The Higher Education Authority
An tÚdarás um Ard-Oideachas
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Creating and Sustaining the Innovation Society

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HEA

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An tÚdarás um Ard-Oideachas

Creating and Sustaining the Innovation Society

Foreword

The Authority is engaged in developing a vision and strategy for higher education in Ireland based on a process of consultation with key stakeholders.

The place and development of research in the higher education system is an essential part of the vision and the strategy.

This discussion document has been prepared by the HEA as part of its strategic development process. It has also been prepared as the Authority's initial contribution to the work of the Commission established by the Government under the aegis of the Irish Council for Science, Technology and Innovation (ICSTI) to develop a framework for national policy for research and technological development.

The Authority is also about to embark on a process of consultation with key stakeholders as part of its strategic planning exercise.

Higher Education Authority

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Acronyms

BERD:	Business Expenditure on R&D
CNRS:	Centre National de la Recherche Scientifique (France)
COFORD:	National Council for Forest Research and Development
DETE:	Department of Enterprise, Trade and Employment
DES:	Department of Education and Science
DMMC:	Dublin Molecular Medicine Centre
EI:	Enterprise Ireland
EPA:	Environmental Protection Agency
ESRI:	Economic and Social Research Institute
EU:	European Union
FTE:	Full Time Equivalent
GDP:	Gross Domestic Product
GERD:	Gross Domestic Expenditure on R&D
GOVERD:	Expenditure on R&D in the Government Sector
HE:	Higher Education
HEA:	Higher Education Authority
HEI:	Higher Education Institutions
HERD:	Expenditure on R&D in the Higher Education Sector
HRB:	Health Research Board
ICSTI:	Irish Council for Science, Technology and Innovation
ICT:	Information and Communication Technologies
IDA:	Industrial Development Agency
IOT:	Institute of Technology
IRCHSS:	Irish Research Council for the Humanities and Social Sciences
IRCSET:	Irish Research Council for Science, Engineering and Technology
NDP:	National Development Plan
NESC:	National Economic and Social Council
NIH:	National Institute of Health (US)
NQAI:	National Qualifications Authority of Ireland
NSF:	National Science Foundation
OECD:	Organisation for Economic Cooperation and Development
OPR:	Public Research Institute (France)
OST:	Office of Science and Technology
PHG:	Programme for Human Genomics
PRTLI:	Programme for Research in Third-Level Institutions
PSR:	Public Sector Research (US)
R&D:	Research and Development
RCSI:	Royal College of Surgeons in Ireland
RTD:	Research and Technology Development
RTDI:	Research and Technical Development Infrastructure
SFI:	Science Foundation Ireland
STI	Science Technology and Innovation
ST:	Science and Technology
WWW:	World Wide Web

executive summary

Innovation is a National Imperative

1. Ireland needs to become an 'Innovation Society'. Innovation, which goes beyond and subsumes industrial policy, is needed in all areas of public policy, particularly economic policy and social policy. Ireland needs to move from a situation where our economic growth relies, to a very considerable extent, on foreign direct investment and imported technology (an 'Investment-Driven' economy), to one where the basis for growth arises, to a much greater extent, from indigenous innovation (an 'Innovation-Driven' economy). In order to reach this goal a paradigm shift in public policy is required which puts innovation at the centre of the policy agenda.

How Will We Do It?

2. Higher education and research will be central to achieving the paradigm shift. The State has a vital role to play. State financial support for the two key domains of an innovation system will be critical for success. We refer to these domains as "Knowledge Production" and "Knowledge Transfer and Development". The most important outcomes from investment in these two domains will be enhanced levels of knowledge and skills for our people. Education (particularly higher education), learning, research and technology will be at the centre of this transformation. The essential organic connection between teaching, research, and learning in higher education, which determines the quality of human resources, and which is vital for progress, must be further enhanced and strengthened.

Support for "Knowledge Production"

3. This domain encompasses education, learning and research. The higher education sector is the platform for building up the required capacity. The HEA is encouraged by the fact that considerable support has been provided for this domain in the National Development Plan. Key building blocks are in place:

- The HEA provides core funding for research in the universities through the block grant which is a combined teaching and research budget;
- Massive support for building up institutional research capacity is being provided through the allocation of over €600m to support institutional research strategies and joint research programmes through the Programme for Research in Third Level Institutions (PRTLI) which is managed by the HEA;
- The Technological Sector Research Fund, which is managed by the Department of Education and Science, supports research programmes in the institutes of technology;
- Funding for research projects, programmes, postgraduate research students and fellowships is provided by the two newly established research councils, the Irish Research Council for the Humanities and Social Sciences (IRCHSS) and the Irish Research Council for Science, Engineering and Technology (IRCSET).
- The funding of strategically oriented basic research in support of key areas of industrial and social policy (including health) are being supported by the funding programmes of Science Foundation Ireland (SFI) and the Health Research Board (HRB);
- Sectoral and functional objectives of government departments are being supported by enhanced levels of funding for problem solving and policy development, thus enhancing research in agencies such as the Marine Institute, Teagasc, EPA and COFORD.

4. The Authority believes that these components, underpinned by a strong higher education sector, are placing the higher education and research system on a pathway which will lead to

- A strong, world-class research community
- Third level institutions with international reputations for quality research
- Significant improvements in the supply of highly trained and research-experienced graduates and postgraduates
- Research programmes supporting public policy objectives in key areas such as industry, agriculture, health, marine and natural resources, environmental protection.

5. This system, which like many international systems, has a diversity of agencies with clear and complementary missions, is beginning to have an impact. Some of the funding organisations such as SFI and the research councils are new and the PRTLI investments are only now beginning to make an impact. The Authority believes it would be premature to engage at this stage in radical organisational changes (or in deep surgery) to the system.

Knowledge Development and Transfer

6. This domain requires systemic support particularly in the areas of technology transfer and the commercialisation of research. It involves the transfer of research results, skills and knowledge into society and the economy. It encompasses activities such as applied research and development, technology transfer, the exploitation of intellectual property and the commercialisation of research. It is crucial that these processes work well so that Irish society can reap significant dividends from the increased levels of public expenditure on research in the knowledge production domain.

7. The Authority believes that a policy or business model for commercialisation of research is required and that EI should take a lead role in this area, with a particular focus on development of indigenous industry in line with its mandate. Furthermore, in line with the original objectives of Technology Foresight, to enhance interaction between researchers and industry/business, SFI should develop this area so as to enhance the investment of multinationals in R&D in Ireland. In co-operation with the Industrial Development Authority (IDA), these agencies have a vital role to play in taking the lead in regard to the key policy objectives of developing, an indigenous "innovation-driven" industrial base, with strong complementary resources capable of reaching into the research system, and the embedding of foreign-owned knowledge-based multinational firms into the Irish economy and innovation system.

8. The Authority strongly believes that the complex range of policies and differing, but complementary, objectives required to ensure the efficient and mutually supportive operation of the two domains within the innovation system, are unlikely to be addressed successfully by a single organisation or by centralised funding for research. Such a single organisation would be likely to be subject to tensions between different policy objectives, creating risks of confusion and imbalance.

The Roles of the Departments of Education and Science and Enterprise, Trade and Employment

9. In terms of the broad roles for the two major players involved in the transformation to an "Innovation Society", the HEA envisages the Department of Education and Science as playing an enabling or supply role, establishing the foundations and framework conditions through investment in knowledge, people and skills. The Department of Enterprise, Trade and Employment and its related agencies, will need to address the demand conditions for research and technology in business and industry, especially in the areas of development and commercialisation.

10. In order to ensure a complete and all encompassing "Innovation Society", all government departments and their agencies will have a role to play. Moving forward, at an operational level, there is a need for a mechanism for regular and systematic information exchange between the main funding agencies, so as to (1) avoid duplication of funding, (2) to evaluate programming and scheduling between agencies, and (3) to maximise returns to the Exchequer. Thus the Co-operation Agreement ('Merrion Agreement'), which is signed by the majority of agencies who fund research in the higher education sector, should be signed by all agencies so that co-operation between agencies becomes formalised and coherent.

The Need for Effective Oversight

11. An effective policy oversight and review capacity is required at the centre of Government in order to ensure that the innovation system works efficiently and effectively. Ireland currently does not have such a system. In developing the oversight arrangements there is a need to distinguish between the concepts of 'oversight' and 'control'. There is also a need to avoid the inherent difficulties which would result if oversight functions are assigned to a government department or agency which has sectoral missions and responsibilities, irrespective of how important these are. New mechanisms are needed for policy oversight and review at the centre of government which will have the confidence and support of all the relevant stakeholders, and in which they can all effectively participate. The Authority presents a number of options for consideration for such oversight.

Summary of our Recommendations:

12. The Authority therefore recommends:

- Establishing overarching structures at the centre of Government involving the principal Ministers and senior officials, to provide policy review and oversight. We outline a number of options for the consideration of the Commission in Chapter 6 and of course others can be devised. We do not intend to be prescriptive about the detail but we do emphasise that the design principles are vitally important. The essential criteria for success and effectiveness in our view are that the structures should be located at the centre of Government (with direct reporting relationships to the Taoiseach and the Tánaiste) and should not report to a government department or agency which has line, sectoral or operational responsibilities.
- Putting the research councils on a statutory basis.
- Relocating ICSTI at the centre of government with new reporting relationships in order to provide independent advice to the central oversight and review structures.
- Reviewing and refocusing the roles of EI and SFI in technology transfer and commercialisation processes and in the building of research and innovation capabilities in the business sector.
- Implementation of formalised and effective co-operation arrangements, including information dissemination, between all the operational agencies funding research in the higher education sector and ensuring that the research community can form a coherent overview in regard to the objectives and requirements of the different funding programmes and can easily identify potential funding sources. We recommend that the research funders jointly consider constructing and maintaining a web-based information portal which (with appropriate internet links) would act as a 'one-stop' source of access.

Conclusion

13. Finally, the HEA, as the statutory body responsible for advising the Minister for Education and Science on all aspects of higher education and research, welcomes the opportunity to contribute to the work of the Commission. In preparing its contribution the HEA was guided by a number of informing principles:

- that research is an integral part of education and that there are inseparable and interdependent linkages between teaching, research and learning which must be maintained so as to enhance the quality of graduate and knowledge outputs;
- that innovation encompasses a complex range of activities and dimensions, which while they can broadly be categorised into the two broad domains of 'Knowledge Production' and 'Knowledge Development and Transfer', require a broad suite of different policy and funding responses ;
- in response to this complexity there is a need for a diversity of funding agencies to meet different policy and sectoral needs;
- an appropriate balance of "secure" and competitively based funding programmes for institutions and individuals will allow the participants in the research system to plan in advance and develop capabilities and knowledge; this in turn will provide the knowledge base and platform which will facilitate mission oriented funding organisations to respond to public policy priorities. This can most effectively be achieved through a diversity of funding agencies with clearly defined, different and complementary missions;
- the need for a focused policy oversight and review capacity of the different dimensions of the innovation system and that this should be located at the centre of government.

As we move into a new millennium, we see the higher education sector playing a more prominent role in advanced national economies and societies, which strengthens the traditional role and contribution of the sector. Higher education is now a provider and facilitator of wealth creation through the endowment of human capital and the generation and exploitation of new knowledge. Increasingly, the sector is becoming a central player underpinning the national innovation system. The Authority is committed to ensuring that this new role is supported and developed to the fullest extent.

chapter one

Research, higher education, learning and society: the role and activities of the Higher Education Authority

In this introductory chapter the structure of higher education in Ireland, the statutory role and responsibilities of the HEA, and the funding and policy developments in which the Authority is currently involved is outlined. The chapter outlines the key role played by HEA in the funding of research in third level institutions in Ireland. The chapter also emphasises the inseparable and interdependent linkages between research and education, the impacts of basic research on the quality of graduate output and explains why the Authority attaches high priority to its support of basic research. It does so in a context where higher education is now a provider and facilitator of wealth creation through the endowment of human capital and the generation, dissemination and exploitation of new knowledge.

Introduction

1.1 As the new millennium unfolds, the higher education sector has a prominent role in advanced national economies and societies, which strengthens the traditional role and contribution of the sector. Higher education is now a provider and facilitator of wealth creation through the endowment of human capital and the generation, dissemination and exploitation of new knowledge. Increasingly, the sector is becoming a central player underpinning the national innovation system. The Authority is committed to ensuring that this new role is supported and developed to the fullest extent.

1.2 The Higher Education Authority (HEA) is the statutory body with responsibility for advising the Minister for Education and Science on all aspects of higher education and research[1].

1.3 The HEA has the statutory obligation to assist the co-ordination of state investment in education and research in the higher education (HE) sector, and to assess and make recommendations to the Minister for Education and Science on state financial provision for education and research. (The statutory obligations of HEA in respect of education and research are outlined in Annex 1).

1.4 The higher education (HE) system in Ireland comprises the university sector, the technological sector (Institutes of Technology), and a number of other specialised institutions. The vast majority of students are enrolled in the universities or in the institutes of technology. The development of the third level system has been based upon a differentiated system of third-level education. The part formed by the seven universities has state funding allocated by the Authority. The other part includes the institutes of technology, with state funding allocated directly by the Department of Education and Science (although the policy objective is to transfer responsibility for funding of the institutes of technology to the HEA). Both sectors have different, but interrelated and complementary missions.

1.5 The HEA allocates capital and recurrent funding to the institutions under its aegis[2] on an annual basis. The recurrent grant is allocated to the institutions, in accordance with a formula-based funding model and is on a 'block grant' basis, thus allowing the institutions discretion in the allocation of funds between their functions of teaching, research and related activities. (Details of the block grant funding system are provided in Annex 2.) This funding model has been in place for over 10 years and the HEA is commencing a review of its operation.

1.6 The institutions, which make up the Irish higher education system, provide for almost 120,000 full-time and over 32,000 part time students, and employ over 20,000 staff.

1.7 The State provides for an investment of approximately €1.4 billion (2002) per annum to support the Irish higher education system (Table 1.1).

Table 1.1 Higher Education: Enrolments and State Funding

Sector	Total Student Enrolment 2000/2001	State Funding 2001 Outturn €000
Universities/Other HEA Institutions	80,567	649,225
Institutes of Technology	66,060	489,868
Other Institutions	5,629	20,517
TOTAL	**152,256**	**1,159,610**

1.8 There are more than 20 third level institutions in the HE sector with an involvement in research. Over 2,600 researchers (FTEs) work in these institutions which have an annual expenditure on research of approximately €228 million per annum (0.26% of GDP)[3]. The universities account for more than 80% of HE sector research. Two thirds of the funding for research in the HE sector comes from public sources. Approximately 80% of public funded R&D is performed in the higher education sector[4].

1 *The Higher Education Authority (HEA) established in 1972 under the provisions of the Higher Education Authority Act, 1971.*

2 *The following are the institutions to which the provisions of the Higher Education Authority Act 1971 apply: University College Dublin, National University of Ireland, Dublin; University College Cork, National University of Ireland, Cork; National University of Ireland, Galway; National University of Ireland, Maynooth; University of Dublin, Trinity College; University of Limerick; Dublin City University; and three designated institutions National College of Art and Design; Royal Irish Academy and Royal College of Surgeons in Ireland.*

3 *Forfás. OECD-Main Science & Technology Indicators, 1999. The OECD average is 0.38% of GDP.*

4 *Forfás. Research and Development in the Public Sector, 2000.*

1.9 The public sources for research funding in the HE sector from 2000 to date are shown in Figure 1.1 and Table 1.2. The main funding comes via the Department of Education and Science (DES) and the HEA.

Figure 1.1 Percentage Distribution of Research Funding Allocations to Higher Education Sector - 2000 to end of June 2002

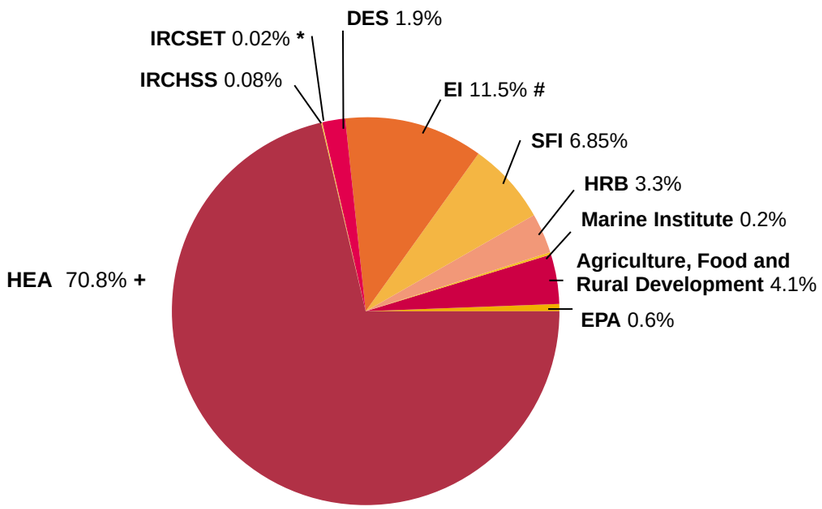


Table 1.2 Research Funding Allocations to Higher Education Sector-2000 to end June 2002

Agency	€m
Department of Agriculture, Food and Rural Development	40.99
Department of Education and Science (DES)	18.45
Enterprise Ireland (EI)	113.93#
Environmental Protection Agency (EPA)	5.88
Higher Education Authority (HEA)	701.04+
Health Research Board (HRB)	32.61
Irish Research Council for the Humanities and Social Sciences (IRCHSS)	8.11
Irish Research Council for Science, Engineering and Technology (IRCSET)	0.24*
Marine Institute	1.94
Science Foundation Ireland (SFI)	67.00

Source: Private Communications from Government Departments and Research Funding Agencies 2002
 # This excludes funding of €238.3m for the support of research under the Competitive RTI scheme, National Collaboration and Infrastructure Research, Capability and Training. This scheme supports commercially focused, industry led projects in product and process development although third level institutions may be included as collaborators
+ Funding allocated by the HEA includes PRTLI but excludes allocation in December 1999 of €206m. This programme is administered by the HEA on behalf of the Department of Education and Science
**IRCSET established in 2001.*

HEA Support for Research

1.10 HEA 'block grant' funding to its designated institutions provides for both teaching and research. The funding model operated by the HEA reflects this dual purpose.

1.11 HEA funding is the most significant source of support for third level research. HEA funding mechanisms are:

- The combined teaching and education budget which provides the necessary bedrock for research funding (€100 million approx of combined grant in 2002 allocated to research). Other agencies supporting research provide incremental funding on top of this foundation.[5]
- The Programme for Research in Third Level Institutions (PRTLI) which has allocated in excess of €600 million to date (since December 1999)
- A fund for collaboration between Irish third-level institutions and Media Lab Europe, administered by the HEA on behalf of the Department of Communications, Marine and Natural Resources, which has allocated €2.54 million since 2000, €12.7m to be allocated over the period of the programme.
- The Transport Research Programme, administered by the Higher Education Authority on behalf of the Department of Transport, launched in 2002.

1.12 The Programme for Research in Third Level Institutions (PRTLI) allocates funding on a competitive basis to third level institutions (including those outside the aegis of the HEA). The objectives of the Programme are (i) facilitation of the strategic development of institutional research capabilities (infrastructural and programmatic), (ii) enhancement of the numbers, quality and relevance of graduate output and (iii) support of high quality inter-disciplinary and inter-institutional research.

5 *Forfás surveys estimate that academics, whose salaries are fully funded by the HEA, spend 25% of their time on research. In addition to directly funding research activities, the HEA block grant also subsidises other research funding agencies, which do not contribute to existing academic salaries in their research grants. Forfás: Survey of Research in the Higher Education Sector 1998*

1.13 The total support for research allocated under the competitive PRTLI to date is shown in Table 1.3.

Table 1.3 PRTLI Allocations under the National Development Plan to Date

		Capital (€M)	Programmatic (€M)	Total (€M)
Cycle 1	1999	177.5	28.6	206.1
Cycle 2	2000	48.8	29.7	78.5
Cycle 3	2001	178.0	142.4	320.4
TOTAL		**404.3**	**200.7**	**605.0**

1.14 The impacts of PRTLI have been significant:

- 62 new and expanded research programmes established
- 90,000 additional square metres of research space funded, from an indicative baseline of 50,000 in 1999.
- 796 new post-graduate research posts in place to date in the research system with projected numbers of over 1,500 by the end of Cycle 3 (PRTLI funded research posts are projected to increase from 192 in 1999 to over 1,600 in 2006, an increase of over 730%)
- 40 new inter-institutional programmes/initiatives established
- Over 1,900 publications to date arising from PRTLI funded programmes (over 2.5 years), representing a 250% increase in output compared to the previous period.
- New research funding to 15 third level institutions in total, including 6 Institutes of Technology.

1.15 The PRTLI is dramatically changing the HE research landscape. Pre PRTLI, HEA together with other organisations supported a number of important research initiatives. While limited, these pre PRTLI initiatives were significant. In particular, they assisted university researchers in their very credible participation in competitive European research programmes, and in bringing in very important international funding to the research system, at a time of limited support from Irish Government sources. As summarised above, Irish researchers have unequivocally demonstrated that when adequately resourced they are internationally competitive in terms of publications and generation of intellectual property results. Further information about the PRTLI, which is managed by the HEA on behalf of the Department of Education and Science, is provided in Chapter 5.

Other Research Funders in the HE Sector

1.16 The two recently established Research Councils-The Irish Research Council for Science, Engineering and Technology (IRCSET) and the Irish Research Council for the Humanities and Social Sciences (IRCHSS)-now provide 'bottom-up' funding for talented individual researchers, students and postdoctoral fellows. In addition, to complete the picture, support for basic research is also provided by Science Foundation Ireland (SFI) in the sectors of biotechnology and information and communications technologies (€67m allocated to date since 2000) and by Enterprise Ireland (EI) project research (€7.9m allocated in 2001) and the Health Research Board (HRB) (€11.6m in 2001). As a result, there are now well-established funding mechanisms in place to support individual researchers, research projects and institutions and which provide integrated programmatic support for the development of centers of excellence within and between the institutions. Further information on these programmes and their objectives is contained in Chapter 5.

Why HEA Supports the Funding of Scholarship and Basic Research; the Links Between Research, Education and Learning

1.17 The Authority's support for scholarship and basic research is central in meeting its statutory obligations. We welcome the endorsement of PRTLI and the commitment to its continuation in the Agreed Programme for Government[6]. The Authority welcomes the commitment to developing a world-class research capacity, utilising the distinct and inter-connected roles of the different support programmes now available. Explicit and sustained Government support, such as this, will go a long way towards embedding a dynamic research culture in the economy, and in society.

1.18 Educational policy in Ireland has always acknowledged the importance of a scholarship encompassing comprehensive engagement in research and the seamless connection between research and teaching. The importance of this essential interdependence and its significance for the quality of learning and teaching is fully endorsed by the Authority.

6 An Agreed Programme for Government Between Fianna Fáil and The Progressive Democrats, June 2002

1.19 The Authority is convinced that Ireland must build competitive advantage based on the skills and knowledge of our people, as the primary sustainable long-term resource available to the economy and our society. This will require a sustained commitment to basic research, largely because engagement in basic research and exposure to its methods, enhances the quality of human resources for the economy. Because many of the benefits of basic research are embedded in human skills and experience, and are not carried in codified formats such as intellectual property, the contributions of basic research to the economy are delivered, inter alia, through people. The link between basic research and education and training is central to the whole relationship and to the capacity of the innovation system, particularly in the case of an economy like Ireland, with, in international terms, a relatively small industrial base.

1.20 Despite serious financial constraints, and the demand on financial resources resulting from increasing enrolments of undergraduates, the methods by which the HEA allocated funding to the universities from the 1970s onwards consistently acknowledged the importance of engagement in research by university personnel and the seamless connection between research and teaching. The importance of this interplay and its significance for the quality of learning and teaching is fully endorsed by the Authority.

The Returns to Society

1.21 The primary justifications for investment in basic research is health and social gain, and economic development and advancement. Furthermore there are two primary economic justifications for investment in basic research. The first relates to the return on investment and the second to the enhancement of human capital.

1.22 The actual economic returns are well rehearsed. Measuring the impacts of research on the economy has exercised economists for more than four decades - the earlier work of Denison and Solow, followed by researchers like Mansfield and more recently by Paul Romer at Stanford. R&D, according to these studies, has accounted for between 12 and 25 per cent of annual growth in productivity during the post-World War decades in the US[7]. There is a consensus that the returns on research investment are relatively high, roughly double the average historical return to stock market investments, with even higher so called 'social returns', or returns to society as a whole. Edwin Mansfield has estimated a 28% social rate of return on investment in academic research[8]. There is also convincing evidence of the value of publicly funded science. For example, from a sample of almost 400,000 US patents, more than 70% of the papers cited by industry were to "public science". There was evidence also of a growing dependence of private technology on public science[9]. And there are many examples in the literature of considerably higher rates of return[10].

1. 23 While the attention of economists has focused on the economic returns to research, there are other benefits. The benefits to individuals and the health and social gains from investment in medical research and healthcare, though these are obviously more difficult to quantify, are self evident. Also difficult to measure quantitatively, but no less valuable, is the importance of investment in the creation of a vibrant research community in the humanities and social sciences, in helping us to understand and interpret our changing society.

1.24 The Authority believes that, in the case of Ireland, the impacts of basic research are largely in the form of tacit knowledge and in skill transfers. Its essential benefits, especially for a country with a small industrial base, comes in the main through its effects on human capital. The importance of the link with education and training is thus evident. Human capital, in the form of skilled manpower, provides the vital link between basic research and the innovation system. This is why the linkage between basic research and the education system is central and must be maintained and strengthened.

1.25 Because of the human capital dimension, Ireland cannot adopt a 'free rider' strategy towards basic research, as in the past. We would miss the embedded knowledge that involvement in basic research provides through enhancement of graduate output and we would be kept outside the 'invisible colleges', the international knowledge networks, where those who have nothing to trade will not be involved. Investment in research concerns all of society and all of scholarship.

7 *Jorgenson Dale W. "Investing in Productivity Growth" in Technology and Economics. Washington DC., National Academy Press 1991 p59.*

8 *Mansfield, E. Academic Research and Industrial Innovation. Research Policy 20, pp1-20.*
9 *Francis Narin, Kimberly S. Hamilton, and Dominic Olivastro. "The Increasing Linkage Between US Technology and Public Science", Research Policy 26(3) 1997 317-330*
10 *See, for example, a study of basic research in Ireland published by Forfás and carried out by Technopolis and Keith Pavitt-An Evaluation of the Basic Research Grants Scheme operated by Forbairt. Undated (circa 1997)*

1.26 The Authority thus believes that the importance of higher education, research and learning transcends the economic domain. At a broader level, higher education promotes social well-being. It preserves, widens and advances the intellectual, cultural and artistic accomplishments of society. It brings rigorous, sustained and critical evaluations of the past to bear on the present, and the possible futures of society, and in doing so can promote social cohesion. It functions through commitment to the highest standards of education and research in all the various branches of learning and scholarship. It equips society with the skills and qualities necessary for sustainable economic growth and prosperity and the capacity to construct a society based on social justice and individual freedom.

chapter two

Ireland needs to become an innovation society

In this chapter the need for Ireland to make a fundamental paradigm shift to becoming an innovation society is addressed. The reasons why this shift is essential and its implications are considered. Attention is drawn to the central role of a national system of innovation in enabling such a shift, and some of the new fundamentals underlying it, especially the role of education, research and the science base are identified. We emphasise that the overarching importance of innovation includes, but transcends, the economic and industrial domains and includes every facet of scholarship and knowledge. The creation and enhancement of human capital as a primary objective from increased investment in research, technology and innovation is identified. Human capital is the foundation on which new competitive advantages for the Irish economy must be built. The Authority believes that education and research are the cornerstones of the national innovation system and that embedded knowledge in human capital is their most important contribution. Our demographic structures leave us well placed to develop a strategic comparative advantage in this vital area. Finally, the Authority's commitment to protecting and enlarging the links between teaching, research and learning - a triple helix of interlocking connections is stated.

A National Innovation System

2.1 The terms of reference request the Commission to "develop an overarching framework for national policy in research and technological development". The Authority considers that such a framework should be set in the context of a comprehensive national innovation system. A similar logic is suggested by Porter[11], for example:

"The overarching principle in addressing science and technology should be to create an innovation policy, not just a science and technology policy"

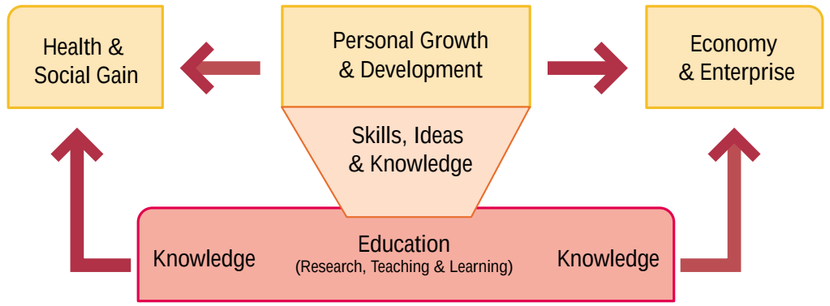
2.2 Correctly, in the Authority's view, this widens the perspective. Consequently, the issues to be considered go well beyond consideration of the structures and processes for policy co-ordination and resource allocation. In particular, they must address the drivers of innovation in the economy and the requirements for embedding innovation in the culture of Irish society.

11 Michael Porter. The Competitive Advantage of Nations. The Free Press NY. 1998.

Ireland Needs to Become an 'Innovation Society'

2.3 It is essential, in the Authority's opinion, that Ireland becomes "an innovation society", where the need and capacity for innovation is at the centre of policy making, structures for government and public administration, the implementation of public policy and, of course in the private sector and the market economy. We discuss the structural economic pressures because of which we must take this policy direction later in this chapter. But innovation is important, not just for the economic domain of Irish life. It also has overarching significance for societal development and the quality of life, extending, for example into areas of social gain and sustainable development, environmental quality and health care, as well as into the personal domain, i.e., the private lives of citizens and their role as members of communities (Figure 2.1).

Figure 2.1 The Dimensions of the 'Innovation Society'



2.4 Ten years ago, a report from the National Economic and Social Council (NESC), identified the stimulation of an "Irish system of innovation" as a major policy challenge. According to this Report[12]:

"-whether Ireland can hook right on to a new techno-economic paradigm is largely dependent on its national system of innovation"

2.5 The move to an "innovation society" will involve significant changes. In our view, the future sources of competitive advantage in Ireland will be found to a very considerable extent in human resources. This is the starting point. It both subsumes and goes

12 Mjoset, Lars. The Irish Economy in a Comparative Institutional Perspective. Report published by the National Economic and Social Council. December 1992.

beyond a concern with industrial development and involves substantially more than a simple readjustment to industrial policy. For the future, the education system must be the driver of Ireland's competitive advantage. The aim of future policies must be to create a new competitive advantage for Ireland in human capital through investment in education and research in the third level system. Our demographics are favourable and will help us to establish this position. This transcending view of innovation, (which encompasses all areas of national life and all domains of scholarship), is the only feasible and sustainable route for Ireland to the innovation society. Unless current assumptions are radically altered, there is a risk it is feared that discontinuities, which are already evident in current thinking about innovation policies, will continue.

The Dimensions of the Challenge

2.6 Ireland needs to source an increasing proportion of the intellectual and knowledge content of the goods and services produced within the country. This means doing more product and process research and development in this country. It means technologically upgrading Irish owned industry, increasing the volume and quality of research carried out in the business sector and making Ireland a more attractive place for multinationals to carry out research and development. It particularly involves increasing the education and skills level of the labour force so that more people have experience of and are trained in research and development. If we succeed in doing this, then cost competitiveness (narrowly focused on labour costs) becomes less important. There is little doubt that education, training and research are the decisive factors in driving national competitive advantage, especially as improving human resources set rising standards for all[13].

2.7 Innovation itself is a complex process embracing concepts such as the willingness and capacity to respond to our curiosity and spirit of enquiry, to search for a greater and enhanced understanding of ourselves and of the universe in which we live and to generate and apply new knowledge. The willingness to be innovators, in effect the willingness to change, is critical to our development in all aspects of our lives - as individuals, in our families and communities, in our work places and as participants in the wider national and international economy and society.

13 Porter, Michael 1998 op. cit.

2.8 In all of this education has a vital role to play. The education system, at all levels, provides the means to develop personal capacities for innovation, creativity, discovery, critical enquiry and judgement, thus enabling people to play a full part as members of an innovation society and to achieve their full potential as creative individuals.

2.9 The need to embrace the challenges of being an "innovation society" has perhaps never been so important or critical for future national prosperity and social and cultural development. According to Porter[14],

"In the modern global economy, prosperity is a nation's choice"

However, these choices will not be available, unless changes are made. The extent of the changes required is evident from the following indicators:

- Figures provided by Forfás[15] show that BERD (Business Expenditure on R&D) was 0.88% of GDP in 1999 compared with 0.91% in 1997 and 0.89% in 1995. The EU average BERD is 1.21% of GDP. The OECD average is 1.53%. The trend since 1995 indicates that Irish business is falling further behind its international competitors. Strong R&D capabilities and 'complementary assets' in the business sector are essential, if the benefits from public support for basic research in the universities is to be maximised.
- The Global Competitiveness Report[16], ranks Ireland 11th overall, of 75 countries (with Finland in first place), but only 28th on the innovation dimension. Clearly, our innovation performance needs to be addressed.

Innovation and the Economy

2.10 The remarkably high growth rates achieved in the Irish economy during the 1990s are evidence of our national success across a range of policy areas, such as education, taxation and industrial policy in exploiting the growth potential of the Irish economy. Membership of the European Union, which gave Irish industry access to one of the largest and highest income markets in the world, was an important precondition for success. In addition, a supportive macroeconomic and fiscal environment, successful social partnership processes and structures and the education system, all provided the macro economic and supply side conditions for a most successful economic

14 Porter Michael. 1998 op cit.
15 Not yet published by Forfás
16 The Global Competitiveness Report 2001-2002. World Economic Forum, Switzerland. 2001 - The Growth Competitiveness Index: Measuring Technological Advancement and the Stages of Development By John W. McArthur and Jeffrey D. Sachs, Center for International Development, Harvard University

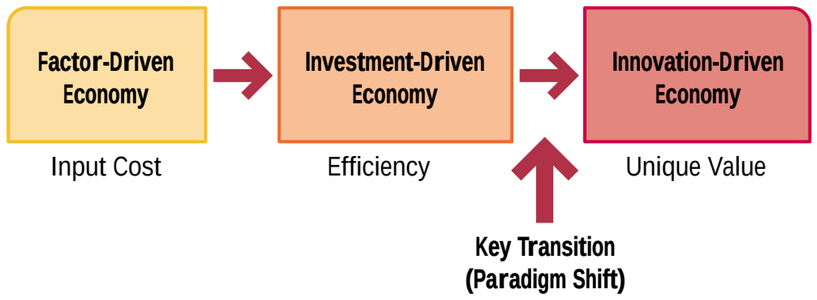
performance, where the motor for development was to a very considerable extent provided by the exceptional success of the Industrial Development Agency (IDA) in attracting direct foreign direct investment into the manufacturing sector.

2.11 Many, but not all, of the conditions, including EU membership, supportive of this economic performance, had already been in place before the 1990s. Considerable success had previously been achieved in attracting foreign direct industrial investment and in developing the education system. But, it was not until all the preconditions, particularly in the areas of fiscal policy and the efficient functioning of the labour market were in place, that the full potential of the Irish economy could be realised.

2.12 This phase of economic development can be characterised as owing a great deal to the "importation" of technology and foreign direct investment, as well as having an efficient macroeconomic framework. This has resulted in increased numbers of people at work and higher incomes. Inevitably, as capacity constraints in areas such as housing and infrastructure became more evident, it also led to higher costs, in the Irish economy, as well as a tightening labour market. This leaves the economy vulnerable to competition from lower cost economies, particularly in Central and Eastern Europe and in Asia, following a similar development path, unless we can move further up the value chain, embedding knowledge into production and economic output.

2.13 The influential Global Competitiveness Report[17] identifies three stages of development. (See Fig. 2.2) In the first stage, and "at low levels of economic development, economic growth is determined primarily by the mobilisation of primary factors of production-land, primary commodities and unskilled labour. As economies

Figure 2.2 Stages of Economic Development



17 *The Global Competitiveness Report 2001 - 2002. op. cit*

move from low-to middle-income status, global competitiveness becomes Investment-Driven, as economic growth is increasingly achieved by harnessing global technologies to local production". The authors identify a number of features, including foreign direct investment, joint ventures and out sourcing arrangements and integration of national production systems into the international economy, as being characteristic of the second "Investment-Driven" stage of development.

2.14 This description provides a plausible explanation of Irish industrial development for the last forty years. In particular, since the late 1950s public policy has been consistent in using low, or zero corporate tax rates, as well as other tax incentives and direct expenditure grants as incentives for attracting mobile international industrial investment into Ireland. This policy has continued to be successful, but we are already beginning to experience, through the emergence of constraints such as labour and skill shortages, cost inflation and stresses on infrastructural capacity, the limitations of undue reliance on this route for economic development. Indeed the Report comments:

"....Ireland which has been tremendously successful in attracting foreign investment for manufacturing, now faces the need to justify higher wages and higher local costs without yet having developed a world-class innovation structure".

2.15 The third phase of economic development, according to the authors of the Report "involves the evolution from middle-income status to high-income status". This involves "the transition from a technology-importing economy to a technology-generating economy, one that innovates in at least some sectors of the global technological frontier". The Report states that "perhaps the hardest transition is from technology-importing, efficiency-based development to innovation-based development. This requires a direct government role in fostering a high rate of innovation, through public as well as private investments in research and development, higher education, and improved capital markets and regulatory systems that support the start-up of high-technology enterprises". The Report also states that for "high-income economies at this Innovation-Driven stage of economic development, global competitiveness is critically linked to high rates of social learning (especially science-based learning) and the rapid ability to shift to new technologies"

2.16 Perhaps the authors' reference to "hardest transition" is an understatement. The extent of the change involved maybe more akin to what Kuhn[18] describes as a "paradigm shift", indicating a fundamental change in the underlying assumptions and not simply a transition or a process of incremental change, however rapid. The new paradigm for economic development will be built on two elements, both in turn depending on the quality of human capital. The first requires policies to support the embedding of foreign investment through the development of human resources for research in third level institutions, so that research-based firms locating in Ireland can effectively interface with the local education and research systems to the mutual benefit of both. The second requires the development of indigenous research-based innovating firms. Human capital and indigenous research provide the seedbed for both. Without them sustainable development will not be possible in the future.

2.17 Clearly then, the fundamentals underlying such a paradigm shift are very different from the past[19]. These new fundamentals include:

- The emergence of world class research institutions in the third level sector.
- Improving the supply of highly trained and research-experienced scientists and engineers
- Strong collaboration and interaction between companies in Ireland and the Irish third level sector, bridging the gap between business and the research base
- Companies in Ireland, foreign and indigenous, innovating on technology frontiers
- A reducing reliance on foreign technologies

To achieve these we need to commit very considerable resources to all the dimensions of innovation, particularly to advanced education and learning, research, development and technology transfer.

18 The Structure of Scientific Revolutions-Thomas S. Kuhn (Chicago: U of Chicago P, 1962)
19 The Global Competitiveness Report 2001-2002 op. cit.

Table 2.1 Gross Expenditure on R&D% GDP-1999[20]

Country	GERD as a % GDP in 1999	Country	GERD as a % GDP in 1999
Sweden	3.80	United Kingdom	1.87
Finland	3.22	Canada	1.83
US	2.65	Norway	1.70
Germany	2.44	Ireland	1.21
France	2.19	Italy	1.03
Denmark	2.06	Spain	0.89
Netherlands	2.05	Portugal	0.76

2.18 Managing the change to an innovation society is now a key challenge for public policy. Notwithstanding recent economic and social policy successes, and the significant allocations for research, technology and innovation in the National Development Plan[21] this will be a difficult trajectory for Ireland. In comparison with other developed OECD countries, Ireland has traditionally had a modestly developed and poorly resourced innovation system-particularly in relation to expenditure on research and development (Table 2.1).

2.19 Our demographic structure on the other hand equips us to catch up with competitor countries in terms of developing our innovation capacity. While Ireland, in common with most developed countries, needs to embrace the culture and structures of life long learning, the flow of talent critically depends on the 20-30 year old cohort in the population. In comparison with other European countries Ireland is relatively abundant in this critically important age cohort arising from the fact that our "baby boom" lagged behind that of other developed countries by over two decades. This gives us a population structure better suited to investment in human capital than many of our developed country competitors. This in turn will enable us to develop comparative advantage in knowledge economy products and from this the competitive advantage vital for sustained higher levels of economic growth.

2.20 It also means that we need to develop attractive career structures for people working in research, science and technology. By doing so we will attract talent from our own indigenous population, and through immigration.

20 Source: Forfás; OECD-Main Science & Technology Indicators 2000
21 Ireland National Development Plan 2000-2006

An Innovation Society Embraces, but Extends Beyond, the Economic Domain

2.21 The policy priority must be the development of an 'innovation society'. Achieving this will require extension beyond the purely economic domain and into other areas of public policy, in all of which, education is the central player. Innovation is a transcending requirement: it includes economic policy and science and technology, but transcends them and encompasses all areas of public life and policy and of scholarship.

2.22 Innovation may perhaps be usefully envisaged as a complex and interconnected, but diverse web of activities and processes. These extend through a range of activities and domains of scholarship and require interaction between these domains. They include fundamental or basic research (investigations prompted by the search for understanding, by a spirit of enquiry, "the need to understand why", the testing and refinement of hypotheses and the development, adaptation and (frequently) the rejection of theoretical models). In addition, research, particularly in the areas of science, technology, medicine and engineering, as well as in areas of scholarship such as economics, sociology, law and the disciplines encompassed by business studies can be, and frequently are, prompted by the desire to improve products and processes and to better understand and improve public and private sector policies, processes and systems.

2.23 Innovation encompasses the spectrum of activities from strategic research, applied research and development and the commercialisation of new technologies (including the generation and exploitation of intellectual property). It also extends beyond the areas of science and technology (important though these are) and involves other areas of scholarship, including the humanities and the social sciences. It would be a mistake to think that the justification for research in these areas relates solely to so-called "higher order" reasons and motivations and does not have any relationship to more tangible social needs. For example, research into Ireland's place in regional and global history enhances our understanding of our identity. In purely utilitarian terms, this can enhance our economic self-confidence and indeed the quality and performance of our public institutions.

2.24 We need the enhanced understanding, arising from research and creative activity, in the humanities and in the social sciences to enable our society to successfully embrace the challenges and social transitions in moving from what was forty years ago a conservative, inward looking and relatively poor society, to one which should be enterprising, outward looking, progressive and prosperous. We also aspire to a society characterised by social justice, adherence to a model of sustainable development and providing an environment within which we can achieve fulfilment as members of society and as individuals. We need to understand the dynamics of social partnership in order to continue to make it work for the betterment of the economy and society. We need to be able to make informed decisions about our future in Europe. We also need the humanities and social sciences to guide and inform us in addressing the many serious ethical questions arising from the advancing knowledge in biology and medicine, where our traditional assumptions and views in relation to such fundamental and essential issues as human life itself need to be extended to embrace the challenges emanating from new insights and developments.

2.25 Research, development and innovation policy should be an increasingly important part of economic and industrial policy, but it would be a serious error to conclude that it is just a part of, or is exclusively concerned with, economic and industrial policy. The importance of research, development and innovation policy extends beyond and transcends economic and industrial policy. We can draw a parallel here with education. Improvements in education contributed to about 20% of the growth performance of the so-called 'Celtic Tiger' phenomenon when the Irish economy experienced very rapid rates of growth in the last half of the 1990's[22]. Clearly education policy is important for industrial policy, but we recognise that the importance of education extends beyond and transcends industrial policy. Would society accept that education and industrial policy are synonymous or that education policy is a part of industrial policy? We do not think that this would be acceptable. Education and research make an essential contribution to industrial policy, but they are not subsumed by it and should not focus exclusively on objectives of industrial and economic policy.

2.26 It would be a major policy error, with serious negative moral and ethical implications, if higher education and research system activities were subordinated to economic activities. Education and research must remain true to their higher order missions of enhancing the capacity of each individual in the search for personal fulfilment, understanding and development. We refute any view that there is a choice to be made between so-called "utilitarian" and "higher order" objectives for education and research. Such a view is incorrect and perhaps dangerous. Both objectives must

22 ESRI Medium Term Review 2001-2007, No. 8 September 2001 by David Duffy, John Fitzgerald, Jonathan Hore, Ide Kearney and Conall MacCoille

co-exist. We need to strive for a holistic education and research system which provides us as individuals, and as a society, with the means to make our contributions in the economic, social and cultural domains of our society, but which also provides us with the means to achieve our personal goals for self realisation and fulfilment.

The Role of Education and the Intrinsic Relationship Between Higher Education and Research

2.27 The multifaceted processes involved in innovation depend on people who manifest a range of important qualities and characteristics. An innovation society needs people who are creative, questioning, inventive, disciplined and who have good judgement and are capable of responding creatively and constructively to change. The education system, at all levels, has an essential role in bringing this about. Preparation for knowledge intensive employment means that graduates must understand the fundamentals of core scientific disciplines, work on state of the art equipment, appreciate the relevance of the leading edge of technology, have the capacity for creative approaches to advanced problems and be trained in particular modes of analysis and thought.

2.28 The Authority endorses this view of the essential interconnection and linkage between education and research. We are strongly of the opinion that personal exposure and experience gained in carrying out research in a third level environment is the best teacher of these skills and capabilities.

2.29 For many undergraduates, and for all post-graduate students, direct involvement in research should be an essential part of their educational experience. The challenge for the educational system is to embed the 'research mind set' especially in its post-graduates.

2.30 The educational dividend from research is true for all countries, but may be particularly important for a small country like Ireland where, because of our size, the economic and social returns from the generation of new knowledge and discoveries, and the application of knowledge generated elsewhere, may be less important than the dividend that comes from the research-based education of graduates from our higher education institutions - or in economic terms the generation of new and enhanced human capital. We would not accept a narrow mechanistic view, which sees research as a separate activity and domain to education and learning, therefore, and leads to overlooking the vital and central role of higher education in a successful innovation system.

2.31 Accordingly, we see education and research as the cornerstones of the national innovation system and we see the embedded knowledge in human capital and related outcomes as being perhaps the most important contribution. HEA policy and activities will continue to ensure the strengthening of the links between education and research, working closely with the education institutions, to ensure a balanced agenda of teaching, research and learning.

2.32 Human capital and its ability to generate and exploit knowledge are redefining world economies. The essential tools for international competitiveness in the new global economy are innovation, ideas, skills and knowledge. All are characterised by the intensive use of human capital. All connect fundamentally with human enterprise. And all depend on quality education and research at third level.

2.33 Support for research in higher education institutions as an element of the national system of innovation, is justified by the economic importance of education-based basic research, and by the contribution of engagement in research to the production of high quality personnel for the innovation system. While the model of a seamless and linear progression from basic research to commercialisation is largely discredited (the innovation process is more complicated than that), it remains a fact that basic research is the principal underlying factor in technological innovation, in the long-term. Good applied research builds on basic research. Ireland needs more of both.

2.34 The Authority is committed to enhancing the link between teaching, research and learning-a triple helix of interlocking connections. National policies in respect to education, and in particular to the quality of educational output, would be damaged were these linkages to be disrupted or weakened. The Authority is convinced that research exposure is critical in the formation of human capital and has a significant influence on the quality of part of the central mission of the Department of Education and Science and the funding of research must remain a responsibility of the Department.

2.35 This analysis provides a first approximation for a broad delineation of roles for the major players, particularly the Department of Education and Science and the Department of Enterprise, Trade and Employment in making the transition and supporting the emergence and growth of the innovation society. It is clear that the former will play an enabling role and must be concerned with establishing the foundations and framework conditions through investment in research infrastructure and human capital (the supply side), while the latter and its related agencies, will need to address the demand conditions for research and technology in business and industry, especially in the areas of development and commercialisation. Our view of these relationships is illustrated in Table 2.2.

Table 2.2 Departmental Roles in the 'Innovation Society'

Department of Education and Science	Department of Enterprise, Trade and Employment
Higher education/business interaction and networking/links to the research base	
• Supply of human resources • Research capabilities in higher education • Research infrastructure • Enabling core technology platform research • International linkages and mobility	• BERD performance • Commercialisation supports/services • Embedding the multinationals and binding the two sectors of industry more closely • Marketing Ireland's growing research capabilities to international business

2.36 And both departments must work well together. Technological and industrial innovation increasingly depends on scientific progress although the relationships between them are complex. In the past, technological innovation often preceded scientific understanding, today, scientific advances increasingly determine technological progress. In the new technologies, science, technology and innovation are tightly interwoven. In subsequent chapters, we will examine how these broad relationships can be best developed and the institutional structures that will be required to support them.

chapter three

Establishing a World Class Innovation System - Operating Principles and Organisational Criteria

In the previous chapter the policy challenge facing Ireland was discussed. This challenge is to successfully broaden the base for economic development from a high degree of dependence on foreign knowledge - embedded investment as a primary engine of economic growth, to a position where the capacity of the economy and society to generate, develop and apply knowledge becomes increasingly significant in underpinning economic and social development. This means that Ireland needs to develop a world-class research, development and innovation system. In this chapter, the operating principles which should underpin the construction and development of such a system are developed and discussed. We conclude that a number of policy instruments are required and that these need to be implemented by organisations with clear and focused missions.

The management of the transformation from an "Investment-Driven" to an "Innovation-Driven" economy and society is of vital importance. Accordingly, in developing these principles, the level of Ireland's economic and societal development and in particular, the development path and strategies that have been successfully and consistently pursued in the past are taken into account. It is concluded that the development pathway requires that policy instruments should, in addition to the development of indigenous research based industries, include a focus on attracting foreign commercial direct investment into research and development activities in Ireland, which would contribute to "embedding" foreign owned multi-national enterprises in the economy. A related strategic objective would be to develop and intensify linkages in the innovation area between multi-national and indigenous enterprises as well as between both sectors of industry and the third level sector.

In later chapters we use these principles and criteria to discuss the arrangements applying in other countries (Chapter 4) and in Ireland (Chapter 5) and to inform our proposals in Chapter 6.

Introduction

3.1 A national system of innovation includes all the inter-related institutional and structural factors in a nation that generate, select and diffuse innovation[23]. The genesis of this view of an innovation system can be found in definitions of institutional arrangements as sets of habits, routines, rules and laws, which regulate the way people behave and which make it unnecessary to start from scratch every day[24]. National innovation systems tend to be culturally embedded and to differ from one country to the next. Nevertheless, we would expect that some overarching and universal principles would also be relevant. Human behaviour and economic and social organisation share many common features across countries. Furthermore, knowledge itself is universal. Economies and societies are becoming increasingly integrated and interdependent. International cooperation, particularly within the EU, is also increasingly important for research, development and innovation in Ireland.

The Key Dimensions

3.2 In Annex 3, Figure A.3.1 we illustrate some of the important dimensions of national innovation systems which need to be addressed in the design of a world class system. An appropriate strategic positioning in respect of these is a prerequisite for success.

3.3 The relationships and linkages between these dimensions (which in a sense we can regard as key success factors) are demonstrated by the use of an illustrative device in Annex 3, Figure A.3.2. The diagram shows the linkages, particularly between research and generation of new knowledge and understanding, both for policy formation and support of public welfare and for industrial innovation links. The spectrum spans a range of activities from basic curiosity driven research, through to the exploitation and commercialisation of intellectual property. All components of the research system are important, either directly or indirectly, to the strength of the national innovation system.

3.4 The relationships between the different elements and stages are complex. It would be a mistake to assume that there is an inevitable linear sequence between basic research and successful commercialisation. Nevertheless, and conscious of the risks of over-simplification, we can group the dimensions illustrated in Annex 3, Figures A.3.1 and A.3.2 under a number of broader headings, which include:

- Education and learning
- Basic research
- Applied research
- Development
- Technology transfer
- Commercialisation

23 Johnson B. Institutional Learning. Chapter 2 in Lundvall National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning. Pinter, London 1992.

24 See, for example, Veblen, T. The Place of Science in Modern Civilisation. Reprint Augustus Kelly, New York (1965) 1919.

3.5 This analysis allows us to group the dimensions into two broad domains. This will also provide us later in this discussion with some guidelines on the appropriate specialisations, as well as the relevant division of labour which is required between the relevant support agencies.

The Two Key Domains

3.6 The first domain, which we describe as ‘Knowledge Production’, includes the dimensions which relate to education, training, basic research, and learning (whether curiosity driven or mission-oriented). The research and higher education system and institutions are central to this domain and to a successful innovation system. Their contribution comes in the form of human capital through investment in education and skills, through participation in research and through the efficient translation of the outputs of research (including patents and intellectual property). Effective linkages and co-operation with industry are important for this last stage. International comparisons show that Ireland needs to enhance its knowledge base in order to increase and deepen the human capital and knowledge base which will provide the foundations for future innovations. This requires increased levels of investment in higher education, research and training-at a time when other countries are doing likewise. The improving quality of human resources and research intensity, worldwide, is intensifying the challenge.

3.7 Our analysis also highlights the second important domain in the form of the corresponding importance of the processes of dissemination, transfer, mobility and commercialisation - in other words, the 'output side'. We refer to this domain as ‘Knowledge Development and Transfer’. It is obvious in regard to these aspects, that policy and services for commercialisation must be user driven and respond to user needs. They must also be flexible. The experience in innovation management is that one size does not fit all. The design of incentives and services is crucially important. Schemes must fit company needs, not the reverse. Such "customisation" requires a specialisation in agency capabilities, as well as a close proximity to, and regular contact with research users. Equally, commercialisation structures and processes should have a "good fit" with the higher education system and with researchers. The complexity of the innovation system and the limited linearity between research and application means that specialised institutional structures are required, if complex business innovation and commercialisation support is to be effectively discharged by the relevant public bodies.

3.8 In summary, these two broad dimensions of the national innovation system are mutually interdependent. Because there is not a linear causality between basic research and innovation, attention to commercialisation is vital, if investments in basic research are to bear fruit. Research is a necessary, but not sufficient condition for innovation. Unless the commercialisation domain is properly resourced and structured, Ireland will fail to exploit the economic and social returns from investment in basic research. On the other hand, even a well designed and resourced commercialisation structure will not yield economic returns, unless it can draw on a world-class research base of sufficient depth and scale.

3.9 In the Irish context, consideration of the ‘Knowledge Development and Transfer’ domain, and particularly the matter of co-operation between businesses and higher education, should also encompass relationships between Irish higher education institutions and multinational corporations. We discussed in Chapter 2 the need for Ireland to make a paradigm shift from an 'Investment-Driven' economy to an 'Innovation-Driven' society. This will be a major undertaking requiring considerable investment, as well as major developments in policy and behaviour. The economic dividends from the new investments in research, technology and innovation will arise only in the long term. In the interval, public policy must continue to support and attract foreign direct investment. Indeed, it is certain that foreign direct investment will continue to be a significant motor of economic development after we have achieved success in becoming an 'Innovation-Driven' society. However, the profile of investment projects is changing and will continue to do so as the economy moves up the "value added" ladder. Encouraging multinational companies, particularly those which already have investments here, to invest in research and development in Ireland and to undertake research collaborations with higher education institutions, will be a part of the way forward, not just for attracting new investment, but also for locating business functions in Ireland which are less likely to be threatened by short term economic fluctuations or cost competitive pressures. Such an approach (which we understand is already being pursued) contributes to the policy objective of "embedding" the multinational enterprise in the economy and should be reflected in the organisational architecture. A related strategic objective is to develop and intensify linkages in the innovation area between multi-national and indigenous enterprises, as well as between both sectors of industry and the third level sector.

Implications for the Policy Framework and Institutional Structures

3.10 The preceding discussion of the complexity of the innovation "landscape" helps us to identify the requirements for a successful policy framework. In our view, such a framework is likely to be one which has a number of specific policy objectives and instruments, encompassing a range of diverse but interdependent policy areas ranging from education and training to areas such as taxation policy and incentives, the environment for venture capital and the arrangements for the ownership and control of intellectual property. Each of these policy areas requires appropriate support systems and structures, backed up by customised funding modalities. The scope and diversity of the elements in a national innovation system demonstrate the need for a co-ordinated intervention and support from a variety of specialist and dedicated funding agencies, each with its own context specific understanding of the dynamics of the subjects and of the institutions involved.

3.11 In our view, this complex range of policies and activities is unlikely to be addressed successfully by a single organisation. Clarity of mission and clear lines of accountability are among the essential criteria for successful organisations. 'One-stop-shop' models of organisation for the promotion and management of state support for research and development might be superficially attractive. But, given the complexity of the system they are likely to be ineffective. A single organisation operating in a complex policy and operational domain will inevitably be subject to tensions between different policy objectives. This creates risks of confusion and imbalances. Reduced accountability will also result from a lack of clarity of mission. A single organisation is unlikely to be able to address a multiplicity of objectives which, though mutually reinforcing and interdependent, require different organisational approaches and skill sets.

3.12 In this regard we were struck by the emphatic opinion of the United States Committee for Economic Development:

"Federal support for basic research should be diverse in its funding sources, resisting efforts for central control or concentration in one mission area. The diverse model is most viable politically and is best-suited for the unpredictable nature of basic research outcomes. Therefore, we do not support calls for a 'Department of Science' or for an NSF that would envelop all other federal sources of basic research support." [25]

25 US Committee for Economic Development. America's Basic Research. Prosperity Through Discovery. 1998. The Committee is now approaching its 60th anniversary and comprises leaders from business and academia in the US.

3.13 A similar view has been stated by An Taoiseach;

"The Government is fully committed to continuing to support the development of a vibrant research community in Ireland. We are also committed to ensuring that there are a range of funding avenues open so that we have no return to the days of a highly prescriptive research policy. While we have to make sure that we invest strategically, we also have to let the academic community meet the challenge of developing organically. With funding schemes providing for individuals, institutions and national strategic priorities, I believe that we are now reaching a position where Ireland will be able to become internationally recognised as a research centre." [26]

3.14 The relevant provisions in the Agreed Programme for Government also reflect this approach.

- "We will work to ensure that Ireland develops a world-class research capacity. We also recognise the importance of encouraging a dynamic research culture and will continue to support research on the basis of recognising the distinct, but also inter-connected roles of different programmes, from individual grants up to more targeted support for areas of national strategic interest.
- We will ensure that the Programme for Research in Third-Level Institutions administered by the Higher Education Authority on behalf of the Government is maintained with funding rounds being placed on a multi-annual basis.
- We will place Science Foundation Ireland on a statutory basis as a dynamic vehicle to provide funding for areas of strategic national importance including ICTs and biotechnology.
- We will bring together the Irish Research Council for Science, Engineering & Technology and the Irish Council for the Humanities and Social Sciences Research as parts of a new council."[27]

3.15 These views also concur with conclusions that can be derived from analyses carried out by OECD[28] and EU[29], that, having regard to the importance of each countries history of development:

- There is unlikely to be a universal set of best practices for effective RTD investment policies, although broad guidelines can be derived which can be utilised as learning tools by countries.
- 'Best practice' is not an absolute and is nearly always context specific and path-dependent with each system having different priorities and challenges.

26 Speech by An Taoiseach, Mr Bertie Ahern, T.D., at the Conway Institute of Biomolecular and Biomedical Research, U.C.D., 6th March 2002
27 An Agreed Programme for Government Between Fianna Fáil and The Progressive Democrats, June 2002
28 The OECD Jobs Strategy:Technology, Productivity and Job Creation-Best Policy Practices, 1998.
29 Commission Staff Working Paper; Benchmarking National RTD Policies , European Commission 2002

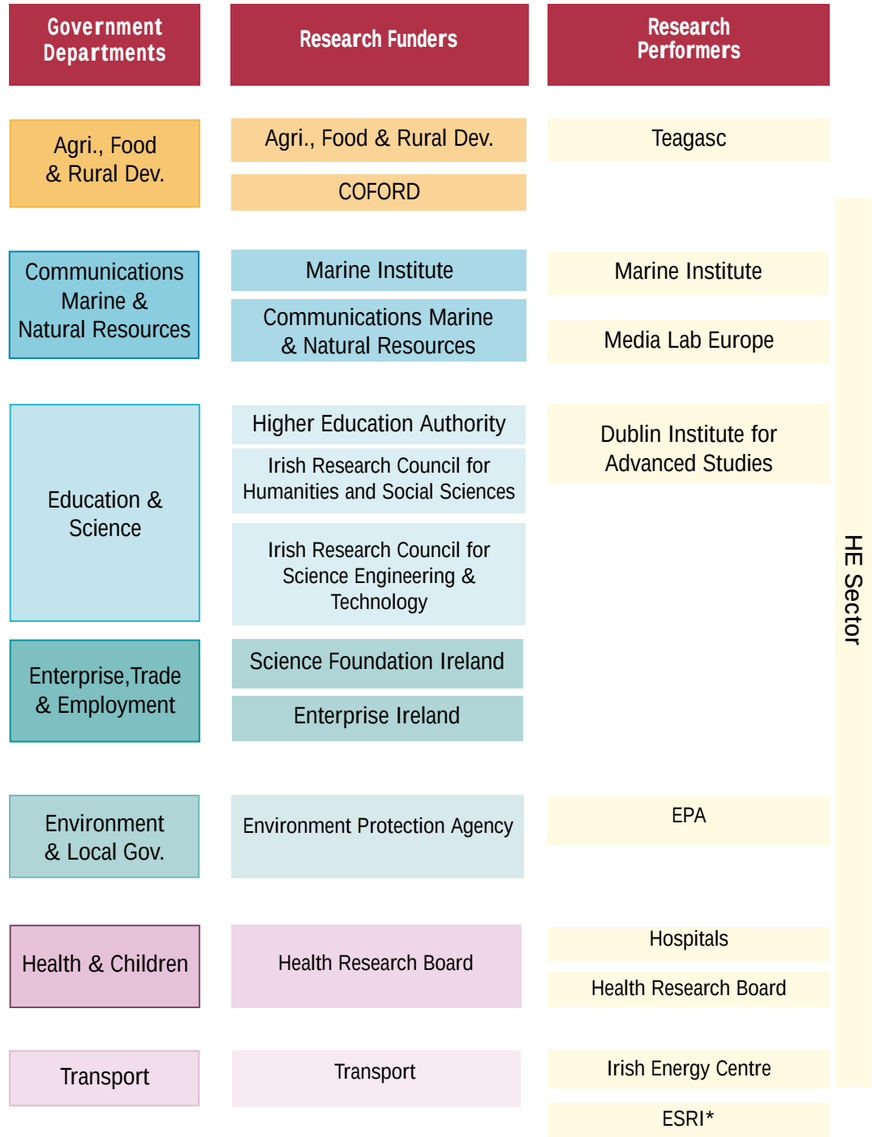
- The complexity of RTD and innovation systems is such that individual policy instruments applied in isolation, are less likely to have a substantial impact on overall performance. There is a need for a broad portfolio of policy instruments in order to heighten the chances of success of a national innovation system.

3.16 The HEA accepts the requirement for a diversity of institutions and policy instruments. We also see the need for policy coherence, oversight on behalf of Government, effective co-ordination between Government Departments and effective inter organisational co-operation.

Research in Support of Public Policy - the 'Functional' Dimensions

3.17 Our discussion in relation to public policy in this chapter has focused mainly on the overarching policy objective of effecting the major transformation to an "Innovation-Driven" society. The role of research in support of individual sectoral public policy objectives is also important. In this respect Government Departments (Ministries) need access to research activities, results and outcomes relevant to their own areas of concern. This is particularly the case in respect of areas such as economic and social policy and analysis, agriculture, health, education, marine resources, environmental policy and transport. The research structure should take account of this reality. Ireland already has a number of 'functionally' focused research and development performing or funding organisations. These include the Health Research Board (HRB), the Economic and Social Research Institute (ESRI), Teagasc, the Marine Institute and the Environmental Protection Agency (EPA). Government Departments which are involved in directly commissioning research from the third level institutions include, Agriculture, Food and Rural Development, Communications, Marine and Natural Resources, Education and Science, Enterprise, Trade and Employment, Environment and Local Government, Health and Children and Transport. These arrangements are included in the illustration in Figure 3.1.

Figure 3.1 Public Research Funders and Performers



**The Economic Research Institute (ESRI) is an independent, non-profitmaking body.*

International Co-operation

3.18 The design of a structure to support innovation should also have regard to the international dimension. Knowledge is international. Involvement in international research programmes has been critically important in the development of the Irish research system. Indeed, during the 1980s and the 1990s, in the absence of sufficient national funding, participation in EU-funded programmes became an essential operational and funding support for Irish researchers, particularly those working in third level institutions. An effective structure for research, development and innovation should be such as to ensure optimum participation by the Irish research community and institutions in international research co-operation, particularly within the European Union and its Framework Programmes and in the developing European Research Area. We note in this regard that the Agreed Programme for Government[30] includes a commitment to

"working to ensure that Ireland maximises its draw-down under the EU 6th Framework Programme for Research and Development"

3.19 However the benefits from interactions in the European context go beyond potential funding. Whilst Ireland is moving to becoming an Innovation-Driven Society, the European Union is moving in the same direction, and many of our partners are more advanced in this regard than we are. Therefore, it is of paramount importance that Ireland is a full partner and works with the rest of the European Union to bring benefits to the European economy as a whole. Furthermore, the benefits to be accrued from interactions with researchers in the international domain cannot be underestimated, if we seek to establish ourselves as world players in this arena. Our presence thus must be felt in the international, and in particular in the European arena.

The Operating Principles

3.20 Arising from this discussion we can begin to set out the operational principles which we consider should underpin the design of a national system for research, development and innovation and particularly for the provision of State financial support:

- A broad portfolio of policy instruments is required.
- These will not be efficiently and effectively delivered through a centralised funding and organisational structure. A number of "mission focused" and effectively coordinated organisations are required.
- Support modalities and mechanisms need to be sufficiently flexible to provide support for a continuum of activity from education and learning, research and development (in all their dimensions), to technology transfer and commercialisation.
- Support systems and mechanisms need to respond to the needs of public policy both sectoral and functional (e.g. in health, agriculture, industrial development, environmental protection and the development of marine resources).
- The system should be structured in such a way that the opportunities for optimum international co-operation can be realised.
- There is a need for effective central structures for policy review and oversight.

Applying the Operating Principles - the Implications for the Organisational Framework

3.21 Mapping the scope of agency participation and inter-agency collaboration in the implementation of the principles set out in paragraph 3.20 requires consideration of different mechanisms for the different levels of action involved from policy co-ordination, planning and funding, through to implementation, monitoring and evaluation. In determining institutional roles, it is necessary to distinguish clearly between different types of actions and responsibilities. Policy co-ordination is not the same as functional control and will require a different approach and modalities.

3.22 There are at least two tasks in this design and mapping exercise. The first is to establish criteria which would underpin organisational effectiveness. The second is to identify the appropriate missions or areas of organisational responsibility.

30 An Agreed Programme for Government Between Fianna Fáil and The Progressive Democrats, June 2002

Criteria for Organisational Effectiveness

3.23 Our belief is that the design of institutional responsibilities for research funding ought to include the following criteria:

- **Clarity of mission**-each organisation should have a clear and unambiguous mission and corresponding accountability.
- **Fitness for purpose**-the organisation's form and activities should be consistent with its mission; it should be competent, legitimate and appropriate for the funding actions that are needed.
- **Subsidiarity**-institutions deciding on funding should be closest to the point of performance.
- **Synergy**-the funding body should be able to manage the interdependencies that exist between knowledge intensive institutions and exploit possibilities for economies of both scope and scale between them.
- **Organisational learning**-accumulated institutional knowledge, which is built on established and agreed common codes for coordination and communication among the research performers, should be maximized.[31]

Appropriate Missions or Areas of Organisational Responsibility

3.24 Our basic premise is that organisations should not only have, and adhere to, clear and explicit statements of purpose, but they should also operate within clearly understood domains. We identify a number of these domains using for ease of reference the schematic list we set out previously in this chapter. As we discussed, the organisational missions would fit within two broad domains.

3.25 The first 'Knowledge Production' encompasses:

- Education and learning
- Basic research

Within this domain the key support activities include:

1. The provision of State financial support at institutional and student level for teaching and learning in higher educational institutions, as well as the implementation of effective frameworks for governance, management and quality assurance.
2. Having regard to the intrinsic interdependence of research, education and learning, the provision of State financial support for individuals, research projects and teams, as well as for institutions in order to promote the development of world class research capacity across all the domains of scholarship, including the humanities, the social sciences, science and technology, medicine etc.

3.26 The second domain, ‘Knowledge Development and Transfer’, as we discussed earlier in this chapter encompasses:

- Applied Research
- Development
- Technology Transfer
- Commercialisation

The key requirements for State action in this domain include:

1. The need for both systemic and project based support systems which will optimise the processes of technology transfer and commercialisation.
2. The need to promote research co-operation and collaborations between business enterprises and higher education institutions.
3. The need to develop the so-called 'complementary assets' in companies i.e. skills, R&D etc. in order to improve the potential for stronger interaction between business and the research base.
4. A framework which enables the efficient exploitation of intellectual property. These requirements are identified in the Agreed Programme for Government [32]

- "We will actively support research collaboration between firms and third-level institutions.”
- “We will seek to improve structures and practices to enhance the commercialisation of publicly funded research."

31 Features characterising organisational learning (a different concept from individual learning), include rules in which processes are embedded, coordination processes and conflict reduction mechanisms most of which are cumulative and path dependent. See, for example, M. Teubal's Horizontal technology policies in Latecomers in the Global Economy. Edited by Michael Storper, Stavros B. Thomadakis and Lena Tsipouri. Routledge 1998.

32 An Agreed Programme for Government Between Fianna Fáil and The Progressive Democrats, June 2002

The Importance of Clarity of Mission

3.27 It may be important to assert that the criteria of effectiveness, particularly the need for clarity of mission, are unlikely to be met by an organisation functioning in more than one of these two domains. However, this same criterion may also require the need for the presence of more than one organisation within a specific domain. This is particularly the case in respect of the organisational arrangements for the provision of State funding for research in higher education institutions. We identify two broad categories of required funding mechanisms.

(i) Support is required at institutional level in respect of funding for essential institutional capacity such as staffing, physical infrastructure, running costs for laboratories and research facilities and core institutional research programmes.

(ii) Specific funding programmes are also required for individual projects and programmes, as well as an array of supports for individuals, including scholarship programmes for research students and funding for post-doctoral fellowships.

3.28 In our view, the management and operation of these funding activities should be entrusted to separate organisations with appropriate missions, mandates and structures.

Finally.....

3.29 We will return to this analysis in Chapters 5 and 6. In doing so, we will examine the present institutional landscape. In addition to principles and criteria which will guide us in identifying an effective division of labour between the key players, it will be necessary also to ensure:

- Effective policy oversight and co-ordination arrangements
- A mix of sectoral and horizontal funding mechanisms
- Funding modalities providing support for individuals, projects and institutions
- The need for organisational arrangements to have regard to, and to support, Government policy - including the provision of research support in sectoral areas such as agriculture, health, environment and marine resources
- Effective structures for enhancing involvement by the Irish research community in international cooperation activities and in securing funding from international (particularly EU) funding programmes.

3.30 The discussion in this Chapter may have appeared to be concerned to a very considerable extent with research, development and innovation in science and technology. Clearly, these are the areas of knowledge where the need for effective structures and mechanisms for commercialisation is most pressing. However, it should be evident from our discussion in Chapter 2 that we are also concerned with the organisational arrangements for the funding of research in the humanities and the social sciences. We regard the principles which we have set out as relevant to the organisation of funding for research in all areas of scholarship.

chapter four

International Experience-Policy Co-ordination, Structures and Funding[33]

33 *The data for this Chapter is drawn from information in the public domain, the WWW and published studies and reports. We have tried to access the most recent information on structures and systems, but appreciate that these arrangements are frequently being reorganised and changed. We understand that the Commission intends making its own enquiries on these aspects in a selected number of countries.*

In this chapter we look at research, development and innovation structures in other countries against the perspective of the principles which we have advanced in Chapter 3.

The European experience is comprised of institutional landscapes in continuous evolution and change with frequent reviews and structural alterations, as countries search for appropriate structural and policy co-ordination mechanisms. Existing arrangements appear to be bound up with country and context specific circumstances, with path dependencies tending to shape the direction of change.

However, despite a diversity of funding structures and approaches, we find compelling evidence of support, both in Europe and in the US, for the principles outlined in Chapter 3.

In particular, it is evident that there is a preference for multi-agency models of organisation, which provide a variety of merit-based funding opportunities for researchers, open to all disciplines and areas of scholarship, built on a bedrock of solid institutional research infrastructure in the third level sector. We found most countries searching for better arrangements for overarching policy co-ordination, as well as evidence of resistance to centralised control of research funding.

Diversity of Institutional Structures

4.1 In Europe, the public funding of research is regulated, managed and conducted by a wide variety of agencies and institutions. Over the past twenty-five years, European governments have repeatedly changed and restructured their institutional arrangements in pursuit of more effective structures. These changes have covered a wide spectrum, involving, inter alia, the organisation and location of research, the prioritisation of specific fields, the scope of agencies responsible for funding and the mechanisms for the allocation of funds and for policy co-ordination. As authors of a recent report point out, the defining characteristic of European research systems is their diversity, reflecting, as they do, different social, economic, political, institutional, legal and historical contexts in which both structures and systems have emerged, evolved and operated.[34]

34 See, for example, SPRU European Comparison of Public Research Systems September 1999.

4.2 As the authors point out, the political history of each country has had its own influence, the German occupation on Norwegian universities, Fascism on public research systems in Portugal and Spain, the Communist regime on the structures in countries of Central and Eastern Europe, World War II on the growth of defence research institutions in Sweden, the commitment to nuclear research on the emergence of dedicated research structures in the UK, France, Germany, Norway and Sweden. The early lead of the former USSR in space impacted on US military and defence research policies. The development of the Land Grant Colleges on US campuses influenced the development of structures for agricultural research in the US. In addition, international bodies, like OECD and EU, have influenced institutional arrangements for research and policy co-ordination. Both have influenced the design of structures in Italy, Spain, Portugal and Sweden, for example.

4.3 Government expectations of research have also influenced the structural arrangements that have been put in place the priority given to 'advancement of knowledge' in Sweden and France, for example, or the support for public welfare (health, environment, public safety) in Germany, or the priority accorded to prestige and high profile programmes in France and Italy and in Spain, even during periods of limited funding for research. The uniquely French approach to the so-called 'Programmes de Development Technologique' known as the Grandes Programmes, a major feature of the French research landscape, are well known for their successes in boosting "national champions" such as SGS, Thompson, Alcatel, Airbus and Aerospatiale.[35]

4.4 Some countries have tried merging responsibilities at government level for higher education, research and technology on the grounds that bringing them into closer contact will help them to contribute better to wealth creation - France, Germany and Italy, for example. Others have adopted different approaches. Denmark has tried a variety of formats, merging ministerial responsibilities for research and technology, and later separating them, and, on another occasion, dividing responsibility for universities between a Ministry for Research and the Ministry for Education.[36]

4.5 The German system, for example, is characterised by a predominantly independent institute structure, the French by the Centre National de Recherche Scientifique (CNRS), while in Sweden the research system is largely university based. Another distinguishing feature of the French research system is the presence of a large number

35 Laredo, P. and de Laat B. Public Sector Research in France for TSER SOEC-CTp9-1036 Changing Structure, Organisation and Nature of PSR Systems June 1998

36 The term Ministry is used to indicate Government Departments, except in the Irish case when the official name of the Department is being used.

of Organismes Publics de Recherche (OPRs), mission oriented public research institutes, each active in a specific field. The UK has taken a different approach, with similar laboratories being privatised in recent years.

4.6 Germany has the greatest proliferation of research performing bodies. In addition to the universities and government laboratories, it has four different categories of stand alone research institutes. The French system is relatively centralised, the German is very decentralised, with many mechanisms to promote co-ordination. The German experience appears to be that efforts at institutional co-ordination may be dysfunctional and can result in the lowest common denominator being agreed in an effort to get everyone to the table. Compromises acceptable to all are reported to frequently result in controversial issues being shelved.[37]

4.7 In some countries, France and Germany, for example, funding is concentrated in one Ministry, which is responsible for more than half of the Government's funds for research and development. In others, Australia and Japan for example, two-thirds of the funds are allocated by the Ministry of Education and a Science and Technology Ministry. In Canada, decisions on research funding are spread over a large number of Ministries and agencies.

4.8 In France, there is a Ministry of Research, in Germany a Federal Ministry of Education, and in Italy a Ministry of Universities and Scientific and Technological Research. In the UK and Portugal, for example, responsibilities for science and technology are to some extent separate from higher education.

4.9 Norway has a strong tradition of Research Councils. Until 1992 these were linked to their respective Ministries in education, agriculture, fisheries, industry etc. Some were strongly mission oriented. This changed in 1992 with the establishment of a single Council structure, under the Ministry of Education.

4.10 Approximately one third of Norwegian research is performed in the independent, close to market, research institute sector. The opposite is the case in Sweden where the university sector dominates. Here, the universities appear to be regarded as the most appropriate location for publicly funded research, although debate has continued about this.

37 PREST Measuring and ensuring excellence in government science and technology: International Practices. Jan 2001

4.11 In Sweden, the Ministry of Education has the central role, with responsibility for the preparation of a White Paper on research every three years. Sectoral policies have a strong bearing on research funding and policy. For example, health policy influences medical and health research. Research Councils have been found to be a stable and competent force in funding of research for many years. A recent restructuring has resulted in the establishment of the Swedish Research Council, consisting of a Board with three scientific committees. This is the largest agency and the major funder, with responsibility for funding basic research, providing expertise on research policy and strengthening the position of basic research in Sweden. Two other Research Councils have been established, one for environment, forestry and agriculture and the other for social issues and quality of life. The research institute sector is relatively small in Sweden.

4.12 Denmark has a centralised approach, with a Ministry for Science, Technology and Innovation, but there appear to have been some difficulties with this arrangement, resulting in some revision and reconstitution of the structures for policy co-ordination. Research Councils operate under the Ministry of Education and there has been an ongoing debate about co-ordination, overview and national strategy. Formerly, co-ordination responsibilities fell to the Ministry of Education and Science. More recently, a new Ministry for Science, Technology and Innovation was established, though there appears to have been some resistance to a centralised planning approach.[38] Denmark has a relatively large independent laboratory and institute sector, accounting for some 17% of Danish research expenditure

4.13 Finland, a world leader in terms of the commitment made to investment in research, has established an operational distinction between science and technology. The Ministry for Education is responsible for science policy and the Ministry for Trade and Industry for technology policy. The Academy of Finland, a state organisation incorporating four Research Councils, is the most important financing organisation for basic and university research and operates under the Ministry for Education. The Ministry for Trade and Industry provides support for industrial research and development through Tekes (The National Technology Agency), operating under the aegis of the Ministry, and is the most important funding agency for industrial research and technology. Overarching policy advice is provided through a Science and Technology Policy Council, which is chaired by the Prime Minister. The Council membership includes Government Ministers, key officials and experts and operates

38 Skoie, Hans. The Scandanavian Countries and their Systems of Public Research. Norwegian Institute for Studies in Research and Higher Education. Dec 1998.

with two sub-committees, one responsible to the Council for science policy and the other for technology policy, which are chaired by the respective Ministers. The Council has helped to improve collaboration and to defuse earlier rivalries between the different funding agencies.

4.14 The UK system puts emphasis on research within a university framework, combining graduate teaching and research. The Department of Education and Skills (DES), and higher education funding councils in the UK, support research through funding allocated to colleges (who make individual expenditure decisions). This funding is guided by the Research Assessment Exercise (RAE). The funding councils have also recently invested in research infrastructure through a dedicated programme. Responsibility for science and technology in the UK rests with the Treasury, Cabinet Office and the Office of Science and Technology, part of the Department of Trade and Industry (DTI). However, these appear to provide only loose guidance, setting the key principles and the general framework. Following a period of increased central intervention during the early 1990s, which was criticised for being inflexible, policy and implementation at the more detailed level has been devolved to the individual sectoral Ministries.

4.15 The seven UK Research Councils have rationalised their research institutes and funding has been directed towards the universities on the grounds that they provide more flexibility for moving rapidly into new areas, as the need arises. Government laboratories have been privatised and now compete with the universities and research institutes for Government contracts. Research institutes in Norway and in Italy have undergone extensive restructuring and, as in many countries, must pay their way through contract work.

4.16 In the US, most of the funding comes from eight mission-oriented Departments/Agencies as shown below in Table 4.1, with Health, Defence and NASA being the biggest contributors.[39] The agencies outlined below sponsor most of the research in US colleges and universities, with the NIH accounting for approximately half of the total federal outlay in this regard.

Table 4.1 US Research Agencies and Actual Expenditure in 2001

Research Agencies	Number of Budget Lines	2001 Actual
National Institutes of Health (NIH)	24	$20.6bn
National Science Foundation (NSF)	9	$4.5bn
Department of Agriculture	7	$2.38bn
Department of Commerce	3	$2.63bn
Department of Defense	3	$8.93bn
Department of Energy	2	$2.02bn
Environmental Protection Agency	1	$0.71bn
National Aeronautics and Space Administration (NASA)	4	€6.88bn

4.17 The official science agency, the National Science Foundation (NSF), accounts for about 22% of the Federal support for basic research and approximately 3% of the total Federal research budget[40]. Multiple funding arrangements and research intensive universities integrating research and teaching form the backbone of the US research system. The influential US Committee for Economic Development has fully endorsed the principles of plurality and diversity in the funding for basic research.[41] The Committee's view is that sources of support should be diverse and the objectives of basic research similarly so, and there should not be any attempt to impose central control or to concentrate resources in pre-selected research areas or nominated research institutions. A free market in ideas and entrepreneurial competition for research funding is preferred to top-down decision-making. We referred in Chapter 3 to the emphatic opposition of the committee to centralisation of basic research funding, either at NSF or in a Department of Science.

4.18 The successful US innovation system is based on recognising the connection between teaching and research. After World War II, the United States made the remarkable national policy decision that the Federal Government should invest heavily in scientific research, and that most federally sponsored research should be done in the nation's universities. This policy was unique in the world at the time, and has helped to elevate

39 The Chronicle of Higher Education, 15 February 2002. US Budget 2002
40 Hurt, John C. Creating, Connecting and Collaborating; The Role of Academe in the 21st Century. NSF Workshop October 2001.
41 US Committee for Economic Development. America's Basic Research. Prosperity Through Discovery. 1998.

scientific research in the US to the highest standards in the world. Other nations, most notably Russia and to a lesser extent Japan separated teaching institutions (the universities) from research institutions (government or industry laboratories) and lost the opportunity for the synergy between higher education, learning and research that characterises the US system.[42]

4.19 In a study for the EU involving twelve European countries, the University of Sussex reports, "there is no single model able to reflect the diversity of funding arrangements for PSR (public sector research) in the countries studied" and also that "there has been extensive reorganisation of the agencies (usually councils) that provide research grants, but no general trends emerge from these changes".[43]

4.20 When it comes to structural arrangements, it is clear that there are no universal detailed prescriptions for organisational architecture. While Research Council structures are common in many countries, they are by no means the choice of all, as Table 4.2 demonstrates:

Table 4.2 Main Funding Structures - Basic Research

Country	Main Funders
US	Departments/NASA/NIH/NSF
Finland	The Academy /Research Councils
Germany	Federal Government/DFG
Norway/Denmark/Sweden	Research Councils
France	Ministry of Research/CNRS
UK	DTI, 7 Research Councils, DES
Netherlands	Ministry of Education/NWO/Research Councils

Continuing Flux

4.21 The European experience is of institutional landscapes in continuous evolution and change with frequent reviews and structural alterations as countries search for appropriate structural and policy co-ordination mechanisms. Mergers and restructuring continue, growth in the number of funding bodies is followed by consolidations. Attempts at central co-ordination appear at times to run into difficulties and resistance from the research community. Sometimes co-ordination is the responsibility of the Ministry of Education (Sweden and Norway), sometimes the Research Ministry (Denmark). There appears to be an ongoing tension between centralised and sectoral approaches (Denmark, for example). In the UK, pressures for relevance and value for money have led to the use of performance indicators, league tables and benchmarking exercises with concomitant bureaucracy. Some UK academics complain that they spend more time writing reports justifying their activities and assessing others, than they do in the pursuit of teaching or research![44]

4.22 In France, over the past ten years, universities and the Grande Ecoles have extended their function of higher education establishments, and qualitatively and quantitatively play an increasing role in academic research, next to the CNRS. This has been accompanied with a progressive inter-mingling of researchers from both sets of institutions. Both have dramatically improved their links with industry.

4.23 Sometimes agencies appear to be moving in opposite directions. For example, at a time when the CNRS was becoming more socio-economically oriented, the public research institutes (OPRs) have followed the opposite path and established themselves more firmly in academic traditions. The universities and Grandes Ecoles have transformed themselves from educational institutions to fully fledged teaching and research organisations.

4.24 Government institutes are being privatised (UK) and moved closer to the market (Iceland and Norway) while in other countries (France) some are moving closer to academic research.

Policy Co-Ordination

4.25 Many countries have experienced difficulties in establishing policy co-ordination and overview at national level.

4.26 France appears to have a highly co-ordinated system, with central co-ordination over general strategy. But implementation and control is delegated to the sectoral Ministries. The German system would superficially appear to be the least co-ordinated, but informal systems and the need for Lander and Bund co-operation produces co-ordination.

42 Feller, Irwin. The American University System as a Performer of Basic and Applied Research and More. Conference Paper. Cambridge Mass. September 1998.
43 SPRU 1999 op cit
44 Sharp, Margaret. The UK Experiment: Science, technology and industrial policy 1975-1997 paper for Triple Helix Conference, Rio de Janiero, April 2000.

4.27 Arrangements for policy co-ordination are generally complex and interwoven with their respective national economies, with no particular structural arrangement appearing to dominate (Table 4.3)

Table 4.3 Structures for Policy Co-ordination

	Overarching Policy Co-ordination
US	President's Council/NSTC
Germany	Bundestag Committee/Ministry of Education & Research
Finland	Science and Technology Policy Council, chaired by Prime Minister
Norway	Ministry of Education, Research and Church Affairs
Sweden	Ministry of Education and Science
Austria	Council for Research and Technological Development
France	Ministry of Research
Denmark	Ministry of Science, Technology and Innovation
Netherlands	Ministry for Education, Culture and Society
UK	Treasury/Cabinet Office/DTI/OST/Ministerial Committee

Some Conclusions

4.28 Existing 'models' of research organisation appear to be strongly country and context specific. Path dependency not only explains the structures of national systems, it also determines the pace and the extent of change which may be possible. There would not appear to be a universal model, as such, which could be replicated in the Irish situation. On the basis of the evidence available, questions would have to be asked whether any model being considered is a success, whether it is the cause of the success of a particular national innovation system or if other factors are at work and whether it would be successful under different circumstances. Path dependency and contexts do count and have an impact.

4.29 Therefore, in searching for improved institutional arrangements or overarching mechanisms, it would be wise to take full account of the cultural, socio-economic, political, institutional and legal contexts within which particular institutional arrangements have emerged, evolved and developed.

4.30 While many of the elements of other country's systems can also be found in the arrangements which currently exist in Ireland, the Authority believes that it is very difficult to identify a single preferred model, or structure for the organisation of research policy and funding structures, from the evidence of international practice, which can be confidently recommended for Ireland.

4.31 The evidence does however suggest some trends that might be taken into account, as well as some operating principles that appear to be important in working out appropriate arrangements for the Irish system. These have stimulated the following observations, based on the principles outlined in Chapter 3:

- The universities and their associated institutions such as hospitals, and higher education institutes seem to be emerging as the central research players. A common trend is the increasing proportion of research taking place in universities, with a decreasing role for research institutes.
- The position of independent research laboratories and institutes appears to be weakening. Some are being asked to move closer to the market, others are being privatised. In some cases, they are finding it appropriate to establish stronger connections with the universities. The flexibility of the university research base appears to be an advantage.
- The provision of multiple and diverse funding opportunities for researchers in the higher education sector, operating on merit based, competitive funding processes, open to all research disciplines and areas of scholarship
- The presence of independent mechanisms (outside Ministries) for the funding of basic research, Research Councils in many countries, for example.
- The presence of a strong 'sectoral approach' in many countries, where Government Departments/Ministries are responsible for the funding research related to their individual missions and requirements.
- The difficulties that seem to have been encountered by attempts to establish centralised top down control mechanisms.
- The need for a centralised policy co-ordination function at the national level which focuses on co-ordination rather than control.

chapter five | The Irish Experience

In this chapter we examine the existing structures for supporting research, development and innovation in Ireland against the perspectives of the principles set out in Chapter 3 and the discussion of structures in other countries in Chapter 4. The funding mechanisms and structures now in place for basic research in the higher education sector are broadly appropriate, satisfy the principles set out in Chapter 3 are functioning effectively and are more streamlined than in many successful European and North American research systems. Nevertheless we identify some shortcomings at the systemic level. These include the lack of an effective policy co-ordination mechanism at national level, the need for greater clarity about the mission and role of some agencies in funding basic research in the higher education sector, the need for the development of policies and structures for the systemic support for commercialisation and its related activities and the need for co-operation on programming, scheduling and information dissemination between the agencies currently funding research in the higher education sector.

This chapter is presented in two sections. Section 5.A presents an overview of the Irish research funding system and the agencies generating core capacity in the system (including the HEA-PRTLI). Section 5.B sets out a critical review of funding mechanisms in the Irish research system and the current overarching structures for policy co-ordination. The system is reviewed with reference to principles set out in Chapter 3. In this section we also outline some proposals for addressing shortcomings in the system. Our complete set of recommendations is set out in Chapter 6.

Section 5.A: An Overview of How Research is Funded in the Higher Education System and the Mechanisms Generating Core Capacity in the System

Introduction

5.1 As illustrated previously, public funding for research in Ireland is currently provided by different Government Departments. Most publicly funded research is carried out in the universities.[45]

Figure 5.1 Public Research Funders and Performers

Government Departments	Research Funders	Research Performers
Agri., Food & Rural Dev.	Agri., Food & Rural Dev.	Teagasc
	COFORD	
Communications Marine & Natural Resources	Marine Institute	Marine Institute
	Communications Marine & Natural Resources	Media Lab Europe
Education & Science	Higher Education Authority	Dublin Institute for Advanced Studies
	Irish Research Council for Humanities and Social Sciences	
	Irish Research Council for Science Engineering & Technology	
Enterprise,Trade & Employment	Science Foundation Ireland	
	Enterprise Ireland	
Environment & Local Gov.	Environment Protection Agency	EPA
Health & Children	Health Research Board	Hospitals
		Health Research Board
Transport	Transport	Irish Energy Centre
		ESRI*

HE Sector

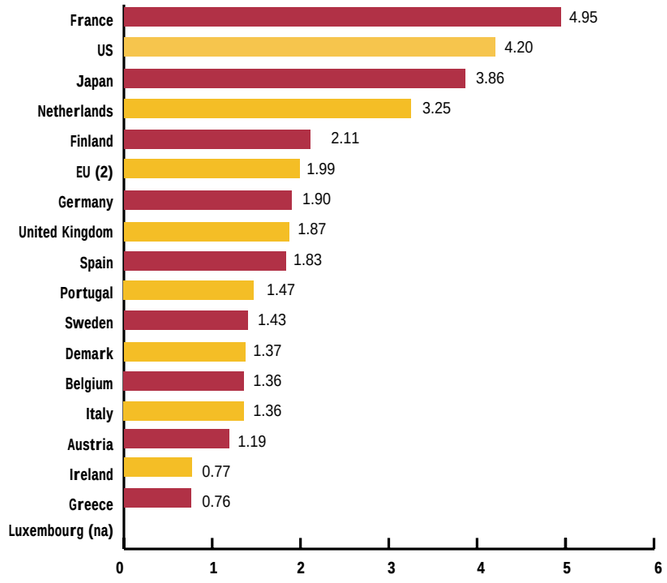
**The Economic Research Institute (ESRI) is an independent, non-profitmaking body.*

45 *Forfás. State Expenditure on Science and Technology 2000.*

5.2 In regard to the performance of public research, there are now more than 20 third level institutions with an involvement in research. The volume of research performed in the government sector is smaller than in the third level sector. The main research organisations in the government sector are Teagasc, the Marine Institute, the ESRI and the Health Research Board. For the most part, the institutional centre of gravity for publicly funded research in Ireland is now located in the higher education system (particularly in the universities).

5.3 The funding structures and elements are now established. Funding levels, although improving, are still low by international standards (Figure 5.2). It should be evident from our discussion in Chapter 2 that a high policy priority needs to be given to the funding of research, development and innovation in order to raise the development potential of the economy and society to a new level.

Figure 5.2: Share of government budget allocated to R&D[46]



Above Data refers to 1999, prior to investments by Irish Government through NDP.
Source: DG Research
Data: Eurostat, Member States, DG Ecfin, US (NSF), Japan (Nistep).
Notes: (1) B, EL, E, F, IRL, I, UK, US and EU: 1999; all countries: 2000. (2) L data are not included in the EU average

5.4 A summary outline of the activities of public sector organisations involved in the funding of research in higher education institutions is shown in Table 5.1.

46 Indicators for benchmarking of national research policies. European Commission 2001

Table 5.1 Summary of Research Funding Provided to HE Institutions in 2001

Organisation	Funding Activities	Expenditure in 2001
Higher Education Authority (HEA)	•"Institutional bedrock" funding (block grant) •Funding of institutional strategies (PRTLI) •Collaborative projects between third level institutions and Media Lab Europe (MLE) •Transport research (on behalf of Department of Transport-commencing 2002)	€100m (est.) €45.9m €1.27m N/A
Irish Research Council for the Humanities and Social Sciences(IRCHSS)	Scholarships, fellowships and research projects in response to applications from researchers and in areas selected by the investigators/scholars	€3.27m
Irish Research Council for Science, Engineering and Technology (IRCSET)	Scholarships, fellowships and research projects in response to applications from researchers and in areas selected by the investigators/scholars	Established in 2001 Estimate for 2002 €5.2m
Department of Education and Science (DES)	Technological Sector Research Fund; support of research capabilities in Institutes of Technology funding provided to researchers and their teams.	€2.6m
Science Foundation Ireland (SFI)	Fellowships and research programmes in response to applications from scientists and technologists in selected areas of economic importance-currently biotechnology and information and communications technologies (including joint funding with industry)	€11.08m
Health Research Board (HRB)	Fellowships and research programmes in response to applications from clinicians, biomedical scientists and technologists in areas of health and social gain.	€11.66m
Enterprise Ireland (EI)#	•Funding support for R&D activities in higher education institutions in the cases of basic and strategic research as well as funding support for scholarships. •Funding support for co-operation between HEIs and firms in the short to medium term exploitation of research, development of an industry agenda to direct these networks and creation of scale in research groups of strategic importance to firms in Ireland	€7.92m €45.2m
Dept. of Agriculture, Food & Rural Development	Support for projects in agriculture areas where gaps are identified and support for innovation and project development in the food industry	€4.5m
Marine Institute	Funding support to enhance and consolidate the performance of the marine sector in Ireland and to provide RTDI capacity and infrastructure.	No funding provided in 2001. Estimate for 2002 €0.58m
EPA	A number of programmes to support research in the environmental area and environmental policy	€3.7m

Source: Private Communications with Government Departments and Agencies 2002
 # This excludes funding of €104.9m for the support for research under the Competitive RTI scheme, National Collaboration and Infrastructure Research, Capability and Training. This scheme supports commercially focused, industry led projects in product and process development although third level institutions may be included as collaborators

Core Capacity for Research Funding

5.5 People and facilities (physical infrastructure etc.) are the essential building blocks for the research system and provide the foundations for programme and project funding. In targeting financial support for research, the Authority is implementing the stated policy position of Government, outlined in the Green and White Papers on Education, acknowledging the role of research in the advancement of knowledge and learning in the third level sector.[47] In the following paragraphs we will briefly outline the funding activities directed at generating "core capacity" in the research system.

HEA-Block Grant

5.6 The HEA 'block grant' for teaching and research provides "institutional bedrock" Exchequer funding for research in the universities. An analogous system for funding research is not yet in place for the institutes of technology where research activities are dependent on programme, project and contract funding. The research component of this unified budget for the universities will amount to approximately €100 million in 2002. The universities have discretion within the framework of their legal obligations, to apportion the block grant between research and teaching.

Technological Sector Research Programme

5.7 The Department of Education and Science provides funding for the institutes of technology which is aimed at supporting and strengthening the research capability of the technological sector, through enabling institutions to focus on research projects based on the core strengths of the institutions individually or of the sector as a whole. The aim is to enhance the skills profile and experiences of researchers and by fostering a climate for excellence in a number of research areas. Support in this area focuses on three strands:

- Post Graduate R&D Skills
- Enterprise Platform Programme
- Core Research Strengths Enhancement

47 The Green and White Papers on Education of 1992 and 1995 dealt with the educational aspects of research and its place in the university sector, in the Institutes of Technology, and in the Dublin Institute of Technology.

An allocation of €38.1 million has been specifically made available for research in the technological sector for the period 2000 to mid 2002. Funding is allocated after competitive processes, involving adjudication by panels comprised of national and international experts. The criteria used to select projects are the academic excellence of the individual researcher/project, the quality, relevance and technical merit of the project.

The Research Councils

5.8 Two Research Councils - the Irish Research Council for the Humanities and the Social Sciences (IRCHSS) and The Irish Council for Science, Engineering and Technology (IRCSET) - have been established (2000 and 2001 respectively), bringing Ireland into line with many European research funding models. The IRCHSS has extended its funding to include research student scholarships, postdoctoral fellowships and visiting professorships, and a funded project scheme has recently been launched. The IRCSET has established support schemes for research students and researchers and further programmes are planned.

5.9 These two Councils provide funding for individual researchers and projects. Funding is disbursed by the Councils using an internationally benchmarked, competitive, peer reviewed process, designed to support excellent researchers and research. The Agreed Programme for Government states that the Councils will be brought together as parts of a new council.

"We will bring together the Irish Research Council for Science, Engineering & Technology and the Irish Council for Humanities and Social Sciences Research as parts of a new council." [48]

We welcome this commitment and recommend that the councils be placed on a statutory footing.

48 An Agreed Programme for Government Between Fianna Fáil and The Progressive Democrats, June 2002. Page 65.

HEA-PRTLI

5.10 In 1998, the Government launched the Programme for Research in Third Level Institutions (PRTLI). The PRTLI, which is managed by the HEA on behalf of the Minister for Education and Science and the Government, provides integrated financial support for institutional strategies, programmes and infrastructure. The programme is competitive. Calls for proposals are issued to all publicly funded third level institutions. The proposals are evaluated by an international panel of distinguished researchers and scholars on the basis of excellence under three criteria - strategic planning (including inter-institutional collaboration), research quality, and the impact of the research strategy and programmes in improving the quality of teaching in the proposing institution. One of the requirements of the competition is that the institutions prepare and submit strategies for research and identify institutional priorities.

5.11 To date an unprecedented €600 million has been allocated to third level institutions under this programme for research. Substantial funding has also been provided from private philanthropic sources who have supported the strategic focus and competitive basis of the programme.

5.12 The strategic approach underpinning the PRTLI dates back to the commissioning by the Authority in the mid-1990s of a comprehensive assessment by the CIRCA Group of the funding and management of research in the universities.

5.13 In addition to recommending increased funding for research, and the establishment of research councils, the CIRCA report[49] also called for a more strategic approach, at the institutional level, to the funding of institutional strengths and core competencies in research, for more explicit institutional planning and prioritisation and for the promotion of greater inter-institutional co-operation and inter-disciplinarity within the third level system. With the improvement in public finances from the middle of the 1990s onward, the case for improved funding of research was made with much greater success than had hitherto been the case. In particular, the provisions of the National Development Plan 2000-2006 for research have been very important in enabling the Authority to develop funding programmes.

49 Organisation, Management and Funding of University Research in Ireland and Europe. CIRCA Group Report for the HEA. Published by the HEA in December 1996.

5.14 Key elements in the PRTLI approach include:

- Supporting institutional research strategies
- Establishing potentially world class and significant centres of research excellence
- Building the foundation and capacity for advanced research in the institutions - foundation rather than incremental funding
- Promoting and embedding inter-institutional collaborative research in order to counterbalance limitations of scale in the Irish system
- Incentivising the establishment of efficient and effective management of research in the institutions
- Assisting the development of institutional missions and strategies for research
- Strengthening the synergies between research and education, in the formation of human capital through embedding research in the education process and securing the education dividend from research
- Capturing the 'process benefits' from participation in research - its impacts on human capital, skill development and institutional competitiveness. Other funders are (or ought to be) concerned with the knowledge outputs from research and the systems for transfer and commercialisation of these.

5.15 The PRTLI initiative was motivated primarily by the following considerations:

- The need for prioritisation, based on institutional strengths, in the face of constrained resources
- The need to build collaborative inter-institutional programmes to overcome problems of scale and rapidly rising research costs
- The need to develop research centres with critical mass
- The importance of encouraging transdisciplinary and interdisciplinary basic research
- The desirability of assisting research strategies in smaller research institutions through alliances and collaborative arrangements with larger institutions
- The benefit of integrated funding packages providing support for personnel, infrastructure and recurrent programme costs.

5.16 Some quantitative indicators of the impact to date of PRTLI have already been outlined in Section 1.12.

5.17 The impact of PRTLI can be further illustrated by reporting that to date funding has been provided for a total of 33 centres, within and across many research disciplines. Details of all the centres and programmes funded are presented in Annex 4. A number of these centres are listed below for illustrative purposes. A key point to note is that these centres include significant collaboration with other institutions.

- The Research Institute for Networks and Communications Engineering (RINCE) at Dublin City University (€10.47m)
- The Marine Research Institute at National University of Ireland Galway (€19.13m)
- The National Institute for Regional and Spatial Analysis (NIRSA) at National University of Ireland, Maynooth (€2.71m)
- A National Nanofabrication facility at University College Cork (€27.7m)
- Materials and Surface Science at University of Limerick (€15.8m)
- The Humanities Institute of Ireland at University College Dublin (€7.61m)
- The Institute for International Integration Studies at Trinity College Dublin (€8.41m)

5.18 An example of the type of collaboration that has developed between institutions would be the co-operation in environment research taking place between the PRTLI funded

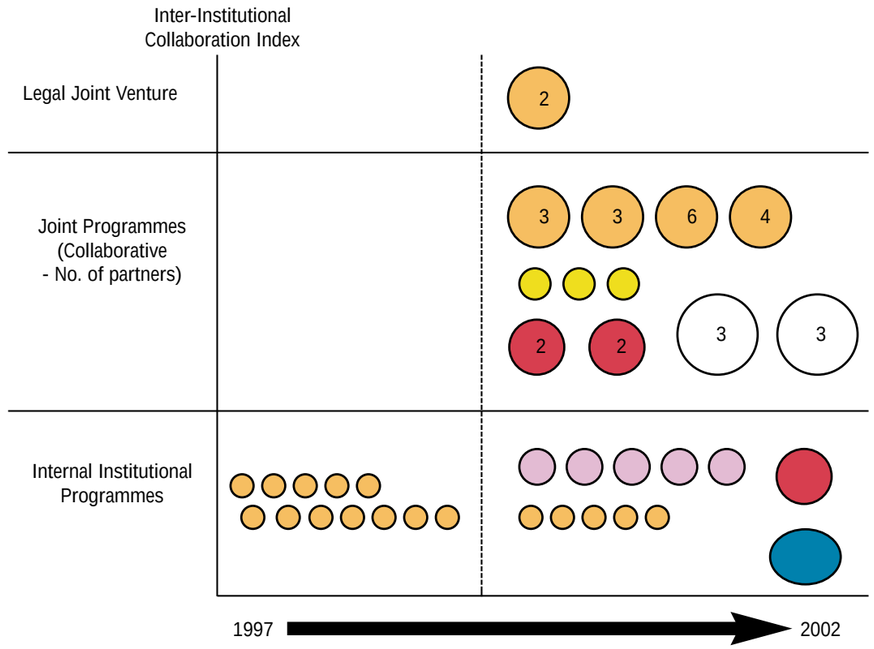
- Environmental Research Institute at UCC (€27m),
- Environmental Change Institute at NUIG (€9.5m),
- Centre for Sustainability at IT Sligo (€3.18m),
- and a total of eight other institutions contributing their expertise and skills to these programmes.

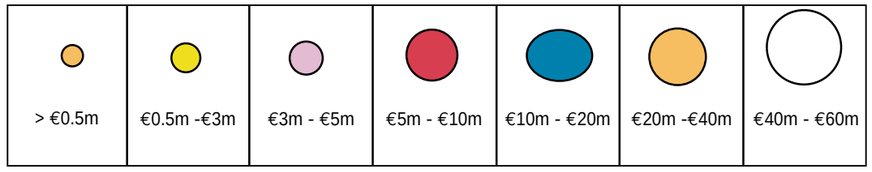
5.19 The formation of the Dublin Molecular Medicine Centre (DMMC), a joint venture[50] between University College Dublin (UCD) and Trinity College Dublin (TCD), represents a further evolution of the collaboration model in the Irish context. The DMMC is now also collaborating with the Royal College of Surgeons in Ireland (RCSI) for work on the Programme for Human Genomics (PHG). PRTLI has provided funding in excess of €70m for the establishment of the DMMC and the associated Programme for Human Genomics.

50 Constituted as a jointly controlled but separate legal entity with its own governance and management structures

Indeed the area of biomedicine and bioscience has been particularly productive in the establishment of inter-institutional collaborations as demonstrated below in Figure 5.3 which contrasts the current landscape for collaborations with that in 1997.

Fig 5.3 Research in Biosciences/Biomedical*
**incl. Neurosience, reproduction biology, biomedical engineering*





Note; Twelve third level institutions have received funding for research in biomedicine and/or biosciences from PRTLI. In 1997, each of these 12 institutions were in receipt of less than €0.5m for research in these fields. In 2002, twelve collaborations have been formed, with 7 of the 12 institutions also receiving significant funding for intramural research in these fields. (The numbers in the discs represent the number of third level institutions involved in each collaboration).

5.20 The extent of the inter-institutional collaboration now underway is illustrated for the Materials and Engineering Sciences fields, and in the Humanities in the diagrams in Annex 5 (Figures A.5.1 and A.5.2 respectively).

5.21 The PRTLI responds to contemporary requirements for a mix of disciplinary (Mode 1) and transdisciplinary and team based (Mode 2) approaches for basic research. Some writers are now postulating a new mode of scientific research and the emergence of new forms of work organisation in science. This new mode is essentially trans-disciplinary and undertaken by transient 'research collectives'. It is especially evident in the fields of new materials, biogenetics and information technology. There is also evidence of Mode 2 structures in the humanities and social sciences. Gibbons and his colleagues argue that this new mode is a truly general feature of modern science, developing alongside traditional disciplinary structures and requiring new organisational and funding arrangements.[51] The PRTLI approach fits very well with this thinking. Examples of centres which have a strong inter-disciplinary focus[52] are the Urban Institute (UCD), encompassing contributions to research programmes from engineering, environment, health, sociology and geography researchers, and the Centre for Transport Research and Innovation (TCD) encompassing contributions to research programmes from civil and mechanical engineering, computer science, economics and psychology researchers.

5.22 All of the PRTLI research in these centres are at an early stage but the outputs to date demonstrate the importance of strong institutions, funded by PRTLI. [53]

5.23 Thus the PRTLI is enabling institutions to strategically prioritise their research investments and to focus on the development of centres of excellence, consistent with their individual strengths. It (PRTLI) has accelerated cross disciplinary and inter-institutional co-operation within the (modestly resourced in comparison with many other OECD countries) third level system. The Authority is encouraged by the commitment in the Agreed Programme for Government for the continuation of PRTLI.

51 Gibbons M. et al The New Production of Knowledge. The Dynamics of Science and Research in Contemporary Societies. Sage London 1994.

52 Defined as incorporating research from the technical sciences and social sciences and/or humanities

53 For example, work in the biomedical area funded by PRTLI has contributed to four Nature publications in the past 18 months, with numerous other publications in journals such as, the Proceedings of the National Academy of Sciences, the Journal of Biological Chemistry, Journal of Virology, Journal of Immunology, Journal of Experimental Medicine, the EMBO Journal, the FASEB Journal and the Journal of the American Chemistry Society.

The Transforming Effect of the PRTLI

5.24 The PRTLI is having a transforming effect on research in the third level system. The scale of the investment has created new capacity and critical mass and has provided funding for the recruitment of over 700 new researchers. This has created a new dynamic in the institutions with consideration now being given with development of career paths for researchers in institutions.

5.25 The programme has also been critical in developing inter-institutional co-operation on a new and unprecedented scale. In doing so it has directly addressed a critical shortcoming in the Irish research system. For example, the formation of the DMMC (see para. 5.19) has now created the potential for Dublin to become a significant player internationally in biomedical research.

5.26 The response of the higher education sector to the strategic, organisational and management challenges posed by the PRTLI has been remarkable. Strategic planning processes for research are now in place in all the institutions which have successfully competed for funding under the programme. This has ensured effective prioritisation and selection of research areas, the formation and transdisciplinary research teams and programmes as well as very significant levels of inter-institutional co-operation. All of this required institutional leadership, flexibility and capacity of a high order.

5.27 In terms of capacity, activity and potential the system is undergoing a step-change.

5.28 An independent process review of the PRTLI is now being carried out on behalf of the Authority. This follows earlier independent reviews which led to changes and modifications in the programme. The Authority will evaluate the results of this latest review and reflect its findings in further calls for proposals. Earlier reviews identified the need for more powerful incentives for collaboration (which were acted on). The current review has identified suggestions that supplementary expert assessments at project level might be incorporated in the evaluation process carried out by the International Assessment Panel.

Section 5.B: Research Funding Mechanisms - an Overview of the Funding Mechanisms and of the Current Overarching Structures for Policy Co-Ordination

The Role and Function of Research Funding Mechanisms in the Irish System

5.29 The funding provided through the HEA, the research councils and the Department of Education and Science provides a consistent and mutually supportive suite of supports for basic research in the higher education sector. Other agencies also provide funding on a competitive basis for basic researchers, particularly EI, HRB and SFI. In contrast to the HEA and IRCHSS and IRCSET, these bodies largely have a mission oriented or functional interest in funding research to support policy in specific policy areas-such as economic and industrial policy (SFI and EI) and health and social gain in the case of the HRB.

5.30 Institutionally, the higher education sector now comprises all the required components - individual, project and institutional funding, to meet both sectoral mission oriented and horizontal objectives. The research councils have added the needed 'bottom up' approach, which will ensure that individual talent is supported across all disciplines. HEA provides 'core funding' for research through the block grant and strategically formed research funding though the PRLTI.

Strengths of the System - Consistency with the Principles and Criteria (Chapter 3)

5.31 The structures and mechanisms for the support of research in third level institutions are now stronger and more coherent than at any time in the past. Ireland now has a research system with potential for rapid and substantial growth and one which is well integrated with higher education. Based on competitive funding mechanisms and multiple funding sources, and rooted in the higher education sector, the research system now begins to reflect some of the key characteristics of the US research model.

Mission Orientation

5.32 Similar to the arrangements in many other European countries, the Irish research system has historically functioned on a distributed basis as well as through horizontally focussed programmes such as the programmes funded through the Department of Education and Science, the HEA and the research councils. The strength of the vertical or mission oriented dimension is that this allows individual government departments to commission research needed to underpin their own objectives and those of their agencies. Collectively these departments are a very strong group with an interest in funding research. Most of the key areas of Government (and the relevant departments) are involved, education, health, industry, agriculture and others and they provide a more coherent range of interest in research than would be case, if research were to be organised under a single department or agency. The research priorities of the funders and their related financial allocations are influenced by the responsibilities and missions of individual "line" departments - agricultural research by the mission of the Department of Agriculture and Food and Rural Development, medical research by the Department of Health and Children, and so on. The 'subsidiarity' concepts embedded in this approach ensure that decisions on research funding are taken at the most appropriate level of administration. This has been an important constituent of research funding in Ireland since the emergence of science policy in the early 1960s.

5.33 The strengths of this approach are evident in a close alignment of research with sectoral objectives. Its effectiveness has not been challenged in any of the substantive reviews of national industrial policy or in those of science and technology policy, Culleton (1992)[54], Tierney (1995)[55] or Travers (1996)[56] for example, or in any of the OECD reviews (1974)[57] or in the Government White Paper (1996)[58] on policies for science, technology and innovation.

5.34 It is also useful to distinguish between two strands under the heading of "mission orientation".

54 Culleton Report 1992 A Time for Change-Industrial Policy in the 1990's
55 Tierney Report 1995 Making Knowledge Work for Us
56 Travers 1996 Working party on Implementation of the Tierney Recommendations
57 OECD 1974 Review of National Science Policy-Ireland
58 Government White Paper on Science Technology and Innovation 1996

Strategic Research Funding

5.35 The first can be described as the strategic stand where research focused on activities which support the achievement of broad sectoral objectives e.g. in relation to industrial and health policy. The activities of SFI, EI and the HRB are perhaps most appropriately described as being those of research funders with a strategic mission orientation.

Functional Research Funding

5.36 The funding support for research provided by organisations such as the Marine Institute, COFORD, Teagasc might on the other hand be more appropriately described as 'functional' in character. In these cases our understanding is that funding tends to be directed more towards very specific objectives (including problem solving) which arise from the objectives and mission of the funding organisation.

5.37 While this distinctions between strategic and functional orientation are useful for conceptual purposes they should not be pursued relentlessly as it is clear even from this brief discussion that 'mission-oriented' research funding organisations may have both strategic and more tightly focused functional dimensions to their activities.

Mission Orientation and Horizontal Support

5.38 The distinction between a 'mission oriented' and the 'horizontal' approaches is one, which is in our view much more important than the distinction between 'strategic' and 'functional' for the design of 'organisational' architecture of the funding system. The latter 'horizontal approach' appropriately describes programmes such as those funded through the HEA, the research councils and the Department of Education and Science which support research and development across all disciplines and sectors. The provision of sufficient support for this strand is essential for constructing the foundations and capacity for carrying out mission oriented research. This is an important feature of the criterion for 'clarity of mission' which we identified in Chapter 3 (para 3.27). Failure to satisfy this criterion will not only lead to confusion in terms of organisational policies and activities but will also make it much more difficult to ensure accountability and effective performance evaluation

Coherence of the System

5.39 Figure 5.4 provides a schematic illustration of the system and arrangements from State funding of research in the higher education system. The system has the organisational diversity which, as described by An Taoiseach[59], ensures

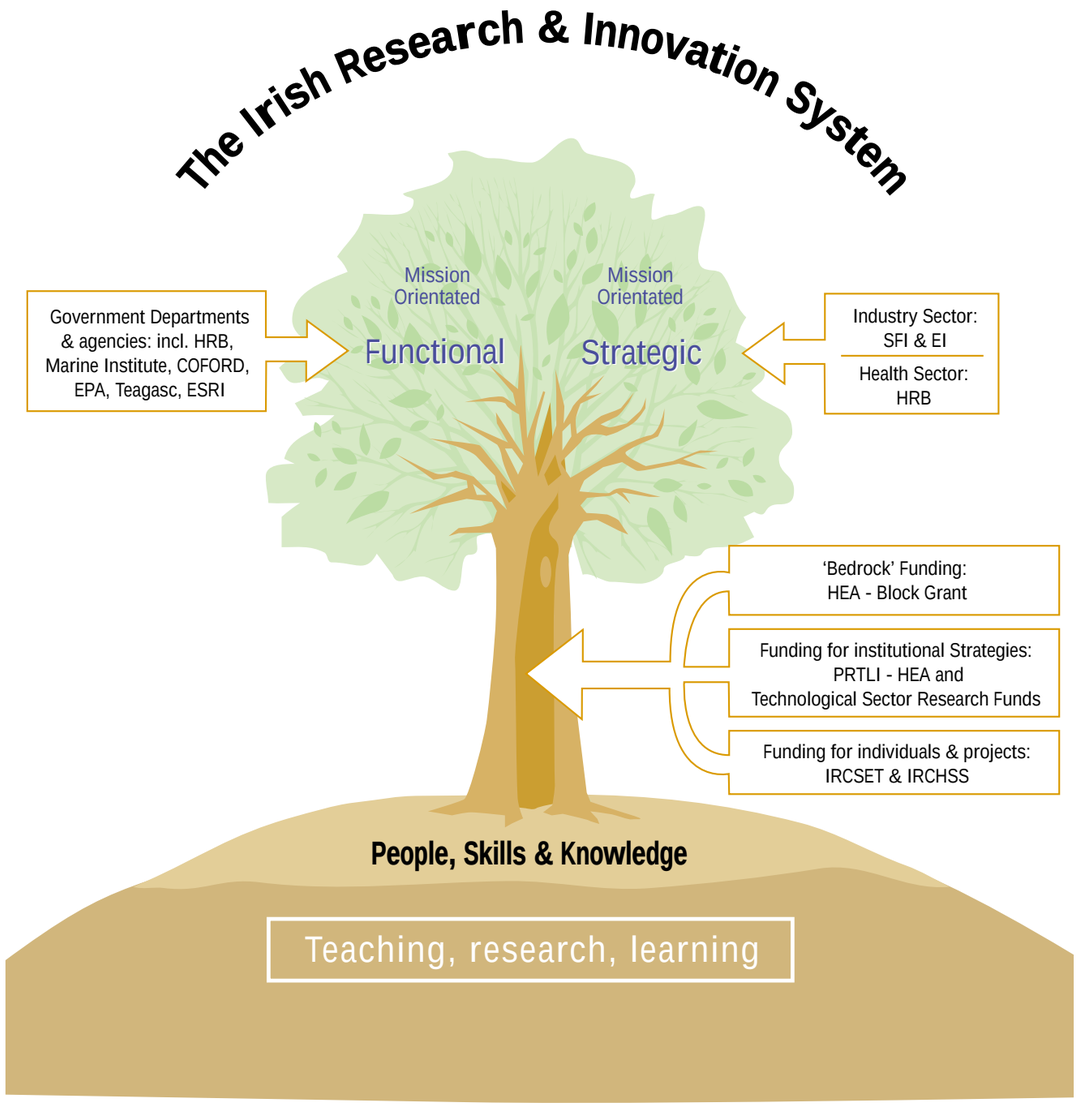
"funding schemes providing for individuals, institutions and national strategic priorities".

5.40 The rationale underpinning this system is, we believe, persuasive. The relative stability of the funding available from the HEA block grant provides the institutions with core funding for the continuation and development of research activities across disciplines. The multi-annual funding provided under the PRTLI allows the institutions to focus funding and resources on strategically selected priorities. These areas have been selected by the institutions following strategic planning exercises which have regard to the existing and developing strengths of the institutions as well as the external environment (including public policy priorities). The funding activities of the research councils provide individual scholars and investigations with funding to pursue research in areas selected by them. Funding for SFI, EI and the HRB are focused on supporting strategic public policy objectives in the areas of industrial policy and the promotion of health and social gain respectively. Finally, organisations such as the Department of Agriculture and Food and Rural Development, the EPA, COFORD and the Marine Institute support research directly related to their own sectoral missions (which we have described as the functional dimension).

5.41 In our opinion, the institutional arrangements also provide the potential for securing an optimum balance between streams of funding described by the OECD[60] as sure, precarious and contract based funding. A balance needs to be struck between providing the long term security of funding required for institutional capacity building, maintenance and renewal on the one hand, and on the other ensuring that the

59 Speech by An Taoiseach, Mr Bertie Ahern, T.D., at the Conway Institute of Biomolecular and Biomedical Research, U.C.D., 6th March 2002
60 The Management of Science Systems (1999), OECD, Paris

Figure 5.4 Schematic Illustration of the Irish Research and Innovation system



Acronyms: COFORD= Cooperative for Forestry Research and Development; EI=Enterprise Ireland; EPA=Environmental Protection Agency; ESRI = Economic and Social Research Institute; HEA = Higher Education Authority; HRB= Health Research Board; IRCHSS=Irish Research Council for Humanities and Social Sciences; IRCSET=Irish Research Council for Science, Engineering and Technology; SFI=Science Foundation Ireland.

research system is incentivised to respond to changing public policy priorities, economic and social developments and, new developments in knowledge. Competition is also an important stimulus for excellence. Other policy challenges include ensuring that the inevitable tensions between academic freedom, institutional autonomy and public policy priorities are resolved constructively and in a way which promotes positive outcomes. A particular concern of public policy would be to ensure that the knowledge and skills base of the system is sufficiently broad so that it has the capacity to respond quickly and effectively to unexpected developments both in research and in the wider economic and social domains. We believe that the architecture of the system we have described in the preceding paragraphs is in principle capable of meeting these challenges.

5.42 A mixture of "sure" funding (through the HEA block grant) and competitive programmes, projects and schemes are required. In our view internationally benchmarked competition is a vital ingredient and we are encouraged by the commitment to external assessments in the Agreed Programme for Government [61]

Does the System Design Fit the Principles?

5.43 The 'institutional architecture' for the funding organisations accords, we believe, with the principles we set out in Chapter 3. Nevertheless, we identify some shortcomings in the following paragraphs. However, we are confident that these shortcomings can be successfully addressed and we make some suggestions as to how this might be done.

5.44 The principles and criteria in Chapter 3 help us to identify five major shortcomings :

- The lack of a satisfactory mechanism for overarching policy co-ordination.
- The need for a comprehensive approach to commercialisation.
- A degree of confusion about the mission and activities of SFI and its future role in the funding of basic research
- The need for clarity with regard to Ireland's contribution to the development of EU research policy and the European Research Arena

61 An Agreed Programme for Government Between Fianna Fáil and The Progressive Democrats, June 2002

- The need for permanent and formalised co-ordination at an operational level between the agencies currently engaged in funding research in the higher education sector.

Overarching Policy Perspective and Structures

5.45 The need for effective structures in these areas arises under a number of headings including requirements for

- Objective reviews of the policies and performance of the research funding organisations (including their own reviews of the performance of their funding programmes).
- Continued review and appraisal of the funding balance and distribution within the overall system, and
- Overview of the extent to which potential synergies between the funding programmes of the various organisation are being realised.

5.46 While many of the features of the distribution of tasks between organisations are satisfactory, difficulties have arisen with the arrangements for review and oversight.

5.47 Provisions for national co-ordination and resource source allocation were outlined in the 1996 White Paper on Science and Technology[62] and functions in this area are assigned by legislation to the Minister for Enterprise, Trade and Employment and to Forfás. The White Paper also proposed that the Government would adopt an integrated process for prioritising S&T spending which would be convened under an interdepartmental committee, under the direction of a cabinet committee.

62 White Paper. Science, Technology and Innovation. 1996

5.48 The White Paper also envisaged that responsibility for national co-ordination of science and technology across Ministries would be assigned to an individual office - the Office of Science and Technology (OST), located within what is now the Department of Enterprise, Trade and Employment.

5.49 The White Paper also provided for an independent science policy advisory function to be carried out by ICSTI (the Irish Council for Science, Technology and Innovation) which is legally constituted as a sub-board of Forfás, a statutory agency reporting to the Department of Enterprise, Trade and Employment.

5.50 Finally, the White Paper also envisaged overarching co-ordinated mechanisms involving an interdepartmental Committee on Science and Technology, and a Cabinet Sub Committee on Science and Technology.

5.51 These arrangements were never fully implemented. The Cabinet Sub Committee has never met and the Inter Departmental Committee relatively infrequently. Furthermore, the structure as envisaged has been overtaken by subsequent policy developments. The most significant of these were the much enhanced role in research policy and funding undertaken by successive Ministers for Education and Science since 1997[63], the launch of the PRTLI in 1998, the setting up of the research councils in 2000 and 2001 respectively, the establishment of SFI and the recent decision made by the Tánaiste and Minister for Enterprise, Trade and Employment that she would take on direct responsibility for science and technology policy.[64]

5.52 However, these developments do not explain why the 1996 arrangements were not effective. The reasons are more fundamental and had more to do with the difficulties which resulted from assigning oversight and review functions to the Department of Enterprise, Trade and Employment and its agencies, which also have specific sectoral responsibilities for industrial and private sector services development and regulation. There are inevitable tensions between pursuit of a sectoral mission (notwithstanding its importance) and the carrying out of oversight and review functions. With hindsight, there was a serious shortcoming in the design of the overarching structure. The outcomes were confusion in the research community about overarching policy objectives and concerns about responsibility and functions among other departments and organisations.

63 The legal title of the Ministry and Department was changed from 'Education' to 'Education and Science' in 1997 following the formation of a new Government.

64 Between 1997 and 2002, science and technology policy had been the responsibility of a Minister for State (the Minister for Science and Technology) assigned to both the Departments of Enterprise, Trade and Employment and Education and Science and prior to that the Minister for State had been assigned to what is now the Department of Enterprise, Trade and Employment.

5.53 Redressing this critical shortcoming poses formidable difficulties for system design. Our recommendations in Chapter 6 attempt to meet these challenges.

5.54 The second reason is that the proposed process of settling expenditure estimates through a Cabinet Committee does not accord with the established practice of agreeing Exchequer expenditure estimates. These are determined by the outcome of bilateral negotiations between the Minister for Finance and 'spending' Ministers within the constraints of a fiscal framework agreed at Government. This process is already complex and sensitive and did not adapt to a further overarching input. A Cabinet Committee could have played an important role in respect of setting policy directions but this did not turn out to be the case.

5.55 New arrangements are needed. Science, technology and research are horizontal functions. They need horizontal mechanisms to co-ordinate them, not sectoral ones, as is currently the situation. In our view, oversight and overall co-ordination for research, development and innovation is a central government function, best exercised in a way which ensures a distinction between policy oversight on the one hand and control on the other.

Support for Commercialisation Policies and Activities

5.56 Policy and organisational structures need to ensure that the technology-providing and the technology-using parts of the innovation system are effective, interacting and well balanced. There is also a need to address the R&D performance of Irish industry-foreign and indigenous. Firms are the main actors in the innovation system. They tend not to rely directly on higher education institutions as sources of information or stimulus for innovation. Other interactions are more important for them, with customers, competitors, suppliers etc. Nevertheless, the interactions between the activities of academic research and commercial developments are very real and important (and in areas such as biotechnology, they can be critically so). The technological transfer processes between research and commercial development are changing and in some cases becoming more compressed and shorter in duration. The current substantial Exchequer investments in basic research will not yield optimum economic returns unless firms possess strong 'complementary resources', i.e. the capacity to interact with the higher education institutions, sufficient numbers of scientists and engineers and good quality facilities and policies, resources and structures in place to fund commercialisation and technology transfer. Furthering collaboration between academic and industrial research and improving access by industry to the research base are now major priorities. Transfer structures and processes, as well as commercialisation supports are key areas to be addressed in national innovation policy.

5.57 Innovation is more market-driven than supply-driven. It relies on networking and co-operation between industry and the research base. Firms are demanding this connection, especially where innovation is directly rooted in research (biotechnology, information technology and new materials, for example). There is a need to strengthen links between research and industry, to strengthen communications, collaboration, transfer and commercialisation processes. These concerns affect both foreign and indigenous industry and represent important policy challenges for the industrial development agencies.

5.58 The innovation system is complex, dealing with a diverse range of subject areas, a web of activities and a range of motivations and interests, while the "pure" researcher is concerned with testing hypotheses and developing theories in the pursuit of knowledge, the interests of companies and investors (including venture capitalists) are commercial but varied, and Government has a transcending array of interests.

5.59 The Authority is strongly of the opinion that a single set of policy instruments would be incapable of addressing all of these successfully. In our view, the case for specialisation among the agencies involved is very strong. A basis for determining appropriate agency roles and the best division of labour between the participating agencies has already been outlined in Chapter 3.

Science Foundation Ireland (SFI)

5.60 There is a perception that SFI, which was established to fund research in areas underpinning the strategically chosen priority areas of biotechnology and ICT, has evolved into supporting basic research in many of the disciplines of science and

technology. It has developed funding programmes for principal investigators and visiting researchers and proposes to fund the development in the third level institutions of a number of centres of research excellence. There appears in practice to be some overlap between SFI and IRCSET, and perhaps with HRB.

5.61 The original concept of the Technology Foresight process envisaged embedding an ongoing partnership process between researchers and industry and identifying areas where advanced technologies were opening up new possibilities for industry. This would involve a continuous process of interaction between researchers and research technology users and performers on the commercial side. We are concerned that the technology transfer process aspects may be lost, unlike the UK, where Foresight is an important way of engaging industry with the research base. We acknowledge the steps recently taken by SFI through the Science, Engineering and Technology campus-industry partnerships initiative.

5.62 The vision of an 'innovation society', and its attendant requirements, which we outlined in Chapter 2, will take time to achieve. In the meantime, there is a range of important issues, of concern to the Authority, which require the attention of the industrial development bodies, including SFI. These include, as we discussed in Chapter 3 (para 3.9), embedding multinational investment, binding the multi-national and indigenous sectors of the economy more closely, improving the interaction between business and the research base and further strengthening complementary assets on the business side, all of which will improve the capacity for interaction with the expanding research capabilities now being established and will enhance the potential economic benefits. There will also be growing opportunities for international marketing of Ireland's emerging research strengths to international industry. While these tasks lie mostly within the domain of industrial policy, they are of concern to the Authority. We are very mindful of the fact that research is a necessary, but not a sufficient condition, for the achievement of an 'innovation society' and we are concerned that the demand side is accorded the attention it now needs. The Authority considers it appropriate that SFI be engaged in the research dimension of these tasks and we note and welcome the launch of the SFI programme for Science, Engineering and Technology (SFI) campus-industry partnerships in this context.

Enterprise Ireland (EI)

5.63 The future role of EI in funding basic research also needs to be clarified. There is already an appropriate array of funding sources for basic research within the HE sector, PRTLI, IRCSET and IRCHSS and specific research programmes operated by the HRB. The Basic Research Grants Scheme operated by Enterprise Ireland (EI) though modestly funded at the time, was an important source of support for the research system during the 1980s and the early 1990s at a time when Exchequer funding for research was seriously constrained and when there was no other Exchequer source of 'horizontal' funding for project based research and for fellowships for science and technology. We acknowledge and appreciate the important contribution made by Enterprise Ireland during that period but at this stage of development, however, we consider that the scheme would more appropriately be managed by IRCSET.

EU Research Policy

5.64 As Europe moves towards the creation of a European Research Area, there is a need for a clear voice from Ireland with regard to the policy developments taking place in the European context. Currently there is a lack of clarity as to the process for contributing in this regard. Whilst the DETE, and the Office for Science and Technology, have adopted a role, the process is disjointed with no clear system for consultation with other key stakeholders in the Irish Research and Innovation system. This would be a key area for development within any overarching policy framework.

Operational Collaboration

5.65 The principal requirement, in the Authority's view, would be to make existing arrangements work, rather than adding new structures. A recent agreement between the main research funding agencies in the HE sector on modalities for an improved information exchange at the operational levels, would appear to offer a useful opportunity to strengthen the existing position, provided all the relevant agencies agree to the approach proposed[65].

65 The Co-operation Agreement (so called 'Merrion Agreement') which has been signed by the HEA, HRB, IRCHSS and IRCSET-sets down procedures and modalities for exchange of information and mutual co-operation between the main funding bodies for research in the higher education sector.

5.66 There are a number of areas where the funding agencies could usefully work together. These include :

- synchronisation of the timing of calls for proposals and review mechanisms having regard to the need to ensure that compliance and administrative burdens on the research community are minimised
- development of collaborative programmes in particular niche areas
- ensuring that the research community can form a coherent overview in regard to the objectives and requirements of the different funding programmes and can easily identify and apply to potential sources of funding
- providing a common point of access for the research base for the business sector and other users.

chapter six

Conclusions and Recommendations

Section 6.A: Conclusions

6.1 The key concepts that have informed the Authority in developing this document are the following:

- The essential organic connection between teaching, research and learning and the location of these in the higher education sector.
- The requirement for a number of funding sources and mechanisms to ensure a flexible and robust research system and to satisfy the wide-ranging requirements of the national innovation system.
- The requirement for policy oversight and review mechanisms that have the confidence and support of all key players and that do not confuse oversight with control.
- The central role of research in moving Ireland to an innovation society, a paradigm shift for public policy, equiring the development of new competitive advantages for Ireland based on human resources and education, embedding foreign investment in the Irish economy and the development of world class indigenous capability in basic research and achieving high rates of economic and social return from State expenditure on research.

6.2 The Authority's position is that proposals for structural or process changes that might be considered should be evaluated against their potential to strengthen the contribution of research and education to the national system of innovation in its widest sense, including, but transcending the objectives of industrial policy.

A Number of Funding Organisations and Mechanisms are Needed

6.3 As we have discussed in Chapter 3, the requirement for a number of funding sources and mechanisms arises from the complexity both of the several dimensions in the innovation process and of the relationships and interactions between them. An efficient, effective and rational innovation system requires a number of policy instruments and organisations with clear missions and accountabilities. We have set out a number of principles and criteria which we consider should inform the design of such a system. We have also found that our informing concepts, criteria and principles accord satisfactorily with our survey of structures in other countries.

6.4 In Chapter 3 of this document we have drawn a conceptual distinction between two broad domains in the innovation process. We have called the first, the ‘knowledge production’ domain. The second we refer to as ‘knowledge transfer and development’.

6.5 We believe that the funding structures concerned with the ‘knowledge production’ domain are appropriate and are working well. Some of them have been put in place only recently. It would be premature now to engage in radical changes or in deep surgery. The research community and the institutions involved need continuity and stability of funding procedures. Neither do we see evidence from our survey of international experience which would indicate a compelling case for fundamental structural change in this domain. If anything, the most significant characteristic of other funding systems and structures is both their diversity and their continuous flux, as countries continue to search for appropriate structural solutions for the management and co-ordination of public funded investments in research.

6.6 The funding modalities for third level research are now well balanced with a mix of individual, project, and institutional funding. These arrangements should be retained and properly resourced. The Irish research system is evolving gradually towards the US model of strong well funded universities providing a good environment for world class researchers and research teams. It is also providing a balance of traditional discipline based research, as well as newer forms of trans-disciplinary, inter-institutional and team based research. The system is centred in the higher education system (particularly the universities) which draws on multiple funding sources. Like the US system, it is focused on developing institutional leadership and puts its emphasis on strengthening research within the higher education framework and the development of centres of excellence which combine graduate teaching and research.

6.7 Furthermore the Authority is satisfied that the funding structures, in addition to providing the 'horizontal' capacity dimension also reflect the need for the funding of mission oriented research, including within the higher education system. We believe that research activity and as a consequence, the funding structures, must be capable of responding to the missions and needs of individual Government departments, as well as ensuring its contribution to the production of high quality graduate output, an objective of the Department of Education and Science.

6.8 The Authority considers it essential that the operational Departments are able to influence research policy and resource allocation within their own domains and relative to their individual development missions. The Authority is convinced that this is the best way of ensuring relevance and value for money in the research agenda and of securing adequate research funding.

6.9 In light of the above, the Authority would be concerned at any developments that would:

- In the case of education, break or damage the essential intricate link between teaching, research and learning; any arrangement which would reduce the interaction between research and higher education, or make it more difficult, would be misguided.
- Remove the research function from the service of individual Departmental missions and objectives, or reduce the effectiveness of research in the pursuit of these missions.
- Result in third level research policy being driven exclusively by a single issue agenda.
- Centralise responsibility for research policy and research funding in a central 'superagency'.

6.10 Notwithstanding our broad satisfaction with the funding arrangements in the 'knowledge production' domain we have in Chapter 5 identified and discussed a number of areas where significant changes are needed.

6.11 The key areas to be addressed are

- The need to establish an overarching policy review and oversight function, at Government level which will have the confidence and support of all the key players.
- The need to provide systemic support for processes of technology transfer and the commercialisation of research and technology; this includes ensuring that there is as smooth as possible a transfer of skills, knowledge and intellectual property from the knowledge production domain into economy and society, i.e. having an effective domain for knowledge transfer and development.

- The requirement for a regular and systematic information exchange at the operational level between the main agencies involved in supporting research in the third level system.
- Clarification of agency roles, with respect to the funding of basic research and how this activity fits with agency mandates.

Policy Review and Oversight

6.12 Adjustments at the policy review and oversight are called for, particularly because the existing structures for overarching policy co-ordination, which date back to the 1996 White Paper, have not worked. We have discussed the reasons why this is the case. Our recommendations in the next section (6.B) attempt to address the shortcomings we identified.

Technology Transfer and Commercialisation of Research Technology

6.13 This domain, which we have referred to as knowledge transfer and development, is crucially important. If structures and processes in this area work effectively and well, Irish society will reap significant dividends from the increased levels of Exchequer expenditure on research. The consequences of failure are very high, not just in terms of the loss in the expected returns, but also because the goal of becoming an 'Innovation-Driven' society will not have been realised.

6.14 The position regarding the provision of state support in the area of technology transfer and commercialisation is unclear and is causing confusion. Whilst ICSTI, SFI and EI are all involved or interested in developing this area; a systematic framework for Exchequer support for this area is also lacking. We welcome the fact that EI has recently taken the lead with regard to the establishment of a framework for this activity. Such a framework is needed in particular to support institutions in the higher education sector in the expensive activity of commercialisation of research results. Equally,

structures and mechanisms need to be put in place to ensure that efficient and effective relationships (which have regard to, and appropriately protect, the interests of all sides) are put in place between firms, and higher education institutions.

6.15 ICSTI has already made proposals as to the policy directions and initiatives required in this essential area.[66] We are encouraged that this is the case. EI has historically had an involvement in this area and SFI is now proceeding with a programme for funding research centres involving collaboration between businesses and higher education institutions. A comprehensive range of actions and initiatives is required. We suggest some specific functions for EI and SFI in this area in paragraphs 6.19 and 6.20.

Exchanges of Information and Co-Operation Between the Funding Agencies

6.16 The need for this is self-evident. Bilateral[67] and multilateral arrangements have been developed. Recently the HEA, HRB and the Research Councils have formalised the co-operation arrangements at a multilateral level and EI have now become actively involved in this process.[68] SFI equally has indicated that is subscribes to the objectives of open and effective co-operation between the agencies. This is potentially a very important framework and we would wish to see all the relevant agencies fully and formally involved.

6.17 The operational co-operation between the funding agencies should also extend to ensuring that the research community can easily and efficiently access information about funding programmes and possibilities. We recommend that the research funders jointly consider constructing and maintaining a web-based information portal which (with appropriate internet links) would act as a 'one-stop' source of access.

66 Statement on Commercialisation of Publicly Funded Research, ICSTI, February 2001
67 For example the informal information sharing arrangements between EI and HRB
68 The Co-operation Agreement (so called 'Merrion Agreement') signed by the HEA, HRB , IRCHSS and IRCSET- sets down procedures and modalities for exchange of information and mutual co-operation between the main funding bodies for research in the higher education sector.

Clarification of Agency Roles

6.18 In our view, there is some confusion about the role and activities of SFI. Its stated objectives are to support strategic research in research areas which are considered to be of strategic economic importance. The areas currently selected are biotechnology and information and communications technologies (ICT). However, SFI is currently perceived (particularly in the research community) as developing a mandate of supporting basic research in most areas of the physical and biological sciences. Some of its funding programmes, which include grants and awards for fellowships and programmes, would seem to be more appropriate to a science and technology research council such as IRCSET.

6.19 The original thinking behind the Technology Foresight and SFI concepts was to focus research funding in selected priority defined areas and to develop dynamic collaborative relationships between researchers and industry. The many expectations of SFI, including pressure to take a wide definition of the scientific disciplines underpinning biotechnology and ICT, may run the risk of diluting its mission and effectiveness as well as give rise to the potential for confusion between its role and that of other funders, including IRCSET and the HRB. This would be unfortunate, particularly as we see important and necessary roles for the agency in the strategic research area and particularly in contributing in a direct way to the policy objective of embedding foreign direct investment in Ireland through an increasing engagement by foreign owned multinational enterprises in research activities in Ireland, both directly and in co-operation with Irish higher education institutions and other firms located here.

Enterprise Ireland (EI)

6.20 We referred earlier (para 5.63) to the positive role of EI in funding basic research when other indigenous sources of funding were absent. Supporting basic research does not fit well with EI as an agency with a mandate to support business enterprise. Furthermore it directly overlaps with the mandate and activities of IRCSET. We suggest that EI take lead roles in areas such as, the funding of immediately commercialisable research and technology transfer, the oversight and funding of national policy in relation to intellectual property and the provision and maintenance of strategic national facilities for commercialisation and technology development such as bioincubator facilities, and that its basic research support activities be undertaken by IRCSET.

Section 6.B: Recommendations

6.21 The Authority therefore recommends :

- Establishing overarching structures at the centre of Government involving the principal Ministers and senior officials, to provide overarching policy review and oversight. We discuss how this proposal might be implemented and structured in paragraphs 6.23 to 6.29 below. A number of variants are possible. We outline a small number and others can be devised. We do not intend to be prescriptive about the detail but we do emphasise that the design principles are vitally important. The essential criteria for success and effectiveness in our view are that the structures should be located at the centre of Government (with direct reporting relationships to the Taoiseach and Tánaiste) and should not report to a government department or agency which has line, sectoral or operational responsibilities.
- Putting the research councils on a statutory basis.
- Relocating ICSTI at the centre of government with new reporting relationships in order to provide independent advice to the central oversight and review structures.
- Reviewing and refocusing the roles of EI and SFI in technology transfer and commercialisation processes and in the building of research, development and innovation in the business sector.
- Implementation of formalised and effective co-operation arrangements including information dissemination between all the operational agencies funding research in the higher education sector and ensuring that the research community can form a coherent overview in regard to the objectives and requirements of the different funding programmes and can easily identify potential funding sources.

Policy Review and Oversight: a Cabinet Sub-Committee

6.22 In Chapter 5 we have concluded why policy oversight is necessary and why, in our view, the arrangements proposed in the 1996 White Paper were not effective. Research, technology and innovation policy is a very good example of a cross-cutting area of public policy transcending, but involving, the interests and responsibilities of a

number of Ministers and Departments. A Cabinet Sub-Committee to be chaired by An Taoiseach or the Tánaiste, could constitute the central part of a new over-arching structure. The membership of the sub-committee would include the Ministers for Education and Science, Enterprise, Trade and Employment, Health and Children, Agriculture, Forestry and Rural Development, Transport, Communications, Marine and Natural Resources and Environment and Local Government.

6.23 The oversight role of this sub-Committee would include :

- review of national policy for research, technology and innovation and the policies and performance of the individual research funding organisations.
- review of the adequacy of Exchequer expenditure on research, technology and innovation and its distribution.
- ensuring that potential synergies between the funding programmes of the various organisations are being achieved and that opportunities for engagement in international research programmes (particularly within the EU) are being fully realised.

6.24 This proposed structure is very similar to the Science and Technology Policy Council in Finland, which is chaired by the Prime Minister with the Ministers of Education and Science and Trade Industry and Finance and other ministers as members, along with ten expert members. This structure has ensured coherence and effectiveness in the very successful Finnish innovation system.

6.25 The Finnish model of including expert members and heads of agencies in a permanent Cabinet sub-Committee would be unusual in the context of structures for Government in Ireland. If the Finnish model of 'mixed' membership were considered not to be relevant, an alternative arrangement for involving non-Ministerial members would be to constitute an Executive Committee reporting to the Cabinet Sub-Committee. The Executive Committee could be chaired by the Secretary General of a central government department e.g. the Department of An Taoiseach; other members would include the Secretaries General of the relevant Government Departments, the heads of the funding agencies, and representatives of the heads of the major research performing organisations.

6.26 The provision of appropriate administrative and technical support for these structures would be critical in ensuring their effectiveness. A small, but high calibre and dedicated secretariat, in the form of an Office for Research, Technology and Innovation Policy, located in a central government Department (ideally the Department of the Taoiseach) would be needed. The membership of this office would include personnel seconded from the relevant government departments (and particularly the Departments of Education and Science, Enterprise, Trade and Employment and Health and Children), from the agencies reporting to these departments, as well as personnel recruited specifically for this purpose.

6.27 It is important that the secondment and assignment of staff to this office should be on an exclusive basis. In setting up these structures it might be useful to draw on the provisions of Section 12 of the Public Service Management Act, 1997 which provides a legal mechanism for enabling the appointment of civil servants, from different government departments to work together as a team in pursuit of objectives common to more than one department. It is essential that these structures (the Executive Committee and the Office) be part of the central functions of the Government and not part of a 'line' department and accordingly should not have executive or operational responsibilities.

6.28 A variant of the proposals for developing new overarching structures would be to create a new Office and position of Chief Advisor to the government on Science, Technology and Innovation Policy at the centre of Government. We envisage that if such a position was created its effectiveness would require that the office holder would not have operational responsibilities or be part of a ‘line’ departmental or agency structure. The functions of the Chief Adviser, and her or his office, would include those which we have outlined above in relation to policy oversight for research, development and innovation but they could also extend to the provisions of independent expert advice to Government in relation to the range of policy issues which have a scientific and technological dimension such as environment, health, agriculture and education.

6.29 Another variant could be a structure, combining a mix of senior executive and expert representation from the relevant departments, agencies and outside interests, ideally chaired by the Taoiseach or the Tánaiste, or alternatively by the Secretary General of the Department of the Taoiseach. It is envisaged that much of the work of the body would be carried out in sub-committees, along the lines of the Finnish model, for example. This committee would be serviced by a small and high calibre office, along the lines we have discussed above.

ICSTI - a New Role and Location

6.30 Implementation of these new structures should, in our view, entail a review of the terms of reference, 'location' and composition of ICSTI which plays a useful role as a source of policy advice. Currently, the legal basis for ICSTI is as a sub-board of Forfás. It would be consistent with the thrust of our recommendations that ICSTI function as a broadly-based advisory body reporting to the proposed overarching structure, rather than to Forfás. The Secretariat support for ICSTI would be provided by the new Office.

In Conclusion

6.31 The provision of public funding on a hitherto unprecedented scale, together with new funding mechanisms and structures, is having a transforming effect. The measures necessary to ensure that Ireland becomes one of the leading innovation societies in the world are now being taken. We agree with the Chairman of the IDA, that "Education is fundamental to economic development" and that special attention now needs to be given to investing in research and development in higher education and in industry[69]. We believe that if attention is given to the issues which we have identified, and if our proposals are implemented, our society we will be placed on a trajectory which will enable us to achieve the ambitious objectives to which we aspire.

69 Chairman's (Mr. John Dunne) Statement, IDA Annual Report 2001, July 2002.

annexes

Annex 1

Higher Education Authority (HEA)

The Higher Education Authority (HEA) was established in 1972. The HEA is charged with, under the provisions of the Higher Education Authority Act, 1971, the following general functions:

- furthering the development of higher education
- assisting in the co-ordination of State investment in higher education and preparing proposals for such investment
- promoting an appreciation of the value of higher education and research
- promoting the attainment of equality of opportunity in higher education
- promoting the democratisation of the structure of higher education.

In addition, it has the following specific functions:

- advising the Minister on the need for establishment of new institutions of higher education, on their nature and form, and on legislative measures in relation to their establishment (or in relation to existing institutions)
- maintaining a continuous review of the demand and need for higher education
- making recommendations to the Minister on provision of student places and the balance between institutions
- making recommendations for State financial provision for higher education and research, either in relation to current or future periods
- instituting and conducting studies on problems of higher education and research, and publication of reports of such studies
- payments to institutions of higher education out of monies provided by the Oireachtas, such amounts as may be determined by the Authority and subject to such conditions as the Authority thinks fit.

Annex 2

Recurrent Funding Model

1. Recurrent funding provided annually by the HEA to the institutions has traditionally contributed to both the teaching and research functions of the universities. Over the last ten years (approximately) this grant has been allocated by the HEA using a model which combines formula-driven criteria and targeted funding. Allocations are made on a "block grant" basis, i.e., institutions have discretion to allocate these funds internally as they see fit-across departments, faculties and administrative units and between teaching, research and other activities.

2. The recurrent allocation for 2001 amounted to €346m, of which in excess of 90% relates to block grant funding and the remainder (c. 7%) relating to targeted funding.

3. The block grant element splits approximately two-thirds core grant and one-third grant in lieu of tuition fees. (In 1996, the Government abolished tuition fees for eligible full-time undergraduate students).

4. The core grant is allocated by the HEA using a formula-based funding mechanism. Unit cost data per student across a range of academic subject groupings (both undergraduate and post-graduate) are used to compare performance and cost-effectiveness of each university versus the average for the sector. The outcome of this analysis informs the grant allocation process.

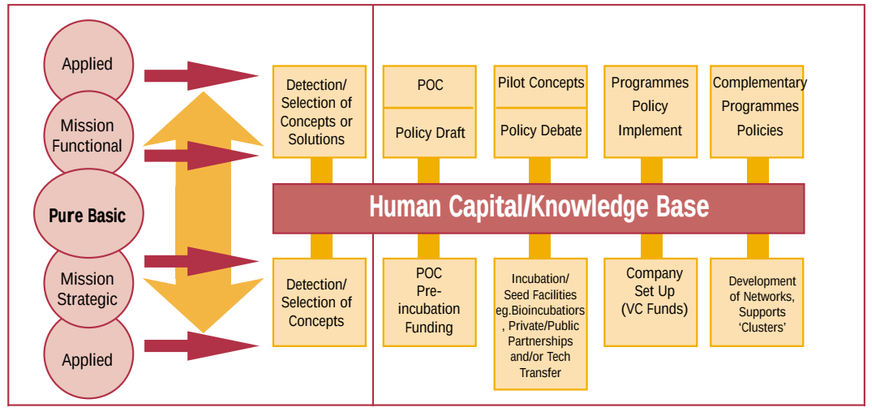
5. The grant in lieu of undergraduate full-time fees is allocated by the HEA on the basis of audited student numbers, returned by each institution.

6. Targeted funding was introduced by the HEA in 1996. These funds are used by the HEA to help grow and develop specific new areas which have been identified nationally as policy priorities, e.g. access for disadvantaged students, student retention, increasing the output of graduates in specific skills areas, research infrastructure, quality assurance etc. Funds are allocated by the HEA on the basis of the quality and merit of the proposals. Funding is specific to the targeted areas.

Figure A.3.1 Dimensions of Innovation Systems - Pre-requisites for Success

People	Knowledge	Infrastructure & Services
Education and skill attainment levels of the work force	Composition and balance of R&D (GERD, BERD, HERD, GOVERD)	World-class research institutions and facilities
Numbers and proportion in the labour force of qualified researchers	Knowledge dissemination and diffusion	Centres of Excellence
Mobility of workers, students and researchers	Effective linkages between teaching, learning, research, development and innovation	World class communications infrastructure
Numbers and proportion of researchers from other countries	Co-operation involving firms and third level institutions	Venture capital/seed capital availability
Proportion of the labour force which is engaged in participation in high-tech services and industrial sectors. Extent of networking	International co-operation in research Publications Patenting/licencing Technology transfer Commercialisation Spin-offs/incubation	Commercialisation facilities e.g. incubators, bio-incubators Services for exploitation of ideas/innovations Mechanisms to support public/private partnerships and/or transfers of technologies Competitive environment, taxation etc Clarity in respect of the ownership and control of intellectual property rights

Figure A.3.2: Knowledge Production, and Knowledge Transfer and Development-a schematic representation



Knowledge Production

- Strong HE Institutions
- Skills Graduates/Researchers
- Research Quality/Excellence
- Balanced Portfolio of Research
- Clear Outputs/Deliverables
- Links with Ultimate Utilisers

Knowledge Transfer and Development

- Links with Translators'
- Skills Graduates/Human Capital
- Balanced Portfolio
- Mechanisms for Exploitation of IPR
- Infrastructure for Incubation Phase
- Well Managed Funds for Start-Ups

Note:
POC= Proof of concept
VC = Venture Capital
IPR = Intellectual Property Rights

Annex 4

Centres and Programmes funded by PRTLI

Presented in alphabetical order based on lead institution for the Centre or programme of research as appropriate. As many of the Centres and programmes are multi- and inter-disciplinary, headings are for ease of reference and illustrative purposes only.

Acronyms

AIT	Athlone Institute of Technology
Cork IT	Cork Institute of Technology
DCU	Dublin City University
DIAS	Dublin Institute for Advanced Studies
DIT	Dublin Institute of Technology
GMIT	Galway Mayo Institute of Technology
IT Carlow	Institute of Technology, Carlow
IT Sligo	Institute of Technology, Sligo
IT Tallaght	Institute of Technology, Tallaght
IT Tralee	Institute of Technology, Tralee
LIT	Limerick Institute of Technology
NUIG	National University of Ireland, Galway
NUIM	National University of Ireland, Maynooth
QUB	Queens University Belfast
RCSI	Royal College of Surgeons in Ireland
SPD	St. Patrick's College, Drumcondra
TCD	Trinity College Dublin
UCC	University College Cork
UCD	University College Dublin
UL	University of Limerick
WIT	Waterford Institute of Technology

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Bioscience/Medicine				
Biomedical Engineering				
Centre for Biopolymer and Biomolecular Research	AIT	NUIG, Uni. of Coleraine	€2.3m	Focus on the development and evaluation of invasive medical device materials using know-how and skills in toxicology and polymer engineering.
National Centre for Biomedical Engineering Science	NUIG	UCC, UL, UCD, TCD , GMIT, IT Sligo and AIT	€32.3m	Muliti-disciplinary research in eight major research areas: Cell and molecular Biotechnology, Gene therapy, Cell development and apoptosis, Genome instability, Biomaterials, Biofilms, new Measurement Methodologies and Biomechanics
Trinity Centre for Bioengineering	TCD	NUIG	€5.4m	Multidisciplinary research programme with the National Centre for Biomedical Engineering in NUIG. Main focus of programmes to find bio-engineering solutions to skeletal diseases.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Cellular and Molecular Biology				
National Centre for Cellular Biotechnology	DCU	NUIM, IT Tallaght	€34.3m	The scientific focus of the centre: will be functional genomics, specifically cell differentiation, cell biology of cancer, cell biology of microbial disease, target identification for disease diagnosis and therapy, new molecules, bioethics and studying public perceptions of biotechnology.
Research Programme in Molecular Cell Biology	TCD	RCSI	€0.6m	Research in gene functionality /bioinformatics by graduate students providing an interdisciplinary, integrated research and training environment in the field of Molecular Cell Biology
Biosciences Institute	UCC	-	€19.7m	Research programmes in genetics, molecular science, biochemistry, microbiology, physiology and neuroscience. Particular focus on cancer research and cell signalling. The Institute will encompass the Food and Health Sciences research unit.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Research Programme in Food and Health	UCC	NUIG, NUIM, QUB, UL	€4.1m	Multi-disciplinary research in the areas of food safety and toxicology, and consumer analysis, i.e. Specifically the interaction between foods, their components and the physiological status of the human host.
Conway Institute for Biomolecular and Biomedical Research	UCD	RCSI, TCD	€62.3m	Multidisciplinary research; areas of Advanced Biomolecular Synthesis, Structure/Activity of Biomolecules, Molecular Medicine, Integrative Biology and Science and Society. The molecular basis for common ailments such as diabetic kidney disease, rheumatoid arthritis, asthma and atherosclerosis will be studied and molecules associated with these conditions identified. An extension of the Conway, the Centre for Synthesis and Chemical Biology, will focus on the design/synthesis of molecules that alter the function of selected biological targets and discover/develop novel therapeutic agents.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
DUBLIN Centre for Biomolecular Medicine (DMMC)	UCD/TCD	RCSI, NUIM	€26.9m	The joint venture, incorporating a multidisciplinary team from the basic sciences as well as from the clinical sciences, (located at UCD campus and TCD campus St. James's Hospital). Research focusing on fundamental processes occurring at the molecular level that lead to diseases. Main areas: Molecular mechanisms of inflammation, injury and repair; Molecular basis for host defence and determinants of infectivity; Mechanisms of gastrointestinal inflammation and the inflammation/cancer sequence; Differential gene expression, and the molecular basis for fibrosis and ageing.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Immunology				
Research programme in biosciences - Institute for Immunology	NUIM	-	€5.5m	Research areas include: Immunity to infectious diseases, Neuroimmunology and inflammation, Vaccine delivery systems and mucosal adjuvants, Tumour biology and cancer vaccines, Lymphocyte biology and Mucosal immunology of the respiratory tract.
Biopharmaceutical Sciences				
Institute of Biopharmaceutical Sciences	RCSI	UCD, TCD, NUIM	€11m	Research in gene therapy particularly in the areas of cystic fibrosis and cardiovascular disease.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Biopharmaceutical Sciences Network (BSN)	RCSI	UCC, TCD, NUIM	€9.4m	Focus on the integration of basic and clinical research towards a better understanding of how drugs work in humans - application of genomics and proteomics to support a gene therapy programme. Specific programmes include Genetics of drug response, Signalling through adhesion receptors, Cyclooxygenase and eicosanoids in cardiovascular disease, Targeted gene depletion in the evaluation of novel therapies for psychiatric disease, Evaluation of gene therapy for the inflammatory manifestations of Cystic Fibrosis.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Molecular Medicine and Biopharmaceutical Science				
Programme for Human Genomics	RCSI (BSN) TCD/UCD (DMMC)		€44.8m	Research to identify therapeutic targets with three specific elements; 1. Candidate gene identification through transcriptomics and proteomics, 2. High throughput variant detection, genotyping and gene validation in human disease, 3. The identification of therapeutic targets through state-of-the-art functional genomics, transgenics and gene knockout technologies.
Reproductive Biology				
Research Programme in Integrative Reproductive Biology	UCC	NUIG, RCSI, UCD	€2.0m	Focus of research to (1) identify and characterise maternal and fetal genes in the key aspects of implantation, gestational physiology and immunology in reproduction and (2) identification of human genes underlying common reproductive disorders.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Bioengineering - Agroecology				
Research programme in biosciences-Institute for Bioengineering and Agroecology	NUIM	DIT, IT Sligo, GMIT, WIT	€5.5m	Main research themes are: (1) genetics, development, behaviour and ecology of biological control organisms, especially Heterohabditis and its symbiont bacterium Potorhabus: (2) developmental biology, stress physiology and genetic modification of plants, including plastid transformation; and (3) ecological management of gene inserted in plants or biocontrol organisms.
Neuroscience				
Institute of Neuroscience and National Neuroscience Network	TCD	UCC, UCD	€28.7m	Main focus of research, is the identification of the mechanisms of change in the central nervous system so as to assist in the understanding of neurodegenerative diseases and potential treatments for same. Funding also for research in Neuro-degeneration and mental decline in the process of ageing.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Environment/Marine				
Research Programme in Environmental Science	Carlow IT	-	€1.2m	Using biotechnological techniques, research into the treatment of toxic pollutants in soil and water, the environmental impact of current agricultural practices and biochemical work in the area of cereal crops and the conversion of waste raw materials from the malting brewing and distilling industries into valuable products.
Research Programme in Ecotoxicology, Waste reduction and Air Pollution	Cork IT	UCC, NUIG	€2.4m	Research on waste reduction and air pollution include the themes of zero emissions and wastes, closed material cycles, automated process control and air pollution monitoring. Ecotoxicological research focuses on the detrimental effects of Harmful Algal Blooms (HAB) and the poisoning of shellfish in coastal and inland waters.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Environmental Change Institute	NUIG	UCC, UL, UCD, AIT	€9.5m	Mulitdisciplinary research in the areas of Marine Science and Rural Development. Work complements research at the ERI at UCC (below). Priority areas of research include Biodiversity, Climate change (incl. research based on palaeoenvironmental research), Marine environment, Waste, Social and Economic dimensions and Human Impact.
Research Programme in Marine Science-Marine Research Institute	NUIG	TCD, UCC, UL	€19.1m	Research focusing on the biology and culture marine organisms, marine communities-structure and function, ocean-floor sensing-mapping and modelling and integrated legal, socio-economic framework for marine sources.
Centre for Sustainability	IT Sligo	NUIG, UCD, UL, LIT, TCD	€3.2m	Research to address gaps in knowledge about the nature of sludge, treatment of sludges, about the reuse of biosolids and about systems for overall waste management.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Environmental Research Institute (and ECOSITE)	UCC	NUIG,UL,IT Tralee,IT, Carlow, UCD, DIT, IT Tallaght, GMIT	€27m	Institute supports and integrates environmental, marine and coastal research and its work complements the work at the ECI at NUIG (above). Areas of research include Biodiversity evaluation and ecosystem function, Coastal infrastructure development, Environmental biotechnology, Environmental chemistry, Environmental engineering, Eco-electronics, Environmental management, legislation and policy, Sustainable energy and Geographic information systems and modelling.
ICT/Communications/Advanced Computation				
Research Centre in Networks and Communications Engineering	DCU	-	€10.5m	Multidisciplinary research in information and communications technology under a small number of over-arching themes; high-speed networking, mobility of users and applications and user interface. The aim of the centre is to bring practical reality to the concepts of the Information Age.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Research programme on Grid-enabled computational Physics of Natural Phenomena	DIAS	DCU, NUIG, UCD, HEAnet Met Eireann, Armagh Observatory, Grid Ireland	€11.8m	The objectives of the research are to (I) link researchers in computational Physics by working on the development of a powerful computational grid which will create a world-class research environment in this discipline and (II) to use computational physics (enabled by the Grid) to investigate natural phenomena such as earthquakes and climatic changes
Research in Health Informatics -the MediLink programme	DIT and TCD	-	€0.8m	Focus of the research is to determine innovative applications of ICT (software development) for the support of the delivery of healthcare by providing the clinician with immediate and direct access to all information and knowledge necessary to treat the patient. Two domains are being targeted initially; the medical device area (hip replacement) and diabetes patho-physiology and management.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Institute for Information Technology and Advanced Computation Research	TCD	-	€19.8m	Mulitdisciplinary research of Global Management of Local Resources, Self-Organising networks, Sophisticated Applications that are Compute Intensive, Analysis of Algorithm Performance for Varying Network Architectures and High Performance computing and Visualisation.
Informatics Research Centre	UCC	-	€5.2m	Research on themes such as Information theory, the Theory of Computation and Computing paradigms.
Research Programme in Smart Space Management	WIT	CIT, TCD	€5m	The M-zones research programme on novel information and communications management technology to support dynamic, integrated management of participants, information appliances and smart space infrastructure. Research of ways to develop easily accessed, networked, computer technologies to facilitate mobile working at multiple locations.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Material Science and Engineering				
Engineering				
National Centre for Sensor Research	DCU	IT Tallaght	€11m	Multidisciplinary research on developing biosensors and chemical sensors which deal with problems of significant societal concern, eg. medical diagnostics, food quality assurance and environmental monitoring. Research focuses on eight clusters ranging from fundamental studies in molecular recognition through to application-driven sensors and micro-systems.
National Centre for Plasma Science and Technology	DCU	IT Tallaght	€7m	Multidisciplinary research on a fundamental understanding of plasma behaviour and the development of applications. Research on low temperature plasmas, laser generated plasmas, computational modelling, solid state spectroscopy, plasma and surface chemistry, mathematical science, thin film electronic materials, plasma processing and surface characterisation.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
National Nanofabrication Facility	UCC	CIT	€27.7m	Multidisciplinary research on areas of design, synthesis, fabrication and characterisation of nanoscale materials and nanostructures whilst extending established core research platforms to the emerging and strategically important areas of nanoscale electronics and photonics.
Material Sciences				
Institute for Advanced Materials Science	TCD	DCU	€14.6m	Multidisciplinary research focused on 5 objectives:1. to synthesise novel functional materials, 2. to advance fundamental understanding of the behaviour and properties of materials, 3. to promote development of materials with novel or superior properties, 4. develop processes to produce, modify and shape materials, 5. explore novel device concepts and applications.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Materials and Surface Science Institute (MSSI)	UL	WIT, NUIG, UCC	€15.8m	Research activity focused on materials design for use in information storage processing, transportation, healthcare and environmentally sustainable industrial chemical processing. Four broad areas are being utilised to support the research: Catalysis, Active Materials, Structural material and Interfacial science.
Method Development				
Biological/Physical Science Techniques				
Optical Characterisation and Spectroscopic Facility	DIT	-	€10.4m	The facility research activities are in the areas of Physics, Chemistry and Materials. A Facility for Optical Characterisation and Spectroscopy (FOCAS) for research into techniques for utilisation in the areas of science, food science and engineering.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Analytical and Biological Chemistry Research Facility	UCC	-	€7.7m	Research focusing on synthesis, separation and detection/characterisation of molecules from low molecular weights to larger biomolecules such as proteins. A further component of research will be data acquisition and analysis from the output of scientific measurement techniques.
Social Science & Humanities				
Centre for the Study of Human Settlement and Historical Change	NUIG	UL, UCC, TCD	€3.7m	Multi-disciplinary and co-operative research on topics related to the histories of human migration, settlement and cultural change. Study of human settlement and historical change on local, regional, national and transnational scales. Projects include: Plantations in Ireland, Atlantic and intra-European Colonisation 1500-1900 and Ireland and the British Empire.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Centre for Innovation and Structural Change	NUIG	DCU, UCD	€2.9m	Research and research training in the areas of the innovation processes and policies that are fundamental to the development of a knowledge-based economy.
National Institute for Regional and Spatial Analysis	NUIM	DIT, IT Sligo, GMIT, WIT, MIC	€2.7m	Research on an interdisciplinary level to study the impact of global processes on regional and spatial development. Two main themes; 1. Spatial and Social Exclusion, 2. Global Processes and Regional Change. A Centralised Spatial Information systems database funded.
Research programmes in Mediterranean & Near Eastern Studies, Irish-Scottish studies and a National Political and Social Survey	TCD	-	€3.6m	Research in the Classics: Hebrew, Biblical and Theological Studies to study the interaction of the Greco-Roman world with the cultures of the ancient Near East. Research in modern day attitudes, politics, historical development, migration, literature, society and civil development and relationships between Ireland and Scotland .

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Institute for International Integration Studies	TCD	NUIM	€8.4m	Research on issues of international integration under the research themes 1. The world economy, 2. Globalization and the nation state and 3. International regulation
Centre for Transportation Research and Innovation (TRIP)	TCD	UCC	€2m	Research projects within the theme areas of: 1. Information and Communication Technologies (ICT) for transport; 2. Transportation demand and supply; 3. Safety improvements across all modes; 4. Environmental impacts of transport and their management; 5. Quality of life.
Research Programme in History and Society	UCC	-	€1.2m	Research in such areas as Early and Medieval Irish, Law , Philosophy, Ancient Classics and Hispanic Studies

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
The Urban Institute Ireland	UCD	TCD	€6.2m	The Urban Institute Ireland, the only centre of its kind in Europe, will demonstrate the highest standards in energy and resource efficiency, with the support of the Irish Energy Centre (Sustainable Energy Ireland). Five programme areas have been selected: Transport and Urban infrastructure, Building environment and Existing settlements, Economic and social analysis of urban areas, Managing urban change.

Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Institute for the Study of Social Change	UCD	TCD, NUIM	€7.9m	The interdisciplinary research programme covers the following themes: Understanding and monitoring social change; Sources of economic growth; Poverty, inequality and social exclusion; Political changes in Ireland North and South; European integration; Legitimacy, Identity, Diversity, Citizenship and participation in multilevel democracies; Sociology of health and illness/health Economics; International Trade and Investment; Public Opinion and Political Behaviour; Governance and Policy Evaluation. A national social archive funded.

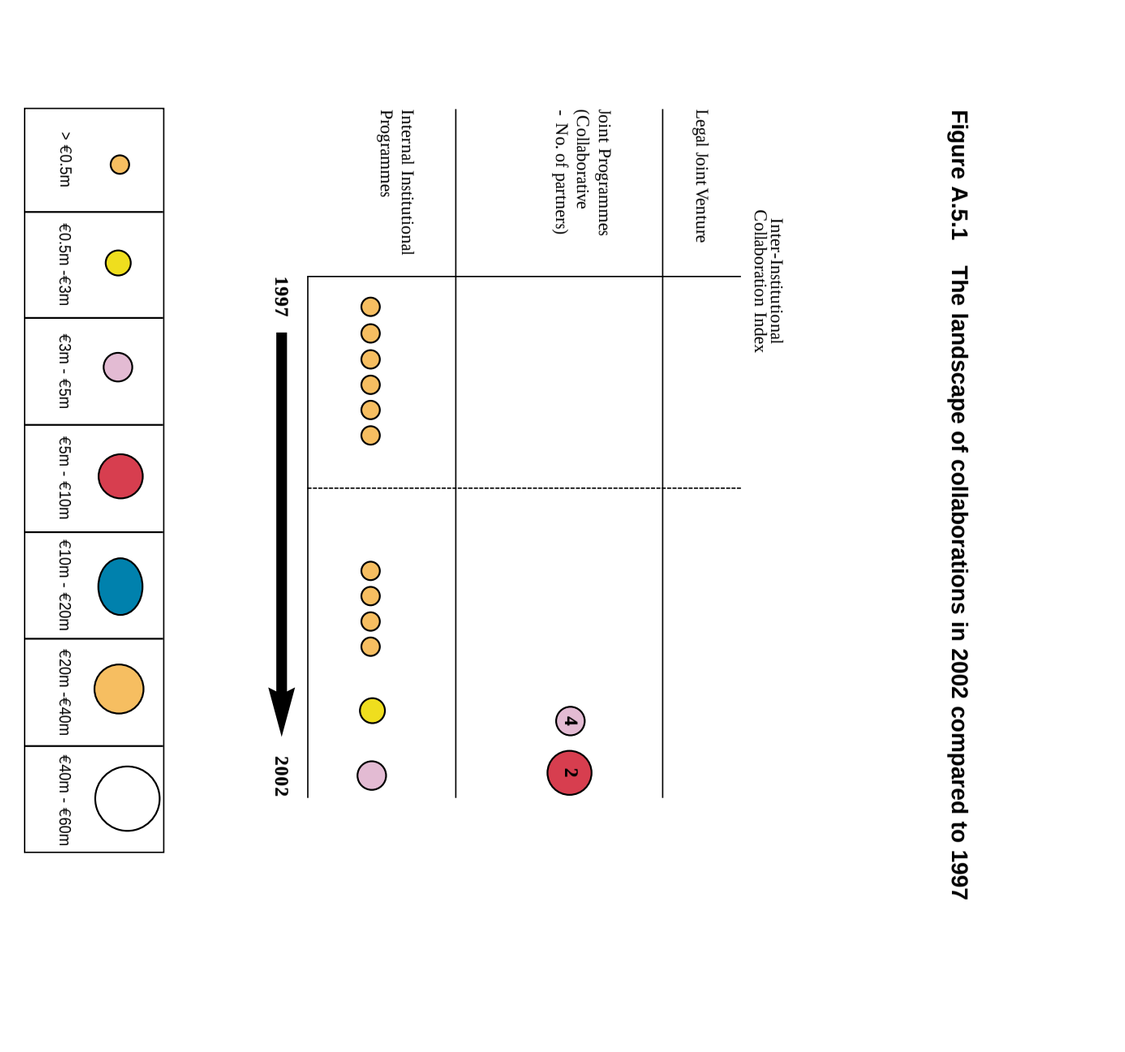
Centre/Research Programme	Lead Institution	Research Collaborations	Funding	Research Summary
Humanities Institute of Ireland	UCD	SPD	€7.6m	The initial research programme, Identity, Memory and Meaning in the Twenty-First Century. The programme will be supported by the development of an innovative Irish Virtual Research Library and Archive. Multidisciplinary research will examine the nature of identity and its psychological, philosophical, social and historical dynamics.
Research Resources/Library				
National Research Resource	TCD	-	€25.8m	
Research Library	UCC	-	€28.6m	

Note;

New Centres and Programmes being funded by PRTLI on the basis that as per the objectives of the PRTLI, research in these programmatic areas would have been previously carried out at the institution and deemed to be (a) areas of existing or developing strength, and (b) to be of strategic importance to the college.

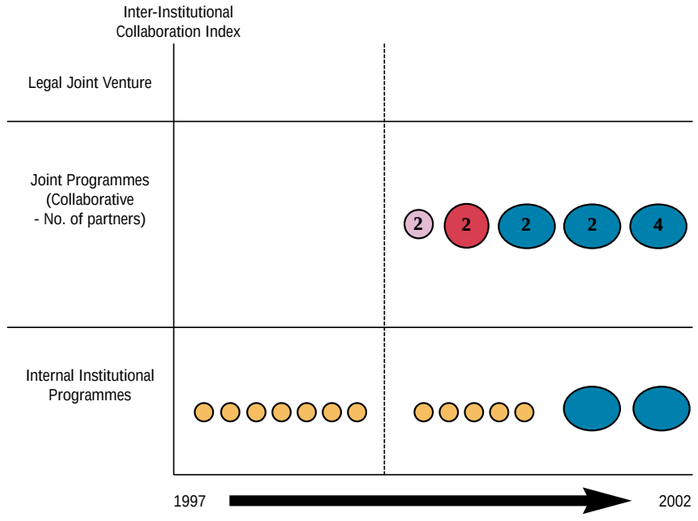
Annex 5

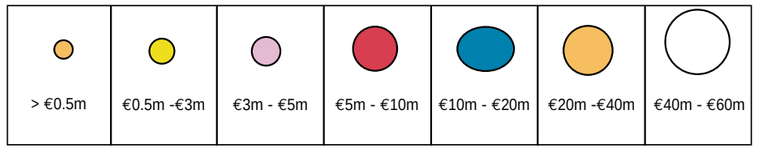
Figure A.5.1 The landscape of collaborations in 2002 compared to 1997



Note: Six third level institutions have received funding for humanities research from PRTLI. In 1997, each of these 6 institutions were in receipt of less than €0.5m. In 2002, two major collaborations have been formed in the humanities, with 2 of the 6 institutions also receiving significant funding for intramural research in the humanities. The numbers in the discs represent the number of third level institutions involved in each collaboration.

Figure A.5.2 Research in Materials and Engineering Science*

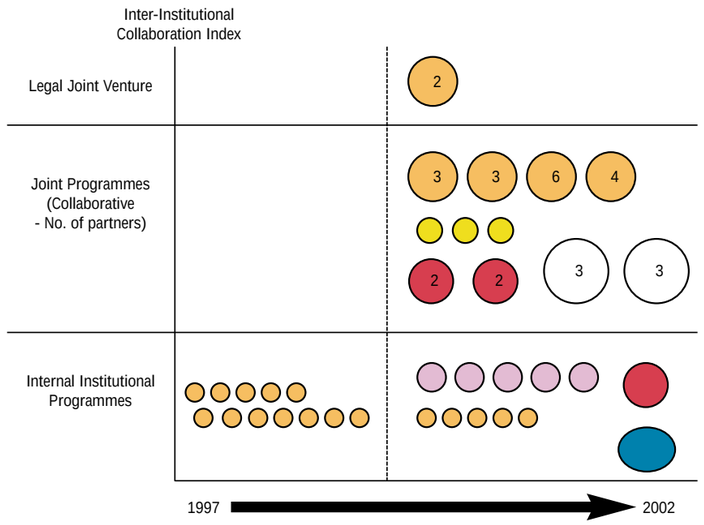


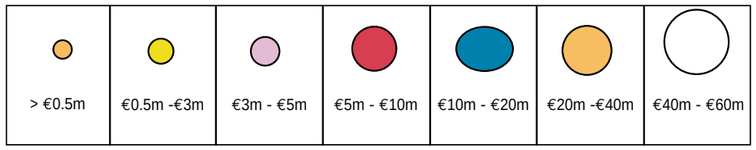


NOTE: Seven third level institutions have received funding for research in materials and/or engineering studies from PRTLI. In 1997, each of these 7 institutions were in receipt of less than €0.5m. In 2002, five collaborations have been formed, with 2 of the 7 institutions also receiving significant funding for intramural research in these fields. The numbers in the discs represent the number of third level institutions involved in each collaboration.

Figure A.5.3 Research in Biosciences/Biomedical*

**incl. Neurosience, reproduction biology, biomedical engineering*





Note: Twelve third level institutions have received funding for research in biomedicine and/or biosciences from PRTLI. In 1997, each of these 12 institutions were in receipt of less than €0.5m for research in these fields. In 2002, twelve collaborations have been formed, with 7 of the 12 institutions also receiving significant funding for intramural research in these fields. (The numbers in the discs represent the number of third level institutions involved in each collaboration).

Members of the Higher Education Authority July 2002

1.	Dr. Don Thornhill:	Chairman, Higher Education Authority
2.	Professor Patricia Barker:	Registrar, Dublin City University
3.	Professor Tom Boylan:	Department of Economics. National University of Ireland, Galway
4.	Professor Hugh Brady:	Department of Medicine and Therapeutics, University College Dublin and Mater Hospital
5.	Dr. Maurice Bric:	Department of Modern History, University College Dublin
6.	Mr William James Caves:	Former Chief Executive, Northern Ireland Schools Examinations and Assessment Council (CCEA)
7.	Ms Antoinette Nic Gearailt:	Principal, The Donahies Community School
8.	Ms Prisca Grady:	Business Consultant
9.	Ms Maura Grant:	Director of Programmes relating to Educational Disadvantage Department of Education and Science
10.	Professor Gary Granville:	Faculty of Education, National College of Art and Design
11.	Mr Paul Hannigan:	Director, Letterkenny Institute of Technology
12.	Mr Colm Jordan:	President, Union of Students in Ireland
13.	Ms Monica Leech:	Communications Consultant
14.	Dr. Tom McCarthy:	Dean of Graduate Studies, National University of Ireland, Maynooth
15.	Professor Ciaran Murphy:	Bank of Ireland Professor of Business Information Systems Department of Business Information Systems, University College Cork
16.	Mr Barry O'Brien:	Director (Estate and Support Services), Royal College of Surgeons in Ireland
17.	Dr Lorraine Sweeney:	Businesswoman