# STI OUTLOOK 2002 – COUNTRY RESPONSE TO POLICY QUESTIONNAIRE

## GERMANY

### 1. General framework and trends in science, technology, and industry policy

German policy emphasises the encouragement of entrepreneurship by several activities: Modernisation of qualification, instruments for the financing of enterprises beyond the reforms of Basel II, expansion of entrepreneurial knowledge in schools and universities, as well as special support for the seed-phase of young enterprises.

The tax reform has resulted in a decrease of tax burden for enterprises.

Together with the industry the federal government is currently reflecting on several measures to reduce environmentally harmful emissions by market conform instruments.

### 2. Public sector research and public research organisations

#### *2.1. Policy changes and background/rationale related to public sector R&D*

In Germany, the Federal Government and the *Länder* jointly fund 15 national research centres with a total staff of about 24 000 and an annual budget of DM4 billion, of which 3 billion come from public coffers. These centres, which together form the Hermann von Helmholtz Association of National Research Centres (HGF), constitute by far the largest non-university research organisation in Germany; their budgets account for about 10% of public research funds in Germany and for about 25% of the BMBF research budget.

The centres, each of which was originally founded for a specific purpose – *e.g.* nuclear energy research – today engage in research in a wide range of fields, which are defined by the individual centres and their supervisory boards. Their annual budgets, which are provided by the Federal Government and the respective host *Land*, are primarily determined by the cost of their staff and equipment rather than by the content of their research and relevant goals; this state of affairs provides little incentive for co-operation and competition. In September 2001 the Federal Government, the *Länder* and the centres themselves agreed to introduce a new financing procedure which allows for priority setting for the HGF as a whole and stimulates competition between the individual centres while not affecting their legal independence.

Under this new procedure, the Federal Government and the *Länder*, as funding agencies, determine a research policy framework for the research centres, while the centres develop the scientific subjects jointly, although on a competitive basis. The decision on the funds to be provided for competing proposals will be taken on the basis of recommendations made by the HGF Senate following external evaluation of the proposals. The Senate members do not belong to any of the research centres. The detailed procedure involves the following steps and features:

- The role of the funding agencies will essentially be limited to determining overall objectives as well as the funding for and content of the research areas, which at present include the structure of matter, earth and environment, transport and space, health, energy and key technologies. The annual amount of funds provided for each of these areas is currently between €200 and 300 million.

- Within this framework, the research centres draw up multi-annual programmes in the individual areas, as a rule for periods of five years; the funds required for these programme proposals exceed the total allocations made by the funding agencies for a particular research area.

- The Senate, which is to be given more power and will be composed of representatives from science, industry and government, will appoint international commissions to evaluate the programmes proposed and, on the basis of such evaluation, will make recommendations to the funding agencies regarding the programmes to be funded for a period of several years. Each centre will receive 20% of the funds granted for programmes, or for its share in these programmes, to be used for free research not related to programmes.

- A full-time President, who is not dependent on any of the research centres, equipped with appropriate staff, will ensure transparency of the procedure as well as fair competition.

Together with the new system, suitable new budget provisions are being introduced, the most important ones being the carry-over of funds to the subsequent year and the abolition of binding staffing schedules. As a prerequisite for these changes, it is necessary to adopt a controlling procedure that is suited to scientific activities and makes it possible to control the research centres by applying modern business management methods.

The new system is to be introduced in several stages: in 2003 the first programmes evaluated in accordance with the new procedure will receive funding, starting with health, transport and space research.

### *2.2. Initiatives to reform the organisation and governance of universities and public research organisations*

In December 1996 the heads of the Federal and *Länder* governments agreed on an **evaluation of all jointly funded research institutions** in Germany. The evaluation was aimed at making non-university research in Germany internationally competitive and developing it further, while preserving research resources and opening up the possibility of transferring positions between the jointly funded research institutions. Since then, the *Deutsche Forschungsgemeinschaft* (German Research Association, DFG), the Max Planck Society (MPG) and the Fraunhofer Society (FhG) have been evaluated by international commissions, while the institutions of the Hermann von Helmholtz Association of German Research Centres and the "Blue List" non-university research institutes, which are funded jointly by the Federal Republic and the *Länder*, have been evaluated by the German Science Council (*Wissenschaftsrat*). Furthermore, in July 2000, the Science Council adopted its "Theses for the Future Development of the Science System in Germany", which contain information supplementing the results of the individual evaluation exercises and offer further recommendations regarding both the research system and the functions of the individual research organisations and universities within the system.

The Bund-Länder Commission for Educational Planning and Research Promotion (BLK) has discussed the whole complex of evaluation in a science policy dialogue with the large German science organisations in order to better understand their views and consequently be able to prepare its report to the heads of

government on the basis of a broad, consolidated body of knowledge. The report is preceded by the following five essentials, which are the quintessence of the evaluation reports and the recommendations and of the result of the BLK's internal discussion with the participation of the science and research organisations:

- On the whole, the German science system, in which the universities play a central role, has proved valuable. It is nevertheless necessary to increase the quality of research and the effectiveness of funding.

- The research and science institutions must build up their own characteristic profiles.

- The process of networking and internationalisation of the German science system must be accelerated.

- Competition and co-operation between the institutions of the science system must be increased.

- The German science system must become more flexible.

The report also notes that many of the measures recommended have already been realised or initiated:

1. To make the management of funds more flexible, the heads of the Federal and *Länder* governments in November 1997, on a proposal by the BLK, agreed on management guidelines for the Blue List institutions and the HGF, which are not yet fully applied, however, to the Blue List institutions in all *Länder*. These guidelines provide for more scope and flexibility in the management of funds and personnel. At the same time the heads of government agreed to grant a lump sum to the MPG for a probationary period of 3 years, beginning in 1999. They announced that the same procedure will "soon be applied" in other suitable cases of joint research funding, taking into account the guidelines developed for the MPG budget.

The DFG will be funded in accordance with a single financing formula (Federal Government: 58%; *Länder*: 42%) as from 2002. The DFG's 2002 budget will bring internal trading for all its budgetary chapters, with the only exception of promotional costs and investment expenditure. In addition, the DFG is given more scope in personnel management by introducing a more flexible staffing schedule.

2. The evaluations resulted in a number of changes, of which the most striking, of course, was the termination of joint funding for six institutions of the Blue List.

The merger of the GMD National Research Center for Information Technology and the Fraunhofer Society as well as the planned integration of the Heinrich Hertz Institute of Telecommunications into the FhG are evidence of the "transfer opportunities within the research system" demanded by the Science Council. They also demonstrate that it is possible to counteract the isolationist tendencies of the present science system, which were criticized by the evaluators.

In a positive response to the system evaluations and the resulting recommendations, the DFG, the MPG and the FhG have adopted a large number of measures. The action taken by the DFG ranges from developing new forms of deficit analysis and functional planning to the funding of the DFG research centres to inviting foreign experts to take part in evaluations. Measures taken by the MPG include intensification of co-operation with higher education institutions, the development of new funding tools, eg the International Max Planck Research Schools, as well as strategic research planning. The FhG has increased its efforts to expand its activities in communication technologies, materials research and the life

sciences. It will also enhance its strategic planning and intensify its links with other research institutions and universities.

The HGF will increase flexibility and orientation towards efficiency and excellence by introducing a new funding procedure (programme-oriented funding). In this connection, a competitive element is to be introduced to enhance the working opportunities of high-quality research groups, while at the same time cutting back on the funds for less productive groups. Since 1998 the Blue List institutes have been increasingly included in the quality competition for funds. They are participating with great success in the academic competition for DFG project funds. The evaluation committee set up by the Senate of the Gottfried Wilhelm Leibniz Science Association will soon make its first evaluations to help assure the quality of the R&D work of the Blue List institutions, thereby relieving the Science Council of some of its workload.

3. In order to strengthen internationalisation, as recommended by the BLK, the Federal Government and the *Länder* meeting as members of the BLK, agreed in October 2000 to establish a concerted action "International marketing for higher education and research in Germany". Measures launched are aimed at

- Marketing for higher education and research in Germany.
- Improving support for foreign students and young scientists from abroad.
- Optimising the courses offered and the degrees that can be earned.
- Providing continuing education courses for skilled staff and management personnel from abroad.

Good ideas with great application potential are frequently generated in the course of research projects. These ideas must be identified, developed and commercialised. The German Research Association has set up an **ideas workshop** for this purpose. The workshop acts as an intermediary between science and business. It helps to develop further and present the ideas in a clear and comprehensible way so that potential grant givers can understand the work, language and ideas of researchers and will therefore be ready to invest. The assistance given by the workshop includes assistance with planning, documenting, publishing and presenting ideas. The workshop also organises events to prepare the ground for successful communication with the business sector.

By adopting the Fourth Law amending the Framework Act for Higher Education on 20 August 1998 (BGBl. I page 2190), Germany set the stage for higher education reform. The reform of the higher education system was aimed at encouraging competition and differentiation by means of deregulation, performance orientation and the creation of performance incentives in teaching and research alike.

A fundamental reorientation of government **funding for institutions of higher education** was the pivot of such reform. The allocation of government funds will in future be oriented to the relevant institutions' performance in teaching and research and their support for young scientists. Progress in the enforcement of gender equality, which is among the institutions' missions, will also be taken into account (section 5 of the Act). Internal distribution of the funds granted will, both at the central level and at the department level, also be governed by performance criteria. Increasing parts of the university budgets are given the character of an overall budget and the allocation of funds will be based on specific criteria. Experience so far has shown that the following are important criteria for formula-based allocation:

- A university's number of students and graduates.

- Number of PH.D. degrees.
- Actual duration of studies.
- The amount of external funds raised for research.

Section 6 of the Act requires universities to have systematic **evaluations** of teaching and research carried out on a regular basis.

To give institutions the necessary scope for implementing this type of reform, they had first to be freed from the **detailed control** exercised by the government. The Framework Act for Higher Education was therefore deregulated to a considerable extent. The same will now have to be done for the higher education legislation of the *Länder*. The Framework Act for Higher Education has been reduced to a core of federal provisions that is absolutely necessary for the higher education system in the 21st century.

Another reform project currently being implemented is the modernisation of **employment law** in higher education. One of its elements is the introduction of junior professorships replacing the traditional career path to habilitation and professorship.

In 1998 **accreditation procedures** were set up for the first time for bachelor and master degree courses; today it is even possible for private universities to apply to the Science Council for accreditation in accordance with internationally recognised procedures.

Altogether, output control is increasingly being substituted for the traditional ex-ante control through a legal framework and the allocation of funds in the German higher education system. Agreements between the respective university and the *Land* and also between the university and its departments are being concluded in nearly all *Länder*.

## 3. Government support for private-sector R&D and innovation

### *3.1. Changes to enhance the effectiveness of policy instruments used to provide public support for private sector R&D and innovation*

Specific tax incentives for R&D expenditures don’t belong to the german tax system. R&D expenditures are, of course, deductible as business expenses. The german tax reform leads to substantial tax cuts for enterprises (finally nearly EUR 15 billion). This improves the scope for investment and innovation significantly.

### *3.2. Changes in the balance and/or priority of public support of business R&D and innovation*

Within it’s action plan „innovation and employment for the 21th century“ the federal government pays the evolving internet special attention. New initiatives for the development and test of multimedia-applications were started, especially regarding:

Payment transaction security: Confidence and security are the very foundations of ensuring acceptability for Internet and especially e-commerce transactions. Through its VERNET project, the Federal Ministry of Economics and Technology (BMWi) promotes development and testing of new security technologies, standards and principles of organisational to increase reliability of Internet-based transactions. Through its

Fairpay project, the BMWi promotes development of the kind of technologies needed for electronic payments, on whose basis systems critical in terms of security can be designed and tested.

Digital signature: The digital signature has laid the foundations of concluding legally binding transactions in the Internet. Through its Media@Komm project, the BMWi supports pilot projects introducing virtual town halls and market places and spreading the use of this service in three regions. In the public sector, the focus is on enabling private individuals to make legally binding transactions with public authorities via the Internet, using the digital signature. In the private sector, the focus is on shaping virtual market places. An important approach pursued through this project aims for public-private partnerships allowing transactions to be made that combine the two.

E-learning for purposes of vocational and further training: Lifelong learning is increasingly becoming a condition for success in occupational life; conventional forms of further education are increasingly coming closer to the limits of what they can achieve. Through its “LERNET” project, the BMWi supports new technologies for net-based learning. Branch-specific best-practice examples are to show the possibilities that exist for using the new media and to make these new forms of learning acceptable.

Biotechnology and genetic engineering are of the utmost importance for Germany's future development. As key areas for innovations, they are essential for the country's scientific and economic development in the future. The German Federal Government therefore gives high priority to funding research and development in these fields. In early 2001 the Federal Cabinet adopted the "Framework Programme Biotechnology – Using and Shaping Opportunities". Public money to the amount of DM1.5 billion will be provided over the next five years to support the biotechnology programme. An additional amount of DM350 million will be made available from UMTS funds for the National Genome Research Network. This means that altogether government funds for this area will by 2003 have increased by 123% since 1998. The commercial application of biotechnology and genetic engineering has become established in nearly all sectors of the economy that are relevant to the life sciences. Active start-ups which do research in biotechnology play an important role in developing and using the potential of biotechnology successfully to generate applications. International studies show that, compared with other European countries, Germany has seen the largest number of new biotech companies (Ernst & Young, 8th European Life Science Report, 2001). The participation under collaborative projects of small and medium-sized biotech companies in the new funding programmes listed below is considered particularly important.

The following is an overview of the biotechnology funding programmes launched since the end of 1999 (the launching month of each programme is given in brackets):

1. Bioprofile (November 1999) This funding programme will give three regions the opportunity to develop their economic strength with the aid of modern biotechnology and to hold their own in international competition by means of a special biotechnological profile.

2. Tissue engineering (January 2000)

3. Nanobiotechnology (April 2000)

4. Sustainable BioProduction (April 2000)

5. New efficient methods for functional proteome analysis (June 2000)

6. Bioinformatics training and technology initiative (September 2000)

7. National genome research network (December 2000). A national genome research network focused on combatting disease is to be set up by pooling, networking and expanding the resources of the most efficient partners from science and industry. The central goals to be achieved through this network include the establishment of a critical mass of staff and infrastructure; new resources in the form of high-throughput techniques and platform technologies (eg bioinformatics, proteomics); an effective mechanism for prioritising and focusing research topics from a medical point of view; technology transfer to industry and firm organisational controlling of activities.

*Funding of information technology under the "IT research 2006" programme*

The Federal Government's action programme "Innovation and Jobs in the Information Society of the 21st century" has set the course for Germany's way into the knowledge-based society. The programme gives priority to information and communications technology in the field of education and research. By adopting the action concept "Online – Offline. IT in education", the BMBF has focussed attention on education policy priorities.

Preparations are under way for a complete reorientation and substantial intensification of research in the IT area over the next few years. Reaching beyond the time horizon of the action programme, the funding programme entitled "IT research 2006" will set the programmatic stage for IT research to be funded by the BMBF between 2002 and 2006.

The four most important topics of information and communications technology to be supported under the funding programme "IT research 2006" are:

Nanoelectronics and nanosystems.

Nanoelectronics – that is, microelectronics with miniature functional structures that measure well under 100 nm – will offer the possibility of building extremely complex chips systems with billions of transistors as essential functional elements of new products. These products are intended not only for existing mass markets but also for promising niche markets which may develop into future mass markets.

The funding programme aims to maintain and expand the leadership position Germany has reached in this technology and, at the same time, to pioneer the realisation of internationally agreed road maps. At the same time, Germany is to occupy a top position as a supplier of hardware for the Internet and for intranets in the home, in the car and on the body as well as of hardware to meet the global requirements of mobile communication.

Communications technologies

Current resources in terms of infrastructure, frequency range and standards used will not be sufficient to meet the needs of a long-term growth of communication.

Research in this field is to develop efficient, sustainable utilisation of resources so that the performance, quality and availability of communication systems, of the Internet and mobile communication in particular, is increased in Germany.

Software systems

In many technical areas, software engineering is well on its way to becoming one of the most important production technologies of the 21st century.

The purpose of research in this field is to link individual systems first to form network systems and then, in a next step, to set up a complex network which combines all IT modules into one system. For this to happen, the productivity of software development must be increased by several orders of magnitude, and the quality and usability of the software must be enhanced.

The Internet

The rapid development of the Internet makes new demands on network technology. The radio communications network and the fixed-lines network will no longer be separate networks. Voice communication will be less important while data communication services will expand. New terminals will be required for new network technologies and vice versa.

The BMBF's funding programme is designed to help explore, develop and use the new technologies and their applications in Germany.

The programme will give particular attention to support for young scientists: this includes the funding of IT junior professorships and the early participation of young researchers from universities and other state-maintained research institutions in research and development projects to enable them to do independent scientific work and to achieve the desirable transfer of technology by way of spin-offs.

*BMBF Funding Programme: "Microsystem Technologies 2000+"*

The funding programme "Microsystem Technologies 2000+" (MST 2000+, duration: 2000 – 2003) is intended to systematically support the economic implementation and application of microsystem technologies. It aims at establishing a broad basis of technological know-how in industry and science. Application is of key importance. The funding programme ensures that the potential of microsystem technologies will be rapidly developed in all fields of application. The appropriate tool for doing so is the support for collaborative research and development projects which are important to industry.

In order to achieve the application of microsystems in the development of novel products as soon as possible, the programme **concentrates on applications that are of economic and social importance**:

- Global mobility and information (communication and transportation).
- Improved production and sustainable development (machinery and plant industries, chemistry and laboratory technology).
- Health and living (medical and pharmaceutical applications, environmental technology, food and agriculture as well as household and consumer applications).

Industrial firms determine the content of the collaborative projects and contribute their share by financing the project partners at the institutes. The aim to be achieved is to enable the greatest possible number of enterprises to make use of microsystem technologies. The funding programme is oriented to the needs of users and suppliers of microsystem technologies. It also addresses problems of the industrial manufacturing of MST products.

The main **target group is the sector of small and medium-sized enterprises** (SMEs):

Between 1994 and 2000, a total of about 350 million Euro were granted for 246 collaborative projects. Of that amount, some 270 million Euro were allocated to industry. It is especially remarkable that more than two thirds of that amount of about 270 million Euro were granted to SMEs with an annual turnover of less than 50 million Euro per year. This means that SMEs have a major share in the collaborative projects under the MST 2000+ programme.

In order to enable many SMEs to make use of MST, the BMBF supports the setting-up of an infrastructure which will provide industry with cost-effective facilities to develop and manufacture microsystems. Meanwhile, standardised components have been developed which are of enormous advantage for the conversion of microsystem technologies concepts into marketable products. As a result, SMEs can integrate microsystems into their products as a standard solution. In this way, they can produce economically on a small scale.

For SMEs, involvement with research collaborations and co-operation within networks are particularly important. SMEs regard lack of information technology progress as an important obstacle to innovation. In addition to supporting collaborative projects the BMBF has therefore from the outset implemented **systematic measures to improve innovation processes**, especially the flow of information.

## 4. Enhancing collaboration and networking among innovating organisations

### *4.1. Initiatives to promote collaboration and networking among innovating organisations*

The " PROgramm INNOvation-competence of medium-sized enterprises (PRO INNO) ", started by BMWi in June 1999, is supporting the R&D-co-operation of SME's for the innovation of products, processes and services and thereby creating competitive jobs for the future. Projects of R&D-co-operation between enterprises or with research institutes are promoted by grants. The R&D-projects with partners at home or abroad have to satisfy a high level of innovation and have to imply high technical risks. Beyond that with a so – called „Einstiegsvariante" enterprises are promoted, which want to start an R&D-project in their company for the first time or start again after a break in their R&D-activities for five years. Furthermore temporary personnel exchange is promoted between enterprises and with research institutes as very direct way of technology transfer. PRO INNO is a country wide and technology-spreading programme which offers the freedom of choice for the technology field and the form and the partners of co-operation at home or abroad. Target group of the entire programme are approx. 50.000 innovative SME's in Germany, inclusively Crafts enterprises.

In 2002 a new programme network management east (NEMO)" will be started in Eastern Germany. This measure shall sustain the organisation of regional networks of SME's and research institutes by competent technological and economic management support. The principal objective is the start of efficient innovative networks as they are already available in the old Länder of the Federal Republic. By the help of external network managers small and recent enterprises, which will suffer from the lack of own competence and capacities will be put into the position to use synergic advantages by R&D-co-operation with other enterprises or research institutes and to come together into the market with a larger competence and broader base im future-oriented technology fields.

An initiative for setting up professorships on self-employment at universities was launched in 1999 by the Federal Ministry of Economics and Technology. This initiative is aimed at making it easier for university graduates to abandon an academic career for self-employment and at encouraging university activities to

be spun off on basis. By the end of 2001, 24 such professorships were operative. Numerous others are currently being planned.

### *4.2. Initiatives to promote stronger industry-science relations*

In 2001 the BMWi started a new seed and pre-seed financing support scheme called „BTU-Frühphase“. It provides mentoring by experts with entrepreneurial experience with equity finance through a public bank up to 150.000 € without requiring the commitment of a private sector investor.

## 5. S&T human resources

### *5.1. Policy initiatives in response to real or perceived shortages of scientists and engineers*

The federal government launched a “green card”-initiative for up to 20 thousands highly qualified people from abroad for the IT-sector.

*Extent of shortages of scientists, engineers and other highly skilled personnel*

- IT sector:

Shortage of personnel is a term associated today in particular with the IT sector. In spring 2000, at the height of the dot.com boom, industry reports stated that a total of 93,000 vacancies for highly skilled IT personnel could not be filled (80% of the vacancies were for scientists and engineers). In 2001, the situation was less dramatic, but there were still considerable shortages. During the first half of 2001, according to the ifo barometer for the business climate, 44% of computer services companies had difficulty in finding highly skilled personnel (compared with about 56% at the end of 1998, but only 13% in mid-1995). The number of vacancies for scientists and engineers fell, shrinking by one third, during the period from January to August 2001 compared with the previous year with its - admittedly – historic high.

Now that the dot.com companies are getting into difficulties, the demand for manpower is shifting in particular to the "old economy", where banks and insurance companies are desperately looking for highly qualified personnel. Even in spring 2000, these two industries would have recruited over 13% more IT specialists if they had found them, while the number of unfilled vacancies in the IT industry was "only" 8% at the time. Two thirds of the vacancies that could not be filled were – even then - in sectors other than IT in the strict sense of the word, and this proportion is probably even higher today.

This means: even with the slowing of the boom, the shortage problem in the IT field will not go away. Surveys conducted during the first half of 2000 have shown that there will be a demand for 200,000 scientists and engineers until the end of 2002. Even if this demand is halved, it cannot be met because there will only be 22,000 graduates completing their training by the end of 2002. The steep increase in the number of new students in computer science will only make itself felt on the labour market after 2004, when the market will still be able to absorb large numbers of applicants according to current estimates [ZEW].

- Chemists/biologists:

The rapid growth of the biotech industry is generating a considerable demand for scientists in the fields of genome research and bioinformatics. The number of staff of biotech companies is estimated to double, reaching 23,000 by 2003. Consequently there is the imminent danger of a considerable shortage of highly skilled personnel in the fields of chemistry, biology and, most of all, in bioinformatics. The number of chemistry graduates is only half the number recorded in the eighties, and it will not increase in the short term.

**General:** According to an analysis conducted by the Institute for Employment Research (IAB), one in four vacancies for scientists and engineers could not be filled by companies at the beginning of the year 2000. The most acute shortage is that of engineers, computer scientists and mathematicians. In these professions, one in three vacancies cannot be filled; the situation of service companies with extensive R&D activities is even worse: they can fill only half of their vacancies. The most urgent problems are felt in the field of research and in the IT industry.

But not only scientists and engineers are in short supply. Companies are also desperately looking for skilled labour with vocational qualifications. Here again, one in four vacancies goes unfilled. It is in production and rendering of services where the shortage of people with vocational qualifications is felt most sharply. One in two companies cannot fill its open positions in this field. Pointing only to the shortage of academics does not therefore describe the present situation correctly [IAB].

- Effects of the shortages

In 1998, 16% of all industrial companies (about 10,000 firms) were suffering from a shortage of skilled labour (compared with 10% in 1996). This means that the shortage of staff and the difficulty to raise capital have become equally important innovation obstacles. Companies respond to such shortages mainly by extending the duration of projects, and less frequently by not launching projects in the first place or even by calling off projects. A shortage of academics is often compensated for with a strategy of contracting out or with inter-firm collaborations, which means that the contractor is trying to fulfill his contract vis-à-vis the client. Postponing delivery is another frequent way of handling the problem.

Most companies, however, cope with these problems by making their staff work longer hours. One in three companies asks their staff to work overtime to compensate for the shortage of scientists and engineers, and when we look at the shortage of highly skilled people with vocational qualifications, this percentage increases to one firm in two asking their staff to work overtime [IAB].

**Industry and public research centres compete for staff**: In view of these shortages, government-supported research centres, with their fixed salary structures, find it increasingly difficult to recruit staff. Bottlenecks occur particularly in fields where government centres expand their research activities and therefore have to recruit new staff (genome research, IT).

*Alternative strategies*

**Initial and continuing training**: One company in six has realised that it can solve its shortage problems by offering in-house training. IT firms in particular, which are classified as research-intensive service providers, are offering training to their staff (45% of such firms do so). But there are uncertainties, in particular as far as the new IT occupations are concerned: many firms are not sure whether they have the necessary qualifications to train apprentices. [*ZEW, IAB*].

**Recruiting graduates from other disciplines**: In view of the huge discrepancy between companies' demand for and the supply of computer scientists, firms have to compromise. Only about one company in

three insists on applicants with a specific degree; the other firms accept applicants from other fields or in fact from any discipline as long as the candidates have sufficient knowledge of information technology. Only about 45% of firms want computer science graduates, one company in three looks for engineers, and 8% want to recruit graduates in mathematics or physics.

In the industries traditionally recruiting engineers such as mechanical engineering, general plant construction and electrical engineering, the right degree continues to be a must. Here, an engineering degree is the prerequisite for occupying leadership or executive positions.

As can be seen from the above, the shortage of computer scientists, in turn, leads to bottlenecks in other science and engineering disciplines, in particular in engineering, thus aggravating the shortage of engineers, which obviously is an occupation where vacancies cannot be filled with staff from other disciplines.

### *5.2. Changes in training and education programmes for scientists and engineers*

The introduction of bachelor's and master's degrees in parallel with traditional German degrees was made possible by the Federal Government by the amendment of the Framework Act for Higher Education in 1998. German higher education institutions have since set up more than 1,000 bachelor and master courses as models of a future degrees structure. These models can respond to changes in the requirements of the labour market relatively rapidly, and they are more flexible and more job-oriented and can compete internationally. Graded and modularised academic training offers the advantage of reducing the overall duration of studies and the option of taking up further training, *e.g.* in the form of a part-time master's degree earned to supplement and build on the first-degree training. **Bachelor** and **Master** study courses therefore offer distinct benefits and incentives for studies in the natural sciences and in engineering. The BMBF is using various approaches in supporting and funding increased participation in studies dealing with modern information and communications technologies. In co-operation with the *Länder*, the Federal Government launched a 100 million DM special programme in summer 2000 to enhance computer science studies at higher education institutions. The *Länder* also launched their own initiatives in this field. The measures initiated under the joint Federal and *Länder* programme and under the *Länder's* own programmes have already had a positive impact on training resources, training conditions and training quality. According to information from the Federal Statistical Office, nearly 27,200 new students enrolled in computer science in the academic year 2000/2001 compared with just under 11,000 in 1997. The programme aims to reduce the length of studies in computer science and to facilitate the development and testing of new study courses leading to bachelor's and master's degrees and of further training courses to be offered by institutions.

The Federal Government is supporting a large number of activities designed to arouse young people's interest in technology, engineering and natural science studies. For example, support is given to two initiatives intended to increase the percentage of women in engineering and natural science studies including computer science. These initiatives take the form of information campaigns, one entitled "**Be.Ing – in Zukunft mit Frauen" ("Women, too, can be engineers")** and the other one entitled **"Werde Informatikerin – Be-IT" ("Women should train to be computer scientists")**. These big campaigns are designed to help motivate women to take up studies in engineering or computer science.

### *5.3. Policy changes related to the international migration and mobility of S&T personnel*

The Federal Government is making intensive efforts to increase exchanges of students and scientists. It seeks to achieve two things: to motivate more German students and graduates to spend a period of study or research abroad and to attract more highly qualified students, graduates and scientists from abroad. At the

same time, it is encouraging return migration of German scientists. The target is to raise the percentage of German students with at least one semester of study experience abroad from currently 13% to 20% by 2010 and to increase the proportion of foreign students in Germany from currently 7% to 10% over the next few years.

Measures being taken to increase the percentage of German students with experience acquired during studies abroad:

- Intensification of collaborations between higher education institutions.
- Fostering of new study courses requiring a study period abroad and leading to a binational degree.
- Specific campaigns to make students aware of the courses offered by foreign universities and research institutions in less popular regions.
- removing mental and language barriers (*e.g.* contact fellowships, language courses preceding a study period abroad).

Measures designed to attract foreign students:

- Testing of bachelor and master courses.
- Introduction of internationally-oriented study courses/classes taught in foreign languages (goal: increased orientation of study courses to the interests and needs of international students, *e.g.* by using a foreign language as teaching and working language, encouraging more partnerships between institutions, binational degrees).
- Special post-graduate programmes to facilitate the enrolment of highly qualified applicants from abroad.

Examples of specific measures designed to attract university teachers and scientists from abroad:

- Improving working conditions for foreign scientists (the reform of employment law in higher education and the introduction of junior professorships are two structural measures that improve conditions for both German and foreign scientists).
- Specific programmes to attract university teachers and scientists (the Initiative for the future of higher education institutions as part of the Federal Government's Programme for investing in the future provides support for world-class researchers and young scientists from abroad, including German scientists returning home, who will set up their own research groups in Germany or who will be recruited by higher education institutions as visiting lecturers).

In addition, efforts are being made to improve general conditions:

- Facilitating the entry of international university applicants: Unlike the Deutsche Sprachprüfung, the new *TestDaF* examination offers two advantages: it can also be taken in the student's own country and it is better geared to the requirements of individual study courses.

- Improving or easing requirements under the aliens law and for labour permits (cf. the Federal Government's immigration bill)

- Integration of foreign students (many initiatives are being launched to improve support and integration, including a new fellowship and support programme)

In addition, more marketing measures are being supported:

- Concerted action/umbrella campaign (goal: linking of initiatives, joint action; common slogan "Hi! Potentials – International Careers made in Germany"; Internet portal www.campus-germany.de; advertising campaign/roadshows)

- Consortium for international higher education marketing GATE-Germany

- Courses offered abroad by German higher education institutions.

## 6. International co-operation and globalisation

### *6.1. Initiatives to promote international co-operation in science, technology and innovation*

In the context of the PROgramme „INNOvation-competence of medium-sized enterprises" (PRO INNO) R&D- co-operation of German enterprises with foreign enterprises or research establishments is supported. In order to further develop these international co-operation, a „network technology co-operation " was created as an infrastructure measure within the framework of the programme PRO INNO. It covers at present 17 contact points in 15 countries of Central and Eastern Europe, Latin America as well as Asia. The contact points in an advisory manner support German SME's during the preparation of R&D- co-operation, help with the search for competent and efficient partners and recruit potential co-operation projects of enterprises from the seat country.

## 7. Industry-related policies

### *7.2.Manufacturing*

Germany supports the development of the civil aircraft A 380 by granting a repayable loan according to the Agreement between the Government of the United States of America and the European Economic Community concerning the application of the GATT Agreement on Trade in Civil Aircraft on Trade in Large Civil Aircraft of 1992.

In accordance with the Conclusions of the Industry Council Germany ciesed to grant state aid for orders to purchase ships after 1.1.2001. Other state aid programms or tax incentives for the purchase of ships by german dockyards do not exist.

### *7.4. Intangible Investment*

The Federal Government is currently reviewing the legal framework for corporate governance due to globlisation and internationalisation of capital markets. A commission for the modernisation of stock corporation law was appointed and their report published in July 2001. The recommendations encompass

the presentation of a german corporate governance codex by Spring 2002 and its transformation into legislation.

### *7.5. Corporate Social Responsibility*

An increasing number of European companies are promoting their corporate social responsibility strategies as a response to a variety of social, environmental and economic pressures. The Greenbook of the European Commission of July 2001 aims at the development of new partnerships and new spheres for existing relationships within a company regarding social dialogue, skills acquisition, equal opportunities, anticipation and management of change, at the local or national level with reference to the reinforcement of economic and social cohesion and health protection, and more generally on a global level, concerning environmental protection and respect of fundamental rights. The Federal Government is following the discussion with great interest.

The Institute for Research in SME´s is currently evaluating the “non-profit” activities of enterprises with regard to cultural, ecological, caritative and human capital oriented aspects. The results will reveal the extent with which enterprises respond to the ideal of a “good citizen”.