The path to the knowledge and information society

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The structural role of the science and technology system

«The capacity to create, disseminate and use knowledge and information is increasingly the most important factor for economic growth and improving quality of life» (OECD, 1999). For this reason, the science and technology system takes on a fundamentally important structural role in economic and social progress, and is a basic infrastructure for knowledge-based economies and societies of every country. Also, «countries are becoming increasingly more integrated within a global economy, via the international movement of goods, services, investment, people and ideas», underlining a trend that had started in science beforehand (OECD, 1999).

As the knowledge-based economy requires new qualifications and skills, the quality of personnel is the main factor underlying invention and the spread of technology.

The qualification of personnel is necessarily supported by the scientific system, even from the perspective of technical training. It is very true that the extent and quality of the science and technology system, in close cooperation with higher education institutions, is an essential part of the up-datedness and constant upgrading of education and training. In fact, the science and technology system plays a fundamental role in stimulating creativity, the use of knowledge, innovation, modernisation, constant updating, the development of entrepreneurial attitudes, internationalisation, the adoption of systematic assessment procedures, the strengthening of scientific and technological culture.

Much like the majority of all of the other indicators of the country, the indicators for the Portuguese science and technology system at the beginning of the 80's were a considerable way behind those of the other countries of the European Union.

After entering the EU, this gap has been reduced over the last twenty years and the scientific system has revealed itself to be remarkably dynamic. Although a long way off the levels of some other countries, we find ourselves with a window of opportunity that is very much associated with a young scientific workforce that is highly qualified, very international and rapidly growing, and something that will allow us to reach levels close to those of the European average within the next decade. This window of opportunity is, therefore, very brief. In order to take full advantage of it, permanent attention has to be given to opportunities, needs and resources at the precise moment they arise and great flexibility is needed to face the myriad of changes that occur in terms of politics,

Study on molecular sequencing and evolution.

legislation, institutions and scientific movers.

In this text we will talk about the recent past and the prospects for the future of Science and Technology in Portugal, within the new framework defined by the demands of the knowledge and information society.

First, we identify what were the crucial factors for the beginnings of the scientific development of the country from the mid-60's to the time of Portugal's entry into the EU. In the second part we describe, numerically, the development of the scientific and technological system, which has been distinguished over the last twenty years by an opening up to outside influences and an approximation to the patterns of other European nations. Then, we analyse the main guiding principles of science and technology policy and the measure upon which the abovementioned development and growth are based. In part four we look at two policy instruments related to Science, Technology and Innovation and the Information Society for the period 2000-2006, followed by a description of the main aspects of these areas between 2000 and 2005. Then we present the «*Ligar Portugal*» (Connecting Portugal) initiative, which was approved in July 2005 for the Information Society and the «*Compromisso com a Ciência para o Futuro de Portugal*» (Commitment to Science for Portugal's Future) launched in March 2006, both part of the «*Plano Tecnológico*» (Technology Plan) that began in 2005.

Finally, we conclude with a reflection on the main challenges of, and the obstacles to, the building of the knowledge and information society in our country.

A difficult take-off

From the end of World War II, considerable effort was made and various projects and initiatives were launched in order to encourage research in Portugal.

However, as a number of studies have shown, until the beginning of the 70's one cannot talk about a national scientific system, or even a policy for science (Gago, 1990; Ruivo, 1998). The system was small with no critical mass and the efforts made were distinguished by a lack of human and financial resources. The resulting lack of policy for training, hesitation and the overall lack of conviction in the measures and decisions taken related to the creation and support of institutions and the lack of continuity were the main obstacles to the start and sustainability of growth of the system, as such.

Only after joining the EU did it finally get the boost it needed and scientific development in Portugal really got to «take-off». In 1986, when Portugal joined the EU, it was seen as a decisive opportunity for scientific development, this time founded on internationalisation and being receptive to the outside world as its roots and guarantee of quality.

In the area of science and technology there had been a long period of inconsistent measures, lack of coherence and strategic vision, a scarcity of effectively mobilised financial resources, which led to very little real impact.

The good will and work of certain scientists and politicians committed to the development of science in Portugal were not easily integrated into the framework of the totalitarian regime. During the time of the *Estado Novo*, what little development there was in science was exclusively down to the State, whose attitude revealed a short-term, centralising and standardising of R&D activities that resulted in the isolation and insularity of the country and an excessive focus on Lisbon.

As such, research developed almost exclusively in State Laboratories, Institutes and Research Boards, which were sector-based and created throughout the term of the *Estado Novo* (between 1945 and 1960), they were concentrated in Lisbon and with very limited funds. The main mission of these institutions was to develop applied research to solve the problems of the different sectors with no strategies of internationalisation or connections abroad, be it amongst themselves or with universities and business.

The most important thing for the development of the national scientific system over this long period was the role of international organisations. In 1964 and subsequent years the relationship with the OECD was decisive, especially in the analyses and study of situation of science in Portugal and in the support for the definition of policy strategy. The relationship with NATO's Scientific Committee was also fundamental as the organisation's scholarship programme permitted the beginning of a policy of advanced training for Portuguese scientists abroad.

In 1974 the creation of a democratic regime, the subsequent regional growth and expansion and the opening up of the higher education system all constituted important contextual factors that were vital for the process of the development of the scientific system.

In fact, the regime that resulted from the April revolution of 1974 meant a more open and democratic context from which new and diverse players emerged as well as also defining new rules and introducing something very powerful and influential in the field of science and its system that would become decisive.

That something was the growth, expansion and regional diversification of higher education: while those Portuguese professionals that obtained their PhD abroad in the 60's and 70's were being absorbed by the system, conditions were being created and mechanisms put in place for the same courses to be run nationally. The availability of the right personnel, albeit in a limited number, generated a dynamic, one that continues to this day, of new needs and opportunities for the development of research in universities, improving the level of teaching and research.

Over the last 15 years, research centres, interface institutions, private not-for--profit institutions have been created in universities and their respective faculties and departments and this has created a more flexible working environment and one that adopts operative modes for the transfer and valuing of scientific knowledge.

In this process those research institutions connected with higher education have asserted their research capacity. New needs for personnel with advanced training have emerged and new quality standards have been set.

Various generations of Portuguese people have, at various times, contributed to scientific development and have fought for the assertion of science as a catalyst for the country's development. But only in recent years has that old dream become a reality, due to the political will shown, the support of the European community and the national consensus that has been established regarding the issue of science.

In reality, the «take-off» of our scientific system only occurred from 1986 onwards, after Portugal's integration into the EU, the definition of a political programme of action, the mobilisation of the country's scientific community and the establishing of a national consensus on the importance of developing the scientific system.

At the time, the *Programa Mobilizador de Ciência e Tecnologia* — 1987-90 (Science and Technology Mobilising Programme) played a crucial role in encouraging a new attitude towards the opportunities for building new project teams subject to public tender, as well as the adoption of an open and transparent assessment system. It is also this time that sees the start of the programmed development of areas such as astronomy and astrophysics, molecular biology, biotechnology, ICT and materials science and engineering.

Since then, the main strategic instruments have been the operational programmes of the 1st, 2nd and 3rd Community Support Framework: *Programa CIENCIA* — the Science Programme (1990-1993), *Programa PRAXIS XXI* — the PRAXIS programme XXI (1994-1999), *Programa Operacional Ciência Tecnologia e Inovação* — Science, Technology and Innovation Operational Programme/ *Ciência e Inovação* — Science and Innovation (2000-2006), *Programa Operacional Sociedade da Informação* — the Information Society Operational Programme / *Sociedade do Conhecimento* — Information Society (2000-2006). These last two programmes anticipated the doubling of funding for science and technology in relation to the period of the previous Community Support framework.

It is worth noting, however, that the process of development and growth that has been seen, particularly over the last twenty years, has not always been regular and demonstrates that the system is somewhat vulnerable to ups and downs and political hesitation.

For the next few years, the «*Compromisso com a Ciência para o Futuro de Portugal*» project (Commitment to Science for Portugal's Future) that was launched in March 2006 foresees, among other things, the boosting of the public S&T budget by €250 million more than in 2006 (a rise of 77 % of competitive funding of the S&T system by the *Fundação para a Ciência e a Tecnologia* (Science and Technology Foundation), the hiring of at least 1,000 new PhD's until 2009 and a 60 % increase in the number of PhD and post-PhD grants.

Portugal in Europe and open to the world — 1995 to 2002

The main feature of Science and Technology in Portugal in the period 1995-2002 was its approximation to European standards and opening up to the outside world. The enormous growth in the scientific system can be seen in indicators of size, both in terms of human and financial resources related to research activities, but it can also be seen in indicators related to results and performance, such as scientific production and internationalisation that reveal that this growth has be accompanied by improvements in quality levels as well.

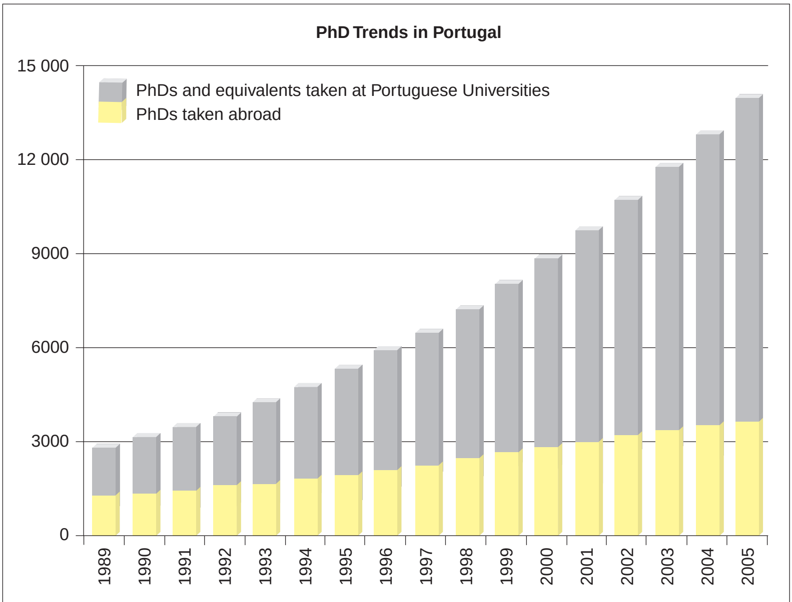
Personnel in science and technology

Personnel specialised in R&D in Portugal steadily grew, as did the number PhDs at or recognised by Portuguese universities. We can say that the advanced nature of personnel has been the driving force of the development and recovery of the ground that had to be made up in science and technology.

In 1988, there were 6,600 researchers (Full-time equivalent — FTE) or 10,800 people, which is 1.4 % of the working population; in 1997, there were 13,500 researchers (FTE) or 22,000 people, representing 2.9 % of the working population; in 2003, 20,200 researchers (FTE) or 35 900 people, which corresponds to 3.7 % of the working population.

In fact, in the period 1997-2003, Portugal was one of the countries in the European Union with the greatest average annual growth in the number of researchers (4.5 %), when in the EU25 it was 2.8 %, although there have been higher average annual growth in Sweden (4.6 %), Austria (5.7 %) and Finland (7.0 %).

Despite this growth, in 2003 the number of researchers (FTE) in Portugal in relation to the working population was still only two-thirds of the UE25 average, less than half of the number in Belgium, Denmark and Luxemburg, about a third



Source: OCT/OCES, *PhDs taken at or recognised by Portuguese Universities*, 1970-2005.

of the number in Sweden and less than a quarter of the number in Finland (Eurostat, 2006).

The annual number of PhDs taken at or recognised by Portuguese universities went from around 100 in 1980 to 590 in 1997 and 1,030 in 2003. It is estimated that the number of professional with PhDs working in the country has gone from 1,700 in 1985 to 11,800 in 2003.

The annual growth in the number of Portuguese PhDs is approximately 9 %, a high figure that was maintained between 1995-2002. In certain scientific fields the average annual growth of PhDs has been considerably higher than the average, for example Biochemical Engineering (24 %), Management (21 %), Philosophy (19 %), Literary Studies (18 %), Psychology (14 %), Linguistics (14 %), Geography (14 %), Biology (13 %), Earth and Space Science (12 %).

Training programmes have sought to ensure the quality of training and diversification of opportunities, via incentives to do PhDs abroad: grants given for PhDs taken abroad represent 46 % of the total for the period in question (OCES, 2006.a, 2006.c).

Beginning in 1997, the awarding of grants financed by the *Fundação para a Ciência e a Tecnologia* (Science and Technology Foundation) for research units and projects was decentralised to scientific institutions. This process was exemplary in the way it simultaneously encouraged decentralisation, responsibility, transparency, rigorous assessment, effectiveness and public advertising of opportunities on a national level at a unified access point on the FCT Internet pages.

Support schemes were introduced for the hiring of staff, especially those with PhDs, within the scope of support programmes for research institutions: R&D Units, State Laboratories, and Associated Laboratories.

From 1996 to 2001, FCT's investment in grants and taking on staff increased by 80 %. At the same time, part of this investment was steadily decentralised for research institutions to apply as they saw fit. In 2001, 30 % of the total was applied in a decentralised fashion by research institutions within the framework of support programmes for scientific institutions and R&D projects (OCT, 2002).

Funding for Science and Technology

R&D expenditure, at 1995 constant prices, was around €273 million in 1988, which translates as 0.41 % of GNP; in 1995 it was €460 million, 0.57 % of GNP;

R&D Expenditure Trends by Sector (Thousands of euros, 1995 constant prices)

	1988		1990		1992		1995		1997		1999		2001	
		%		%		%		%		%		%		%
Companies	67 016	25	99 051	26	103 713	22	96 227	21	121 198	23	161 400	23	266 608	32
Government	90 214	33	96 533	25	105 714	22	124 313	27	130 682	24	198 846	28	173 954	21
Higher Education	92 608	34	136 690	36	205 542	43	170 429	37	216 070	40	274 562	38	307 238	36
PNP	22 846	8	47 088	13	62 811	13	69 068	15	71 676	13	76 783	11	90 363	11
TOTAL	272 684	100	379 362	100	477 780	100	460 037	100	539 626	100	711 591	100	838 163	100

Source: OCT, *Main Science and Technology Indicators in Portugal*, 1988-1995; *Statistical Summaries*, IPCTN 1997, 2001.

Trends in Scientific and Technological Potential: No. of Researchers as a Percentage of Working population and Expenditure on R&D as a Percentage of GNP		
	Researchers / Working Population (‰)	R&D Expenditure / GNP (%)
1988	1,4	0,41
1990	1,6	0,51
1992	2,0	0,61
1995	2,4	0,57
1997	2,8	0,62
1999	3,1	0,76
2001	3,4	0,85
2003	3,7	0,78

Source: OCES, *National Scientific and Technological Potential 1982-2001 — Two decades of R&D activity trends in Portugal*, 2003; OCES, *Statistical Summaries* — IPCTN 03, 2006.

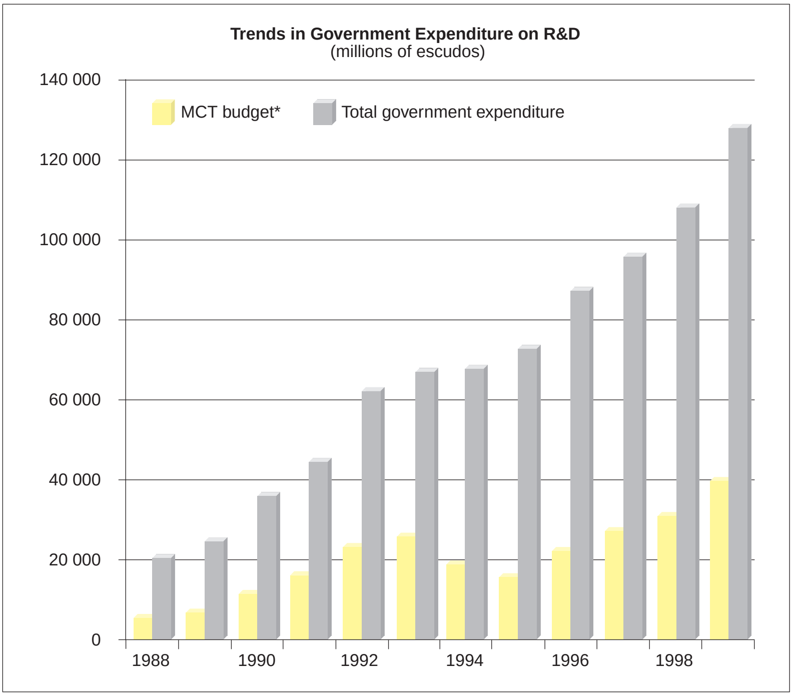
in 2001 it was €838 million, 0.85 % of GNP.

R&D spending in Portugal between 1995 (0.57 % of GNP) and 2001 (0.85 % of GNP) showed average annual growth of 9.5 % (at constant prices), contrasting with the drop between 1992 (0.61 %) and 1995 (0.57 %), after a decade of continued growth. The drop in R&D funding in Portugal between 1992 and 1995 was particularly negative for science and technology in Portugal, especially after a decade of constant growth, despite a rise in personnel levels and the efforts in post-graduate training.

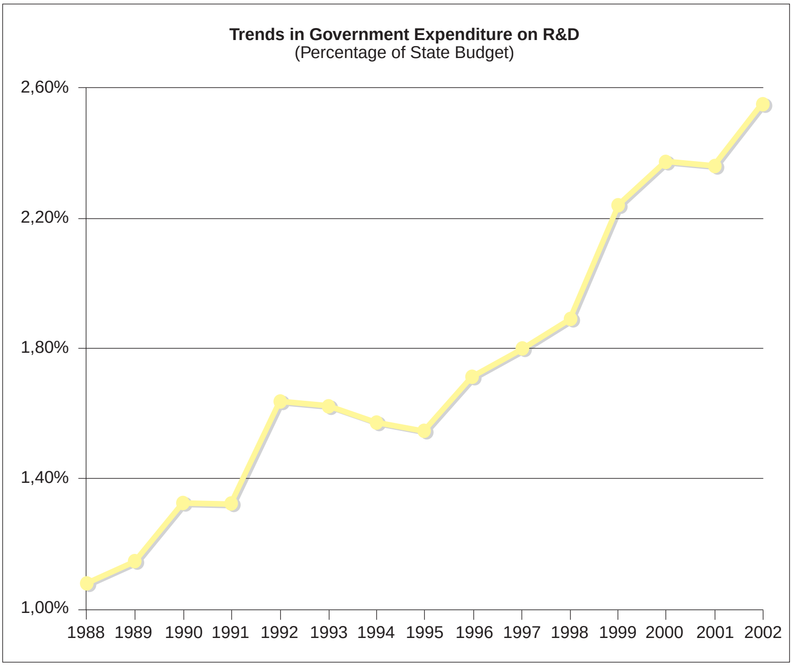
On the other hand, despite high growth levels, R&D expenditure in Portugal remained low. In reality, in 2001 overall R&D expenditure of the EU25 in relation to GNP was 1.9 %. Portugal's expenditure was only 40 % of that of the EU25 and less than a quarter of Sweden and Finland's. The main reason for these differences is the amount of research personnel, technicians or researchers (Eurostat, 2006).

The effort involved in making up lost ground is visible in the public funding for S&T between 1995-2001, in particular the growth of the budget of the system's main funding agency that went from €100 million in 1995 (JNICT), at 2003 constant prices, to €300 million in 2002 (FCT). A substantial part of this money was channelled into the direct funding of R&D institutes and units, for advanced training programmes in science and technology and support for R&D programmes, projects and other activities (OCT, 1998).

The distribution of funding by sector of performance shows that in 1997 R&D expenditure in companies was only 22 % of the total, compared to around 50 % in EU and 60 % in OECD. However, R&D expenditure in companies between 1995 and 2001 showed an average annual growth of about 20 %, inverting the downward trend that has occurred since 1990. The average annual growth of R&D expenditure in companies between 1995 and 2001 was significantly higher than the overall average annual growth in R&D



(*) Secretariat of Science and Technology until 1995, Ministry of Science and Technology from 1995 to 2000.
Source: OCT, *Budgetary Provision*, 1986-1999.



Source: OCT, *Budgetary Provision*, 1986-2002.

expenditure, which was 9.5 %, as can be seen above. In 2001, R&D expenditure in companies was 32 % of total R&D expenditure. In relation to GNP, R&D expenditure in companies fell from 0.14 % in 1990 to 0.11 % in 1995 and grew every year until 2001 when it was 0.27 % of GNP (Eurostat, 2006).

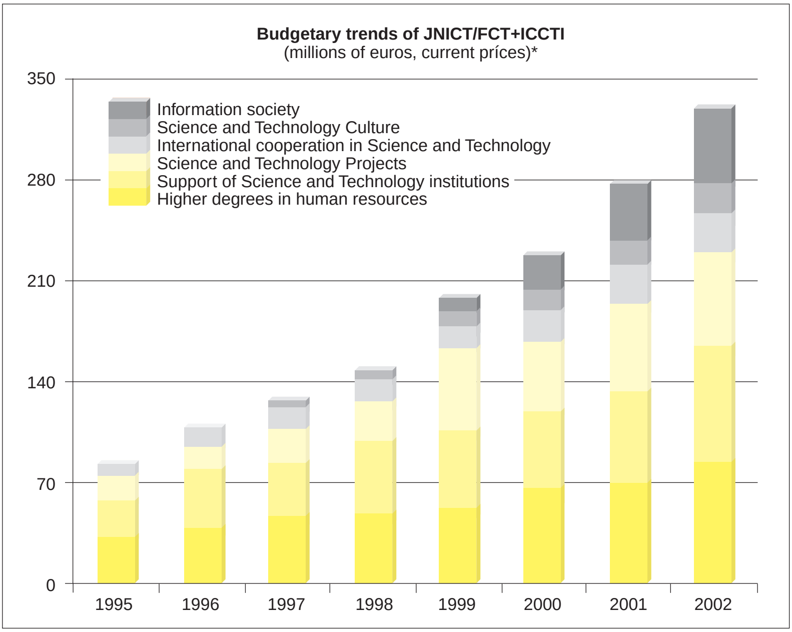
In comparison with more advanced countries, R&D in companies is quite limited in Portugal and this is in part due to the reduced size of those industries that are traditionally R&D intensive, these signs of activity should be seen as a positive trend but limited in their effect unless there are significant changes in the structure of specialisation (Fernandes, 1998).

The improvement in the training of personnel in Portuguese companies is certainly one of the most important factors that will contribute to technological development and greater innovation in the national economy.

Traditionally only a tiny fraction of staff in Portuguese companies were graduates, which is a reflection of the generally low level of education and training in Portugal: nowadays graduates make up only 8 % of the working population, while the European average is 14 %. When we look at the company sector in Portugal (excluding the civil service and freelance workers) the proportion is cut by half. The lack of qualifications within the economic and social fabric of the country is damaging for any policy on technology, but the situation is changing rapidly because of the growth and the opening up of the higher education system.

In fact, in recent years the number of higher education graduates in the total of workers in companies with at least one graduate always goes up in the newest companies, in all sectors and scales.

This trend is decisive, not only because graduate personnel are crucial for



* Figure based on the budgets of the main funding agency for the science and technology system: JNICT until 1997, FCT from 1997 to 2002, to which the ICCTI budget was added.
Source: *Grandes Opções do Plano*, 1995 to 2002.

the progress of technological innovation in companies and in their relationship with universities and scientific institutions, but also it indicates the change in attitude of the younger generations of entrepreneurs in relation to the intangible factors of competitiveness.

With this backdrop, and considering the continued increase in the number of graduates, as well as personnel with post-graduate qualifications over the last decade, we can say that finally conditions are right for highly qualified personnel to be placed in companies in a significant fashion.

On the other hand, it is interesting to see the rise in R&D expenditure in companies between 1995 and 2002 is fundamentally down to new companies or ones that had not declared any R&D activity beforehand, with better qualified personnel and in the more technologically advanced sectors.

Scientific production

Internationally referenced scientific production, that is the work of researchers in Portuguese scientific institutions that is published in internationally recognised journals, is an important indicator of the performance of scientific systems.

National scientific productivity has grown significantly. In the period 1990-95, of all the countries in the EU Portugal was first in terms of the number of scientific publications quoted in the *Science Citation Index (SCI)* — an average annual growth of 12 %, three

Portuguese Scientific Production:
Number of publications* by Year, by Area and by Document Type

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Publications in classified journals												
Physical, Chemical and Earth Sciences	329	392	436	509	541	573	668	788	879	1071	1123	1382
Life Sciences	230	242	298	353	426	511	513	628	699	854	835	894
Clinical Medicine	75	104	125	135	168	207	181	271	274	352	351	356
Agriculture, Biology, and Environmental Sci.	98	103	168	156	209	258	272	317	388	424	468	550
Engineering, Computing & Technology	160	152	184	180	218	271	340	349	416	510	549	555
Social and Behavioral Sciences	26	24	50	47	50	61	92	52	72	85	163	110
Arts & Humanities	8	24	19	19	34	18	28	22	22	37	44	32
[1] Sub-total	925	1040	1279	1398	1645	1899	2093	2427	2749	3333	3533	3878
[2] Non-classified Publications	48	55	70	145	238	316	310	391	445	490	576	508
Total of Publications [1] + [2]	973	1095	1349	1543	1883	2215	2403	2818	3194	3823	4109	4386
Article	735	844	945	1088	1333	1555	1906	2164	2293	2709	3047	3214
Article in Reports	97	107	140	205	213	257	229	300	434	548	473	601
Note	62	45	82		68		125	103				
Critiques	6	8	16	17	27	23	40	32	38	54	79	79
others	74	92	167	167	183	276	227	321	430	511	510	488

* Fractioned Counting Method.
Source: *Institute for Scientific Information, National Citation Report for Portugal, 1981-2001.*

times more than the OECD average and more than double the EU average (OECD, 1999). While the number of researchers in Portugal doubled from 1988 to 1997, the number of publications quoted in the *SCI* more than trebled, 3.5 times higher (OCT, 1999.b). In the period 1995-99, Portugal was first again in the EU in terms of the number of quoted scientific publications in the *SCI*, with an average annual growth of 16 %, more than 5.5 times higher than the EU15 average and more than double the number of the country in second place. In this period the growth in publication was more than double that of the number of researchers (EC, 2001).

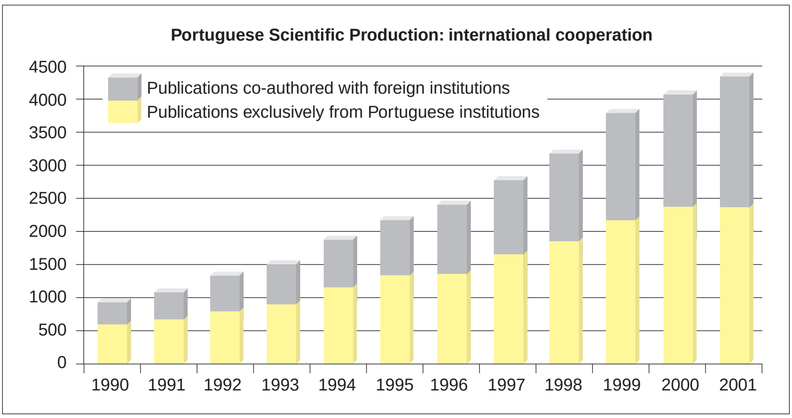
Also, co-authorship in scientific production is a good indicator of international cooperation. In 1997, 41 % of the articles with Portuguese participation that were quoted internationally involved international cooperation, which is a significant improvement on the 28 % recorded in 1980/81. In the period 1995-99, the articles co-authored by researchers in Portugal with researchers abroad numbered 51 % of total articles published, clearly the highest number in the EU15 (EC, 2003). This is an obvious symptom of the increasing openness in the country's science and technology and a favourable position in terms of international scientific cooperation within the context of globalisation.

Scientific partnerships blossomed after Portugal joined the EU: collaboration with Germany, Spain and Italy grew significantly. However, cooperation with the United Kingdom, the U.S.A. and France continue to be the most frequent.

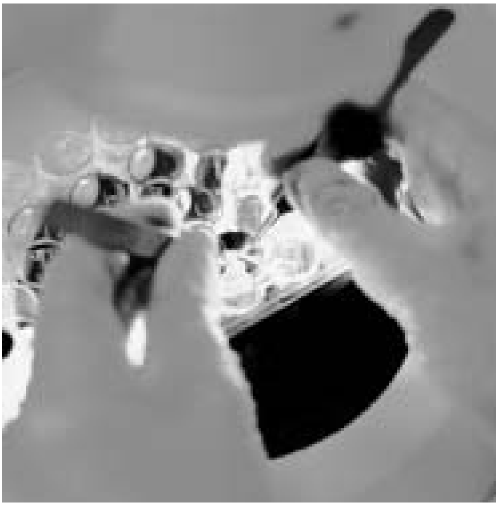
In terms of scientific areas, the scientific cooperation of Portuguese teams with teams in British institutions is particularly important in Earth Sciences, Medical Sciences, Chemical, Bio-Medical Sciences and Biology. The U.S.A. is important for Bio-Medical, Chemical Science and Physics. France's presence is mainly felt in 9Space Sciences and is important in Physics, Medical and Chemical Sciences.

The expansion of international cooperation is also evident in the participation of Portuguese research teams in international projects such as Eureka.

In the 4th EU Framework Programme for Research (1994-1998), the number of participations by Portuguese institutions was 1,551 in 1,117 projects (in 158 they were the lead institution) when the total number of approved projects in this Framework Programme was 13,738 (OCT, 1999.c). In the 5th EU Framework



Source: *Institute for Scientific Information, National Citation Report for Portugal, 1990-2002.*



Embryos in solution.

Programme for Research (1999-2002), the number of participations by Portuguese institutions was 1,442 in 1,071 projects (in 158 they were the lead institution), when the total number of approved projects in this Framework Programme was 11,327 projects.

The growth and receptiveness of the country's science and technology to international cooperation and collaboration are two distinctive features of trends in science and technology in Portugal that now may be entering a new era in their history.

Ensuring quality and sustained growth

If the growth and openness of the national scientific system over the last fifteen years is undeniable then sustainability is yet to be guaranteed and will not happen automatically.

The main statistical indicators reveal that the scientific system is far from being robust enough for independent survival and self-reproduction, given its current size, its accelerated growth and the fragility and recent nature of the majority of the institutions in question.

The fall in R&D expenditure growth between 1992 and 1995 was not only due to political hesitancy but also due to the difficulties that the still fragile scientific system faced in asserting and defending itself from the same hesitations.

The political programme established between 1995 and 2002 proposed a strategy to definitively make up ground, strengthening the institutions and ensuring quality.

The main guidelines were:

— Increasing the number and qualification of personnel in R&D as the basis and guarantee of sustained growth;

— Developing and consolidating a culture of external and independent assessment and institutionalisation of mechanisms of self-assessment and external monitoring;

— Consolidating and improving the qualification of institutions of science and technology, their organisation, leadership and capacity for strategic programming;

— Consolidating the internationalisation and participation Portuguese participation in the major international R&D bodies, with a view to ensuring quality levels of an international standard;

— Promoting high quality international research projects in science and technology, within a context of stability and a rigorously assessed framework, including projects of public interest and associated with consolidating the capacity for participating in major international scientific bodies;

— Stimulating research in applied technology and innovation, in particular via research projects in associations between scientific institutions and business, where the companies lead and partially fund the venture;

— Promoting scientific culture in young people via the development of experimental science teaching and other projects in conjunction with scientific institutions;

— Legislative reform of the science and technology system, including the creation of institutions administering science and technology policy that are in line with current national situation, the definition of the legal basis of research institutions, a review of the career status of researcher and review of researcher scholars;

— Institutionalising regular observation and analysis mechanisms for the science and technology system, for the dissemination of information about its current state and trends and to support the definition of a science and technology policy;

— Making up ground with the launch of the foundations for the information society, via general access and skills for the population, the development of information and communication sciences and technologies and stimulating the availability of Internet content.

The amount of money invested in advanced training programmes, in consolidating scientific institutions, in supporting scientific research and technological development projects, in the expansion of Portuguese participation in intergovernmental scientific organisations and in the promotion of scientific culture and education in this period is probably the most evident expression of the importance that is placed upon to these components of scientific development and the political will that is focussed on them, in order to overcome any scientific handicap.

Preparing quail eggs for ADN injections.

Increase in the amount of personnel with high-level scientific qualifications

Between 1994 and 2002,11,950 advanced training scholarships were funded, 2,670 of which were Master's degrees and 5,900 were PhDs. Of the total amount of PhD scholarships awarded, 46 % were for PhDs abroad, where PhDs in the best foreign universities makes a contribution to meeting the objectives of internationalisation, close contact with international scientific networks and the importing of different practices in Portuguese society.

Assessment, quality, rigour and transparency

Assessment systems are core to quality, internationalisation and the general workings of scientific systems. They take into account decision-making in relation to optimising financial resources, the rationalisation or reform of institutions, increasing productivity and the quality of scientific production and activity.

As we have seen, from 1964 onwards, the OECD monitored assessment programmes for the national scientific system and governmental policy were decisive for the scientific development of the country.

Once again, from 1996 onwards, a profound change to the assessment system was set in motion, if we consider that this is an essential part of the development of the national science and technology system and a guarantee of its quality. The change that was set in motion by the *Fundação para a Ciência e a Tecnologia* (Science and Technology Foundation) basically consisted of the review, clarification and dissemination of assessment procedures for scientific institutions, research projects and scholarship applications. Project and institutional assessment was based on panels of assessors, overwhelmingly made up of scientists from foreign institutions, involving the direct interaction between proponents and the assessors in public application sessions for research projects or units. Another important aspect was the inclusion of quality assessment criteria for those previously funded projects that the team participated in and the contribution of the projects for the integration of new researchers.

This was how a coherent and transparent assessment process was achieved, whose quality was recognised by the scientific community nationally and internationally and which marked the beginning of a regular and responsible model of R&D funding, giving stability and requiring accountability from research institutions.

The assessment of scientific institutions that involved all State Laboratories, more than 350 research units from all knowledge areas, and was funded by the *Fundação para a Ciência e a Tecnologia*, followed the abovementioned principles.

The assessment process of the State Laboratories resulted in a number of measures that were part of the first phase of a programme supporting its reform, which began in 1998 with the creation of project teams for specific issues of public interest: risk reduction and prevention (seismic, radiological and nuclear, building decay), sea sciences and technologies, and tropical science research. By making funds available, the aim was to rejuvenate researchers and research and to modernise research project managment and make it more flexible in State Laboratories, partially subject to the recruitment of new researchers and the adoption of the rules for autonomous management by the researchers responsible for the project. On the other hand, the publishing of the Legal Regime for Research Institutions and the review of the Research Career Statute resulted in the re-jigging of the staff structure of State Laboratories and how they worked and were managed.

The result of the assessment of the research units was a more detailed knowledge of the state of the national science and technology system, not only at the level of each unit but also in each scientific area and group in the system. The assessment process also stimulated the change in science's leading figures, the definition of strategic orientation, the internationalisation of activity, the qualification of scientific activities, the organisation and the extension of PhD and post-PhD opportunities and the participation in promoting scientific culture.

It was realised that there was major potential for scientific work of considerable international quality, although this was hindered by certain factors. Firstly, structural deficiencies in the organisation and make-up of the units, which could be attributed to previous funding policies, which favoured larger units and certain priority areas over quality and research results. Secondly, compatibility problems between scientific work and the organisation of university teaching at the time current, in particular the little time teaching staff had to do research because of an excessive teaching load, the lack of administrative and technical support and the inflexibility in contracting personnel.

The consolidation and qualification of scientific institutions

The Multi-annual Funding Programme for R&D Units, which was possibly the most important consolidation programme for scientific institutions, began to make basic and programme funds available after periodic international assessment. Around 335 units in all knowledge areas were included in the Programme. The total amount of funding that the Programme had available rose considerably over the period 1995-2002: it rose from €7.5 million in 1995 and 1996, to €20 million in 1997, €28 million in 1999, €30 million in 2000, €35 million 2001 (OCT, 2002).

Apart from funding the units' work, this programme has also served as a stimulus for the internal re-organisation and the direction of institutions, the consolidation of their autonomy, their capacity to raise funds outside the system and creation of the conditions for the generation of more employment in science as a result of the periodic international assessments.

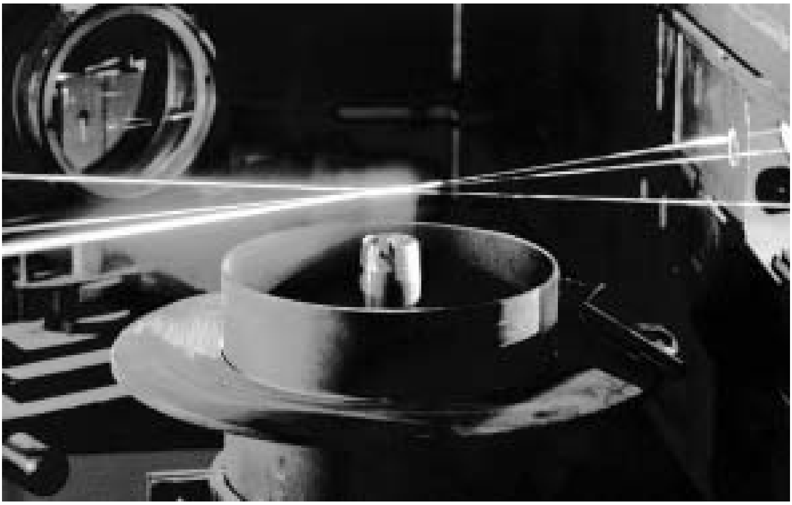
All the information regarding the assessment procedure has been published and widely disseminated and both the assessment results and general information about the research units is also available on the Internet. The information about the units, including exhaustive lists of research teams, the respective interest areas and e-mail addresses, is updated annually by the units themselves via the Internet and then made public. This proved to be an effective instrument of interconnection and communication between researchers and institutions.

Consolidation of Internationalisation of Science and Technology

The recognition of the importance of international cooperation as an essential instrument for developing and improving the quality of the science and technology system, within the context of increasing social and economic globalisation, led to the promotion of a policy of international cooperation.

A group of large international laboratories play a major role in creating new scientific perspectives, in terms of access to latest instruments and the consolidation and improvement of skills in the participating scientific communities. For these reasons, since 1995 Portugal has partici-

Measuring the speed and concentration-points of CO2 jets simultaneously.



Combustion and incinerator-behaviour trials.

pated and been involved in a number of major international scientific projects:

— The renewal of the *Comité Misto Portugal-CERN* (Centre Européene Pour La Recherche Nucleaire) mandate until 2007, ensuring the continuing advice on funding scientific work in the areas of CERN and the continuation of the agreement on the training of young Portuguese engineers at the CERN, a committee which Portugal joined in 1985;

— The project for the creation of a European Oceans Agency;

— The agreement between Portugal and the European Space Agency (ESA) in 1996, giving research institutions and companies the chance to participate in optional programmes, such as those of the ARTES programme, and the Portugal's subsequent negotiation and full adherence to ESA in 1999;

— Portugal has joined the European Laboratory of Molecular Biology, the European Laboratory of Sincrotron Radiation, the Ocean Drilling Programme via the European Consortium formed at the European Science Foundation and the Consultative Group on International Agricultural Research (CGIAR);

— Starting negotiations on Portugal's full membership of the European Southern Observatory (ESO);

— Participation in the major networks of multilateral scientific cooperation, such as EUREKA, COST (e.g. in telecommunications, transport, forestry products, bio-technology and agriculture) and CYTED-IBEROEKA.

Promotion of high-quality research projects

The funding of R&D projects grew considerably in all areas of science and technology, alongside the clarification of the processes of public tender and assessment, as well as the adoption of more appropriate rules on the availability of funding.

Apart from funding for projects in all the scientific areas there were tenders for areas that focused on areas of specific public interest, in partnership and co-funded by other bodies. The following programmes stand out: Applied Scientific Research on Forest Fires, Research on the Gypsy Community, Scientific Research on Gender Social Relations and Policies for Equality between Men and Women, Research on Social Security and Social Policies, Integrated Programme for Social and Human Sciences, Scientific Research and Technological Development in Nature Conservation, Scientific and Technological Research on Issues Related to the Promotion of Portuguese Language and Culture Abroad (*Programa Lusitânia*).

The annual open tenders for international cooperation projects are also specific, for example: Scientific and Technological Research within the Scope of the Cooperation Agreement with the European Laboratory for Particle Physics (CERN), Science and Technology Work in Astronomy within the Scope of the Cooperation Agreement with the European Southern Observatory (ESO).

There were also new programmes that focused on areas of major importance: Science and Technology of the

Sea, Computational Processing of the Portuguese Language, Aerospace Science and Technology. Specific tenders for research projects have already been invited in the first two programmes.

In addition to the research projects in partnership with business, supported via the Innovation Agency, in 2001 there were around 2,326 research projects in operation (the majority lasting for 2 or 3 years), making up a total funding of €200 million distributed in all areas of science based on an open competitive basis.

Integration of social and human science in science policy

Social and Human Sciences have long been systematically disregarded or marginalized in terms of the scientific development of the country. The definition of priorities in the Science Programme was particularly negative as it excluded the Social and Human Sciences from all funding programmes for creating infrastructure, for research project support and advanced training programmes.

In the period 1995-2002 various projects were launched, with a view to putting these knowledge areas on an equal footing, in terms of opportunities within science policy. In particular, measures were taken to consolidate research units, increase the number of PhDs and researchers in the field, support research projects and encourage internationalisation. It is worth highlighting the launch of the Integrated Programme for Social and Human Sciences in 1996 and the survey of national scientific production in national and foreign publications.

All the programmes for project support, advanced training and support for research units now covered all knowledge areas, this being considered essential for the balanced development of the scientific system.

Stimulating applied technological research and innovation

As we have seen, issues related to technological capacity and business innovation in our country are closely associated with the history of our industry, are integral part of the industrial structure itself and the traditional lack of personnel of varying qualification levels.

The modernisation and the opening up of Portuguese society in general and the structural changes that are happening slowly but surely allow a certain amount of optimism. These changes are visible in some general indicators. For example, between 1985-96 Portugal was the country in the EU with the highest annual growth in added value in knowledge-based industries: double that of the OECD and more than double that of the EU.

Democracy and the expansion of the higher education system were certainly decisive in this modernisation process, but the work of other players and sectors was also important.

A large number of projects were started by the Innovation Agency, with a view to consolidating technological capacity and business innovation. Support mechanisms for companies were developed to identify problems and needs via technology audits; identifying research results and technologies of interest to companies; supporting the circulation of this information and the meeting of the supply and demand of technologies, for example via the organisation of Contact Scholarships.

Scientific employment in companies was promoted via incentives for the mobility of personnel between university and business, support for companies hiring personnel with Master's or PhDs, advanced training (for Master's and specialisation courses in industry, in conjunction with universities in particular), and internships for engineers at foreign scientific institutes with cutting-edge technology, like in the case of CERN, ESO and NASA.

Applied technology research has been directly supported, especially for consortium projects, creating links and habits of cooperation between business and research and encouraging relationships and the transfer of knowledge, skills and technologies. These aspects are particularly important when one clearly recognises «innovation does not depend only on the independent performance of companies, universities and research institutes any more, but increasingly on how these institutions cooperate.» (OECD, 1999).

The Innovation Agency ensured the promotion of Portuguese industry at CERN with great success, promoting a sharp increase in the sale of Portuguese goods and services to that prestigious and demanding scientific organisation. After a long period of lowly numbers since Portugal joined CERN in 1985, the number of contract rose ten-fold between 1996 and 2001, when it reached €6.8 million (OCT, 2002).

In 1997 a system of tax breaks for company R&D activity was applied, which resulted in Portugal being the country of the OECD with the greatest growth of tax breaks of this type between 1990 and 1998 and placing it third in the league table of OECD countries in terms of R&D tax breaks, after Spain and Canada (OECD, 1999).

Promotion of a science and technology culture — the *Programa Ciência Viva* (Living Science Programme)

Throughout the 90's various surveys on the scientific culture of Europeans were carried out, asking about scientific knowledge but also about attitudes and opinions regarding science (OCT, 1998). The results from Portugal, when compared internationally, confirmed the need for a special programme to strengthen scientific and technological culture and the position of science in society in general. It is not risking too much to say that perhaps this is the area where objectives and policy have been the most innovative at an international level and demonstrative of a broad strategic vision in recent years.

In developmental terms, the situation of the Portuguese population had improved in relation to indicators of knowledge and understanding of scientific methods, as well as in relation to confidence in science, but had worsened with respect to cognitive uncertainty and a group of indicators of attitudes regarding interest and curiosity in scientific issues.

The state of the Portuguese population's scientific culture was mainly explained by how it was learned, as well as the lack of opportunities to have contact with the world of science and technology: the results of the survey demonstrated that education level was the variable that best explained the different levels of scientific knowledge, due to the learning and socialisation opportunities that school offers, as well as opinions and attitudes towards science and knowledge in particular was distinguished by an almost total lack of experimental teaching of science and little teaching of technology.

According to the results of the international survey on the performance levels of pupils (between 9 and 13 years old), the average performance of Portuguese children in both maths and science were particularly weak, although those pupils that had experience of or had seen experiments in the classroom had better results.

In relation to opportunities for contact with the world of science and technology, the lack of museums, specialist magazines, radio and television programmes, etc., for either adults or young people was cited as influential.

Water robotics — the catamaran **Delfim.**

The *Ciência Viva* (Living Science) Programme was launched in 1996 and chose the guiding principles that school and the experimental teaching of science were fundamental to the creation of a science and technology culture.

The policy for disseminating science and technology culture involved two factors in Portugal: targeting young people and involving scientific institutions as a strategy for promoting quality. This meant involving scientists and scientific institutions in the various projects and using things like mechanisms for inviting tender, independent assessment, monitoring and the publication of results, all things that scientific institutions had been using for a long time.

There were four fundamental instruments in the work of *Programa Ciência Viva*:

1) The *Ciência Viva na Escola* (Living Science at School) Programme, which supported and funded the development of experimental teaching in schools, with the involvement of the scientific and educational community. Between 1996 and 2001 five annual tenders were invited, which resulted in around 3,120 projects, involving more than 2,000 schools, 5,000 teachers and half a million young people (about 40 % of the corresponding school population), which represents an investment of 24 million euros (OCT, 2002).

2) The School-Scientific Institution Twinning Programme, which promotes joint activities and makes technical and scientific support available, instituting regular collaboration and a sharing of resources between schools and scientific institutions.

3) A national network of *Ciência Viva* Centres, created as interactive spaces for the dissemination of science to the population in general, but also platforms for regional scientific, cultural and economic development via the involvement of the

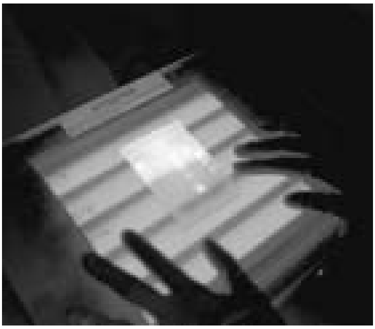
most active regional members in these areas. The objective of this instrument is to create a network of centres with branches in all districts. The first centre opened in the Algarve in 1997, followed by the Planetarium in Porto, the Exploratorium Infante D. Henrique in Coimbra, and the Science Centre at Europarque da Feira. The *Pavilhão do Conhecimento — Ciência Viva* (Knowledge Pavillion) was created in the *Parque das Nações* in Lisbon, as a national resources centre for the whole network of *Ciência Viva* Centres, presenting a number of exhibitions from the best science centres in the world at its inauguration. In 2002 the Ciência Viva Centre in Vila do Conde opened.

4) The organisation of national campaigns for the dissemination of science, encouraging scientific associativism and giving people the opportunity to observe and have direct and personal contact with scientists and scientific institutions in different knowledge areas. These national campaigns were open to all and free, and were experimental in nature, seen as the empirical verification of knowledge, the meeting of theory and practice, active observation interacting with specialists in their respective areas of expertise.

Making up ground in the launch of foundations for the information society

The emergence of the Information Society is the result of the growing importance, presence and core and wide-ranging nature of information in the various fields of social action, shaping the contour of contemporary modern societies.

Within this context, the capacity for the production, accumulation, processing and exchange of knowledge has gradually come to be a determining factor in the productivity and competitiveness of economies in an integrated, geometrically variable and global



Agar-agar jelly with DNA, digested with restricting enzymes.

network. Of course, the capacity for the production, management and dissemination of information largely depends on the technological capacity of the socio--economic units, which severely limits to degree of development and implementation of the Information Society.

Technological capacity is not limited to the degree to which the infrastructure of the Information Society is developed, to the investment in the creation and permanent expansion of communication and information networks. The maximising of these infrastructures by way of linking them to the R&D system is an essential condition for the permanent creation of knowledge, processes and products and for the training of personnel that are necessary for technological innovation and the consolidation of the productive process based on scientific knowledge. Also, technological capacity is still dependent on the degree of technology dissemination and the degree to which those technologies are used and socially appropriated, with the role of education system being decisive in the qualification and training of personnel and the general and simple access to information and communication systems by the general population.

Public and private decision-makers need to pay particular attention to the virtuous coordination between these technical and social systems. What are core to this coordination are the distribution and access to equipment, services and content, the development, interconnection and availability of network, the cost and other general conditions of use and access. Consequently, apart from the efforts in terms of investment in fixed capital and infrastructures, the investment in know-how and knowledge is crucial, especially in research, in the development of applications, in software and information content, alongside the training of personnel and the creation of competencies at all levels of education and qualification.

In Portugal, like in other countries, the challenges of a polcy programme for the Information Society are countless.

From 1995, the political recognition of the importance of information and knowledge in contemporary societies as a driving force for development led to the definition of the Information Society as a new interventionist public sector, wide-ranging and important and one that began to be part of the planning instruments of governmental action and social conciliation.

In the first phase policy measures focused on:

— The creation of the Mission for the Information Society and the drawing up of the Green Paper for the Information Society, approved by the government in 1997 and subsequently presented to Parliament, in which major strategic options and a coordinated set of concrete policy measures were combined;

— Improving the scientific computation network and extending it to state laboratories, polytechnics, science centres and museums, science, education and culture associations, schools from the 1st to the 12th grade and public libraries, becoming the communication infrastructure that will lead to a real national knowledge network;

— Activating projects for schools, the civil service, institutions that produce or use information and businesses.

Out of a vast array of projects the following were crucial for the development process.

Science, Technology and Society Network

The basis for the creation of the Science, Technology and Society Network was (RCTS) a major extension to bandwidth and accessibility to foreign countries and the decisive consolidation of the national scientific network that, apart from the universities and the R&D

Eco-car built in an experimental science-teaching/learning programme.

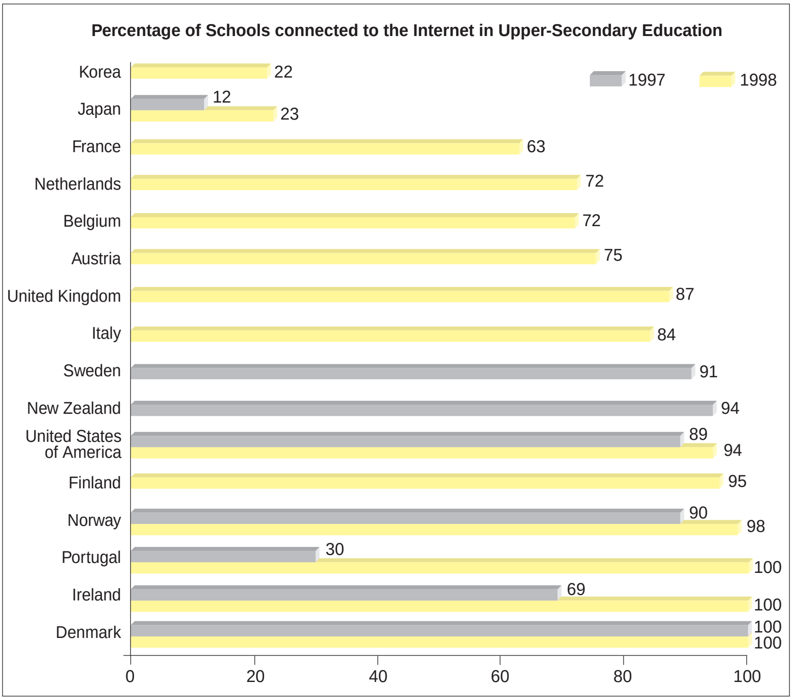
institutes and centres associated with it, began to include state laboratories, polytechnics, museums, science, education and culture associations, schools from the 1st to the 12th grade and public libraries, as they became connected to the Internet.

The network allows for the growing development of communication between the scientific, technological, school and socio-cultural communities: teachers and pupils of various schools, as well as members of municipal libraries have access to the Internet, thus reducing the inequalities that result from different degrees of information access.

Internet at School Programme

In 1997, the *Unidade de Apoio à Rede Telemática Educativa* (Telematic Education Network Support Unit) was created in the Ministry of Science and Technology with the objective of developing the Internet at School Programme in partnership with *Fundação para a Computação Científica Nacional* (National Scientific Computation Foundation), which is the body responsible for the running of the Science, Technology and Society Network and the registration of **.pt** Internet domains. This aim of this programme was to hook schools up to the Internet, via the installation of multimedia computers in school libraries/media archives and maintenance of the system. In this way, all young people at school not only have access to CD-Rom but also access to the Internet as an excellent resource for information and expression.

In September 1999, all of the 1,700 state and private schools from the 5th to the 12th grade, 220 1st cycle compulsory education schools, 80 associated cultural, scientific and education bodies, around 250 public libraries and 15 museums were hooked up to the Internet.



Source: OECD Secretariat, according to national data.

From 1998 onwards, the phased expansion to all primary schools was launched, which was to be done in conjunction with the local authorities and would include teacher training centres.

Thousands of students and teachers were made aware of the pedagogical potential of the Internet in a systematic and practical way: greater scope and speed of research and information gathering, greater independence and democracy in information access and the communication between schools and society, familiarisation of the student population with technologies and technological processes that they will encounter in their future professional life.

Thus, Portugal joined those countries at the forefront of school Internet connection, while simultaneously introducing new ways of appropriating ICT and making access more widespread, as well as introducing the innovative concept of a computer network that links higher education institutions, other scientific institutions, schools, public libraries, museums and scientific, educational and cultural associations — a true National Knowledge Network.

In 2001 the connection of all the 1st cycle schools in compulsory education was completed, also via the RCTS, making Portugal one of the first countries in the world where all 1st to 12th grade schools were connected to the Internet.

National Project for Citizens with Special Needs

The objective of the National Project for Citizens with Special Needs programme was to help those citizens to enjoy the benefits of new information and communications technologies in order to better integrate socially and to improve their quality of life. As well as other measures, it was decided that the general-directorates, similar services and the public institutes would make their information available on the Internet, so citizens with special needs could access it.

In this way, Portugal put a high priority on citizens with special needs having access to modern information and communication technologies while simultaneously becoming a leader in this field in Europe.

Digital Cities Programme

1998 saw the launch of the Digital Cities Programme. In the first pilot phase a group of coordinated projects centred on previously selected towns and cities, the programme then was open to all the towns and cities in the country. These projects focused on a number of issues, from improving urban life to combating social exclusion, from fighting inwardness and isolation to trying to improve competitiveness in those economic sectors integrated into the digital economy.

The following projects were approved for the first phase of the programme:

— Aveiro — integration of public service via telematic networks to improve various aspects of urban life, involving a large number of local players;

— Marinha Grande — applied to the moulding industry and in partnership with the representative associations of the sector, this project aimed to consolidate the economic competitiveness of the sector via advanced telecommunications processes and new digital and communications services that allow simultaneous creation and analysis between clients and suppliers located in a variety of places on the globe;

— Bragança — the collaboration between various local players, especially for the construction of a monitoring model and encouragement of the widespread use of telematic resources, especially the Internet, in all types of institutions, from teaching to companies with the objective of combating insularity;

— Guarda — again with the objective of combating insularity;

— Greater Lisbon and Setúbal — seeking to integrate ethnic minorities, in cooperation with the *Alto Comissariado para a Imigração e Minorias Étnicas* (High Comission for Immigration and Ethnic Minorities). The *«Com as Minorias»* (With Minorities) project was developed by seven immigrant associations in the Metropolitan Area of Lisbon, which functioned as centres of dissemination.

National Initiative for E-Commerce

This project was created within the context of Digital Economy.

The legal status of electronic documents and digital signatures was approved by the Decree-Law of August 2nd, 1999. This made Portugal one of the first three Eu*ropean countries to define explicit and innovative legislation on this issue, considerably earlier than the first European Commission initiatives.*

The equivalence of the electronically emitted and sent invoice to the paper invoice was also approved, regulating the way they are kept.

Alongside the widespread practice of e-commerce among Portuguese companies, the State was also involved in this modernisation, with the civil service being encouraged to use e-commerce.

Promoting the Growth of Portuguese Content on the Internet

To give Portugal maximum visibility and projection possible on the Internet, the objective of multiplying Portuguese content in cyberspace one thousand-fold in the short-term was defined.

To achieve this objective required the national mobilisation of efforts and resources. Considering the usefulness of the information held by public bodies, in 1999 the Government decreed that all publications, forms, information produced by directorate-generals and similar bodies, as well as public institutes, be made available in digital format on the Internet.

R&D on Computational Processing of Portuguese Programme

A research and development programme on the computational processing of the Portuguese language was started because the development and availability of these instruments for the treatment of written or spoken Portuguese on the world market is considered strategic to the very future of the Portuguese language and, at the same time, for the economic and social development of the country. The Programme, which is carried out in partnership with both national and foreign entities, is aimed at the creation of software, Portuguese word and voice recognition products and their dissemination and use worldwide. Tenders for R&D projects have already been invited.

The main objectives of the programme are the development of computer systems that use and recognise the Portuguese language, allowing a better understanding of the structure of Portuguese, how Portuguese has developed and its relationship with other languages, and the development instruments to improve man-machine communication and computer-assisted human communication and search engines and access in Portuguese to information in other languages in electronic format.

This also constitutes a resource centre for the computational processing of the Portuguese language that a catalogue of corpora, lexicons, dictionary and computer tools that are permanently accessible on the Internet; a catalogue of institutions, projects and researchers; a

Experimental statistics-teaching/learning programme.

list of publications; a remote access service to Portuguese corpora; a compilation of theses and other work; a search system; and a forum on matters related to computational processing of the language.

Despite being rather modest in relation to the availability of materials in the area and the size of the community in which it works, this is about a systematic and very complete mass of resources that puts Portugal among very few countries that has such exhaustive information about the computational processing of its language on the Internet. The current resources are clearly insufficient, but making an inventory of them, making them openly available and maintaining research and easy interconnection services with the various players involved, constitutes an indispensable starting point for future development.

Planning of scientific and technological development for 2000-2006

The preparation of the White Paper for the Scientific and Technological Development in Portugal (2000-2006), particularly the documents written and the analyses made as a result of the assessments of science and technology institutions, the discussions and debates in the various sessions organised throughout the country and the debate prompted at the Science and Technology Policy Permanent Forum since July 1998, meant that there was broad participation from the science and technology community and other social and economic stakeholders in identifying the needs and opportunities for scientific and technological development in the near future. The results of this planning and consultation process were part of the Regional Development Plan for 2000-2006 and proposals for the new Community Support Framework.

The Science, Technology and Innovation Programme and the Information Society Programme aimed to respond to the issues raised in the abovementioned process, defining the policy instruments that would create the conditions for the information and knowledge society to flourish. Between 2000 and 2006, from a financial point of view, this corresponded to double the amount of funding given between 1994 and1999.

The medium-term strategic objective of the Science, Technology and Innovation Operational Programme (called the Science and Innovation Operational Programme in 2004) in Portugal was to make up lost ground in the field of science and bring it more in line with EU averages. Apart from consolidation along the lines of the work done between 1995 and 1999, described in the previous section, new areas were focussed upon.

Train, Qualify and Create Employment in Science — Promoting a solid base of qualification, the creation of employment in science, placing PhD-qualified staff in businesses and science and technology institutions and consolidating leadership in science, the aim being to reach average European levels for scientific qualifications by extending and consolidating the growth of recent years.

Experimental e-learning programme.

Create a Modern and Coherent Network of Scientific Institutions — Via the development of a coherent network of Science and Technology institutions that are duly coordinated among themselves and with the social and economic fabric of the country, as well as an integral part of the European S&T networks. Within this context it is worth highlighting the network of Associated Laboratories, the launch of the National S&T Library Network (in 2003 under the name of the Knowledge Library Online (*b-on*) and the future Observation and Monitoring Networks, supported by regulating laboratories, especially in the areas of environmental control and public health.

Encouraging the Cooperation between R&D Institutions and Companies and the Creation of a Network of Scientific Research Results Recognition Centres — Consolidating the impact of joint research between business and scientific institutions with the launch of monitored project tenders, for example, the launch of structural and strategic cross-sector programmes. Create a network of Scientific Research Results Recognition Centres, within the scientific institutions associated with higher education, with a light organisational structure that gives better national coverage. Support the integration of R&D opportunities in major public investment programmes.

Put Technology on the Cultural Map: How are things done? Promoting Science for All — Within the context of the Living Science Programme and organised on a national scale, the «How are things done?» project, encouraging guided tours of companies and other institutions of technology, production of support materials and the dissemination of educational material related to technologies and production processes and making it available in a telematic format. Importance is placed on encouraging the development of content of a scientific and tecnological nature for telematic networks and the media, with the objective of promoting access to scientific information for all citizens.

The Information Society Programe (called the Knowledge Society Operational Programme in 2004) was set up to encourage accessiblilty and participation, development and experimentation, strategic coordination of regional and sector policy for the promotion of information technology for social purposes. This foundation programme presupposed the complementary nature of other instruments and programmes in the different sectors (in the economy, education and training, health, culture, transport, the civil service, justice, environment, etc.). The main policy aims were the following:

To Develop Competencies — Via the launch of a national process of training and certification of basic competencies in information technologies and associating a diploma for these basic competencies with the conclusion of compulsory education, thus ensuring that all students leave school with certified skills in this area.

To Increase the Volume of and Accessibility to Content in Digital Form — Creating the conditions for widespread computer and Internet use, increasing Portuguese content on the Internet and the supply of mass-products for the family market, setting up public Internet access points in all areas of the country, making public information freely available in digital format for civil use and producing content with added value.

To Promote the Use and Interconnection of High Debit Networks — Via the launch and implementation of the first National Information Highway Plan and encouraging greater supply, interconnection, use and regulation of broadband networks. It is also worth mentioning the importance of the programme to increase the availability of the high debit network for scientific and educational purposes as well as for the demonstration of new services of major social worth (RCTS-2) and their coordination with international programmes (Internet Programme 2, etc.).

Extending the Digital Cities Programme to the Whole Country — Giving greater emphasis to the National Project for the Information Society.

The Information Society and Science and Technology in the period 2002-2005

In 2001, a public tender was invited to extend the Digital Cities Programme in the context of the *Programa Operacional Sociedade da Informação — POSI* (Information Society Operational Programme), and the first public Internet Spaces were created, which even to this day are one of the most important means of access to the Internet in Portugal. Also in 2001, the Decree-Law that created the Basic Competencies in Information Technologies Diploma was approved and the Interministerial Commission for the Information Society invited tender to assess the Internet sites of bodies integrated within direct or indirect State administration. Very importantly, all the schools in the country were hooked up to the Internet by the end of 2001.

In November 2002, the *Unidade de Missão Inovação Conhecimento — UMIC* (Knowledge Innovation Mission Unit) was set up to define and guide the policies of the Information Society and Electronic Government in Portugal. Its action plan, which was approved in June 2003, was based on seven main points: (i) an information society for all; (ii) new capacities; (iii) quality and efficiency in public services; (iv) better citizenship; (v) health for all; (vi) new ways of creating economic value; and (vii) attractive content.

The *UMIC* presented the National Broadband Project in August 2003. This was approved by government with the aim of giving widespread broadband access and use in Portugal, contributing to «increasing levels of productivity and competitiveness in the national economy» on the one hand and, on the other, creating «greater social cohesion».

The abovementioned guidelines were adopted for the re-programming of *POSI*, which had received considerable financial support in 2004, based on the programming reserve approved in the negotiations with the European Commission in 2000, and became known as the *Programa Operacional Sociedade do Conhecimento — POSC* (Knowledge Society Operational Programme).

The UMIC's activities were organised around legislative projects and specific projects that were meant to achieve the objectives laid out in the National Broadband Project. The legislative measures covered areas like electronic government, citizens with special needs, electronic signatures and invoices, copyright, personal data and privacy, e-commerce, public electronic purchase, access to *Diário da República*, re-utilistion of public information and rights to move to broadband infrastructure. Other measures within programmes included the re-definition of the focus of the Digital Cities project that became known as the Digital Regions project, the launch of the *e-U: Campus Virtual do Ensino Superior* (Virtual Higher Education Campus) and the b-on: Biblioteca do Conhecimento *Online* (Knowledge Library Online), implementing the S&T National Library Network foreseen for 1999 in the operational programmes prepared for the 3rd Community Support Framework and prepared from 2000 to 2003 by the *Observatório das Ciências e Tecnologias/da Ciência e do Ensino Superior* (Science and Technology/ Science and Higher Education Observatory), and various programmes within the scope of the civil service (e.g. via the citizen's gateway and the boosting of the system of electronic public purchases).

In the field of Science, the 2002-2005 period corresponded to the slowdown in development that had been felt since 1995. R&D expenditure, which had reached 0.85 % of GNP in 2001, fell to 0.78 % of GNP in 2003. The FCT budget, at constant 2003 prices, dropped from 2002 until 2004, falling to €200 million, which was the same level as four years previous in 2000. More seriously, the effective financial support given by FCT, at constant prices, fell in 2002 and 2003 to the point where the level of this last year was lower than 5 years previously in 1998. Public money for R&D activities in relation to GNP indicate that in 2005 Portugal (0.73 %) was a little below the EU25 average of (0.74 %) and the EU15 (0.76 %), but well below countries like France (0.94 %) and Finland (1.04 %) (Eurostat, 2006).

R&D expenditure in businesses fell from 0.27 % of GNP in 2001 to 0.26 % of GNP in 2003. The system of tax benefits for company R&D was halted in 2003.

The number of scholarships for PhDs and post-PhD study fell significantly, as did those reseach grants awarded for R&D projects and units. The efforts to place PhD-qualified people in R&D institutions were stopped and the placement of people with this profile in companies was also slowed down. Hiring researchers within the scope of support programmes for R&D institutions (R&D Units, State Laboratories and Associate Laboratories) was undermined by delays and reductions in funding.

The Support Projects for State Laboratory Reform foreseen in the CSF III were interrupted, the International Advisory and Evaluation Commission was closed down and the implementation of its recommendations suspended and the financial autonomy of State Laboratories withdrawn when the International Commission recommended greater autonomy.

The Annual Tender for *Ciência Viva na Escola* (Living Science at School) projects continued beyond 2002. The State Budget for the Living Science was cut by 60 % defrom 2002 to 2003. The future of the main *Ciência Viva* centre — the Knowledge Pavillion in *Parque das Nações* in Lisbon — was in serious doubt.

Science, Technology, Information Society and the training of Personnel at the core of the Political Strategy

Within the context of the 2005 general election an ambitious **Plano Tecnológico** (Technological Plan) was launched with the following aims: Make Portugal part of the Information Society, give new impetus to business innovation, make up ground in science and technology, train personnel.

At the end of July 2005 the **Ligar Portugal** (Connecting Portugal) project was launched, which established the general policy aims for the Information Society in Portugal up to 2010, and responded to the challenges set by the European Commission project «2010 — A European Information Society for growth and employment«. Its general aims included: promote modern citizenship, ensure the competitiveness of the national telecommunications market, guarantee transparency in the civil service, promote the growing use of ICT by business, ensure the development of new technology-based companies, encourage scientific and technological development.

Among those areas that would particularly benefit from greater use of ICT the following are the most obvious: the modernisation and opening up of schools; the modernisation of the civil service; the distribution of information that is of particular public interest, in areas that involve risk to the public, environment, food safety, health, or national security; routine systems for monitoring and correcting policy and updating implemented measures.

The Connecting Portugal programme makes it very clear that the opportunites that ICT offers should lead to concrete improvements in Portuguese organisations, improvements that should make them more demanding and raise levels of efficiency, competency and productivity to those of the most advanced countries, positioning us collectively as a society where:

— Knowledge and Information are fundamental cultural, social and economic values;

— There is a socially inclusive society for all citizens, where the cooperation between people and institutions is encouraged and there is a network of cooperation at work;

— Technological development becomes a powerful instrument for the creation of wealth, economic growth and employment and is a crucial factor in the competitiveness of national business;

— The social appropriation of ICTs is associated with a culture of truth and transparency, of clear and objective evaluation, of freedom of expression and access to information, of organisational efficiency and openness towards other countries.

The following are some of the achievements of the Connecting Portugal project (UMIC, 2006):

— In January 2006, all state schools from the 1st to the 12th grade were hooked up to broadband Internet, with the exception of a small number of schools that were going to close in the summer of the same year.

— In November 2005, a system of tax incentives was approved to facilitate the purchase of computers on the part of families with students, with a tax break of up to €250 and half the cost of the computer and Internet connection when the items are bought within a three-year period from December 1st 2005 onwards.

— In 2005/06, within the scope of the *CRIE — Equipa de Missão Computadores, Redes e Internet na Escola* (Computers, Network and Internet at School Mission Group), there were more than 11,000 activities for the building of electronic portfolios, 11,600 for the construction of school Internet pages, 5,400 joint projects, involving 18 higher education institutions, 18 virtual resource centres, 6,583 schools (89 % of all 1st cycle schools in compulsory education), 17,417 teachers, 967 assistants, 175,111 pupils, 27,517 school visits with a total time of 137,000 hours, with 71,274 diplomas being awarded for basic ITC skills, 3/4 of those receiving the diplomas being 4th grade pupils and 2,207 being teachers.

— Also in 2005/06, *CRIE* was involved in the training of ICT teacher trainers, with 573 participants, 228 training bodies, 34 training courses, 18 ICT Competencies Centres with a Moodle system, as well as the training of 15,109 teachers in 175 projects and the dissemination of the Moodle system and its use to 2,940 teachers. 19,635 computers were installed in 1,309 ICT rooms in 1,159 schools.

— In 2006, the *Escolas, Professores e Computadores Portáteis do Ministério da Educação* (Ministry of Education's School, Teachers and Laptop Computers) project supplied 1,100 schools with 26,000 laptop computers for around 11,600 teachers for practical activities with about 200,000 students.

— In 2005/06 32 Technology Specialisation Courses in ICT were created, involving 16 higher education colleges in 11 places.

— In 2005, the number of higher education institutions with wireless networks increased from 8 to 57 under the Virtual Campus (e-U) project, covering 85 % of all higher education, a group of schools with more than 300,000 students including all public higher education institutions. Given the roaming, intermural nature of this network, the integration of all universities and polytechnics on a single Virtual Campus is assured.

— The Internet Spaces Network was organised to integrate the current group of 840 Internet Spaces into an organised community from various parts of the country and a wide range of locations, which make up the biggest network of free public Internet access points in the whole of Europe, where the regular use of computers and Internet is supported by staff (monitors).

— In 2005 the band width of international connections with RCTS was more than doubled, reaching 2,5 Gbps, and the band width between Lisbon and Braga increased from 1 Gbps to 10 Gbps, as a result of the FCCN's acquisition and installation of a fibre-optic link between the two cities. This meant guaranteeing 10 Gbps connections for the 7 biggest universities — Lisbon, the Lisbon *Técnica*, Lisbon's *Nova*, Coimbra, Aveiro, Porto and Minho — and therefore 60 % of the higher education system and 78 % of those universities with FCT approved research units as well as increasing band width for Porto and Coimbra polytechnics.

— At the Portugal-Spain Summit in November 2005 it was agreed that the two countries would complete their education and research fibre optic networks up to the respective frontiers of Alentejo--Extremadura and Minho-Galicia, ensuring a redundant ring connection in fibre, with mutual advantages in terms of increasing international broadband and security of persistence connections if the line is cut. The public tenders for the acquisition of these installations have already started. These connections will finally allow the RCTS to be connected to the GÉANT2 European Union network at 10 Gbps, resolving the long standing problem of Portugal being the only EU15 country, with the exceptioin of Greece, that did not have access to this band width to link up with the research and education networks of the other countries. Also, the extension of the RCTS fibre optic to all the district capitals is being prepared, guaranteeing this type of connection to all public higher education institutions.

— The number of **.pt**-registered domains on the Internet grew by 36 % over 2005, reaching around 80,000. In March 2006 new rules came into force that were established to facilitate the registering of domains and reduce the cost of doing so by around 40 % by using an exclusively online registration system. These alterations resulted in more than 100,000 domains by August 2006, the objective for the end of 2006. Also, the automatic registration of **.pt** domains was guaranteed for companies set up via the *Empresa na Hora* and *Empresa Online* systems.

— The (b-on) *Biblioteca Científica Online* (Scientific Library Online) gives unlimited and permanent access in research and higher education institutions to the complete texts of over 16,750 international scientific publications from 16 publishers, via the negotiated subscriptions with these publishers on a national level. In 2005, the number of articles downloaded by the members of this library numbered 3.4 million, when it was 2.1 million in 2004, figures that demonstrate a very high level of use.

— In April 2006, the National GRID project was launched. Currently, more than 2,000 computers are connected in GRID, with an extension to 5,000 in the near future. The FCT invited public tender for projects in this area.

— The Creative Commons Licenses were adapted for Portugal, which permit the open sharing of knowledge and works by their authors in a simple, effective and very flexible way, making a number of standard licenses available that guarantee protection and freedom — with some rights reserved. The Portuguese version of these licenses was launched on November 13th 2006.

— The project to develop the Citizens Card was started mid-2005 with the aim of making it available in 2007, making Portugal part of the first group of countries in the EU to make an electronic ID card available and be one of the countries with more dematerialised services that use this type of card.

— The Portuguese Electronic Passport became available on August 28th 2006, after the respective project only having been started in the second quarter of 2005, allowing Portugal to make up sufficient ground to be the 11th country of the EU to issue electronic passports;

— The State Electronic Certification System was created in June 2006, after a process that started in November 2005, the aim of which was to ensure the issue and management of electronic signatures in the civil service, guaranteeing the workings of a specific Public Key Infrastructure, which will allow for the complete dematerialisation of the legislative process, among other applications.

— In June 2006 the *Diário da República* (Diary of the Republic) began to be published in electronic format, permitting free and unlimited access on the Internet and saving 27 tonnes of paper a day.

— In 2006, apart from a re-organisation to make it more user-friendly, the *Portal do Cidadão* (Citizen's Gateway) included an Electronic Payments Platform that issued references for payments via ATMs and from home or work via homebanking, amongst other services. Use of the

Citizen's Gateway increased significantly from the beginning to the end of 2005, for example 46 % in traffic, 32 % in sessions and 29 % in one-off visitors.

— The Company Gateway was made available to the public at the end of June 2006. One of the services available was the possibility to set up a company entirely via the Internet — *Empresa Online* (Online Company) —, an electronic consultancy for issues related to business where questions and issues are dealt with by the *IAPMEI — Instituto de Apoio às Pequenas e Médias Empresas e ao Investimento* (Institute for the Support of Small and Medium-Sized Companies and Investment), and the *Dossier Electrónico da Empresa* (Electronic Company File) where the various files of the different companies with AP are kept together and made available to the partners of the company in a user-friendly and secure manner.

— Throughout 2005, the *Programa Nacional de Compras Electrónicas — PNCE* (National Electronic Purchasing Programme) expanded significantly: the number of aggregation and negotiation process increased from 27 to 52, the number of bodies involved went from 19 to 370 and the number of product categories considered increased from 4 to 12. In 2006, the PNCE was extended to all ministries and to become general practice within each ministry, now involving around 800 bodies and more than 94 processes of aggregation and negotiation. Ministerial Purchase Units have been set up, which centralise purchasing at ministerial level and the National Public Purchasing Agency was established to begin its work in 2007.

— The total value of the business negotiated by the PNCE since the beginning of the programme has reached €40 million, with a saving of around 20 %. Over 2005, there was a 33 % increase in the total amount negotiated within the programme when compared with the total amount of the previous two years, and just in the first half of 2006 the value of public electronic purchases was about double that of the total of the previous three years, which illustrates just how fast the programme is developing in recent times.

— In August 2005 the Government decided that the civil service should adopt and give preference to electronic invoices from the beginning of 2007 onwards. A working group, made up of civil service bodies and other persons, was set up to review legislative projects related to electronic invoices and the drawing up of a Electronic Invoice Guide. Between July and November, various pilot schemes ran that involved dozens of public bodies from almost all of the ministries, various bodies that supply electronic invoice services and a number of suppliers. These pilot schemes demonstrated how the various electronic invoice reception and issuing systems work in the civil service and a philosophy of service sharing based in the General-Secretariats of the various ministries that permits the practical general use of electronic invoices in the whole civil service, with those bodies involved in the pilot schemes allowing the adoption of electronic invoices for the organisms of all of the ministries involved.

In relation to the observation and benchmarking of the information society, we highlight the following:

— Computer use among those who have frequented upper-secondary and higher education is one of the highest in the EU25, 87 % and 91 % respectively.

— Internet use among those who have frequented upper-secondary and higher education is one of the highest in the EU25, 80 % and 87 % respectively.

— An increase of 32 % in the number of central civil service bodies with broadband connections above 2 Mbps between 2005 and 2006.

— An increase of 68 % in the number of municipal councils with broadband connections above 2 Mbps between 2005 and 2006.

— An increase of 40 % in municipal council discussion forums between the executive and citizens on the Internet.

— Between 2004 and 2006 an average annual growth of 118 % in the number of hospitals with broadband connections above 2 Mbps.

— Between 2004 and 2006 the doubling of the number of hospital Internet sites with information on prevention and health care (now 50 % of sites).

— Hospital Internet sites with information on how to proceed in the event of a medical emergency grew four-fold between 2004 and 2006 (now 30 % of sites).

— A third of hospitals made purchases online in 2005, of those hospitals another third paid online.

— 96 % of large companies, 83 % of medium-sized companies and 59 % of small companies have a broadband connection; in the EU25 ranking for large companies Portugal is in second place (with two other countries).

— 48 % of large companies, 31 % of medium-sized companies and 25 % of small companies use the Internet or other electronic networks to purchase and/or receive purchase orders of goods and/or services.

— Portugal has risen sharply in the rankings for Complete Online Availability of Basic public Services, from October 2004 to April 2006: (i) from 15th to 11th among the 28 countries of EU25 + Norway, Iceland and Switzerland, (ii) from 13th to 10th in the EU25, (iii) from 11th to 7th in the EU15. These figures, which come from the latest assessment of the online availability of basic public services in April 2006, were made available by the European Commission on June 29th 2006. From October 2004 to April 2005, Portugal's complete availability indicator figure beat Germany, Spain, Ireland, Iceland and Italy and in the sophistication indicator it beat Spain, Holland, Iceland and Italy. In these two indicators Portugal is above average when compared to the group of countries in question. The increase of these two indicators in Portugal was the 5th biggest of the 28 countries involved.

— According to EUROSTAT, Portugal is in the top 5 countries for individuals and top 3 for companies for the number of electronic forms sent to public bodies in the EU15.

— Internet income tax declarations exceeded 2.2 million in 2006, which is extremely high within an international context and corresponds to more than 40 % of the working population; everything related to VAT is dealt with exclusively via the Internet.

In March 2006 the Compromisso com a Ciência para o Futuro de Portugal (Commitment to Science for Portugal's Future) project was launched. With ambitious goals for 2009, this project adopts the following five major aims:

— Focus on scientific knowledge and scientific and technical competencies, measured at the highest international level.

— Invest in Personnel and Science and Technology culture.

— Invest in R&D institutions, public and private, in terms of the consolidation, responsibility, organisation and infrastructure of the network.

— Focus on internationalisation, high standards and assessment.

— Invest in the economic aspects of research.

The implementation of this project means increasing the 2007 S&T state budget by €250 million more than in 2006 (this means a 77 % increase in competitive financing if the S&T system by the FCT).

Among the measures imbedded in the Commitment to Science for Portugal's Future project, some of the first to be implemented are:

— In April 2006, the launch of the first tenders for programme-contracts with public or private scientific institutions for the funding of individual research work contracts for PhDs via open competition and international assessment of merit. The programme-contracts will allow the hiring of at least 1,000 new PhD-qualified personnel until 2009 and will be focused on consolidating the critical masses or the creation of new teams, as well as the mobility of researchers.

— 60 % increase in the number of new PhD and post-PhD grants and the granting of scholarships for 2006 five months earlier than predicted.

— Creation of a PhD in clinical research programme associated with medical internships, with the aim of involving 300 PhD-qualified personnel until 2009 and creating integration scholarships for research of first-degree and Master's degree students (in recognised R&D centres).

— Creation of the International Iberian Nanotechnology Laboratory based in Braga, an international organisation *par excellence* promoted by Spain and Portugal but open to the later membership by other countries and the international recruitment of 200 researchers.

— Creation of 4 new Associated Laboratories in the fields of nanotechnologies, energy and transport.

— Creation of a major network of S&T international partnerships, including Higher Education and research institutions, as well as companies in association with international scientific organisations, foreign universities and other world renowned science and technology bodies. The first of these partnerships was the MIT — Portugal Programme, followed by partnerships with Carnegie Mellon University and Texas University in Austin.

— Reform of State Laboratories based on the recommendations of an International Working Group: 5 State Laboratories were closed down or integrated into other institutions; 2 were created, *Laboratório Nacional de Energia e Geologia* (National Energy and Geology Laboratory) and the *Laboratório de Recursos Biológicos Nacionais* (National Biological Resources Laboratory); the Forensic Medicine Institute was made a State Laboratory; the innovative private, not-for-profit R&D Consortium model was set up, coordinating State Laboratories, Associate Laboratories, companies and other national and international bodies, starting with the creation of 4 consortiums (*BIOPLIS* for biology and biotechnology, *Física-N* for nuclear physics and high energy and distributed computation, *RISCOS* for the prevention and mitigation of natural and environmental risks, *OCEANO* for oceanography); the *Centro Internacional de Vulcanologia* (International Vulcanology Centre) was created in the Azores; a State Laboratory Mobilising Programme was created in the FCT, focusing on supporting the development of R&D centres and networks in their involvement in national and international partnerships and the competitive mobilisation of the most relevant R&D capacities of each institution; it was decided that an international *Comité Científico e Técnico* (Scientific and Technical Committee) would be created to monitor such reform.

— Support for the creation of 75 technology-based companies, university spin-offs since mid-2005.

— Creation of 22 scientific research results recognition centres and the transfer of innovative ideas and concepts to business that make up a network that operates within higher education institutions, including all 14 public universities.

— Creation of 9 collaboration networks, whose aims are excellence and the development of innovation and knowledge clusters that are made up of companies, research centres and institutions, universities, polytechnics, technology centres, public bodies and business associations, involving 158 entities and 87 companies.

— Tenders for projects for *Ciência Viva nas Escolas* (Living Science in Schools) re-started, with 900 of them being approved in 2006. Around 700 student internships took place in research laboratories during the summer months of 2006. In August and September *Ciência Viva* got thousand of Portuguese people involved in a whole host of activities about Astronomy, Biology, Geology, Engineering and a number of lighthouse visits. The *Ciência Viva* network of centres was updated and extended to 13 all over the country, with a predicted 5 new ones to be opened by the end of 2008.

The system of tax relief for company R&D that was discontinued in 2003 was restarted and consolidated in 2005, putting Portugal back on the map as one of the countries in the OECD with some of the most generous tax breaks for company R&D.

It is well known that the significant increase of the S&T budget between 2005 and 2006 (11 %) and the even more generous increase between 2006 and 2007 (22 %) have meant new growth in funding for R&D activities.

After the decrease between 2002 and 2003, public funding for S&T increased again but we would have to wait until 2005 to reach the same level of three years previously, at constant prices, with a sharp increase for 2006 and 2007. From 2004 onwards, the FCT budget increased considerably, although only in 2006 did it surpass the level of 2002. Within the scope of the *Compromisso com a Ciência para o Futuro de Portugal* project, the FCT had a major budget increase for 2007, reaching €543 at current prices.

Overcoming the obstacles on the path to the knowledge society

In 2010 Portugal will have capacity to have a scientific system that is equal to the EU average, in terms of personnel and public investment in S&T. It is still necessary to adjust the R&D expenditure per researcher and ensure that the growth in company R&D expenditure continues, but in terms of the most important aspects of the scientific system the dynamism and growth rate of the 1995-2001 period and the continuation of these factors after 2005 constituted a driving force that can put Portugal virtually on an equal footing with most other European countries.

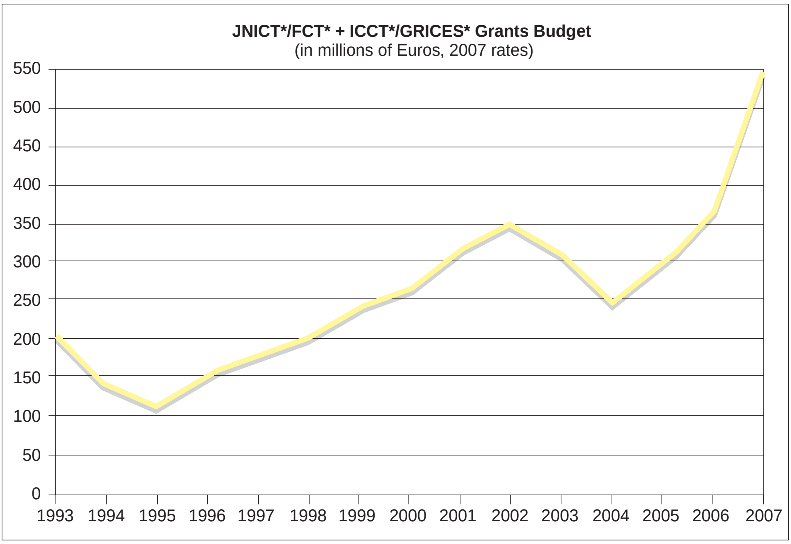
The chronic fragility of scientific institutions, the frugality and instability of the state budget for S&T, geographic concentration and the minimal role of business in research activities are issues that are starting to be resolved.

But sustained growth is not achieved automatically. On top of the progress already made there has to be continuous efforts. A lack of persistence could have grave consequences, as was seen in the period 1992-1995 and later in 2002-2005, when there was an interruption in the growth of investment in S&T.

In truth, there are a number of serious obstacles that have to be overcome in the immediate future if Portugal is to reach the necessary levels of advanced scientific and technological development to obtain the major benefits of the information and knowledge society.

Appropriate Availability of University Professors for Research — Some of the main obstacles in research institutes and centres that are associated with universities and have been highlighted by international evaluation are on a university level. Contrary to the current position, it is particularly necessary that scientific excellence within the universities be represented and that it plays a part in determining university management. A modern and efficient management of the teaching and student body is essential in terms of the final impact of university activity on teaching/learning, research and serving society. Heavy teaching loads and long teaching and exam periods impose serious limitations on the appropriate amount of time needed for research, within the context of global competitiveness, and add little in the way of extra learning opportunites. This point is more pressing when one takes into account the fact that the number of PhD-qualified personnel that work in universities or in associated private not-for-profit institutions and it becomes clear that the effectiveness of the national science and technology system critically depends on the availability of university teaching staff for science and technology activities and the effectiveness of university research.

Flexible Ways of Hiring and Placing Reseachers and Support Staff for Research — It is necessary to surpass the problems encountered when hiring researchers and give opportunities to young scientists and the possibility of rejuvenating research teams with contractual stability. The low levels of technical support staff for research



Source: OCT/OCES. Grants awarded by the JNICT up to 1997, and by the FCT from 1998 to 2007, together with grants awarded by the ICCTI from 1998 to 2002 and by the GRICES from 2003 to 2006 (international cooperation activity in science and technology (S&T) transferred from the JNICT to the ICCTI in 1997, the latter then being transferred to the GRICES in 2003 and subsequently to the FCT in 2007).

*GRICES: Gabinete de Relações Internacionais da Ciência e do Ensino Superior (MCTES) – Office for International Relations in Science and Technology
* FCT - Fundação para a Ciência e a Tecnologia – Science and Technology Foundation
*ICCTI: Instituto de Cooperação Científica e Tecnológica Internacional – Institute for International Scientific and Tecnological Cooperation
* JNICT – Junta Nacional Investigação Científica e Tecnologia – National Board for Scientific and technological Research

activities in Portugal is another problem that needs to be resolved, not only on the level of financial resources and training opportunities but also in terms of more flexible forms of placement and hiring.

Quick and Flexible Placement of Young PhDs — The quick and flexible placement of young PhD-qualified personnel in the various public and private bodies involved in R&D is crucial for the development of the science and technology system. There is a serious lack of this type of personnel in some institutions in the university system in comparison with many other countries in the OECD, however the situation is worse in polytechnics, companies and State Laboratories and there are institutional and structural obstacles that need to be removed. This is not just about the opportunity to hire but also having the opportunity to do highly productive research with the right amount of time, to assert individual scientific and technological career paths and promote access for young PhDs to lead R&D projects. One cannot underestimate the problems of institutional balance associated with the major influx of new researchers and the substitution of the top echelons. These issues will have to be resolved in the next few years so that opportunities resulting from the young and dynamic scientific workforce that has been created are not wasted.

Institutional Mobility of Researchers — Another major obstacle is the mobility of researchers between different institutions and sectors. This issue is crucial when one considers the importance of diversity of experiences and the expansion of networking in a knowledge and information society but mobility is very limited in Portugal. Therefore, it is essential to remove impediments to the mobility of teaching and research staff between universities, throughout the country and between universities, business, state laboratories and polytechnics.

Consolidation of Private Investment in Science and Technology — When it comes to private investment in science and technology, one must take into account that Portugal has no industry that depends on scientific research, nor is it likely to in the near future, be it via the relocation of industries or a major change in the industrial profile of the country. Despite the positive nature of recent changes in the business sector related to high technology and the creation of innovative new companies, the relatively low levels of private expenditure on R&D represents a problem that has to be increasingly dealt with. Given that R&D investment essentially depends on R&D personnel, a major increase in private investment in science and technology is linked to the capacity and interest in increasing the numbers of R&D personnel in companies.

Top Quality Higher Education for a Greater Proportion of the Population — On a more general level, there is the problem of the Portuguese population's generally low level of qualifications, where figures for higher education are poor compared with most EU or OECD countries. This type of problem cannot be solved in the short term and is something that is the basis of the low average qualification level of personnel in all sectors of the economy, particularly in business. Innovation and the incorporation of knowledge in the various economic and social activities are clearly limited by this situation. Overcoming this obstacle with top quality higher education presents a major challenge.

Social Establishment and Robustness of Scientific and Technological Development — It is worth mentioning another factor that has contributed to the fragility of scientific and technological development. As recently demonstrated and illustrated in this text, the vulnerability of this development to political changes shows how dependent it is on political orientation, the miltancy of those involved and a general atmosphere of the recognition of the importance of investment in scientific development that was constructed and all together form favourable conditions.

In a phase where the stability and the deep social roots of the science and technology system are not guaranteed, if the system is left to its own devices under normal conditions, we cannot be sure that it doesn't regress. This regression even applies in relation to its current fundamental areas of support: independent peer-assessment, procedural rigour and stability, transparency in the decision-making process, extensive and open public information, consolidation of internationalisation, achieving levels of funding similar to those of the most developed countries, linking the scientific system to business innovation, to the development of the information society, to scientific education and the dissemination of a science and technology culture, strengthening partnerships with other stakeholders (schools, companies, local authorities, other civil service bodies, etc.). This reference, quoted verbatim from the 2000 edition of this text, not only proved to be a premonition but also, unfortunately, describes the current situation.

To sum up, and as was mentioned at the beginning of this text, we find ourselves before a narrow window that looks out onto the opportunities of the knowledge society and economy. To take full advantage of them the commitment of all of the professionals and institutions of the science and technology system is needed, as well as significant and rapid institutional change.

The problems we face are considerable, and not easily resolved, but what is new is that only a few years ago Portugal was so far behind that nobody could have guessed that science, technology, the information society and the qualification of personnel would take on such a central role in national strategic policy and that it would be possible to aspire to the scientific and technological development now within our reach in such a short space of time. We can do it, if we are able to overcome the obstacles on our way to the knowledge-based society and economy.