A slight increase in the share of female researchers in industry has been observed between 1993 and 1999. As in Germany, women tend to be more concentrated in the field of pharmaceuticals, but their representation is significantly better in France (50% compared to 37% in Germany). Even in the fields where participation is lowest, one is about twice as likely to encounter a female researcher in France than in Germany.

The German Faktenbericht 2002²⁰ presents data on women in industrial research for 1999. The presence of female researchers is relatively higher in the areas of food and tobacco processing, textiles and chemical industry (nearly one-third). Companies whose main economic activity centers around pharmaceuticals employ the highest proportion of women researchers (37%). The proportion of women researchers is particularly low in the areas of vehicle construction (6.5%) – and especially in the sub-groups of other vehicle construction and aerospace vehicle construction (3.8% in each) – and of mechanical engineering (5.4%). The percentage of women was lowest in broadcasting, television and telecommunications technology with 3% only.

A glance at the situation in the associated countries

In the associated countries women participation in industrial research tends to be comparatively higher than in the Member States.

Country differences in this group are however substantial. In Switzerland, Norway, and, to a lesser degree, also in Czechia and Hungary female participation rates in industrial research assemble those in the EU.

¹⁸ Sex-disaggregated data for the UK are not available yet.

¹⁹ French Ministry of Research, 2002, Women in French Research. The White Paper.

²⁰ Bundesministerium für Bildung und Forschung (BMBF), 2002, Faktenbericht 2002

Table 3.4: Numbers and percentage of female researchers in industrial research (BES), Associated countries, 1999

Countries	Researchers in industrial research*	Women researchers in industrial research	Women researchers in industrial research (%)
Bulgaria	1,435	637	44.4
Switzerland	17,210	2,845	16.5
Cyprus	189	39	20.6
Czech Republic	9,488	1,559	16.4
Estonia	651	232	35.6
Hungary	4,063	948	23.3
Iceland	842	197	23.4
Lithuania	339	153	45.1
Latvia	211	71	33.6
Norway	12,626	2,476	19.6
Slovenia	1,772	506	28.6
Slovakia*	2,552	742	29.4

Source: DG Research, Unit C5

Data: Eurostat, New Cronos; DG Research, WiS database.

Notes: No data for Israel, Malta, Poland and Romania.

Exceptions to the reference year: Iceland, Lithuania (2000)

* = Full-time equivalent.

In the US, 19% of all researchers in industry are women²¹

Since the National Research Council (NRC) published its first report on women in industrial research, *Why so few?* (NRC, 1993), sex-disaggregated statistics have become much more available in the US²². In 1999, about every fourth researcher (scientist or engineer) in the US was a female. Nearly two thirds of them worked in the private sector, mainly in industry/businesses. Others were self-employed, or worked in private-non-profit institutions. Some 38% of all female researchers worked in governmental and educational institutions.

Just over half (52%) of all women scientists and engineers in industry are computer scientists or mathematicians, 23% engineers, 9% life scientists, 8% physical scientists and 7% social scientists²³.

Gender differences in industrial research have decreased in the US (as in Europe). The largest gender differences remain in engineering and in the physical sciences where women are more likely to be found in applied research than in basic research²⁴.

²¹ These data are based on different definitions as for instance the date of the OECD cited above (compare table 3.2). Thus, the different data sets cannot be compared. However, the distributions across the various sectors and female participation rates provide a good indication.

²² It is worth noting that the US National Science Foundation's biennial Scientists and Engineers Statistical Data System (SESTAT) surveys enable scientists and engineers to be defined in terms of education or occupation or both: it is an extremely rich data set that may serve as a model for Europe.

²³ NSB, 2002, Appendix, Table 3-40, p A3 138-9

²⁴ National Research Council, 2001, From Scarcity to Visibility. Gender Differences in the Careers of Doctoral Scientist and Engineers, Washington DC.

Box 3.5

Ask any working mother, and chances are, she will say that having to juggle a family and a job is incredibly taxing. Employers are beginning to do their bit, but some are changing more quickly than others. A survey published by *Human Resources* magazine shows that while more than 70% of public sector organisations have formal flexible working policies, less than 25% of private sector organisations do. This figure drops to 14% for FTSE 250 firms.

Source: Maria Scott, *The Observer*, 18 November 2001

Working conditions and trends for female researchers in industry in EU Member States

Based on the European Labour Force Survey (LFS) in 2002 a first analysis has been undertaken to analyse working conditions and situation of female researchers in industry. Preliminary data show the following trends²⁵:

- During the last years (1995–2000) in industry (Business Enterprise Sector – BES) employment of highly qualified female scientists and engineers increased faster than that of males.
- At the EU level, nearly 60% (in Spain, more than 80%) of all women scientists and engineers in industry/BES are under 34-years-old, they were significantly younger than their male colleagues and tended to be younger than other female employees (non-researchers) in the same sector.
- Women scientists and engineers are more likely to have a temporary contract than their male colleagues (this is even more pronounced in the public sector). However, there are significant country differences: far more women scientists and engineers have temporary contracts in industry/BES in Belgium, Italy, Luxembourg and Portugal than in other EU countries.
- A higher proportion of female than of male scientists and engineers in industry/BES is employed in small and medium-sized enterprises (SMEs).
- In all EU countries the proportion of women scientists working part-time is clearly smaller than of other female part-time employees in the same sector. Only every sixth female scientist or engineer is working part-time in the business enterprise sector. Country differences are significant: while nearly half of all women scientists and engineers in the Netherlands work part-time, only 4% do so in Denmark.
- Scientists and engineers are four times more likely to work from home than other employees, especially male scientists and engineers. While 12% of women scientists and engineers in enterprises usually or sometimes work from home, the percentage for men is 18%. Again there are distinct country differences. Nearly 50% of all female scientists and engineers in Denmark usually or sometimes work from home, while in Spain and France working from home is almost non-existent.
- In the EU, relatively fewer women (28%), who work as scientists in industry/BES, have one or more children as compared to female non-researchers working in the same sector (34%).

The impact of family

The fact that female researchers tend to be younger probably partly explains the fact that fewer women researchers in industry have children compared with other female employees. Many studies have, however, also shown that highly educated women tend to postpone maternity as the opportunity cost of staying at home to raise children is higher for highly educated women²⁶. If women scientists decide to combine a career with children, they are very dependent on childcare infrastructures, whether formal or informal. These infrastructures still vary enormously across Europe, with respect to their availability, flexibility, quality, and cost. An actual analysis on “Women and men

²⁵ See footnote 3 (Meulders et al: in press) The main sources are the R&D Survey, the European Labour Force Survey (ELFS), and the Structure of Earnings Survey (SES).

²⁶ This depends in part on the national arrangements for maternity leave, for example, length of leave, whether it is paid or not and whether the woman is eligible for promotion while on leave. In both Norway and Sweden there are examples of women being promoted while on maternity leave or while working part-time.

reconciling work and family life” points out that in more than two thirds (up to 94%) of the households in the EU with children, where the mothers have a university degree, both partners are working²⁷. The lack of available childcare provision might explain why some women, especially highly educated ones, decide not to have children (see Gornick et al, 1997; Gustafsson and Meulders, 2000; Gustafsson, 2002).

In Denmark, public childcare is provided for 55% of all children younger than three years, in France childcare facilities are available for 41%, in Finland and Sweden for 34%; on the other side of the spectre, in Germany, UK, Austria, Italy, Spain, and Greece childcare is only available for less than 10% of children younger than three years²⁸. Obviously the lack of child care provisions as well as not harmonised regulations for maternity/paternity leave and for elder care in the EU affects career development and mobility of women considerably and puts them at a disadvantage²⁹. On the one hand, the decision of a number of highly educated women not to have children because of these circumstances, which is cited above, can clearly not remain an answer to this problem either.

Career development

International studies on women’s careers in industrial research in Europe are not available yet. Based on firm level data members of the expert group and other companies reported in autumn 2002 to the Women and Science Unit of DG Research³⁰, it can be concluded that more women researchers have been recruited within the last years. But only very few women are occupying leading positions. Exceptions tend to be the few companies with a woman CEO.

There is a high diversity of career paths and patterns, but at all stages of the scientific career, science and research is losing out on the potential of talented women who are frequently forced out of their professional career by unfavourable circumstances. Frequently women are forced to choose between family and a professional career. Whatever their personal decision is, it always leads to a loss: there are either fewer children or a lack of professional talent³¹. As often, the employer, the firm, will make the choice on the traditional perception of limited performance capabilities of “mothers”, instead of the woman herself.

Box 3.6

Childcare: British parents spend more on childcare than anyone else in Europe, because most is provided privately. The cheapest form of childcare – child minders – typically charge £20 per day, or £100 per week, but most will look after children only until 6pm. Lokewise nurseries, which charge about £200 per week, usually close their doors promptly at 6pm. This leaves anyone who works slightly irregular hours facing the cost of a nanny – anything up to £300 per week plus tax and national insurance.

Source: Maria Scott, *The Observer*, 18 November 2001

Box 3.7

Guilt: Many mothers returning to work face considerable emotional costs. Every week some or other claims that children of working mothers do less well at A-levels, or have to eat substandard food because their mothers are too tired to cook. A study last week even claimed that men with working spouses were sadder.

Source: Maria Scott, *The Observer*, 18 November 2001

²⁷ Ana Franco and Karin Winqvist, 2002, Women and men reconciling work and family life, Statistics in focus, Theme 3 – 9/2002.

²⁸ Council of the European Union, 2000 (12577/00), Review of the implementation by Member States of the European Union and the European institutions of the Beijing Platform for Action: relationship between family life and working life (23 October 2000).

²⁹ See above.

³⁰ In order to collect firm level data, a short questionnaire was developed and sent out by members of the expert group and professional organisations. It was also available on the WIR website. Until November 2002 we received first data mainly from international companies, three from German companies, three from French companies, two from companies based in UK, two in Spain, two in Netherlands, one in Belgium and two private research institutions in Denmark and Germany.

³¹ The phenomenon of the leaky pipeline has been described above (Osborn et al, 2000).

A German study of physicists

A German study on women and men in physics³² analysed the career development of women physicists. Some 11% of all women physicists worked as researchers in industry, another 15% were also employed by industry, but worked in other departments. While quite a high number of men aged 36-45 years tend to leave public sector research for a career in industry, women change sectors less frequently. Only 5% of women physicists in this age group are researchers in industry, compared to 14% of men. Women are clearly under-represented in leading positions, and more frequently do not continue their careers in research (43% of women versus 23% of men).

Wage differences

For the US, salary differences for female and male scientists and engineers are analysed in the Science and Engineering Indicators 2002 (NSB, 2002). The gender pay gap (without controlling for years since graduating, effects of family and other personal characteristics as well as other factors) is highest for those with Bachelors degrees: women earn 35% less. However, for people with PhDs, the difference still amounts to 26%. The study concludes that ‘Marriage is associated with higher salaries for both men and women, but

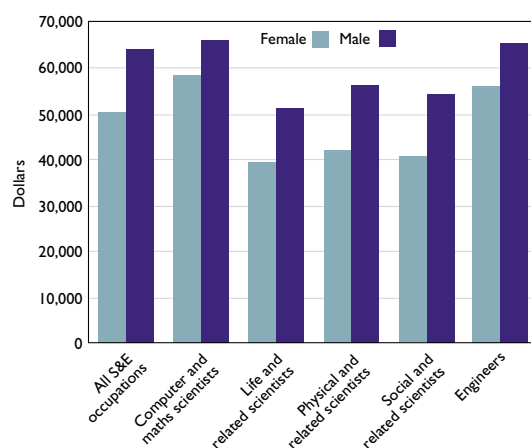
Conclusions

- These are preliminary results – but they indicate the large, widely untapped potential of women.
- Research is loosing out on a high potential of highly qualified people.
- Indicators and benchmarking are needed for stimulating and monitoring progress and for comparing the effects of national and industrial policies.
- Better sex-disaggregated data and studies are needed.
- There are significant differences in the employment of women in industrial research between countries, sectors, and disciplines.
- There is an urgent need to harmonise supporting structures across Europe to allow for better mobility for working parents.
- In addition, in order to meet the challenges of the future more girls have to be attracted to science in order to widen the recruitment base (EURAB http://europa.eu.int/comm/research/eurab/index_en.html).
- The needs of (job-)”returners” have to be addressed.

Box 3.8

Median annual salaries of employed scientists and engineers, by broad occupation and sex in the US (1999)

Source: NSB, Sciences and Engineering Indicators (2002)





A vision for 2010: opportunities and approaches

Designing the company of 2010

Our vision for 2010 is to create companies that have democratic values and provide a richer working life for industrial researchers. Such companies should enable human talent to be released much better than currently is the case. Women as well as men should have opportunities to develop their potential in industrial research – and for men as well as women to enjoy a sensible work/life balance.

The long-term goal is to see a much nearer approximation to a 50/50 gender balance on average in the laboratories and the senior management teams of research-intensive industrial companies. The shorter-term goal, for which we set the date of 2010, is to see far more women recruited than currently pertains and a better gender balance at all levels in industrial research. However, there should not simply be an increase in the numbers of women in the recruitment pool, but also an increase in the numbers progressing to senior positions. Ideally, the gender balance across all grades of industrial researchers in the organisation should reflect the proportion of men and women in the available talent pool.

The picture today is one where the number of women present in an organisation drops, both precipitously and disproportionately, with seniority. It is important to identify the factors that lead to fewer women developing careers. Interestingly, some companies are creating cultures that foster creativity, enterprise and innovation specifically though encouraging women and developing their careers. This chapter includes examples of the practices they are using in order to achieve this.

It is quite clear that a creative work culture, which is essential in today's exceptionally competitive market place, cannot be generated through the efforts of teams of 'clones'. Cloned people produce cloned ideas. In order to create and fan the creative spark, organisations need employees who bring to the table different experiences and different approaches to problem identification and solution.

Box 4.1

'Diverse minds – common goals'.

Source: AstraZeneca R&D Diversity slogan

Box 4.2

'Organisations need not only to value the differences amongst their workforce but to *capitalise* on these'.

Source: Tom McKillop, Chief Executive, AstraZeneca

Organisations are realising that a diverse workforce is not only 'nice to have' but, given its role in increasing creativity and innovation, and the growing significance of women in the marketplace, is now a business need. So what are the opportunities for energising working cultures and releasing employees' potential?

The key lies in changing organisations and their cultures by introducing policies that encourage diversity in all its forms, and for individual employees to make a commitment to putting these policies into effect. In Chapter 2, a case was made for the benefits of such a 'diversity' approach to human resource management, both on the grounds of the business case and because it is the right thing to do. Chapter 3 showed how the current 'laissez-faire' approach does not succeed in growing women in the numbers and at the levels needed by industrial research in Europe. This chapter addresses why and how companies, and other stakeholders, must change to embrace diversity, and in particular, be more successful in recruiting, retaining and promoting women.

'Diversity' in the private sector encompasses a wide range of visible and non-visible characteristics, for example, level of formal education, qualifications, expertise in a particular scientific discipline, experience, technical and interpersonal skills or preferred ways of working. 'Diversity' also refers to equality dimensions such as sex, race and ethnic origin, disability, age, sexual orientation and religious and political belief, all of which are encompassed by the EU Amsterdam Treaty. Whilst all of these characteristics and equality dimensions are important, this report is focusing on women (who, like men, encompass all equality dimensions and characteristics).

One approach to changing organisations and their cultures to increase the representation and participation of women is to apply the EU-backed approach of 'gender mainstreaming', as described in the European Commission Communication (EC, 1996) and the ETAN report (Osborn et al, 2000), to industrial research. But what is gender mainstreaming? It is 'integrating gender equality into all organisations and their cultures, into policies, programmes and projects, into ways of "seeing and doing"' (Rees, 1998). Instead of targeting the 'special needs' of the 'disadvantaged group', it focuses on practices and policies that give rise to that disadvantage in the first place. It means overcoming the traditional stereotypical male 'breadwinner' model of an employee – which is no longer applicable – as the norm around which companies are organised. The reality of the lives of women and men in contemporary times is much more diverse. Women should not need to choose between a career and a family, any more than men do.

In addition to eliminating any remnants of institutionalised sexism, industry and private institutions need to take a good hard look at familiar and accepted processes and behaviours, to try to identify unwitting discriminatory processes that lead to the highly skewed gender statistics shown in Chapter 3.

Gender mainstreaming is relevant for the internal management of the organisation: human resource management, recruitment, staff development and training, promotion policies, work organisation and so on. But it is also relevant for what the company does: the industrial processes concerned with the design of products, development and marketing, manufacture and delivery of new products and services.

Box 4.3

A substantial number of British fathers barely see their children during the week. 45% of fathers in UK get home after their children have gone to bed

Source: Ivana LaValle, National Centre for Social Research study published by the Joseph Rowntree Foundation (<http://www.independent.co.uk/story.jsp?story=337606>)

Box 4.4

Gender mainstreaming is becoming more widely endorsed worldwide. In September 2001, the World Bank's Board of Executive Directors, representing 183 countries, strongly endorsed the strategy

Source: Integrating gender into the World Bank: A strategy for action

One of the principles that underlie gender mainstreaming is about regarding the individual as a 'whole person'. An organisation's 'family friendly' policies benefit both women and men. Both female and male employees need a good work/life balance and both may have caring responsibilities during periods of their careers (such as childcare and, increasingly, eldercare). Hence, much more importance needs to be attached to flexibility and family-friendly arrangements for all employees. This principle means changing the work culture to one where employees are assumed to have a life outside work. Apart from family responsibilities, it may also involve a role in the local community, a trade union, or a professional association or in civic, religious, cultural or public life, or an individual may have a personal commitment to lifelong learning.

Some organisations have 'values' statements' that set out the ethos of the company, and lay down standards or codes of behaviour employees are expected to observe in relation to each other, customers and clients. Some companies extend such policies to encompass values to which their suppliers must adhere, for example with respect to health, the environment and safety – and gender equality (as in the US). However, such 'values' statements' and codes of behaviour in themselves are of little worth if everyday practice does not reflect the policy and if business leaders are not seen to be 'walking the talk'.

A second principle underlying gender mainstreaming, and one that is endorsed in all western societies, is democracy. This means creating a culture where employees feel able to express their views, articulate their needs, are listened to and shown respect. It means that formal and informal work cultures should embrace differences: they should certainly not be allowed to exclude certain groups – however subtly. There should be visible fairness in the allocation of opportunities and resources. It involves encouraging employees to express their views, often through employee surveys or local 'focus' groups, and take an active role in contributing to decision-making processes. There should be transparency in procedures, processes and outcomes. Criteria for recruitment, promotion and decision-making should be clear to everyone. Encouraging staff to speak out can also pre-empt unpopular policies and generate new ideas.

How are these principles put into effect? A combination of technical tools, people skills and institutional arrangements are required.

Technical tools

Firstly, six examples of tools of promoting gender equality are briefly identified.

- The tool at the heart of mainstreaming is 'visioning' (see Rees, 1998). This is also the most challenging element. Through it, we seek to understand and address how existing practices, cultures and institutional arrangements, however inadvertently or subconsciously, disadvantage women more than men (or indeed, vice versa).
- Gender balance in decision-making is needed to address both the business need and the democratic principle. In three Member States, legislation already exists to ensure a gender balance on public bodies, including research councils. Some companies set targets, for example, to create a

Box 4.5

Companies such as Bayer, Ford Motor Company, General Electric, IBM, Merck, Schlumberger, Siemens and many more already offer flexibility in working life, telework programmes, support for women's networks and childcare centres.

Source: www.siemens.com (search 'diversity') <http://leadership.monster.com/diversity.html> (Ford Motor Company)

Box 4.6

'Diversity means more than simply gender – it means accepting people of various ages, religions, skin colours and backgrounds within the organisation. As a global player with activities in 190 countries, the diversity of our employees is one of the great strengths of our organisation'

Source: Dr Klaus Döring, CEO of Siemens Southern Africa, released by FCB Redline, On behalf of Siemens Corporate Communications (<http://www.siemens.com>)

better gender balance among senior management, or to have at minimum one woman on panels for recruitment interviews.

- Sex-disaggregated statistics are a powerful management tool, both in reviewing recruitment and promotion patterns, but also in determining untapped markets. Surprisingly few organisations use such statistics as a tool to review the effectiveness of their policies, or to monitor performance.
- Raw data, even when disaggregated by sex, are of course limited in what they show. Hence, there is much work to be done in developing gender equality indicators. Baseline statistics are needed against which performance targets can be measured. Equality indicators are likely to be made up of a combination of variables, for example proportion of women appointed to certain grades compared with their numbers in the recruitment pool.
- Gender impact assessments can be designed to estimate, in advance, the likely impact of any proposed policy on men and women respectively and to address any undesirable consequences that may be anticipated. For example, some employers include in their eligibility criteria for promotion or training ‘length of continuous service’. This indirectly discriminates against women, who are more likely to have had a career break than men. A gender impact assessment of this criterion would have anticipated this.
- How can we tell if diversity management and gender mainstreaming are being delivered without monitoring, evaluating and auditing? It is surprising how many companies do not have sufficient data on their employees to be able to set a baseline for gender distribution across their organisation. Gender balance⁵ needs to be regarded as a performance indicator, and treated the same way for evaluation purposes as, say, balancing the books. Equal pay reviews, for example, can demonstrate whether the company has a gender pay gap among its industrial researchers that cannot be justified. Some companies conduct regular staff morale surveys that help to bring issues to the surface and raise awareness, for example of perceptions about the openness of the company and its culture to different groups.

Box 4.7

In the Research Directorate-General of the EC, there is a similar rule that all the scientific committees of the Directorate must aim to have at least 40% of both genders. This has substantially altered the gender make up of committees that decide what science should be funded, as well as those that monitor and evaluate successful projects in the EC’s Framework Programmes.

People skills

Secondly, ‘people skills’ are required to administer these tools. Expertise, training and awareness raising are all essential to enable staff to develop the skills to use these tools. Key members of staff need training; for example in developing and using indicators, in conducting gender impact assessments, and in visioning. Relevant (external and internal) websites and attractive material can also be of help.

Companies may need to ‘buy in’ expertise as well as grow their own, just as they do for forecasting, budgeting, health and safety, taking on board the requirements of new legislation and so on. Change agents are often used to work with department heads and gender mainstreaming experts to fast track organisational and cultural change.

⁵ We consciously use the term “gender balance”, not “gender equality”. Gender balance implies a number reflecting the recruitment base.

Institutional prerequisites

Thirdly, there is a set of institutional prerequisites for the successful adoption of diversity policies and gender mainstreaming. These include *commitment from the top*, *incentives to 'build ownership'* and *integrated reporting mechanisms*. The corporate plan should include diversity related aims and objectives. Action plans should specify how they would be met. Senior management must 'walk the talk'. Progress needs to be reviewed against these plans, just like any other business objective. This locks diversity management and gender mainstreaming into the company's culture. It involves a clear allocation of responsibility and accountability. It needs to be taken as seriously as budgeting or health and safety.

Examples of institutional arrangements that can assist include a specially designated committee, chaired by a member of senior management, with built-in accountability, reporting mechanisms and sanctions. Building ownership can be encouraged, for example, by providing financial incentives to achieve targets, integrating diversity and gender balance into performance review systems, and/or by including a section on this issue, including the outcome of gender pay reviews, in annual reports or in corporate social responsibility reporting.

Progress on gender balance is relatively straightforward to measure numerically, through retention and promotion reviews, exit surveys and so on, but it is important to assess improvement in organisational and culture change not only quantitatively but also qualitatively. This can be done, for example, through staff review session, interviews, or focus groups, where groups of staff are brought together to discuss key issues openly as a way of 'taking the temperature'. Staff morale studies, where members of staff are asked a few questions on a regular basis, perhaps by email, about their job satisfaction, the extent to which they feel valued and feel they have a future with the company can be used as sources of more qualitative data. Managers can be forced to make changes, but it is more effective if they also believe that the changes are beneficial to them, their team and the company. Team behaviour may need to be addressed, for example in management courses, to foster a culture where constructive leadership styles and team behaviours are emphasised, supported and rewarded.

Appropriate resources are rarely allocated for work related to diversity issues and redressing the under-representation of women. Diversity measures should be viewed as an investment – indeed, consideration should be given to the financial and opportunity cost of *not* undertaking such measures. As an example, offering all women staff sensible maternity leave arrangements (where this was not offered sufficiently as part of the public welfare system) can result in companies' saving money. The women were much more likely to return to the company after their maternity leave and hence the company avoided incurring the cost of having to recruit and train permanent replacements (Humphreys and Rubery, 1995).

Box 4.8

Deloitte and Touche, by reducing attrition rates for women, saved \$250million in hiring costs and by helping the company to expand rapidly through retention of experienced staff.

Source: Cracken (2000) *Harvard Business Review* December

Recruiting, sustaining and developing women in science

Companies in industrial research need to take active responsibility for building the careers of their employees, ensuring that attention is paid to nurturing those of women as well as men. Some methods of achieving this are:

- increasing the size of the talent pool at all levels and setting aspirational numerical targets for recruitment, as well as for promotion within the organisation.
- establishing open and transparent staff review systems, designed to allow managers to get to know the employees, identify their potential and monitor their performance.
- experimenting with various mentoring schemes – to identify and foster potential.
- monitoring and analysing recruitment, attrition and exits.

Box 4.9

MUFFIN is a mentoring program in computer sciences in Germany. Female computer scientists from different companies, research institutions, and universities are involved as mentors for young women studying computer sciences (<http://www.muffin21.de>)

More specifically, we focus on promotion, retention, returning and recruitment:

Lufthansa, the German airline, has joined with seven other major corporations, including Commerzbank, Robert Bosch and Deutsche Telecom, to offer a so-called cross-mentoring system in which women in one company offer advice to women managers in another firm. It's an effort to help women develop a network that allows male managers to successfully climb the corporate ladder.

C.A. Wallace (2000) 'Germany's Glass Ceiling: Women managers are rare in corporate Germany, where a culture of old boy prejudice still prevails, *Time Europe*, vol 155, no 14 (<http://www.time.com/time/europe/magazine/2000/0410/glass.html>)

Box 4.10

'For every in-company management course, business units are specifically asked to propose a sufficient number of women candidates to ensure a representative gender-balance.'

Source: Norsk Hydro ASA (Norway)

Box 4.11

Women who take career breaks are often penalised for giving priority to unpaid work at certain points in their lives. Rather, this break in a regular professional career may have positive benefits for the company and the individual!

Reaching the top (promoting)

- monitoring succession plans to check for the inclusion of under-represented groups in promotion to top positions and setting aspirational targets for their increase.
- analysing current career paths and success criteria used in promotions. Identifying blockages that hinder women's progress.
- ensuring that development plans include experience of other parts of the organisation – different functions or different geographic locations – as well as relevant off-the-job activities (possibly even include managing a home!).
- ensuring that women receive support from internal networks (e.g. female managers, professional organisations, a helpline, etc)
- offering opportunities for 'work shadowing' (spending a day or week following and observing a board member doing their daily work) in the boardroom or in top management teams.

Following an initiative taken by the Dutch Minister of Economic Affairs, Mrs A. Jorritsma, each member of the ambassador's network of top industrial managers committed themselves to a programme to improve the position of women in their respective companies.

Lifecycles of careers (returning, retaining and career building)

Contemporary industrial researchers may not follow the traditional male pattern of continuous, full-time work from leaving higher education until retirement. Women in particular may be career 'late' or may take time out during the professional career. This means that they will often be older than male counterparts when applying for or being considered for senior roles. Any preconception of an 'ideal' age for a particular role should be avoided.

Good practice for lifecycles of careers, that include late entries, career breaks and re-entries, include the following:

- planning 'returner' and 'keeping in touch' schemes, as well as confidence building for those who are or have been out of the company for a while.
- taking into account the fact that 'dual careers' may mean men and women require jobs for their partners in the company or the vicinity.
- providing childcare or subsidising childcare costs (if there is insufficient affordable, good quality, public childcare available),
- offering careers breaks, flexibility and part-time working, for men and women.
- offering exchanges with researchers in the public sector, in keeping with other EU policies on mobility.

What do 'good practice' companies do to encourage and attract the next generation of female scientists? They ensure that the company's external image is modern and open, interested in women and offering them opportunities, ('female friendly' and 'family friendly').

- they have examples of 'real' role models (not superwomen).
- they send women to represent the company at external events (conferences/analysts meetings/launch events, etc).
- they organise mentoring and networking schemes, to ensure that there are sufficient women around to avoid a feeling of isolation.
- they encourage girls into science by participating in 'take your daughters to work' days and 'girls and science days'.
- they send women scientists to schools and universities to deliver the message about the excitement of science in industry in schools liaison programmes.
- they organise properly managed summer student (internship) schemes, a valuable way of enticing students of high potential to join the company and generating good PR.
- they use internships to award fellowships and scholarships, hence developing relationships with high-potential female candidates.

Conclusion

The core of European industry is industrial research. It is the heartland of innovation, development and ideas. However, the vibrancy of industrial research in Europe is hampered by the fact that it taps into less than half the talent pool. Women's ideas and women's potential tend to be under-represented (and under-valued). Our vision, therefore, is to create democratic, open and transparent companies where women as well as men can prosper, and their ideas can flourish and be developed and contribute to the innovation process.

Box 4.12: IBM UK Maternity Return Payment

Women who have worked for IBM UK for more than five years before taking maternity leave, receive an additional monthly payment equal to 25% of their salary when they return. The payment continues for a period of two years after their return from each period of maternity leave and can be used to help meet childcare costs.

Source: Linda Taylor, IBM UK

Box 4.13

The website <http://www.partnerjob.com> is designed to facilitate geographic mobility by providing help to find a job for an accompanying partner.

Box 4.14

Recruitment:

It's not what you say – it's what you do
It's not what you show – it's what's seen.

It's not what you say – it's what's heard.

Perception is reality

To achieve this will need a strategic approach, informed by research, statistics, monitoring and evaluation. It is important to recognise that most existing organisational cultures are neither attractive to nor supportive of women. They fail to recruit good women industrial researchers and drive others out. This problem needs to be addressed by reviewing company culture and practices and checking the validity of their interpretation of 'the best person for the job'.

Nothing can be done in isolation; a coherent framework is needed. A good place to start is with the statistics – to know where we stand and to detect problem areas. The same applies to understanding employees' perceptions of diversity in the company. The smart use of IT tools can support diversity. Management buy-in and leadership are critically important. To create modern working conditions, we need to open the windows – and our minds!

Companies need to co-operate with others. Companies and national governments have to take the lead to promote changes.



Entrepreneurs: The lifeblood of an innovative economy

The situation of women entrepreneurs

Apart from research in established companies, economies depend to a large extent upon the creativity and innovation of entrepreneurs starting new businesses. Although relatively few researchers turn into entrepreneurs, they play an important role, frequently providing cutting edge innovations, which sometimes have the potential of triggering developments of new industries. This chapter reviews the role of women entrepreneurs in industrial research, focusing in particular on information and communication technologies and biotechnology.

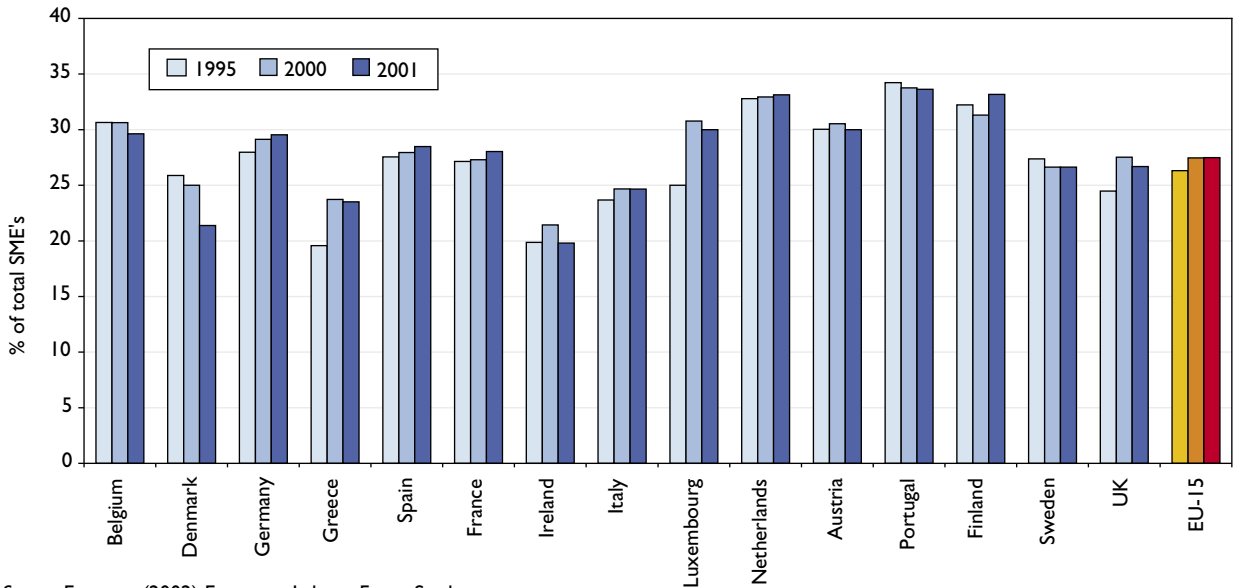
Setting the scene: an overview

The number of women who are self-employed or running their own businesses has grown substantially in the past twenty years. Although they remain a minority of business owners, ranging from 25% to 35% in most countries, their share of business ownership appears to be increasing. This share varies considerably across sector. Structural characteristics may partly explain country differences (see Figure 5.1). In Sweden, for example, women now represent 23% of all business start ups and account for around 25% of all private firms, a proportion common to many other northern European states (Nilsson, 1997). Although firms that are wholly female-owned are a minority of all enterprises, women's participation in business ownership is wider than this. Indeed, a recent study of 18,500 small and medium size enterprises (SMEs) in the UK found that 42% were co-owned by men and women. Co-ownership of businesses by a family often masks the numbers of women who are involved in SME ownership and management.

However, when compared with the US, where a fast growth has been apparent for some time, the EU lags behind in the number of women owned businesses. In 1970, women accounted for only 5% of all small businesses in the US (Brush and Hisrich, 1999); it is now estimated that there are 6.2 million privately held women-owned businesses. These firms generate \$1.15 trillion in sales and employ 9.2 million workers. In the last five years, the number of women-owned firms grew at twice the rate of all US firms,

employment grew at 1.5 times the national average, and sales rose at the same rate. The growth in the number of medium-sized women-owned firms is even stronger. In the past five years, the number of 100 plus employees women-owned firms grew by 44%, and women-owned firms with a turnover of over \$1 million increased in number by 32%, both nearly twice the rate of all comparably sized firms (Centre for Women's Business Research, 2002).

Figure 5.1: Proportion of female entrepreneurs in the EU Member States, 1995-2001



Source: Eurostat (2002) European Labour Force Study

Profile of women entrepreneurs

Box 5.1

'There is considerable unused potential among young women, who in many respects better meet modern requirements in engineering than those typically encountered in technological courses to date.'

Source: Karl-Heinz Minks, Department of Socio-empirical Studies on Education Choices of Students and Graduates, Higher Education Information System GmbH (HIS)

Women-owned firms in Europe can be distinguished from those owned by men in a number of ways. While men start firms across a wide variety of industries, proportionally more women than men set up businesses in the service sector. This contrasts with the US, where, although there is a concentration in services and retailing, women have broken into non-traditional sectors such as construction, wholesaling and transportation. Between 1987 and 1992, the number of women-owned businesses operating in these sectors in the US grew by 94%, 87% and 77% respectively (Brush and Hisrich, 1999). Women-owned businesses are more likely to be smaller and younger than those owned by men, and women business owners tend to be younger than their male counterparts. Women are more likely to operate one-person businesses (sole traders) while men more commonly own incorporated firms or partnership businesses. Women business owners also tend to start their businesses using personal and informal sources of finance, rather than bank credits and venture capital.

A report for the European Commission (IfGH, 2002) referred to the use of support services granted by public policy initiatives, with non-commercial, non-financial conditions. It is noted that women entrepreneurs are generally more willing (27%) to make use of such support services than are male entrepreneurs (17%). These gender differences are even stronger in the case of mature enterprises: 30% of women compared with 10% of men owning enterprises used these services. Additionally, highly educated entrepreneurs are more likely to use support services than are entrepreneurs with just elementary education.

Information and communication technologies (ICTs)

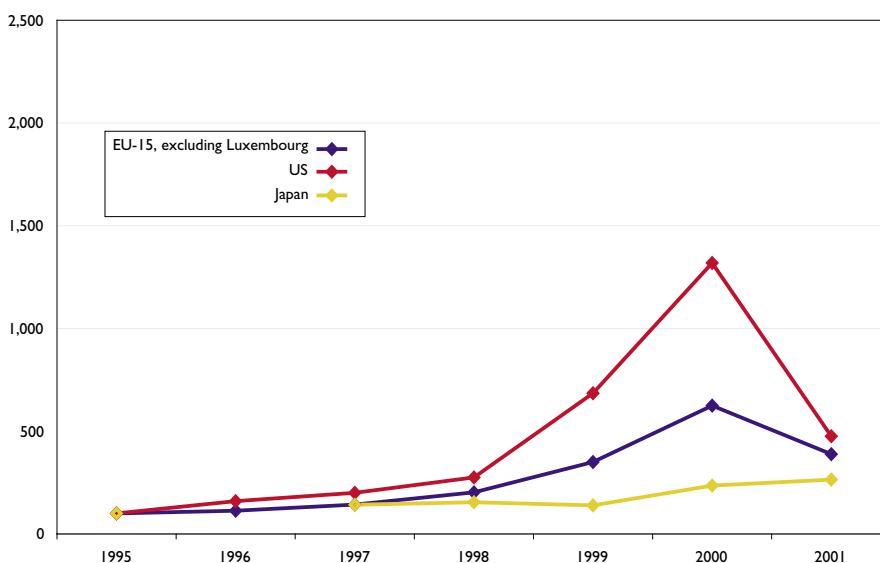
The ICT market has been identified as one of the top business and employment opportunities. However, total R&D expenditure on ICT in the US is three times higher than in Europe. Indeed:

The EU's under-specialisation in ICT is particularly worrying, due to the underpinning role of ICT in all fields of science and technology, and its important impact on productivity gains in all sectors of the economy. (EC (11.09 2002) More Research for Europe: Towards 3% of GDP, Commission Staff Working Paper COM(2002)499 final)

ICT enterprises, especially in the software field, are still operating in immature markets. However, they offer plenty of R&D opportunities, many in areas where there is considerable expertise and qualifications among women. To mention just a few, e-learning, content and knowledge management, collaboration and workflow tools are all developing, but standards have not yet emerged. However, while ICTs have led to the start up of large numbers of internet-based companies, not all SMEs are enthusiastic about using ICTs, or, more precisely, the internet. (In the US: 61% of women business-owners report using it, about the same of men-owned enterprises). Women entrepreneurs are more likely than men entrepreneurs to find the internet beneficial for opening up a wider range of business opportunities (Centre for Women's Business Research <http://www.nfwbo.org/>)

Although 41% of all graduates in science, mathematics, and computing in 2000 were women (ISCED 5 and 6), in general, the level of participation of women in this sector is no better than in other high-tech areas (see Table 3.1). In 2000, 19% of those earning a Ph.D. in computing were women. An even lower percentage of women has made it either to the top or has become visible in other ways in the ICT field. Again only a hand-full, like Carly

Figure 5.2: Growth of venture capital investment* in Eu, US and Japan, 1995-2000



Source: DG Research
 Data: EVCA, 1996-2002; NVCA, 2002; NISEP
 Note: *Venture Capital includes investment in seed, start-up and expansion stages

Fiorina at Hewlett Packard, have made it to the top in R&D-intensive large firms.

Women are under-represented when it comes to venture capital (VC) activities. They have had only a marginal participation in VC-financed start-up companies. The reasons for women not being able to take up their share of these opportunities seem to be no different than in other markets and situations. In view of the fact that these opportunities match the qualifications of women well, this is somewhat disturbing.

Biotechnology

There are a number of reasons why recent developments in the biotechnology industry might be regarded as making it an ideal niche for a good gender balance, or at least, a sector where gender discrimination might be less of a problem. For example:

- biotechnology is a natural career choice for life science students, a discipline which for some years has shown higher percentages of female than male students;
- biotechnology is a recent industry and thus free from past burdens and patterns of gender segregation.

In spite of this, an analysis of the data available to date – mainly from the US – reveals traditional patterns. The number of women in management positions is very low both in start-ups of up to 10 employees as well as in companies established over 20 years ago. An analysis of the presence of women in the 17 companies quoted on the American Stock Exchange Biotechnology Index (BTK) shows that only 16.4% (29 out of 141) of middle to top management positions are held by women. Out of the 17 companies that have most recently completed Initial Public Offerings (IPO) in the US, only 8 out of 124 company directors were women (6.5%) and there were no women board chairs.

The number of women occupying middle to senior management positions is however increasing and could serve as a pool on which to draw in the future. Nevertheless, today the presence of female entrepreneurs or even chief executive officers in biotechnology companies continues to be insignificant in Europe.

Challenges faced by women entrepreneurs

Research investigating women’s experiences of starting and running businesses (generally, rather than specifically in industrial research) suggests that although their motivations are very similar to those of male entrepreneurs, many of the barriers and constraints that they experience are gender-specific (Carter and Allan, 1997). Indeed, gender differences are apparent in many aspects of entrepreneurship. When women enter self-employment, they do so with fewer financial assets, less experience in management and their enterprises tend to be under-resourced.

Women entering self-employment generally lack both hard resources (finance, assets etc) and soft resources (management experience, training etc). They experience difficulties accessing finance both for start-up and business growth. Women tend to use only one third of the starting capital that men do, irrespective of sector, and money to finance growth may be less available to women owned firms largely due to women’s difficulty in gaining access to financial networks.

As a consequence of these and other factors, business ventures owned by women tend to under-perform across a variety of different business measures. Not only is it arguably more difficult for women to start in business, but their growth rates tend to lag behind those of equivalent male-owned firms. Women’s businesses employ fewer staff, are less likely to grow substantially in employment (more than twenty employees) after twelve months in business, have a lower sales turnover, and are valued at a lower level than male owned businesses. Men are significantly more likely to own other businesses (19.6% compared with 8.6% for women) and also to have strong growth ambitions in so far as they want to expand their businesses ‘as far as they could’ (43%, compared with 34% of women) (Rosa et al, 1996).

A Danish longitudinal analysis of new enterprises started in 1994 shows, however, that in all sectors except the wholesale trade, women entrepreneurs have a higher survival rate than men entrepreneurs (Nielsen, 2002), which may mean that measuring success by growth may not always be correct.

Although there has been a great deal of research focusing on technology based SMEs and particularly those that have spun out of academic institutions and large research establishments, little account has been taken of the gender based factors associated with the **high-tech based entrepreneur**. Similarly, although there has been a great deal of research investigating women’s experiences of business ownership, this has been conducted from samples

Box 5.2: The number of women in top jobs grows – at a snail’s pace

Women hold 15.7% or 2,140 out of 13,673 corporate officer positions in the Fortune 500 companies. Up from 8.7%, in 1995 when Catalyst first started counting and 12.5% in 2000.

Source: Dennise Duclaux, Nov 19, 2002 (Reuters)

Box 5.3: Top five barriers to women’s advancement in organisations

	% Women
Stereotypes and preconceptions of women’s roles and abilities	66%
Lack of senior or visibly successful female role models	64%
Lack of significant general management or line experience	63%
Commitment to family or personal responsibilities	62%
Lack of mentoring	61%

(Per cent who strongly agree/agree)

Source: Catalyst (2002) Women in Leadership: A European Business Imperative (www.catalystwomen.org)

Box 5.4

Burkhardt & Greif (2001) analysed the participation of women in regard to patents in Germany 1995-1999 and found clear gender differences:

- The number of women participating in patent applications increased by about 60%, twice as high as the increase of the total.
- However, number of women involved remains very small: they were only involved in 7.5% of all patents and only 4.3% of all patents registered referred to women.
- While companies registered 72% of patents, universities and research institutes registered 4% and individual persons 24%. Women's participation in patents from industry is much lower than of public research.
- While 31% of all 'women patents' were in chemistry, chemistry only accounted for 11% of all patents.
- Women are more involved in group patents: only 18% of all patents involving women were registered by a women alone, by comparison 50% of patents involving men were registered by single man.

Source: Burkhardt, D. and Greif, S (2001) *Frauen im Patentgeschehen in der Bundesrepublik Deutschland*, Ergebnisbericht im Auftrag des Bundesministeriums fuer Bildung und Forschung (BMBF)

derived largely from traditionally 'female-type' sectors. Little is yet known about women starting and owning technology based ventures or those moving into entrepreneurship from an academic background in science, engineering or technology. As a special sub-group of entrepreneurs, they are likely to differ from women entrepreneurs operating in other sectors.

In particular, their pre-venture experience of the labour market will be different. Women working in science and engineering in the private sector and in academic institutions have often been found to experience lower levels of pay and remuneration. This may on the one hand reduce resources that they can take into business ownership, but may also spur them into venture start-up in order to avoid institutional inequalities.

The ability of women researchers to access institutional (bank) finance may be somewhat improved by their experience and educational background compared to women starting other businesses. However, the type of ventures that they start in many cases requires significantly more resources than start ups in the traditional sectors usually favoured by women entrepreneurs, such as retailing and low-order services. It is likely that they will require venture capital to start and sustain their business. Current estimates suggest that in the US, less than 5% of the \$73 billion venture capital pool is awarded to women-owned firms.

Greene et al (1999) suggest three reasons why women experience difficulties in raising equity capital: women choose not to seek this type of external investment; women encounter structural barriers which preclude their access to equity capital; and women lack the knowledge and capabilities to obtain equity capital. In addition, it has also been argued that women choose to start their businesses in sectors or locations that do not match the preferences of external lenders (Brush et al, 2001). Women operating technology based ventures may provide capitalists with business ideas in a preferred sector, but may still have to overcome structural barriers when accessing this type of finance.

Based on existing data, it is difficult to determine causes and effects of this imbalance. When interviewed, women entrepreneurs confirm great difficulties in accessing venture capital. Venture capitalists on the other hand claim that they receive a very low number of investment requests from companies founded or headed by women. The proportion of woman-lead companies that receive venture funding is lower than the proportion of women among entrepreneurs.

What should be done?

One trend among venture investors might turn out to be conducive towards finding a solution. Venture investors are increasingly looking for management teams in the companies in which they invest. Too many negative and costly experiences have proven that time for the 'strong and lonely cowboy-type entrepreneur' is running out. The skills required by any company – and particularly a capital intensive, high-tech venture – to be successful, by far exceed the capabilities of any single person. Therefore, investors more and more often insist on a capable management team, and in many cases supplement the entrepreneur with one or two additional team members as part of the investment package.

The many arguments for the higher rate of productivity and innovation of teams with diversity, including gender diversity, which are cited elsewhere in this report, are particularly true of management teams in new ventures. This means that there is a reason to trust that venture investors will increasingly tend to point to the need for women to be members of management teams. By the same token, prejudices among venture capitalists (VCs) against women entrepreneurs might be overcome, as they also tend to be part of teams rather than stand alone propositions.

The fact that women do not seem to apply to venture funds needs to be addressed. It will be relatively easy to give women access to manuals and instructions on how to approach VCs, and such skills should be included in university based entrepreneurship programmes (in some instances, this is already the case). The inclusion of mentors in first meetings with VCs is another obvious way to overcome hesitations.

Part of the solution might be evolving within the financial sector itself. One of the areas where female professionals have achieved a relatively high penetration in most countries is within financial services. This means that quite a few of the analysts, investment bankers, investment advisors, managers within institutional investors and private equity firms, and indeed investment directors in VC firms, are now women and the number is clearly growing. It seems fair to assume that this will help provide a bridge to the disconnected.

Another positive development is the growing number of virtual networks, like 'High-TechWomen.com' and 'DigitalEve.com', together with an increasing number of websites dedicated to providing women with business advice. These activities provide evidence of women's desire to network and make the most of new technology to achieve their business objectives.

However, there is a need to catalyse the processes already in motion (in particular see paragraphs above). If the number of women entrepreneurs who receive venture funding does not soon show a dramatic increase, there needs to be an awareness-raising exercise. It should target VCs, as well as young women scientists, technologists and engineers, making them familiar with VC expectations and with the present reasons for the disadvantages they face. As Brush (1997:22) states:

... women are less welcome in social networks ... and are left out of some of those loops, meaning they do not have access to as much information. So social structures and the way that women socialise influence the human and social capital endowments with which they start their businesses.

There is a clear need for improved statistics and more research on women entrepreneurs in research-intensive sectors. The focus of attention should be on companies in 'high potential' sectors. The evidence we have suggests that enterprises starting off with a combination of male and female founders have an increased probability of success. Individuals and organisations involved in supporting entrepreneurs, such as venture capitalists and finance houses should be educated and trained to better understand the needs of women entrepreneurs and to be able to support them more effectively.

Box QUIN: Women Inventors in the Nordic Countries

The goals of QUIN:

- to make female innovators visible and noticeable to society
- to give female innovators contacts with other female innovators in other countries
- to encourage women to develop their creativity and realize their ideas - both social and technical ones - for the benefit of society.

Source: Maija Hakala, August 2002, <http://www.quin.biz>

Action points

- Throughout Europe, sex-disaggregated statistics are needed on the participation of women entrepreneurs in the high technology sectors.
- Research should be commissioned to assess the impact of women's perceived own limitations, societally imposed limitations and structural limitations imposed by framework conditions.
- Women's successes in high-tech business need to be made more visible.
- Business networks should be identified that could provide mentors and coaches to women entrepreneurs in particular.
- Grants need to be provided for science and technology graduates that allow specialised part-time, distance learning business education.
- Universities need to be encouraged to provide obligatory minimum tuition in business skills to all science and technology students at undergraduate level.
- Specialised (incubator) facilities need to be provided for undergraduate S&T students who wish to try out innovative proposals while they are still in undergraduate programmes.
- Public funds should be provided to match private sources of finance for entrepreneurs.
- Catalyse the processes already in motion.



Conclusions and recommendations

This report focuses on a significant and growing problem for industry and the economy in Europe. Not only is the number of students choosing science decreasing but the number of people in the science and technology pool is already too small to meet recruitment needs in industrial research for the foreseeable future.

In addition, many European companies have been very slow in developing a diverse and gender-balanced workforce in their research and development departments. This is at a time when the global market means that buying power and decision-making is in the hands of an increasingly diverse customer base. Women, in particular, are in a position to offer new business opportunities. Currently, only about 13% of researchers in European industry are women: the numbers are even smaller in individual countries such as Germany (less than 10%). Women may now constitute the majority of graduates overall, but many, if not most, are lost from long-term careers in science and technology.

This is clearly an unacceptable waste of resources; moreover, the gap between supply and demand for highly qualified as well as diverse employees comes at a particularly unpropitious moment. The EU wants to meet the Lisbon summit vision of a 'knowledge-based economy' and the Barcelona summit goal of increasing the proportion of GDP being spent on R&D to 3%. Concerted action between industry and governments is needed now if they are to meet these challenges by recruiting sufficient scientists with diverse views and talents, particularly women, and keeping them updated, creative and motivated through a longer career span. Dedication from the top will be required to remove the barriers to recruiting, retaining and promoting the appropriate mix of highly competitive industrial research teams.

Pressure on those working in industrial research leaves little time for continuing professional development. On the other hand, continuing professional development of employees is now on the agenda of many human resource departments, time is allocated to it and it is a management deliverable. In contrast, time for reflection and structures that allow for a healthy work/life balance for employees remain 'blind spots'. Industrial researchers are just as likely to have children, elderly relatives and other dependants as other employees. Traditional family structures with the 'male

bread-winner' supported by a 'female-homemaker' are no longer the rule, particularly among younger employees.

Hence, it is important to build into work patterns the flexibility for employees to combine work with other commitments and aspirations, such as family responsibilities as well as community or cultural activities. Companies therefore must rethink how industrial researchers are employed in order to keep the most qualified men and women in the innovation process and to ensure a culturally diverse mix.

Understanding the position of women and men in industrial research in Europe is hampered by the lack of reliable, harmonised sex-disaggregated statistics. Even so, the data presented in earlier chapters of this report demonstrate the preponderant loss and under-utilisation of women in industrial research, at all levels, in all countries considered, and across size and type of industry.

While many women are starting to set up their own businesses in Europe, relatively few of them are in technology, or research-based or high-tech start-ups. There is enormous scope here for well-qualified women to identify gaps in the market and create enterprises in industrial research. Such enterprises can be built around new ways of working: they do not have to follow traditional patterns.

The following brief summary of our recommendations focuses on this question: what can companies, national governments and other stakeholders do to increase the number of women in industrial research, both as employees and as entrepreneurs?

What can companies do to increase diversity and the number of women in industrial research?

Detailed recommendations for companies to become leading edge in diversity management and in the employment of women are presented in Chapter 4. In summary, an open-minded, stimulating as well as gender-aware culture should provide:

Box 6.1

'The vision of our diversity programme is to build an inspiring, innovative and creative culture that everyone wants to belong to and contribute to.'

Source: AstraZeneca

- an attractive work environment, which encourages and provides opportunities for innovation, offers career development opportunities in a life-cycle perspective, values output rather than presence and brain hours rather than body hours;
- a commitment from the top to gender equality, diversity policies and dignity at work values – integrated into strategy and action plans, reporting mechanisms and performance review systems;
- a high degree of transparency and two-way communications systems; merit-based open recruitment and staff review systems, monitoring of succession plans and reviews of success criteria in promotions;
- sound work/life balance policies: maternity and paternity leave, child-care facilities or subsidised child-care costs and emergency leave for caring for sick family members (these should be provided by companies if government does not already provide them);
- flexible work schedules (acceptable to both company and employees), opportunities for (some) distance work (subject to laws and regulations and job requirements); flexibility to explore alternatives to excessive travelling

at times in the life cycle, through redeployment or making more use of new technology or reconsideration of the essential features of the job remit;

- modern role models, networking and mentoring schemes;
- monitoring, evaluation, auditing, statistics, surveys, staff consultation, and analyses of recruitment, attrition and exits; and
- partnership arrangements designed to encourage young women into science with local schools, colleges and universities, offering internships, fellowships, role models, mentors, speakers and opportunities for work shadowing.

What can national governments do to increase diversity and the number of women in industrial research?

Framework conditions

National governments have a keen interest in industrial research, given its importance to the economy. They have a key role to play in increasing the recruitment base (the number of trained scientists) and in providing the legal framework and infrastructure (tax laws, child-care facilities, schools) to keep highly qualified researchers, men and women, active and productive in research and development. National governments can support women in industrial research by:

- ensuring effective sex discrimination and ‘equal pay for work of equal value’ legislation is in place, revising the legislation where it is not working properly and ensuring legislation on parental leave is generous;
- collecting, analysing and publishing sex-disaggregated statistics that define and identify **industrial researchers** as a category;
- providing or subsidising sufficient affordable, good quality child-care, supporting private initiatives for eldercare, making tax laws which support parenthood in all types of family, not just the breadwinner/homemaker model;
- commissioning studies of women in industrial research and on the policies and practices of companies in this sector, publishing and disseminating the statistics and research widely;
- using the statistics and research in planning and review of national policies;
- supporting events and networking initiatives like a ‘Girls’ Science Day’, ‘Take Your Daughter to Work Day’, and ‘World Women in Engineering Day’ – and their equivalents in other disciplines where women are in a minority;
- continuing to benchmark support for women in industrial research with other countries through the Helsinki Group, adopting good practice and where appropriate publicising their own good practice.

Box 6.2

‘50-50 by 2020!’

Source: Old US National Science Foundation motto

What can universities, venture capitalists, but also national governments do to increase the number of entrepreneurs, particularly of women in technical-industrial research?

Universities are the main suppliers of qualified people. They could do more to increase entrepreneurialism among science, engineering and technology students and staff, including women, by:

- providing obligatory minimum tuition in business skills to all science and technology students at undergraduate level; and
- providing specialised (incubator) facilities for students who wish to try out innovative proposals while they are still in undergraduate programmes.

Venture capitalists are the gatekeepers of entrepreneurialism. To ensure that their policies and practices do not discriminate against women, however indirectly or inadvertently, we recommend that they:

- monitor applications and those bids that they support, by sex;
- benchmark on the gender dimension with other financial institutions supporting the self-employed and entrepreneurs;
- foster a gender balance among their advisory staff;
- pro-actively encourage applications from women entrepreneurs; including those who may want to run a business part-time;
- be aware of and accommodate the needs of women setting up their own company after a career break;
- foster networking and mentoring schemes by putting interested clients in touch with others; and
- identify business networks that could provide mentors and coaches to women entrepreneurs.

Governments are invited to support women entrepreneurs in science, engineering and technology by:

- providing public funds to match private sources of finance for entrepreneurs;
- supporting universities financially to enable researchers to prototype ideas before they are ready to seek investment for campus companies;
- developing new sex-disaggregated statistics on entrepreneurs in high technology sectors;
- publishing annual sex-disaggregated statistics on inventors named in patents applied for and taken; and
- commissioning research on women entrepreneurs in R&D, to assess the impact of structural limitations imposed by framework conditions.

Conclusion

Research, broadly defined, has been and will continue to be a core issue for European industry. It is where innovative ideas, so crucial to industry, are developed. However, research goals, research technologies and those using research results are changing quickly in a globalised economy.

The vibrancy of industrial research in Europe depends upon drawing on a wider pool of talent and ideas, including more women who are currently so under-represented. Women are the majority of graduates and are moving into key buying and decision-making powers as consumers. To ensure the competitiveness of European industry on a global scale, organisations and their cultures need to be challenged and to change.

Companies need to develop a commitment to diversity and introduce better work/life policies as well as improved recruitment, retention and career development policies and practices, for men and women, reflecting the diverse cultures and to ensure that they can serve the markets of the future.

The European Union must provide the legal framework and infrastructure to support such changes and ensure that all their actions lead to a concerted approach between governments and industry across Europe. Equal standards and deliverables by national governments with respect to fostering diversity, ensuring the use of the full talent pool of women for research and development and ensuring equal opportunities and mobility across Europe must become a prime goal.

We have examples, from Europe and beyond, of good practices in organisational and cultural change and in government policies. We recommend that governments and the industrial sector explore these good practices, and adopt them, where and as appropriate. Through concerted action, European industry must be better prepared to meet tomorrow's challenges.



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List of abbreviations

ATC	Alcoa Technical Center (US)
BE	Business Enterprise
BERD	Business Domestic Expenditure for Research
BES	Business Enterprise Sector
BMBF	Bundesministerium für Bildung und Forschung, Germany
BTK	Biotechnology Index (US)
CEC	Commission of the European Communities
CEO	Chief Executive Officer
CIREM	Foundation Centre for European Initiatives and Research in the Mediterranean, Barcelona
CR&T	Xerox Corporate Research and Technology (US)
CWSE	Council of Women Scientists and Engineers
DG	Directorate-General
DG RTD	Directorate-General Research
DULBEA	Département d'Economie Appliquée de l'Université Libre de Bruxelles
EARMA	European Association of Research Managers and Administrators
EC	European Commission
EEA	European Economic Area
EIB	European Investment Bank
EIRMA	European Industrial Research Management Association
ELFS	European Labour Force Survey
EMEA	Europe, Middle East and Africa Region
EU	European Union
ERA	European Research Area
ETAN	European Technology Assessment Network
EURAB	European Research Advisory Board
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure for Research
ISCED	International Standard Code for Education (OECD)
HP	Hewlett Packard
ICT	Information and Communication Technology

IfGH	Institut für Gewerbe- und Handelsforschung (Austrian Institute for Small Business Research)
ILO	International Labour Office
IPO	Initial Public Offerings (US)
IT	Information Technology
IUPAP	International Union of Pure and Applied Physics
MBA	Masters in Business Administration
MIT	Massachusetts Institute of Technology
MEP	Member of European Parliament
OECD	Organisation for Economic Co-operation and Development
PhD	Doctor of Philosophy
PNP	Private non-profit
R&D	Research and Development
SES	Structure of Earnings Survey
SESTAT	Scientists and Engineers Statistical Data System (US)
SET	Science, Engineering, Technology (UK, US)
S&T	Science and Technology
SME	Small and medium size enterprises
US	United States
VC	Venture capitalists
WG	Working Group (WIR)
WIR	Women in Industrial Research Group
WiS	Women in Science database of DGR and the Helsinki Group

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Susan Croft is an international public speaker, corporate trainer and author. She is founder and partner of ASC Training & Consulting where she is responsible for communications, management and marketing training. She is also a consultant for the international PR firm, Hill & Knowlton. She plays an active role in public life in both the UK and USA focusing on women's issues in the workplace.



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**RAGNHILD SOLHBERG**

Dr. Ragnhild Solhberg has numerous qualifications in Economics and Policy Sciences, all from the US. She is Vice President, Corporate Center, Norsk Hydro ASA in Oslo, Norway. She has done research for the US Federal Energy Administration, the Office of the Secretary of Defense (Pentagon) and the National Defense Research Institute in Sweden. For the last 20 years she has been employed by industry in Norway. She has had more than 60 appointments on boards, commissions and so on, focusing on, for example, recruitment to science and technology, women in leadership, and research and higher education.

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Professor Dr. Burghilde Wieneke-Toutaoui is professor for Industrial Engineering at the Department of Mechanical Engineering, University of Applied Sciences, Berlin. She is member of the board of and active within the Association of Engineers (VDI) which has 130,000 members. She is spokeswoman for Women in Engineering. Her areas of research are Rapid Prototyping Technologies.



DARCY WINSLOW

Darcy Winslow is Nike's Global Director for Women's Performance Footwear. During her 14 years with Nike, she has held many positions, including Director of Advanced Research and Development, Global Director for Research, Design and Development, and General Manager of Sustainable Business Opportunities. She has qualifications in Exercise Science, Exercise Physiology and Biomechanics. She is a director of SOLV, an Oregon non-profit and the International Sustainable Development Foundation, and a member of the Board of Councilors for the China-US Center for Sustainable Development.



Companies and organisations that participated in the project

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Institutes

CIREM (Foundation Centre for European Initiatives and Research in the Mediterranean)

DTI (Danish Technological Institute)

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ETUI (European Trade Union Institute)

Kompetenzzentrum: "Frauen in Informationsgesellschaft und Technologie"

NUTEK (Swedish Board for Industrial and Technical Development)

Technical University, Madrid

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Associations

EARMA (European Association of Research Managers and Administrators)

EIRMA (European Industrial Research Management Association)

Total E-Quality e.V.

VDI (Verein Deutscher Ingenieure)

Women Innovators Network

Women are giving technology new impetus – Frauen geben Technik neue Impulse e.V.

European Institutions

European Commission

European Parliament

Annex tables

Table 3.1: Enrolment rates in tertiary education* of men and women, in the EU, 1999/2000 (in %)

Country	18-21 years		22-24 years		25-28 years	
	Men	Women	Men	Women	Men	Women
Belgium	36	47	21	20	6	5
Denmark	7	10	23	33	17	21
Germany	7	15	20	20	15	11
Greece	57	63	9	8	3	3
Spain	28	40	26	30	10	9
France	30	40	22	25	5	7
Ireland	30	38	12	12	4	5
Italy	12	17	19	27	12	14
Luxembourg**	–	–	–	–	–	–
Netherlands	24	30	25	22	8	6
Austria	11	18	20	20	14	12
Portugal	22	30	17	23	8	10
Finland	19	26	37	42	21	22
Sweden	13	19	25	30	14	16
UK	26	31	11	12	6	7

* Equivalent to higher education (such as university or equivalent program)

** In Luxembourg most students study abroad because there is no complete university system

Source: Eurostat (2002). The life of women and men in Europe. A statistical portrait, Luxembourg

Table 3.2: Distribution of all ISCED 5 and 6 graduates, men and women, by main field of study, EU, 2000

Field/ Country	Science, mathematics and computing	Engineering, manufacturing and construction	Health and welfare	Education and training	Humanities, arts and services	Agriculture and veterinary	Social science, business and law
Ireland	21.6	12.9	8.2	6.2	18.6	1.3	31.1
Sweden	9.8	20.8	21.3	17.4	8.3	1.7	20.8
France	15.2	15.1	7.7	6.0	17.8	0.6	37.5
Austria	7.5	22.6	9.6	17.8	11.2	3.7	27.6
Finland	6.8	22.8	22.6	6.0	16.7	2.0	23.1
UK	17.0	10.9	14.2	10.2	15.6	1.3	30.7
EU-15	12.2	14.4	15.2	9.5	15.2	1.7	31.8
Germany	9.3	17.3	26.5	9.1	14.8	2.4	20.7
Spain	10.2	14.8	11.7	11.9	13.7	2.5	35.1
Italy	8.3	15.6	16.9	5.1	15.6	2.0	36.5
Belgium	7.3	11.6	20.3	15.4	12.9	1.9	30.4
Denmark	7.3	10.8	29.0	10.7	15.1	2.1	25.0
Portugal	5.4	12.2	13.3	18.1	11.7	2.3	36.9
Netherlands	5.3	10.4	21.5	15.8	10.0	2.5	34.6
Luxembourg	10.7	3.8	6.3	16.6	13.2	–	49.3

Source: DG Research, Unit: C5

Data: Eurostat, New Cronos (see Annex Table 3.2); No data available for Greece.

Table 3.3: Distribution of ISCED 6 women PhD graduates by broad field of study, (ranked by sum of importance of Science and engineering fields), EU, 2000

Field/ Country	Science, mathematics and computing	Engineering, manufactur- ing and construction	Health and welfare	Education and training	Humanities, arts and services	Agriculture and veterinary	Social science, business and law	Unknown/ other
Belgium (Flemish)	50.7	7.0	24.9	0.4	7.0	1.7	7.9	0.44
Ireland	49.6	5.9	11.4	0.8	19.9	1.3	11.0	0.00
Belgium	46.2	5.9	20.3	0.5	10.3	5.1	11.5	0.26
France	44.2	5.7	7.4	1.4	21.6	0.3	18.9	0.54
Belgium (French)	39.8	4.3	13.7	0.6	14.9	9.9	16.8	0.00
UK	35.9	8.1	19.3	4.7	14.3	2.9	14.2	0.63
Sweden	21.2	16.5	36.1	3.9	7.1	3.8	11.2	0.18
EUI5	28.1	6.5	26.9	3.0	14.3	4.0	16.4	0.90
Spain	29.3	3.6	22.9	4.5	13.7	4.0	20.3	1.82
Italy	19.1	13.4	27.1	0.0	17.1	6.3	17.0	0.00
Portugal	21.2	10.6	7.4	6.9	12.3	2.4	31.4	7.69
Austria	20.1	10.0	3.1	10.2	15.4	6.3	33.8	1.08
Denmark	18.2	11.7	34.2	0.0	14.8	11.1	9.7	0.28
Germany	21.7	3.0	43.1	2.0	11.8	5.1	12.6	0.69
Finland	15.7	8.3	25.8	11.7	14.0	2.4	20.5	1.70
Netherlands	15.8	7.3	33.3	0.0	10.5	8.2	24.9	0.00

Source: DG Research, Unit C5

Data: Eurostat, New Cronos

EUI5: estimated, excludes Greece, Luxembourg

Denmark, France and Italy: 1999 data

Luxembourg and Liechtenstein do not have a complete university system. Most students study abroad

Table 3.4: Average gross hourly earnings of women in the public and private sector (in % of men's earnings in each sector) EU, 1998

Country	Public sector	Private sector
EUI5	87	82
Belgium	92	88
Denmark	97	92
Germany	77	73
Greece	91	79
Spain	93	83
France	89	84
Ireland	90	82
Italy	101	89
Luxembourg	*	*
Netherlands	79	81
Austria	92	76
Portugal	108	79
Finland	83	85
Sweden	*	*
UK	83	85

Source: Eurostat (2002) *The life of women and men in Europe: A statistical portrait*, Luxembourg

Notes:

* Data not available