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UNIVERSITY - INDUSTRY
RELATIONS IN PORTUGAL

Manuel Mira Godinho

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UNIVERSITY - INDUSTRY RELATIONS IN PORTUGAL

A study on how universities can move
from a traditional integration in the community
to a more responsive attitude
in terms of socio-economic needs.

ABSTRACT

After the 1970s recession we have been observing in the 1980s several sharp changes in the structures of our societies. The emergence of a new wave of technologies, the intensification of international competition and the relative change of the governments' roles in the post-Welfare State era are some of these transformations. In this new context the traditional role of universities (supplying graduates, production and reproduction of knowledge) has also been changing. The responsiveness of universities to the needs of the community has been increasing and the collaboration with the business world has meant a relative "industrialization" of higher education institutions.

How can these changes affect the Portuguese University? What impacts can we expect in a small semi-industrialized country, with an economy largely dependent on external markets? Through a case-study of one of the largest Portuguese universities (the Technical University of Lisbon) an examination will be made of the possible role of the University in the new context, how the country specific features may mean new opportunities for a intentional action, on the part of the University. This action has two basic directions: (i) transfer of technology to upgrade the technological level of industry; (ii) cultural intervention, changing minds and attitudes in a low-risk pro.e environment.

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CONTENTS

Abstract

Acknowledgements

Chapter 0 - Introduction

- 0.1. General Assumptions
- 0.2. Objective
- 0.3. Implicit Objectives
- 0.4. Achieving the Objectives

Chapter 1 - A Role for the Portuguese University

Summary

- 1.1. University and Industry in the Context of a Semi-Industrialized, Small, Open Economy
- 1.2. Structural Aspects of the Portuguese Economy
- 1.3. Some Issues Arising from Changing Functions

Chapter 2 - Educational System and Universities

Summary

- 2.1. Education: Past Roles
- 2.2. Education: Future Roles
- 2.3. Universities: from Theocracy to Industrialization
 - 2.3.1. Historic Overview
 - 2.3.2. Turning Point
 - 2.3.3. Problems Arising from Responsiveness to Industrial Needs
 - 2.3.4. Where the System Goes
- Conclusion

Chapter 3 - Innovation Policies and the University

Summary

- 3.1. Innovation and Public Policies
 - 3.1.1. The Process of Innovation
 - 3.1.2. Innovation and Public Policy
- 3.2. The Role of Universities in Innovation
 - 3.2.1. Universities and Economic Development
 - 3.2.2. National Experiences of University-Industry Relationship
 - 3.2.3. Mechanisms of Technology Transfer from Universities to Industry
 - 3.2.4. Conditions for Successful Interaction
 - 3.2.5. Universities and Regional Regeneration Policies
- Conclusion

Chapter 4 - Innovation Policies, the Scientific and technological System and the Higher Education Sector in Portugal

Summary

- 4.1. Industrial and Innovation Policies in Portugal
- 4.2. The Scientific and Technological Potential
- 4.3. The Higher Education System
- 4.4. University-Industry Relations in Portugal
 - 4.4.1. The Legal Framework
 - 4.4.2. Some experiences of University-Industry Collaboration in Portugal
- Conclusion

Chapter 5 - Case Study of the Attitudes of the Academic Body of the Universidade Técnica de Lisboa

Summary

- 5.1. The Survey Objectives, Methodology and Limitations
- 5.2. The Population to be Surveyed, the Sample and Rate of Reply
- 5.3. Evolution of the Scientific Potential
- 5.4. University, Economic Development and Autonomy
- 5.5. Scientific and Educational Work at UTL and Levels of Work Satisfaction
 - 5.5.1. Research Quality and Conditions of Scientific Work
 - 5.5.2. Relation between Teaching and Research
 - 5.5.3. Levels of Satisfaction
 - 5.5.4. Salary Level, Academic Career and External Collaboration
- 5.6. Collaboration with External Organisations
 - 5.6.1. The General Mood
 - 5.6.2. Past Collaboration
 - 5.6.3. Future Collaboration
- 5.7. UTL and Research Based Firms
- Conclusion

Concluding Comments

Appendix 1

Appendix 2

Bibliography

INTRODUCTION

0.1. General Assumptions

The structural changes that we have been observing in the 1980's will, with an high probability, determine the evolution of the world economy until the next century.

In the present study I want to stress three changes I consider of the greatest importance: the emergence of a new wave of technologies; the intensification of international competition; and the emergence of new socio-political models and concepts in the industrialized countries rejecting the Welfare State. These three aspects are to some extent inter-related and have largely characterized the post-recession period.

The potentialities and impacts of new technology have been largely focussed by social scientists. As the model of economic reproduction that had predominated since World War II had run out in the 1970's with no more economies of scale to be exploited and with a prospective migration of some industries with relatively conventional technologies to semi-peripheric economies, industrialized countries faced a difficult situation. In addition, the decision of oil producers to increase prices meant a deep recession both in the industrialized economies (exception in Japan) and the developing world. The rate of growth of international trade slowed down and protectionist practices spread everywhere.

The emergence of new technology meant the springing-up of new industries as well as the revitalization of some of the "sun-setting" industries (eg.: car industry). The link between new

technology and international competitiveness was understood from the beginning and national policies and strategies have supported the strengthening of the technological infrastructures to improve the contribution of science to the productive process. Of course, the social costs of new technology are relatively high and governments, particularly in Europe, have had to face the dilemma of improving competitiveness vs. unemployment. The absence of complementarity between new technology and employment in the short term has been the first restraint to economic growth. But the awareness that economic advantage lies, in the long term, in the modernization of national industries, has meant that governments have increasingly embraced liberal policies with regard to the labour markets. The domestic "flexibility" aims to help to insert national industries in the international market.

International trade took off again in the present decade and the degree of trade interdependence among different regions of the world is historically unprecedented. It has been known for a long time that international trade offers mutual advantages, but it is also known that those who trade in scarce resources (to a large extent goods that are the outcome of relatively complex processes of production with a high coefficient of knowhow incorporation) have greater advantages and profit. The distribution of economic activities among different regions of the world therefore benefits those who own "scarce resources" produced by "sun-raising" or "revitalized" industries.

The intensification of international competition in the last few years has been a consequence of the attempts to get

majority shares in the new markets as well as retaining or improving shares in the "old markets". Some regions and countries have been more successful in this fierce competition than others. There are plenty of factors underlying this success (national cultures, models of microeconomic organisation, identification of producers with what is produced, risk assumption capacity, social cohesiveness, institutional arrangements, etc.) but the key factor has undoubtedly been the degree of international competitiveness.

The dynamic of international competitiveness has meant the migration of economic advantage. The long term differentials of social and economic welfare among regions and countries is partially determined by this migration of economic advantage.

The link between science - technology - production - competitiveness cannot be seen exclusively in economic terms. The relation between economic and political power is mutually reinforcing. Both to improve and preserve economic advantage countries usually to set up powerful military machinery. A declining competitiveness (or the inability to improve the current insertion in the world economy), the attitude of followers in technological terms instead of being in the leading-edge of the development of new "scarce resources", can only lead to long term dependence in economic, political, military and cultural terms.

The relative preservation of cultural and political identities is only possible in the context of the modern relations of interdependence if one country (or group of countries) thrives to maintain/improve its advantages in the

"scarce resources" zones.

Science and technology are, thus, in the centre of the perspectives of economic development. National expenditures in R&D have a crucial role in this context. If scientific and technological improvements are neglected, the long-term effect would be dependency and a failure to maintain self-identification.

The claim of national industries and governments that higher education institutions should increase their responsiveness to industrial needs arises from this context. Science is a seminal stage of the production process and universities, as owners of a stock of sophisticated scientific knowledge, have to multiply their links with industries to improve their capacity to compete in the international arena. In the last few years Universities have moved from their traditional role, that of mainly supplying graduates, to a renewed integration in the community.

This change was also triggered off by the crisis of the Welfare State. The competition between different areas of fund allocation (health, social security, education, defence) in a climate of controlled public expenditure has meant a shortage of resources to improve scientific knowledge through research with universities driven to look for alternative sources of funding.

The transfer of technology from universities to industry has thus been done mainly via commercial arrangements. The possibility to seek another responsive reaction is limited by the amount of money the State puts into universities.

The model of research commercialization is not, however, widespread throughout in the industrialized economies. Apart the USSR and the COMECON economies, Japan has not followed this model (as it will be seen in Chapter 2) with universities remaining relatively limited to their traditional roles. As an alternative large companies have developed internal arrangements (or "internal universities") where young graduates (and also long-term employees) are trained (and retrained) to adapt to new processes and technologies. Research is also largely carried out by companies (Japan is the industrialized country with the largest ratio of private R&D/total R&D expenditure).

Despite the differences both models of "university commercialization" and "internal universities" feature the common characteristic of an increased industrialization of university institutions, practices and methods.

The roles, behaviours and attitudes of the traditional university, that spring from the academic culture generated in the Medieval European universities, have been challenged in the 1980's. Improved responsiveness to the needs of the environment has meant a fundamental change in the model of university.

The "industrialization" of universities (together with changes in the whole educational system, in health services, and in cultural institutions that were largely funded by the State in the previous decades) is an important feature of the last years evolution of advanced societies.

0.2. Objective

This study sets out to discuss how the Portuguese universities can move from their traditional role to a more responsive role in terms of socio-economic needs, when science has moved to an integrated stage of the production process and when universities have experienced an "industrialization" in the advanced economies, bearing in mind the characteristics of the country (small semi-industrialized economy, largely open to the external markets, technologically backward, etc.

0.3. Implicit Objectives and Characteristics of the Study

The project of appreciating the prospective roles of the Portuguese University is intended to make a specific contribution to the economic and social development of the country. It is a piece of "applied research" relying on contributions from different areas of social sciences (Economics of Innovation and studies of R&D and of scientific and technological policies, Industrial Economics and industrial policies, Regional Economics and policies of regional regeneration, Sociology of Education, Social Psychology and Organisational Behaviour, etc.).

The study of what is happening in "advanced economies", in terms of the specific experiences of university-industry relations, does not mean that I acknowledge such models as an exclusive model to be used in Portugal. But there is no doubt that adapting appropriate "institutional technologies" from external sources can be a way to improving the current level of development. The problem does not lie in the copy itself

but rather in the way in which the copy is made (with or without improvement) and on the objectives that are implicit in the copy (to follow or to go beyond). The case of Japan exemplifies how a "creative copy" has enabled this country to become world leaders in some areas.

Among the limitations recognized in this study there is one I wish to stress, which is its partiality. It considers the problem of the relationship between university and industry from the standpoint of only one of the potential partners. Further research in this field has to be done from the point of view of industry.

0.4. Achieving the Objectives

In Chapter 1 I discuss what the role of the university can be, by analysing contextual factors that limit any possible strategy whose aim is to break down the barriers between universities and external organisations. Setting up a dynamic high tech sector as a complement to traditional industries is seen as a possible way to improve a country's international specialization.

The aim of Chapter 2 is to discuss major social, economic and political functions of the educational system, how they have evolved over the present century and how they should evolve in a context where, despite short-term benefits, technological changes can have a negative impact on the organisation of the labour market. In connection with this overview of the functions of the educational system, particular attention will be given to the historic evolution of universities, how they have evolved from their original

Theocratic form in the Middle Ages to the current stage of interaction and interpenetration between university and industry. The dangers of an "industrialization" of universities will be analysed, as well as the ways of avoiding such dangers.

The objective of Chapter 3 is to understand some mechanisms of technology development, absorption and spreading throughout the industrial matrix. The study of the innovation process (relations between science, technology and market) stresses the importance of systems of communication as a means of furthering innovation. The role of the State (scientific and technologic policies, reindustrialization efforts) is seen as complementary to the microeconomic efforts of improving competitiveness. Governments have been strengthening national technological infrastructures and universities are one segment of such infrastructures. The relation between university and industry is studied in this context, in which the universities are seen as the producers and managers of knowledge with potential use in industry. Universities are thus in the very early stage of the production process and much of the success of innovation may depend on the links they establish with industry and with other partners (local community, central government, finance). Different national experiences of university-industry relationships are studied in this Chapter and the factors that can help to develop socio-technical networks are also studied. Finally there is a section on the role that has been prescribed for small new technology based firms in regional development/regeneration and how they connect with universities and other partners to revitalize regions with

economic problems (when considered as a region of the EEC, the importance for Portugal becomes particularly significant).

In Chapter 4 the industrial and innovation policies in Portugal are analyzed to understand the current national scientific and technological infrastructure. The technological potential/limitations are seen in accordance with indicators of R&D expenditure, R&D personnel and the relative weight of technology transfer from other countries is compared with locally developed technology. The expansion of the higher education system since the 1940s, educational policies and the roles of higher education in Portugal are also studied. Finally there is an approach to the problem of university-industry interaction in Portugal through an analysis of the current legislation regarding the subject and a short description of some past experiences in the field.

Chapter 5 is a case study of the attitudes of the academic staff of one of the largest Portuguese universities towards collaboration with industry. A survey based on a sample of 25% of the academics working in the Technical University of Lisbon was carried out as well as some interviews of persons with leading responsibilities in the relation with external organisations. The aim of the questionnaire (see Appendix 1) was to assess the attitudes towards collaboration with industry, the role of university in economic development, the relation between academic autonomy, State policies and a renewed integration in the community improving responsiveness to social and economic needs. The levels of work satisfaction were also assessed to understand how they can limit/stimulate collaboration with industry. The technological potential (and

its prospective evolution) is also assessed to understand its importance in an economy largely characterized by a backward technological profile. In the last section of this Chapter the tendency of academics to set up new research based ventures is also assessed.

Finally there is a Chapter of Concluding Comments, where some of the issues raised throughout the project (particularly in Chapter 5) will be analysed once more and some tentative responses and proposals presented with a view to improving the socio-economic role of the university in Portugal.

CHAPTER 1 - A ROLE FOR THE PORTUGUESE UNIVERSITY

SUMMARY

In Chapter 1 I shall discuss what the role of the university can be, analysing contextual factors that limit any possible strategy aiming to break down the barriers between universities and external organisations. The setting up of a dynamic high tech sector as a complement to traditional industries is seen as a possible way to improve the country's international specialization.

1.1. University and Industry in the Context of a Semi-Industrialized, Small, Open Economy

The relation between University and society (and, of course, industry) is largely a two way process. At the same time as society expects certain roles from the universities (reproduction and production of knowledge, etc.) and moulds the University system to perform those tasks as required, the University introduces inputs in the social and economic system in the form of new ideas, scientific and technological knowledge, etc., that contribute to change, and mould future society.

The specificities of this two-way process in the Portuguese context offer particular conditions for an intentional strategy of the University. By taking advantage of their relative autonomy, universities can perform an active and innovative role in contributing to the economic development of the country.

The potential of the relationship between universities and industry can be exploited by following two courses of action.

The first assumes that there exists a gap between the scientific and technologic knowledge available at University and in Industry. Voluntaristic action by the University can make an important contribution to the technological upgrading of the Portuguese industry.

The second course of action, complementary to technology transfer, concerns an intervention at the cultural level which will contribute to the changing of mentalities, attitudes and dominant behaviour in Portuguese society that

do not favour innovation, creativity, and entrepreneurship.

Portuguese society and economy share at the same time characteristics of both developed as well as developing countries.

Despite membership of the OECD and more recently of the EEC, and despite similarities in terms of the workforce distribution (services and industry are the principal sources of employment), the Portuguese economy is largely backward in technological terms. The international specialization of the Portuguese economy relies mainly on labour-intensive industries.

The characteristics of the Portuguese economy present additional restraints to economic development. But the specific features of the situation also offer opportunities that are not to be found in advanced economies.

This particular set of opportunities/restraints can be the basis for a strategy of innovation of University-Industry collaboration in which the University ceases to play a passive role by waiting for the external demand of its technological potential or for the guidelines arising from the macroeconomic policies.

University resources have been mainly concentrated on the teaching function and the major contribution to economic and social development has been the supplying of graduates for the labour market. Research has been seen as a secondary function and has been performed more as a mean of promotion in one academic career rather than solving specific problems of the Portuguese society.

Besides the indirect rapport through the providing of graduates, the relation with industry has been mainly built up on an individual basis. A fair share of the university teachers has developed professional work outside universities. Their practical experience has made an important contribution to bringing together university and industry. But university and industry have, essentially, remained separate worlds, and much can be done to reduce this gap.

The experience of joint-research ventures is recent (in the last three years) and is not yet a common practice in Portuguese universities. Assessment of these experiments has been positive and there is a generally favourable attitude within the academic staff towards the intensification of combined actions.

To take advantage of such positive attitudes towards collaboration a careful and well-connected strategy should be designed. To maximize the benefits of such a strategy one requires a sound knowledge of the relations between science, technology, and market competitiveness in the Portuguese context. An awareness of the changing functions of the University in contemporary world and how they can affect the Portuguese University is also needed. These two points will be discussed in the following two sections.

1.2. Structural Aspects of the Portuguese Economy

In this section I outline the major structural aspects of the Portuguese economy and how they can limit development efforts when scientific and technological knowledge assumes a

central role in the process of social and economic development.

The structural weaknesses of the Portuguese economy are revealed in the fragility of the pattern of international specialization. Such a pattern has prevented the country from overcoming its semi-peripheral situation in the world economy. The continuous growth of the trade deficit in the 1970s and early 1980s evolved to a foreign debt of some US\$17 billion by the end of 1985. The commercial and financial dependence, is a consequence of three aspects: the difficulties in facing external competition in the zones of self-sufficiency; the weakness of the poles of specialization; and the strategic characteristics of the poles of dependence (Ribeiro et al. 1982).

Commercial dependence stems from three main sources: energy, agriculture and technology. If it is relatively easy to understand the energy dependence as a consequence of oil and coal imports (these raw materials do not exist at all), it is not so easy to understand how a country in which a relatively large proportion of the active population continues to be employed in agriculture has a considerable food deficit. Some structural aspects of Portuguese agriculture (property structure, high average age, illiteracy, absence of modern agricultural techniques, lack of entrepreneurial behaviour, etc.) can explain this situation. The third major source of the trade deficit (that I have called "technological dependence") stems from the fact that national industry relies almost completely on the import of capital goods. The import of consumer goods with high technological content (from cars to modern microelectronic gadgetry) also

contributes to such commercial and technological dependence.

The poles of specialization are still concentrated on labour-intensive industries based on low salaries (textiles, footwear, cork-manufacturing, etc.). But there are also some export-orientated industries relying on more capital intensive technologies (cellulose, car accessories, chemicals, etc.) and one now also finds some export industries producing electromechanical goods. But Portuguese specialization has changed slowly and was unable to avoid a drop in the national industries' share of the international market in the 1970s and early 1980s. As a whole the comparative advantage of the Portuguese economy has not been improving.

The trade deficit has only been partially compensated for revenue from tourism and emigrants' remittances. The continuous rising of the foreign debt has, since 1979, led to stringent policies that have slowed down economic growth. The annual growth of the GNP in the 1970-79 period was 4.98% while in the 1980-84 period it dropped to 0.48%.

To understand this evolution one must go back in the economic history of the 20th Century and analyse the microeconomic foundations of this poor performance.

Portuguese entrepreneurs were brought up in a protected environment from the 1930s to the 1960s when the economy started to open its doors to the international market. The lack of external competition led to the creation and survival of two major entrepreneurial segments: on the one hand a relatively modern sector of companies found in the basic industries and interlocked with the financial sector,

amounting to a dozen or so of large and diversified national conglomerates; on the other hand a large number of small/medium-sized firms, largely traditional in their technologies, products, methods of management, and general attitudes.

In 1975 the industrial-financial conglomerates were nationalized and what had been the Portuguese industrial elite disappeared. Of course this did not mean that the modern sector disappeared at all. Much of the structure of the conglomerates remained in the new Public Enterprises and simultaneously a modern sector of medium/large-sized companies (national and foreign capital) continued to operate. But the structure of the labour-intensive and largely unskilled traditional sector also remained, without any significant changes.

In the late 1970s the average size of the Portuguese manufacturing firms was below 20 employees (Table 1). The number of companies with 1,000 or more employees was 181, out of more than 50,000 firms in the manufacturing industry.

Table 1

Size Structure of Portuguese Manufacturing Firms (1977)

Classes of Firm size	Firms		People Working	
	No.	%	No. (1000's)	%
1-4	35660	69.4	60.8	7.1
5-20	9565	18.6	98.9	11.6
21-100	4758	9.3	197.7	23.1
101-500	1193	2.3	236.1	27.6
501-1000	148	0.3	105.2	12.3
+1000	181	0.2	158.0	18.4
TOTAL	51405	100.0	856.7	100.0

Source: Rendeiro (1984)

Studies on the attitudes of Portuguese entrepreneurs are limited. A 1969 study by Makler (submitted as a PhD thesis at Columbia University) on the attitudes of the Portuguese Industrial elite concluded, after surveying a "random sample of 306 elite members" that "there is a larger proportion of founders and heirs heading Portuguese enterprises, which is characteristic of less industrially advanced economies. However, the emergence of the managerial type [...], especially in technically advanced enterprises, indicates that development is occurring in the traditional society". Recent studies (Rendeiro, 1984) explain the low industrial productivity (one third of the EEC average) more as a consequence of the managerial inefficiency than of technical factors (machinery, etc.) or of the skill profile of the Portuguese industry.

The degree of entrepreneurship, both in the private and public sectors, and the inclination to innovate are naturally related to such managerial inefficiency and to the firms' structures. The panorama is not, of course, homogeneous, but a low risk-taking attitude characterizes the dominant behaviour. The attitudes prevailing in Portuguese society do not recognize the value of entrepreneurship or the professional careers in industry and this can explain a good deal of entrepreneurs' behaviour.

It is in this area that the University can perform a remarkable role in changing certain aspects of the dominant culture. Students in universities have been educated more as future employees than as potential employers or entrepreneurs from whom initiative, creativity and innovation are expected. To help change this situation the universities can promote

courses on entrepreneurship and management skills for potential entrepreneurs. The absence of any corporate planning in almost all the small and medium-sized firms or of cost accountability are also possible areas of intervention where short courses of technical up-dating for entrepreneurs, managerial staff, etc., could produce significant changes. Other areas of "cultural intervention" can also be envisaged by the universities.

Another aspect of such a strategy is the direct encouragement of entrepreneurship by universities' staff. The link with industry and economic activities in general can be achieved through different mechanisms of collaboration and technology transfer. These mechanisms range from individual consultancy by the academic staff, and joint research, to the formation of firms by academics in sectors of advanced technology. The launching of this kind of initiative with university support, eventually in collaboration with and/or financial support of large public corporations or advanced private companies (telecommunications, microelectronics, etc.), should be a leading element in any strategy to bring universities and industry together. The example of entrepreneurship in high risk sectors can be important to stimulate new initiatives. The difficulties surrounding this kind of initiative in a country like Portugal are obviously considerable. The identification of opportunities in market-orientated research, the articulation of such research with niche strategies in markets of advanced technology, the mobilization of risk capital to finance the development and marketing of universities' R&D, are difficult.

These initiatives, if successful, as a complement to the already existing small high-tech industries (EID's, Centrel, etc.), and connected to the needs of the main stream of the Portuguese industry, can be a major contribution in establishing a solid high-tech sector and in diversifying the basis of the Portuguese economy.

The research programmes that have been implemented in the last few years are dispersed in many directions and have been criticized because they are not different from the structure of similar programmes in major European countries. The areas of research have been telecommunications, microelectronics, biotechnology and new materials.

This widely orientated research can be partly explained by the structure of research in universities themselves. The areas of research have been developed according to the curricula and areas of undergraduate courses and therefore cover their different subjects and fields of concern.

The interest of Portuguese industry however follows the opposite direction and research (particularly university research that accounts for an important share of national R&D) would be more useful if concentrated in specific areas of inquiry. Research can be more helpful in developing capital goods (in place of consumer goods) by providing the traditional industries of specialization that rely almost completely on imported machinery. The application of CAD/CAM technologies and the development of the machine-tools industry would meet the needs of some traditional industries (textiles, footwear, wood and corkworks, etc.). Furthermore the development of specific machinery can be a step ahead in

terms of the creation of specialized niches in the international market.

Such research guidance means that the current institutional linkages between universities, government laboratories, and public and private companies have to approach the firms that operate in the specialized sectors.

This guidance does not, of course, mean that current research concerns, particularly in fundamental areas, should be dropped. The scientific and technological infrastructure, of which universities are one element, can perform different roles simultaneously.

The pattern of Portuguese Higher Education, with large, long established universities concentrated in metropolitan areas, and small, new universities and other institutions of higher education situated in the peripheral areas, offers conditions for a new form of action when collaborating with external organizations.

The tasks facing universities range from supporting existing industries (improving current products and processes, transfer of knowledge and skills in marketing and management through the provision of courses, etc.) to the creation of new industries (machine tools, instruments, etc.) which, through niche strategies, can help to improve the comparative advantage and insertion in the international market.

1.3. Some Issues Arising from Changing Functions

The "idea of a University" has been undergoing a rapid change in the last 10-20 years as a consequence of social, economic

and political transformations in the developed world. Academic culture is resilient in the face of environmental changes. Many of its features have remained unchanged since the Middle Ages (relation among members of the academic body, rules of upward mobility in the profession, rituals, etc.).

This resilience of University towards change has been overcome by pressure from State and Industry to increase the pay back from the resources and investments that have been put into the University. The move of science to an early stage of the production process leads to the assignement of new tasks and responsibilities to universities.

The advent of new technologies with a horizontal impact on the production system through their applications to almost all "traditional technologies" and the intensification of international competition following the 1970s economic recession have also helped to intensify the changes in the traditional University model in which teaching (reproduction of knowledge) and research (mainly basic to produce "new knowledge") were the main roles that University was expected to perform.

The increasing collaboration between university and industry may mean a progressive "industrialization" of the university (to be seen in the following chapter). But if collaboration will certainly change certain resilient aspects of the academic culture, it can also affect some distinctive features that have to be preserved. The closer integration of universities into the economic system can affect academic autonomy and freedom of inquiry. The commitment among the

academic body to the need to preserve autonomy is clear and any intensified collaboration should be concerned about this aspect.

Although in Portugal the universities have remained completely dependent upon the State Budget, scientific, pedagogic and administrative autonomy has been increasing over the last ten years. Despite the negative effects of preventing governments from implementing temporarily coherent policies, political instability offers further opportunities to expand university autonomy. A diversification of the sources of finance will also help to increase autonomy.

The capacity of the University to negotiate with the State and Industry the preservation of its autonomy on crucial aspects and, on the other hand, its capacity to increase its responsiveness to the needs of the community (enhancing the technologic potential of the economy and stimulating innovative attitudes), constitute a delicate balance that will have to be dealt with in the forthcoming years.

Summary of Chapter 2

The aim of Chapter 2 is to discuss the major social, economic, and political functions of the educational system, how they have evolved over the century, and how they can/will evolve in a context where technological change, despite the immediate benefits, can have a negative impact on the organisation of the labour market. In connection with this overview of the functions of the educational system particular attention will be given to the historical evolution of Universities, how they evolved from their original Theocratic form in the Middle Ages to the current stage of interaction and interpenetration between University and Industry. The dangers of the "industrialization" of the University will be analyzed as well as the ways of avoiding such dangers.

2.1. Education: Past Roles

The functions traditionally assigned to the educational system are the transmission of values and the teaching of skills and technical knowledge to prepare young people for "adult life". In other words, the roles that schools are expected to perform are education and training. The emphasis on these two aspects has shifted towards a greater intensity in the transmission of technical skills to match the requirements of the labour market.

Both education and training can be regarded as just one aspect that consists in the reproduction of knowledge. The educational system has also performed a complementary role, that of the production of knowledge. The stratum to which this function has traditionally been assigned is the higher education system.

The social functions of the educational system have been emphasized over the current century. Much of the work of structural functionalist authors on educational matters set out to stress the ability of education to provide individuals with the means of achieving occupational and social mobility. Early in the 1950's, however, critics of the consensus paradigm stressed that the role of education should not be to provide means of mobility but should rather perform a central role in contributing to social equality.

There were political and economic reasons underlying the motivations of decision makers when the educational system was expanded. In addition to the perspectives stemming from Sociology, the literature on education also received an important contribution from Educational Economics. The

theories of Human Capital, in which education is seen as an investment with a high rate of return, were spread by the OECD and the World Bank in the 1960s. Their influence in economic development theories was wide ranging, from Rostow's "Stages of Growth" to the Basic Needs perspective, and had practical effects in several experiments of development.

The expansion of education in the current century has, however, been instrumental in improving wealth and welfare both in the developed and underdeveloped societies whose aim is to leave behind this situation. But to a certain extent expansion has also been a disappointment. Equal opportunities have not proved to be a way of obtaining equality of outcomes. It was shown by empirical research that differential starting points (socio-economic insertion of the family, ethnic group, zone of residence, etc.) are a determining factor in the possible outcomes.

Much of the literature written on education in the last 10-20 years concentrates on the problem of the inter-generational transmission of inequality.

Basil Bernstein in Britain combined elements of Linguistics and Pedagogy with an analysis of the social structure to show that the family has a key role in the transmission of elaborated and restricted codes of knowledge and expression that are associated with the definition of different social and economic roles respectively.

Bourdieu, a French author relying on Marxist and Weberian influences, developed a conceptual framework where the cultural capital and social capital emerge in a different way of economic capital. According to Bourdieu the family has a

more important role in the transmission of cultural capital than the educational system. There is not a strict identification between the owners of cultural and economic capital. The meritocratic/credentialist ideology prevalent within the school system does not prevail in the outside world. Here social capital (contacts, etc.) has a more important role, in which it reproduces the structures of social and economic dominance. The possibilities of social mobility are in this model very few and those of achieving social change through the educational system are remote. The relative autonomy enjoyed by the academic market is tacit and the ownership and transmission of cultural capital through middle class families strategically placed in the educational system do not challenge the social order.

The common concern of the Bernstein and Bourdieu analyses is the role of the family as an extension of the educational system (and even more important than the educational system) in transmitting values, attitudes, and places in the social and economic structure.

Other critical contributions concerning the contents, meanings, and functions of the educational system have come from Conflict Theories. Neo-Weberian and Neo-Marxist authors appeared on the educational scene at the time of the student movements of the late 1960s. The educational institutions have been seen from the Neo-Weberian point of view as a system shaped arbitrarily by dominant groups according to their purposes. Schools, rather than teaching technical skills and training people, teach status cultures and act as an agent of socialization and differentiation according to the status group of origin. Marxist authors have analyzed the

educational system as a crucial element in the reproduction of the division of labour and of the hegemony of the capitalist class.

* * *

The functions that the educational system (both formal and informal: the family) has been performing have cultural, social, economic, and political meanings. The emphasis on any one of these functions has evolved in accordance with the structural and contextual changes of this century.

The characteristics of the 1980s, that were outlined in the introductory chapter, naturally point to specific functions to be performed by the educational system.

The emergence of new technology represents a structural change with broad and different impacts. In the following section we shall see some of the social and political problems associated with new technology and the role/functions that the educational system can perform in dealing with these problems. Finally I shall be discussing how the structural changes in the 1980s have particularly challenged the tertiary sector of the educational system.

2.2. Education: Future Roles

Much has been said about the previsional impacts of new technology in future social structures. Many studies have discussed the problem of future employment (eg. the recent Leontief report), the future profile of required skills, etc.

One emerging characteristic associated with new technology

is an increasing segmentation of the labour market, with different degrees of employment security associated with each segment (a marginal group, unskilled and mainly unemployed, a semi-skilled group experiencing unstable working conditions, a highly-skilled group with favourable working conditions but with no discretion, and, finally, a small group centralizing power and major decisions). This prospect of a highly polarized, segmented society strongly contrasts with the egalitarian ideas that pushed ahead the Welfare State policies in the past 40 years and represents the prospect of a largely undemocratic society.

This undemocratic prospect can be avoided through an adequate expansion of the educational system (that has slowed down in almost all OECD countries in the last ten years or so). Such development should be quantitative and both qualitative. Both political and economic arguments can be drawn up to justify this attitude towards education.

An action directed towards the changing of the mechanisms of cultural reproduction and the distribution of cultural assets - in a society where knowledge is a crucial factor in long term survival and, as important as any other resources - can be a way out of the undemocratic vision of the future. In addition it can be said that in underprivileged countries or regions the use, creation, and transmission of such cultural capital represents a valuable resource to be exploited. The success of such a strategy depends, of course, on the mobilization of their citizens and institutions.

Assuming that secondary education is universal, the enrolment rates in higher education should expand even more. The focus

of educational concerns should also shift towards the academic curriculum. The key to new development lies as much in the content of education as in its expansion.

Different problems have to be considered when revising academic curriculum. The balance between transmission of cultural values and the weight to be given to the teaching of specialized skills for working life, as well as the relation between continuity (reproduction of accepted values) and the development of critical and innovative abilities, are some of the options to be socially decided.

Opting for a more comprehensive education, in which the idea of specialization is dismissed, means that knowledge, and consequently power, is shared by more people. Interdisciplinarity is, on the other hand, a prerequisite for occupational mobility, important in the context of a high rate of technological change. Citizens should also be provided by the educational system with general knowledge enabling them to manipulate higher codes of communication and instruments enabling them to both rapidly and easily learn new skills and specific knowledge.

The mechanisms of cultural reproduction are much wider than educational institutions. The role of the family, the media, the social environment, etc., has been stressed by social researchers as was seen before. But in view of the renewed importance of the kind of knowledge that has been transmitted by the educational establishment it is possible argue that the academic institutions can play a fundamental role in the redistribution of cultural capital and in the changing of dominant mentality patterns. Values of initiative,

innovation, entrepreneurship, and critical capacities, should be very central to the new educational context.

Following the crisis of the Welfare State no social change can depend on budgetary opportunities. Academic institutions should also refuse any paternalistic approach from the State. The relationship between State, enterprises and citizens has changed and the reorganization of such a relationship should rely on the capacity of each individual or groups of individuals to promote new initiatives and zones of autonomy with regard to the different sources of power in society.

It is known that besides the State and the corporate world there are other forms of social organization that influence social and economic life and should be accounted for in any process of social change. Political parties and interest groups exist and have specific roles both outside and within the boundaries of the educational and university system. The interest groups range from communities of interest (cultural, scientific, etc.), through civic associations, to economic and political lobbies. Any strategy should regard these groups as important contributors to the outcomes of any taken initiatives.

The synergies between different initiatives, whatever the individuals or groups leading them may be, would help to balance power in advanced societies. Besides this, they would play a part opposing the pervasiveness of totalitarian forms of culture that have spreaded around as a consequence of increased economic relations among different groups of regions or countries, helping to preserve a global heterogeneity based upon local values, customs and cultures.

2.3. Universities: from Theocracy to Industrialization

2.3.1. Historic Overview

In a historic perspective A.H.Halsey (1984) differentiated three fundamental stages in the evolution of the University. In the first Theocratic stage the University was dominated by the Church and its objective was the reproduction of theologic knowledge. From the medieval period the European University evolved towards the Aristocratic stage when, in the early modern period, theocracy was displaced by the sons of Aristocratic families. The third stage, called Meritocracy, took place in the XIXth and XXth centuries, shifting the power to the academic group.

It is in this third stage that the discussion of what a University should be has been the object of intense attention from politicians, industrialists, educators, economists, sociologists, etc. The "idea of a University" has been frequently reconsidered during the last hundred years or so. From Cardinal Newman's "The Liberal University" (for whom the idea of an University was embodied in the Victorian model of Oxford at that time), through Humboldt's Berlin Universitat (in which research was the centre of the university's concerns), to Clark Kerr's California University in the 1960's (that represented the "Multiversity" with massive enrolments: the rate of enrolment/age group was around 40% in the 1960's in America; the University of California had itself nearly 300,000 students), the idea of an University has undergone continuous revisions.

Until the II World War the predominant concept of the University was liberal, evolving in the reconstruction period.

to a "technological-democratic" pattern. These two versions of the modern meritocratic university derive their basic model from the German University of the XIXth century where knowledge was pursued without the desire for immediate profit and where entry and exit had been declared free to those who wished to do so.

The expansion of the University in the XXth century was only possible with the mobilisation of an huge quantity of resources provided by the State. From the universities of the last century, financially independent from the central governments, to a situation in which 90% or more of the higher education funding is provided by the State, a considerable distance has been covered.

The concept of post-secondary education has itself undergone a considerable change. The need to provide courses to meet an increasing student demand as well as matching the requirements of the labour market has meant the introduction of shorter courses with more practical purposes. The universities are no longer the only institutions providing educational opportunities after secondary education. There has been, particularly in the last 20-30 years, the setting up of a complex system of tertiary education - the Higher Education system.

Besides this development intended to satisfy both student and labour requirements, higher education has been designed to satisfy other social and economic needs. Universities have moved from the idea of knowledge simply to satisfy idle curiosity towards more utilitarian purposes. The establishment of new tertiary institutions in underdeveloped

or depressed regions is an example of new roles performed.

This short account gives an idea of the rapid change that has happened in this century. But the changes that have been taking place in the last few years will probably contribute to much more dramatic and radical changes than those that occurred up to the recession of the 1970s. The University is now at a turning point, and all the recent discussions about the "idea of a University" have not yet worked out the logic and the major features of the new model of the University.

2.3.2. Turning Point

It is true that throughout the last decades the responsiveness of higher education to market needs has been increasing. But the current involvement of universities and industry has reached a hitherto unprecedented level.

We are now observing a renegotiation of the boundaries of the teaching function, as well as the research function, between university and industry. The number of companies where teaching functions at a postgraduate level are performed has been increasing (particularly in Japan) with a frequent participation of universities' teachers. On the other hand the number of small courses provided at universities to up-date technological and managerial skills of staff-members belonging to industrial companies has also been increasing continuously. This interpenetration between universities and industry is the sequence of an earlier process of "mixing" between University and the State that has its roots in the XIXth century (the French "Grandes Ecoles", etc.), with governments requiring from the university system the

provision of training in a set of needs of different areas of Public Administration.

The current "industrialization" of universities goes further than an exclusive institutional interpenetration. The methodologies of assessing academic activities have been shifting to the use of quantitative methods of performance assessment. The measurement of universities' output is already possible in some aspects (research evaluation, effectiveness of the system in terms of drop-outs/number of graduates, etc.) but is still difficult in the field of teaching, where academic excellence is not easily quantifiable.

Another aspect revealing the "industrialization" of universities is the shift in certain countries (eg.: West Germany) from the payment of studentships to loans payable following the conclusion of the studies. In these cases a return on investment is calculated as any other industrial investment.

Strategic planning has been introduced in some higher education institutions and academic authorities tend to behave as managers of organisations where outputs should be maximized and inputs minimized.

2.2.3. Problems Arising from Responsiveness to Industrial Needs

The increasing collaboration/integration between University and Industry has been both praised and criticized from different perspectives.

Those who support the "industrial" and "practical" role of university have emphasized the link between the efforts to

further industrial competitiveness and the need for intensified collaboration: "In the last decade, university-industry relations have undergone major shifts and changes. Traditional approaches still remain, but have turned out to be insufficient in the face of rising expectations stimulated by intense international competition. Although industry still expects the universities to focus their primary efforts on the training (and retraining) of scientists and engineers, academic research is increasingly seen as offering specific opportunities which call for co-operation" (Ferne 1985, p.23).

The criticism of intensified collaboration has been expressed about the issues of academic autonomy and freedom of enquiry. In an article entitled "On the road to Silicon Valley? The changing relationship between Higher Education and Government in Europe" G.Neave (1984) claims that the pressures for "responsiveness to the community" will lead to a further decline in university autonomy. In his opinion "driven research" (both by public and private sectors) will increase in the future and this will create: (i) tensions between freedom of publishing results and pressures to maintain secrecy; and (ii) a further shift in the balance of power away from the university and in favour of the funding organizations. In his views the "utilitarian" and "vocational" temptations constitute a danger to freedom of inquiry. The move of universities towards research commercialization raises the question of knowing if, in view of this change, the University will not "become further enmeshed in short-term undertakings of a technical or technological nature rather than acting as an ark for free

inquiry and discussion where so ever it lead".

Such kind of reservation has been expressed by large groups both within and outside the University. Attention should be given to such views and they should be carefully analysed if one does not want an increased collaboration between universities and industry to have harmful long term consequences.

As regards university autonomy it is known that this has been declining throughout the XXth century : "Thus the expansion of university studies, especially in the natural and applied sciences [...], has almost completely eroded the financial basis of autonomy, converting the universities to this extent into State dependencies and thus placing the burden of maintaining academic freedom on the beliefs and sentiments of those who wield power in the modern system of government and administration" (Halsey and Trow 1971, p.64). State intervention has been particularly noticeable in the new institutions of higher education implemented in recent decades. And, in another context, universities founded in developing countries have been subject to State intervention in administrative, academic, and political matters.

The complexity of the autonomy problem, in a context where the university and higher education have been funded almost completely by the State, requires a subtle solution. It is a fact that the University is in debt with the community that funds its teaching and research practices. But on the other hand a merely pragmatic view of the University can compromise new advances in science and - more important - the critical and cultural potential inherent in the university system.

This potential is a strategic resource able to guarantee the cultural health and wealth of societies in the long term.

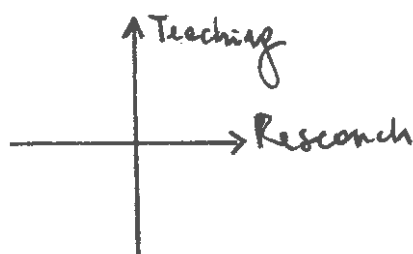
Autonomy is strengthened by academic excellence, regarded in cultural and scientific terms. The possibility of diversifying sources of funding, when adequately managed, can also help to preserve autonomy.

The second argument that critics have put forward concerns a shift in research orientation. The temptation to totally shift the direction of research from basic to commercially more attractive applied research should, of course, be resisted both in the interest of Industry, State, and University. Knowing the difficulties in undertaking basic research with industry, governments should, when funding higher education and particularly universities, preserve basic research through the allocation of specific grants and funds for that purpose.

2.3.4. Where the System Goes

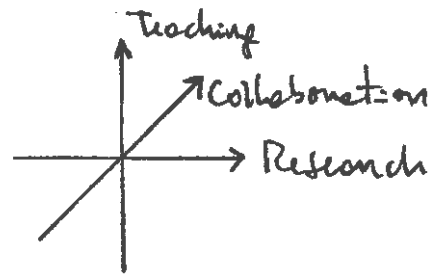
The typology drawn up by Halsey and Trow (1971) more than a decade ago to characterize the university system may be seen in terms of two axes. Halsey and Trow viewed the "traditional" idea of the University as a combination of elitist and research aspects, while the "modern-democratic" university lay somewhere in the space between teaching and expansionist attitudes.

Figure 1.



A third axis can now be added to this typology, concerning the relation with external organisations and particularly with industry.

Figure 2.



This new "three-dimensional space" represents the choices that the University and other higher education institutions can make in the contemporary world. Despite the acknowledged importance of the expansion of the higher education system as a whole, the situation in the near future will be that some institutions will probably remain relatively "elitist" dedicating much of their efforts to postgraduate work. Those institutions will necessarily give priority to research activities and will probably maintain a close collaboration with external organisations. On the other hand other higher education institutions will provide mainly teaching services to an increasing mass of post-secondary students. In this view higher education institutions will not occupy a specific point in the space created by the three axes but will be spread in different points of that space.

The pluralistic funding of research in such a system can help to reduce the dependence upon one single source of financial resources. Diversification of finance can help to balance the decline of autonomy by safeguarding crucial aspects concerning the rights to publish, and academic discretion regarding the selection of certain areas of research - even if they do not meet immediate concerns of industry.

Conclusion

The question arising from the previous discussion of the changing functions of education and universities is how technological requirements can meet recognized social functions.

The provision of further education, in quantity (expansion) and diversity (combining "training" and "educational" aspects), is complementary to economic needs to enhance external competitiveness. However, the interaction between different organisational cultures poses problems. The academic culture and the entrepreneurial culture(s) have distinct features. The success of any interaction does not mean fusion between cultures or integration of the former in the latter. Responsiveness to industrial needs should avoid the loss of autonomy by negotiating the preservation of crucial areas of academic freedom. The support and development of local, regional, and national cultures is the only way to guarantee future cultural wealth.

The integration of the University in the market is a current trend, but it has not yet proved to be an exclusive or irreversible one. The integration of universities in the community can be done through a diversified pattern of interactions, not exclusively through closer relation with industry.

The promotion of values of creativity, initiative, autonomy, self-reliance, and innovation has the dual function of stimulating each group and helping to balance power between a diversity of interests.

In short, there is a delicate balance to be met between social and economic needs. The challenge that faces the post-modern university is how it can stimulate the individual while preserving the collective interest.

CHAPTER 3 - INNOVATION POLICIES AND THE UNIVERSITY

SUMMARY

The objective of Chapter 3 is to understand some mechanisms of technology development, absorption and spreading throughout the industrial matrix. The study of the innovation process (relations between science, technology and market) stresses the importance of the systems of communication to further innovation. The role of the State (scientific and technological policies, reindustrialization efforts) is seen as being complementary to the microeconomic efforts of improving competitiveness. Governments have been strengthening national technological infrastructures. The relation between university and industry is studied in this context, in which universities are seen as the managers and producers of knowledge with potential use in industry. Universities are thus in the early stage of the production process and much of the success of innovation can depend from the linkages they establish with industry and other partners (local community, central government, finance). The experience of different countries in university-industry relationships are studied in this Chapter and the factors that may help to develop socio-technical networks are also studied. Finally there is a section on the role that has been prescribed for small new technology based firms in regional development/regeneration and how they interact with universities and other partners to revitalize regions with economic problems (importance for Portugal, when seen as a region in the EEC context).

3.1. Innovation and Public Policies

3.1.1. The Process of Innovation

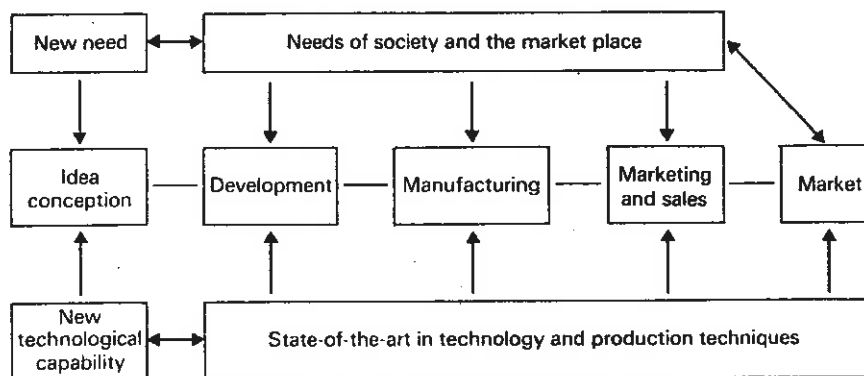
One of the most long-standing debates on the process of innovation is about the causes of innovation itself. The question that has been analysed by researchers and policy-makers concerns the factors that determine an innovation, in the sense defined by C. Freeman (1974): "Industrial innovation includes the technical, design, manufacturing, management and commercial activities involved in the marketing of a new (or improved) product or the first commercial use of a new (or improved) process or equipment".

Until the 1960's the predominant vision about the process of innovation accepted that the trigger of any innovation was a preliminary basic invention. The development of new scientific knowledge would create opportunities for the commercial exploitation of new (or improved) products and processes. However several empirical studies in the 1960's began to show an alternative view of the innovation process: innovations were a response to real needs felt in the market place.

These two alternative models ("Science/technology-push" and "demand-pull") dominated the debate on the causes of innovation until the last decade. This debate now looks sterile and of little interest as most authors and researchers agree that innovation is a consequence of both science and demand factors. The "interactive" models of innovation are now accepted for their accuracy in describing the complex relations of the innovation process, where the sequence between different stages of the process depends on

the specific industry, on the stage of the industry cycle, as well as on the stage of the product's life cycle. In avoiding the linear explanations of the "demand-pull" or "science-push" models, interactive models explain the process of innovation as a net of communications both in the organisation and in the relation between the organisation and the environment.

Figure 3.



Source: Rothwell and Zegveld, 1985.

Despite the general acceptance of the "interactive model", the "demand-pull" and "science push" models have remained a relatively important theoretical point of reference, particularly in terms of assessment of policy-making decisions.

When funding R&D governments tend to overestimate the virtues of the "science-push" models, and neglect factors concerning demand trends, etc., benefitting the creation of technological opportunities. In addition to this partial view of the innovation process public authorities have in mind a linear relation between science and technology that has not been accepted by several researchers of the innovation process.

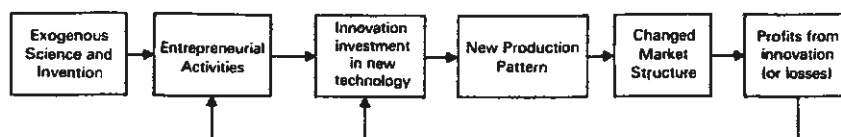
The characteristics of the innovation process do not favour a straight-forward analysis. The emergence of new products, processes and devices as well as the confluence of different scientific and technological knowledge highlighted the interaction among different industries and other sources of information. The innovation process can be studied in the context of a scientific and technological matrix where both intra-sectoral and inter-sectoral changes occur. The state-of-the-art knowledge is concentrated not only in industry but also in universities, government laboratories and other public research institutions. As a consequence the flows of knowledge along the matrix come from different institutional sources to different recipients.

The decisive scientific and/or technological inputs for the innovation process can come from the environment or from within the firm itself. The alternative models of innovation suggested by Schumpeter (in "Theory of Economic Development", 1912, and in "Capitalism, Socialism and Democracy", 1942) highlight two ways of innovation: "In the first case Schumpeter stressed the importance of exogeneous science and invention which, via the medium of entrepreneurial activity, led to the growth of new industrial branches and new areas of demand [...]; in the second case he emphasized the role of the endogeneous science and technology in the R&D laboratories of major companies - strongly coupled to exogeneous science and technology - which again led to new patterns of production and new market structures" (Rothwell and Zegveld 1985, p.61).

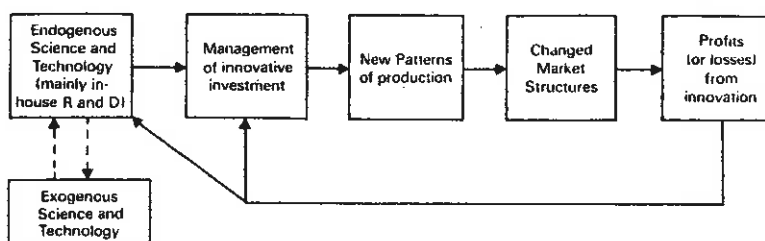
Figure 4.

Schematic Representation of Schumpeter's Models of Innovation

I) Entrepreneurial Innovation



II) Large Firm Managed Innovation



Source: Rothwell and Zegveld 1985, pp.62-63.

The second case of innovation suggested by Schumpeter represents a step ahead of Economic Theory, that has treated technological change as an exogeneous variable rather than an internal reality of the microeconomic units and of the economic system. The production of scientific and technological knowledge via R&D laboratories (in-house or not) has become a part of the economic activity and the increasing involvement of firms in R&D activities in the last few years in fact confirms this view. Nowadays both small and large firms perform R&D activities and the dynamic entrepreneur does not limit his field of action to picking up science and inventions from the environment. Science-based small firms have been rising with in-house research capabilities.

Despite the fact that firms more and more invest in their own R&D facilities, they also set up structures of communication

with the scientific environment, trying to figure out what is going on in the laboratories of their competitors, in university laboratories, what is being published in scientific reviews, etc. The Scientific and Technological information available from the environment still plays an important role in feeding the innovation process. The governments' policies to strengthen the public segments of the technological infrastructure intend to increase the R&D efforts of the private sector. The integration of market-orientated science in the agenda of macro and microeconomic strategies of innovation represents a new qualitative aspect of economic development.

The role of University should be seen in the light of the debates on the innovation process, of the pervasive relation between science, technology and market, and of the changing characteristics of science. A successful strategy of innovation should be based on the idea that innovation is, above all, a process of communication: "There exists an important role for public policy in facilitating linkages between the publically funded scientific and technological infrastructure and industry (as well, of course, as forging more effective links between universities and collective industrial research institutions). If [...] we are now experiencing the emergence of a new wave of generic technologies, the establishment of effective linkages between the infrastructure and industry must be a core element of public innovation policy" (Rothwell and Zegveld 1985, p.80).

3.1.2. Innovation and Public Policy

Government intervention concerning innovation has assumed

different forms and intensities depending on factors of level of development, international competitiveness, geography, tradition of public intervention and ideological principles orientating governments.

The 1970's recession and the intensification of international competition have made clear that the governments of industrialized countries, despite the liberal nature that some of them claim, have applied several kinds of intervention in innovation. The objective of these policies has been the modernization of the industrial structure. But there are some features that have slowed down their implementation. The major constraint upon such policies is the short term social effect of new technology (unemployment) and the psychological climate among entrepreneurs (aversion to risk).

The intended "reindustrialization" has to be done through two complementary vectors: (i) transformation of the "sun-set" industries into higher added-value and more knowledge-intensive industries; (ii) creation of new industries specifically in the areas of emergence of new technology. The first vector, a change in the traditional sectors, is only possible when coupled with the second vector, through the application of new technology to improve old processes and products.

The map of innovation policies that appears in the zone of interaction between Science and Technology policy, industrial policy, and regional regeneration policies, shows n-possible combinations of objectives and instruments for government action. In their book "Industrial Innovation and Public Policy" (1981) Rothwell and Zegveld systematized the most

important measures available to governments in formulating national policies of innovation: (i) Government procurement ("whatever form it takes there is no doubt that the government market has an important influence on industrial innovation" - p.49; (ii) Subsidies to R&D activities of individual firms (or other forms of direct or indirect financial support, eg.: tax incentives); (iii) Laws and regulations; (iv) Support of basic and applied research within the scientific and technological infrastructure ("These activities may take place in universities, in government funded institutions..." - p.50); (v) Policies towards small and medium sized firms ("there is hard evidence of the strategic importance of this group of firms" - p.50). To these points Rothwell and Zegveld add a sixth one, the capacity of governments to influence the general economic climate. This climate "has a major influence on the innovative activities of industrial firms" and is related to many important aspects: "the relative opportunities for profit inside and outside manufacturing industry, the patent system, price and wage controls and general competitive conditions" (p.50).

3.2. The Role of Universities in Innovation

3.2.1. Universities and Economic Development

The traditional roles of the "modern university" - as has already been seen in Chapter 2 above - have been the training and supply of graduates to the labour market and the performing basic research. The academic community has seen these two activities as mutually reinforcing and their

quality as the criteria for assessing the level of excellence of university institutions.

Governments have accepted this duality of objectives as the main contribution of universities to economic development. But the expansion of higher education meant the creation of different kinds of institutions with specific roles in economic development. Technological Universities and Polytechnic Institutes were set up with the objective of training and providing graduates in specific technological areas. The competence and knowledge developed in those areas were expected to be transferred to relevant industries. The New Universities created in some European countries (UK, Norway, Finland, Portugal) in the 1960s and 1970s shared, among their objectives the promotion of regional economic development providing the regions with "high level" equipment and a pool of highly skilled graduates, and acting as a dynamizing element for the depressed or underdeveloped regions.

The reinforcement of the contribution of higher education to economic development through those new institutions introduced an element of tension with regard to the prevailing academic culture, which had stressed considerable freedom in defining research objectives and autonomy as central values. But until the 1970's this tension could survive with no problems, either for the academic community or the funding institutions.

As was previously seen the post-recession period has been characterized by pressure on universities to increase their contribution to the community. The discussion of the relative

contribution of universities in the past has been itself controversial. The accountability of university output and the implementation of policies with that intention has been a concern of those who claim that universities should improve their contribution: "In principle we are convinced that university research has an effect on economic development; it is, however, difficult to identify past effects and to forecast future ones as well as to make a cost-effectiveness analysis. Our efforts in this respect are often partly successful. Consequently, the question is: Can we improve the tools for measuring the effects of universities on economic development?" (Massow 1984, p.106).

Although accurate means to assess the contribution of universities to development do not yet exist, there is a relative consensus among all parties concerned - industry, governments, local communities and universities themselves - that such a contribution should be intensified.

Science and technology are crucial resources in the context of contemporary international competition. The capacity and ability to innovate - the way scientific and technological knowledge is put into material goods and operations - determine economic success and survival in the long term.

Universities and higher education institutions are in general supposed to have an amount of scientific and technological knowledge in stock. As the 1984 OECD document on New Forms of Co-Operation and Communication between Industry and University puts it: "Technological innovation could almost be described as the attempt to institutionalise the search for new types of information within the business enterprises that

collectively make up "industry". One of the most potent sources of such information lies distributed in the network of higher education institutions" (OECD 1984a, p.11).

How the University will be integrated in the innovation process, both from macroeconomic and microeconomic perspectives, is the question arising from the above.

G.Danielou, President of the University of Technology at Compiègne in France (one of the most exemplary processes of creation of links between University and Industry in Europe) compared the magnitude of the profound change that the world has been undergoing with the birth of agriculture 9,000 years ago, and concluded that "We have a tendency to underestimate the rapidity of the technological revolution - our university system is very old; it came out of a long trial and error process and is not suited to the new era" (1984, p.15). This means that another model of university has to be structured to ensure the transfer of technology to industry.

Such a model should be sufficiently flexible to adapt to different realities in terms of level of development, traditional values and dominant local cultures. It will stem from different levels and areas of concern and from the awareness, knowledge and understanding of specific aspects of the reality:

- (i) innovation process;
- (ii) relation between innovation and international competitiveness of national industries;
- (iii) cases of efficient technology transfer from university to industry;
- (iv) different available mechanisms to promote the

transference of technology;

(v) the different actors in the process, their expected roles and the general conditions for a successful transference;

(vi) barriers to a successful transference;

(vii) specific national and regional features.

Some of these aspects have already been discussed in this Chapter. Other will be discussed in the following sections. All will be taken into account when considering different forms of university-industry collaboration and the problems that can stem from the interactions.

3.2.2. National Experiences of University-Industry Relationship

The relation between University and Industry has varied significantly according to the innovation experience of each country. The integration of universities in the innovation process through the commercialization of its research is not a unique model and the communities have not always seen such commercial links as being the best way of taking advantage of the resources spent in universities.

The model of research commercialization is derived from some American experiences (originally MIT and Stanford University).

The Japanese experience in terms of University-Industry relations is quite different from the American model. In Japan the main sources of innovation have been: (i) foreign companies from which technology has been bought and from which products and processes have been copied; and (ii) in-

house laboratories of Japanese companies. The role that universities have been expected to perform is mainly to supply a "general broad education [providing] the socialised "blank sheets" employers prefer" (Institute of Manpower Studies, 1985, p.4). Companies also have their own schools, equivalent in status to universities where further training is provided in specific fields. "The Ministry of Education, which directly employs University staff, [...] actively discourages direct links between academics and companies.[...]. As direct Government employees, University staff in Japan is not allowed to profit from the commercial exploitation of their ideas" (ACARD, 1983, p.66). Despite the lack of direct links between companies and University staff there are many cases of informal collaboration and there exists, as in other countries, a government policy to encourage such links (eg.: the "Science City" at Tsukuba). The prospective long term programmes implemented by MITI also act on as a forum where contacts and ideas are exchanged between companies and university professors. This means that the relation between university and industry is fairly intense but operates on a personal and informal level because direct financial links are not encouraged or even allowed. This situation is, to a certain extent, a consequence of the bureaucratic paternalism of Japanese companies and their strategy of relying mainly on their own resources to perform research and remain competitive.

The American experience is quite different. Since the 1930's universities have been encouraging their staff to collaborate with industry through policies of "lowering the threshold" to commercial interaction at all levels (Bullock, 1984, p.10).

In addition to these policies (that help to create a favourable environment) the practice of universities and their members to contract external institutions was further stimulated by policies of public procurement that have their roots in the II World War period. The relatively small weight of public laboratories (when compared with West European countries) has meant that government requires universities to develop and transfer knowledge and technology to the defence sector. Public procurement through the Defence Department represents a considerable amount of financial resources that flow to the academic system and enable universities to develop leading-edge research, and obtain commercial experience. With the encouraging attitude of universities towards commercial links and towards entrepreneurship, a complex system of interaction between universities, military and civil research, private industry, and financial institutions has been built. In the last few years this system has been seen as a priority instrument to further the capacity of innovation of American industry and as a central means of replying to the Japanese challenges.

Between the Japanese and the American "models", and among the industrialized market economies, there are several degrees of intensity in the relations between university and industry and partial involvement of academic staff in the commercial aspects of the innovations that arise from university inventions.

In European countries there has been a smaller tendency to stimulate academic entrepreneurship and commercialization of the results of research than in America. Despite a tradition of collaboration with industry, particularly from technical

universities, and the setting up of liaison systems in European universities since the 1950's and 1960's, commercial links have not been encouraged. In certain cases, this discouragement is emphasised by legislation that penalyses extra academic work. This stance towards collaboration has been changing recently, with the recession and its consequences. The American model has been identified as a source from which European universities can and should learn.

In the UK efforts have been made for many years to improve university-industry links. Despite a positive impact, the appointment of university liaison officers was not enough to overcome the gap between a recognized excellence at "invention" and a poor performance at "innovation": "Universities have a reservoir of inventiveness which is only partly applied to the benefit of industry" (Caglan et al. 1983, p.5). Programmes and mechanisms have been set up to facilitate the commercialization of university inventions. The stringency of budgetary policies has also put pressure on universities to look for alternative financial sources. Universities have developed different initiatives from which the more sophisticated and wide-ranging has been the implementation of Science Parks (Cambridge, Heriot-Watt in Scotland, etc.). These initiatives have been convergent with the policies of government bodies, from the Research Councils cooperative schemes to the Alvey Programme. This Programme was launched in 1982 with the specific aim of developing a UK capacity in information technology (fifth generation of computers) through a "collaborative effort between industry, the academic sector and other research organisations" (The Alvey Report 1982, p.9). Despite all the

problems concerning the management of these programmes it has been argued that their real contribution has been to break down the barriers between academic institutions and industry.

Other West European countries have been developing similar initiatives aiming to implement collaborative research in new technology and in its applications to national industries.

In addition to national initiatives, the European Commission has implemented several programmes (ESPRIT, RACE, FAST, ERASMUS, COMETT, EUREKA, etc.) that aim to foster the co-operation between European universities and industry both in training, basic research and development of new products.

From what has been said it is possible to conclude that a diversity of approaches has been made. From the European mainstream experiences it is clear that there is a tendency to follow certain aspects of the American model, despite the fact that the efforts of the Public Sector are more important and the general environment less favorable being not so propitious to a spontaneous networking of the different agents taking part of "socio-technical communities".

3.2.3. Mechanisms of Technology Transfer from Universities to Industry

It is quite difficult to draw a typology of the available mechanisms concerning technology transfer from universities to industry. Different countries and different universities have their own experiences in setting up particular institutional arrangements that sometimes perform multiple functions. In this section I will try to draw a systematic picture of available mechanisms that perform simple/specific

functions.

The first group of mechanisms concerns the university liaison systems that have been set up in Britain, The Netherlands, West Germany, etc. Almost all British Universities have some kind of industrial liaison units or appointed liaison officers. Their mission is to act as an intermediary between university and external organisations, and they provide advice and guidance when industrialists approach universities. Some universities have developed these switchboards as independent commercial firms with university capital and specialized staff able to advise academics about ways of commercializing university research. Other universities have implemented industrial liaison programmes in which local or national companies subscribe to an information system that regularly publishes the research and initiatives that have been taken at the university and its research centres.

The second group of mechanisms concerns the legal advisers on patenting and licensing that some universities have appointed. In American universities this function has also been assumed by independent non-profit making foundations, generally in the form of alumni trusts, that take advantage of a wide net of contacts in industry. In Britain this function has been performed by a central agency, the British Technology Group. Until 1983 university research, funded by the Research Councils had to be commercialized exclusively through the BTG.

A third group of mechanisms is concerned with institutions set up by universities aiming to perform applied research,

provide short term technical assistance, and broadcast information for local firms. Several universities have set up technical centres whose work focuses on short term consulting services and technology transfer. These centres are "particularly helpful in communities with fragmented industrial bases where firms are unable to pool their resources effectively" (OTA 1984, p.60). Another kind of initiative, more concerned with performing targeted research, has been set up as research centres, innovation centres or research institutes. These kinds of initiatives can prove particularly suitable for operating in environments where small technology-based firms have been recently set up.

A fourth group of mechanisms concerns joint ventures between university and industry. This kind of partnership can vary from a joint venture between a university and a single firm to a research consortia, in which several small/medium-sized firms pool resources in a co-operative research programme with a university or, alternatively, a large firm organizes a consortia involving several universities.

In addition to this kind of "dual" mechanism a fifth one has been set up in co-operation or through public laboratories or government funded programmes. Examples of this "triangular co-operation" include the Alvey Programme in Britain, or the contracts implemented by Public Sector research organisations, like the institutes affiliated to ATV in Denmark or SINTEF in Norway (OECD 1984a, pp.31-2).

A sixth kind of mechanisms is represented by all kinds of independent initiatives developed by academics. These initiatives range from consultancy to highly structured firms

performing research, development, manufacturing and marketing operations. Sometimes, in limited cases, universities have been partners in the creation of these new ventures providing capital to launch new profit-aiming firms.

Another initiative that can be considered as a seventh kind of mechanism aiming technology transfer are the science and research parks. The supply of infrastructures and, what is more important, the proximity to a university, have been used to incubate new research-based firms or to attract the research facilities of large high-tech companies. The idea of setting up such centres of research and high technology industries is based on the successful experiences of the concentration of research-based firms around Boston/Route 128 and in Silicon Valley, California. The attempts to reproduce these archetypes have had different outcomes, ranging from successful cases, like Cambridge, Heriot-Watt and the Research Triangle Park in North Carolina to a number of failures as a result of "poor planning, insufficient promotion, or lack of ties with nearby industries" (OTA 1984, p.68).

Finally, among the set of mechanisms available, I shall point to a different kind of instrument of technology transfer: programmes of training and retraining for technical and managerial personnel, in which they are provided with new skills. It is a fact that all kinds of collaboration discussed above have effects at this level. "providing continuing education for those already employed by industry" and, on the other hand, "improving science and engineering training" at the universities (OTA 1984, p.62). But in many initiatives the transfer of knowledge through the provision

of short (re)training courses according the needs of local industries has been the principal goal. Furthermore courses have been implemented to provide potential entrepreneurs with managerial skills. "Entrepreneurship" is a quality that some universities imagine can be cultivated through courses in the creation and management of small firms.

* * *

All the mechanisms described have a role in the broadcasting of information and in creating an environment favourable to "networking". In addition to this the mechanisms available help to integrate the different stages of the innovation process by setting up links between science and the marketing of finished products.

3.2.4. Conditions for Successful Interaction

A range of conditions and prerequisites has been detected by different studies on successful experiments of interaction between industry and academia, about the environment in which the university operates and the different actors and their roles in interaction. This does not mean that specific roles will be prescribed in this section. The particular conditions of each environment (country, region) require different combinations of actors/roles.

The interaction between university and industry has in Europe been mainly a triangular relation between universities, industry and government agencies and laboratories. This model contrasts with the practice in the US where the institutional leaders have greatly varied. If traditionally public procurement has had an important role in promoting the relation, the role performed by universities themselves and

industry has been increasingly important. Studies of the American experiments have also stressed the roles of two other partners: financial institutions and local communities. This approach, where the complementarity of efforts is the main characteristic, is quite different from Europe, where governments have tried to conduct the process by implementing national (or supra-national in the EEC case) programmes and initiatives to get university and industry to sit at the same table. The American experiments have been based on a complementarity of efforts and the lead taken has shifted according to the circumstances. Many of the recent experiments have been conducted by local communities (State government, public and private universities, local authorities, local industrialists and managers, etc.) and have tried to reproduce the successful experiments of California and Massachussets.

Many of the factors that have been singled out from the successful experiments of high tech complexes concentrated around universities and research units - "strong research university, skilled labor pool, available financing, the presence of corporate headquarters, transportation, good climate, and cultural amenities" (OTA 1984, p.69) - have in certain circumstances proved to be inadequate in new experiments. New ventures aiming at such development have to assess the opportunities and constraints that exist in the region/country and identify the objectives that can be expected to be attained. This assessment involves identifying the actors and their potential roles, the resources available as well as those that will be required, and the needs of local industries and communities.

Whatever the role universities adopt in the implementation and dynamization of the process, if they wish to have an active role they should meet certain prerequisites.

The first idea about the role of university concerns the attitude of academic authorities towards collaboration. Regulations penalizing extra-academic work may act as a strong constraint on the university-industry interaction. In analysing the environment in which the MIT/Route 128 experience was generated, Mathew Bullock pointed out that "four important factors that lower the threshold [to commercialization of university services] are the research funding arrangements of American universities, which allow academics to pursue an individualistic approach; the permissive and non-exclusive attitude towards terms of employment for academic and non academic staff based on service contracts that set out specifically the services expected of them; the standard allowance of one day per week for academic staff to engage in outside activities; and the limitation of their formal teaching and research engagement to nine months in each year" (Bullock 1983, p.10).

Any efforts at creating links with industry and promoting research-based firms imply a long term commitment from the academic authorities. Such commitment should agree to a master plan in which the university strategy is clear and explicit. In the long term strong leadership is necessary to carry out such strategy.

A condition that universities have to meet in their approach to external organisations is a recognized level of excellence, both in the research performed and in the

start-ups by members of the academic staff. All kind of consultancy services or joint ventures with existing companies are important because technology is to be founded throughout the industrial matrix and the members of universities can obtain invaluable experience from these contacts. On the other hand contacts with industry not only permit the transfer of technology and consequent up-grading of processes, products, etc., but also enable industry to learn how to express their demand for universities' expertise in increasingly better structured ways.

The remaining actors, Government and local communities, can also perform their roles with different degrees of intensity. One has already seen in a previous section (3.1.2.) the possible role of government intervention through public policies of Innovation, Science and Technology, etc. Public policies of S&T appear in a zone of convergence of national policies of reindustrialization and regional regeneration.

Universities should try to link up their cooperative activities with such policies while trying to derive the maximum advantages from them. The favourable attitude of governments towards collaboration can be further developed through the required approaches of universities lobbying to obtain additional legislation to promote necessary changes in the environment. The complementary nature of university strategies and government policies is a crucial prerequisite to a successful university-industry collaboration.

In addition to linking up with broader development efforts, universities should identify local needs and resources, the opportunities and constraints that exist in the region where

the strategy has to be implemented. Institutional collaboration within the region/country is an important factor. The environmental qualities and the local culture (entrepreneurship, ability to interact, partnership) are also crucial factors. The conclusion of some studies that "high technology development efforts have generally been most successful when they are initiated and implemented locally" (OTA 1984, p.70) lead to the next section of this chapter.

3.2.5. Universities and Regional Regeneration Policies

The reason why this section on the role of universities in regional regeneration is introduced here is that Portugal (10M inhabitants, area about 100,000sq.Km) can be seen as a less developed (or possibly depressed) region in the EEC context. In fact the Community countries have implemented policies funded by the FEDER, to assist regions of equivalent populational/geographic dimension. When introducing this point it should be added that one can not overlook the regional contrasts that exist within Portugal itself (more than 3/4 of the GNP is produced in Lisbon, Oporto and in the districts lying between these two metropolitan areas).

* * *

New universities have been set up as instruments of regional development in the last two/three decades. More recently universities have been seen as a suitable instrument for regenerating the industrial basis of depressed regions through the transfer of technology to mature and/or declining industries and also for promoting new start-ups in research based industries.

After World War II regional policies were based on a set of

incentives attempting to attract the branch operations of large firms to operate in regions facing economic problems. The idea was that branch plants would stimulate the local market and help to establish an economic basis for exports. But often such linkages were not established because local firms were not complementary and the branch operations remained largely dependent on outside decisions (from raw materials to qualitative inputs of R&D), the first regional contribution being the demand for local labour, largely unskilled and paid at low wage rates. In contrast with this "exogeneous strategy", in the 1970s regional economists fostered the idea of "self reliant development" (Frieman, 1979), according to prevailing theories about Third World development and also the ILO's suggestions as to a strategy of "basic needs satisfaction". The idea was that less developed or depressed regions had to rely on their own resources and firms had to be set up by local entrepreneurs committed to the region. The process of development of these firms would help to build up a regional matrix of inter-industrial relations. In addition to this the small/medium size of these local firms was seen as a factor in regional flexibility in periods of economic depression.

The evolution of the regional science debates was convergent with empirical conclusions of studies about the trend in business sizes. In the 1970s there was an inversion in the historic trend of rising average size while the relative share of employment in small and medium firms (SMFs) increased in that period. The studies on SMFs have stressed their multiple qualities (employment creation, political, social and cultural value, regional regeneration and capacity

to innovate).

This capacity to innovate particularly concerns a sub-set of SMFs that have been called research-based firms or new technology-based firms (NTBFs). Although lacking the financial capacity of large firms, NTBFs are responsible for a large share of innovation with specific contributions in market niches, etc. Furthermore, empirical analysis shows that an increasing amount of innovation is being shared by the small units of large firms (division/department /establishment) with less than 200 employees.

But keeping in mind the critical factors that can lead to the development of research based industries (risk capital, large market, entrepreneurship, etc.) there is deeply a contradiction between a regional regeneration strategy and a strategy based upon the idea of implementing small NTBF's. Regeneration means employment and new technology is labour saving. The K/L ratio is higher in a NTBF than in a conventional SMF and capital is a scarce resource in depressed regions. Another scarce resource is skilled labour and the implicit scientific and technological knowledge. On the other hand, there are also some positive factors favouring regional regeneration policies supporting NTBFs. Specific natural resources are not very important for new technologies and it is known that traditional factors of industrial location (distance to raw materials source, proximity to market, ratio of weight/volume, etc.) are not decisive as regards NTBFs location; they rely more on different informational and environmental factors and "man-made" resources (skilled labour force, technological infrastructure, venture capital, etc.) than on the

conventional factors of location.

One conclusion following the studies on the "success stories" of high tech development is that in all of them there is a common set of critical factors (seen in the previous section). Besides this common set another factor has been the concentration of NTBFs around a "pole" with the spreading of benefits from that pole to the external space. Such polarization, with exploitation of the synergies between industry and universities is the central issue of some current debates about regional policies. In the 1960s and early 70s industrial polarization was associated with exogeneous strategies, but the current idea of "technopolarization" (Autrement 1985) looks more like a compromise between exogeneous and endogeneous elements. Both in the Route 128 and Silicon Valley cases government procurement (an external factor) was important in early stages of technological development and the "national demand" for microcomputers and semi-conductors was equally important. But the endogeneous resources (university, cultural environment, venture capital, entrepreneurship) were equally decisive.

I think that in Europe some of the identified critical factors are missing everywhere and the right blend of endogenous and exogeneous elements is required to carry out regional development and regeneration strategies based on NTBFs. Such a blended strategy should, in a creative way, reflect the change in regional science paradigms by avoiding dogmatic ready made strategies for regional policies.

The generic objective of an innovative regional strategy is

long-term self-sustained development, in which the region would be able to internalize the benefits of both external and internal investments. In a system of inter-dependent regions this capacity is a consequence of regional competitiveness, the dynamics of the regional economic basis. At the same time as using incentives to export-directed industries, regional policy should support local market-directed industries. The regeneration of the local sector through the introduction of new technology in traditional processes and products of mature industries must be a priority if the policy aims to create links-ups with the export sectors. The capital requirements per new job are not so high in the local sector and so job-creating should be mainly achieved by this means. Such a dualistic strategy, whose objective is to create an interaction between a high tech export sector and a regenerated local sector is only possible with selective and incentive instruments operating simultaneously. Some of the possible incentives are: (i) the stimulation of university-industry interactions; (ii) the stimulation of professional venture capital; (iii) government procurement; (iv) the development of the work force (training and recycling, etc.).

The difficulties in encouraging the emergence of venture capital have already been shown. To a certain extent this means changing the cultural attitudes of owners of wealth. Quoting Dakey (1984): "Much of this behaviour could be replicated by public and private institutions in their efforts to provide investment capital for research and development in small high tech firms. Government agencies in depressed regions could make considerable advances towards

ensuring that the minority of high technology small firms that are born in largely hostile innovation environments are compensated by a locally superior environment for investment finance" (p.158).

Knowing that the scarcity of resources in depressed regions is a restriction upon widespread incentive policies, selectivity should support industrial branches of high potential growth with spin-off potential (or, using Johson and Cathcart words: branches with high rates of fertility) and give priority to regional entrepreneurs with potential for innovation.

In conclusion, new industries supported by NTBFs and socio-technical local communities (in which universities are a central element) are the key to long-term self-sustained development. I think that of the critical factors of such development - financial means, markets and cultural attitude - the third one is the most decisive, and culture is certainly not easily dealt with by conventional policies and strategies.

Factors concerning of science and technology evolution and market trends contribute to the process of innovation. Science has moved to an early stage of the production process with microeconomic units implementing R&D activities. However, the Public efforts of strengthening other segments of the technological infrastructure remain important. The synergies among the different institutions of the infrastructure are central to furthering innovation. Environmental factors, both in terms of extension/quality of the local/national scientific community, and of cultural attitudes towards innovation, are important in nurturing the process of industrial innovation.

A voluntarist strategy led by universities has to take account of these different aspects (importance of science/technology but also of market trends, interactions in the technological infrastructure, etc.). The perspective of such a strategy should be the setting up of socio-technical networks with the participation of different active actors (scientists, industrial entrepreneurs/managers of small and large firms, local and/or central government bodies, interest groups and finance institutions).

CHAPTER 4 - INNOVATION POLICIES, THE SCIENTIFIC AND TECHNOLOGICAL SYSTEM AND THE HIGHER EDUCATION SECTOR IN PORTUGAL

Summary

In Chapter 4 the industrial and innovation policies in Portugal are analysed to understand the current national scientific and technological infrastructure. The technological potential / limitations are seen according to indicators of R&D expenditure, R&D personnel, and the relative weight of the technology transfer from other countries is compared with the locally developed technology. The expansion of the higher education system since the 1940s, the educational policies, and the roles of higher education in Portugal are also studied. Finally there is an approach to the problem of university and industry interaction in Portugal through an analysis of the current legislation on the subject and a short description of some of the past experiments in this field.

4.1. Industrial and Innovation Policies in Portugal

The history of this century's industrial policies in Portugal can be divided, in very broad terms, into three main stages.

The first stage, from the 1940s until the early 1960s can be characterized by the intention to build up a structure of basic industries (steel, cement, basic chemistry) aiming to supply the domestic market with intermediate inputs. This policy, drawn up by a Salazar's cabinet minister, Mr.F.Dias, intended to preserve the autonomy of a country in which the majority of the active population worked in agriculture and related activities.

In the second stage, from the late 1960s until the early 1970s, the industrial policy drawn up by the secretary for industry under Caetano, Mr.R.Martins, was much more complex in its objectives, instruments and links with the international market. The country had joined EFTA and large scale emigration had started from the rural areas towards the urban centres, and especially to some West European countries (France, W.Germany, etc.). At the same time the liberation movements of the Portuguese African territories had launched guerilla warfare against colonial domination. These factors contributed to a change in the attitude of the industrial and financial elite that had grown up in the 1950s and early 1960s along with the basic industries. This elite, concentrated in less than a dozen economic groups with multiple interests in the Portuguese economy, became more "European" in its attitude, and while supporting the military effort in Africa to protect a source of cheap raw materials, it encouraged a new industrial policy that would make it

possible for the country to integrate in the European and world economies. This meant that the policy designed in this period was directed towards a progressive extroversion of the Portuguese economy which included a medium term adhesion to the EEC (the first important commercial agreement with the Community dates from 1972). The strategic intention of this policy was to further develop the network of basic industries and implement new industries producing consumer goods. Taking advantage of its geographic situation, lying between America and the developed European countries, and along the new oil route (after the Suez closure), Portugal could develop capacity for oil refining and petrochemicals, ship building and repair, steel production (adding plan products to long products) and in the car industry (in agreement with an Italian car producer). The inter-sectoral relations between these new industries and the traditional industries (eg.: textiles) would help to provide to an increased potential in terms of international trade.

This strategy was slowed down and finally dropped as a result of two factors: firstly the oil crisis and world recession; secondly the military revolution of 1974 launched against the dictatorship and the colonial war.

The third stage of industrial policy concerns the period from the mid 1970s until the present. This stage is characterized by political instability and continuous change in terms of political majorities and government coalitions. In the last ten years the average life-span of each government has been no more than one year. The impossibility of reflecting on a new model of industrial development attuned to the new conditions (in which the leading private groups had been

nationalized and the basic industries were integrated into the public sector) helped to lead to the extension of the early 1970s industrial policy into the early 1980s. But this policy was not firmly implemented and most of the initial projects were launched but not completed and others did not even get off the ground. The shortage of financial resources, the recession (that had harmed most of the selected sectors), the political instability, and a changing reality as regards industrial policies, meant that the "new industrial policy" of the 1970s was progressively dropped. The appearance of new technologies and the transformation of the "old industries" by these technologies meant that governments of industrialized countries were to change their industrial policies, their priorities and even their framework of action. The Portuguese authorities, confronted with huge domestic problems, were not very sensitive to these changes and the formulation of industrial policies remained more implicit than explicit while scant financial resources were put into plants planned almost ten years before to operate in industries that were at the core of the recession problems (steel, petrochemicals, etc.).

Turning to the more recent period, only in 1983-85 there was an explicit industrial policy formulated as part of a global effort to up-grade the Portuguese industry in the new circumstances of EEC membership. What was really innovative in the policy of Mr.V.Simao (the Industry Minister at the time) was "the articulation of industrial development with the strengthening of the technological base of the industry as a way of promoting a sustained industrial growth and a greater degree of autonomy - this was the innovative factor

of the industrial policy in practice since 1983" (Rodrigues 1986, p.1).

The main objectives of the 1983-85 industrial policy were:

- selective use of domestic raw materials with higher added value;
- qualitative improvement of traditional industries;
- expansion of existing industries with potential for growth and comparative advantage;
- launching a nucleus of new industries based upon advanced technologies.

The central idea of this policy rested on the possibility of diffusing new technologies in the national industries under the necessary condition of strengthening the national system of science and technology. The elaboration of the Medium Term Technological Plan was a clear demonstration of a scientific and technological policy, with specific projects, measures and instruments, which had not hitherto been tried in Portugal.

The National Board of Science and Technological Research (JNICT), set up in 1967 with the purpose of creating a coordinative body of the activities of the national scientific and technological system, has since then performed an important role in implementing a number of actions and producing several documents intended to guide the national activities of R&D. In 1967 the Board presented a "Proposal for a priority action in terms of co-ordination of scientific and technological activities and for definition of the institutional mechanisms able to formulate and support a

national scientific policy" and two years later presented a "National programme of activities in technological research and development". All these proposals and programmes were no more than a statement of intentions with no practical effects (Rolo and Tiburcio 1983, pp.57-58). The document presented by the Board in 1981 "Priorities of Science and Technology" (JNICIT 1981) has, since then, been assumed to be the general guidelines of an implicit scientific and technological policy.

In its effort to draw up an effective technological policy the 1983 Technological Plan identified the following priorities (LNETI 1983):

- to set up bodies with technology policy development capacity;
- to upgrade the technological capabilities of existing firms, through a series of undertakings (standardization and quality control, technological and design centres, demonstration projects, improved industrial extension activities by universities and government laboratories, technology transfer, and health and safety regulations);
- to identify necessary changes in the existing financial and fiscal structure (reformulation of the tax structure, encouragement of venture capital companies, creation of an institution for the financing of innovations);
- encouragement of NTBFs, with assistance during incubation period, etc.;
- improvement of capabilities in certain technologies (metrology, chemical technology, micro-electronics, materials science and biotechnology);
- development of human capital through training of technical

personnel, skilled workers and managers of technology.

These priorities were supported by programmes and initiatives estimated at US\$ 240 millions over a 10 years period. However, political instability once again undermined the continuity of this policy with the collapse of the government coalition in 1985.

Two of the most important programmes in the Technological Plan were "Support for Industrial Innovation" and "Industrial and Technological Modernization". The first programme aimed to partly finance the development of new products and processes and the construction of prototypes through the granting of loans to firms required to pay these loans back three years after completion of the project, with no payment of interest. The purpose of the second programme was to establish contract-programmes between universities, research centres and firms to enable absorption and development of new technologies. Through these contracts the university-industry partnerships received partial financial support to finance the projects without having to pay back that money. Instead a percentage was paid on commercialization of new processes and products.

The projects approved under these two programmes (up to September 1985) were worth 7.5×10^9 ESCS. (about 33 million Pounds) and together LNETI and the Ministry of Industry had raised 44% of their global value. However in December 1985 all those projects were suspended by the new Minister. Only in the Summer of 1986, after a re-appraisal of each project, were the contractual obligations of the Ministry reassumed.

The objective of the present government introducing these

measures has been to avoid a certain dualism in the handling of the scientific and technological policy between LNETI and JNICT. New laws have been promulgated (DL 22/86 and DL 28/86, both from February) to concentrate the co-ordination capacity of scientific and technological policy in the JNICT. Management of the above-mentioned contracts was also moved to JNICT after their suspension. Anyway suspension of several months' research contracts, that represented a completely new experiment in partnership between government departments, industry and university, can lead to negative effects and compromise future initiatives.

What can be said, in conclusion, of the 1983-85 policy is that it was a worth while effort, although its voluntarism and fact that it was divorced from the predominant feelings and attitudes shared by the Portuguese entrepreneurs (see chapter 1) made it impossible to implement and ensure a significant impact on the whole industry. Even its continuity in a slightly different political context is seriously jeopardised. It could not qualify as a new fourth stage in the development of Portuguese industrial policies of this century.

4.2. The Potential of the Technological Infrastructure

I will not give an extensive description of the Portuguese Scientific and Technological System (PSTS), but merely provide figures and introduce some of the major problems to provide an idea of the context. Other recent studies (eg.: LNETI 1983a and 1983b; Mil-Homens 1985) offer a reasonable outlook of the PSTS and its institutional structure.

Table 2

National Effort in R&D in Portugal and Other Countries (1979)

	R&D per capita (US\$)	R&D/GNP (%)	R&D Personnel/ /Active Population (%)
USA	256	2.38	1.27
Japan	157	2.11	—
UK (1978)	142	2.20	1.17
W. Germany	204	2.40	1.37
France	149	1.81	0.98
Spain	14	0.35	0.20
Ireland	34	0.74	0.50
Greece	8	0.19	0.13
Portugal (1980)	8	0.34	0.16

Source: Mil-Homens 1985, p.4.

This table gives an idea of the relative position of Portugal as compared to other OECD countries. It is clear that Portugal has a very poor R&D performance. The resources allocated to these activities have been quite small both in absolute and relative terms. The R&D/GNP ratio is one sixth of the 2.0% average found in the most advanced OECD economies and even smaller than the 0.5% recommended by the United Nations for developing countries.

Table 3

Evolution of R&D Expenditure in Portugal (1976-1982)

	Expenditure in R&D		R&D/ /GNP (%)	Annual Growth (%) (Constant Prices)
	10 ⁶ Escs. (p. 75)	10 ⁶ US\$		
1976	1,100	62.63	0.27	—
1978	1,409	91.38	0.32	13.2
1980	1,655	125.87	0.34	8.4
1982	1,789	160.28	0.35	4.0

Source: JNICT 1985.

The trend in R&D expenditure reveals both an absolute and relative increase, although the former occurs at progressively slower rates. The data concerning 1984 is not yet available (to be published by JNICT in its biennial survey in autumn 86) but it is likely that the increasing trend in R&D expenditure has continued in the recent period.

Table 4

Sources of Finance and Institutions Responsible for
R&D Expenditure (1982)

(10⁶ Escs.)

Institutions responsible for the expenditure						
Sources of Finance	Companies	State	Higher Education	Non-profit Priv. Insts.	Total	%
Companies	1,898.4	5.8	0.1	55.5	1,959.8	30.0
State	32.0	2,756.1	1,262.1	1.1	4,051.3	61.9
H. Education	-	-	20.3	-	20.3	0.3
N.-P.P. Is.	-	11.2	39.8	240.4	291.4	4.5
Foreig. Ins.	113.2	78.8	25.4	1.0	218.4	3.3
TOTAL	2,043.6	2,851.9	1,347.7	298.0	6,541.2	100.
%	31.2	43.6	20.6	4.6	100.0	-

Source: JNICT 1985.

The institutional breakdown of R&D expenditure shows that private industry is responsible for slightly less than one third of the expenditure, public laboratories and departments are responsible for 43.6%, the higher education sector a little above of one fifth, and the non-profit making private institutions have a share of 4.6%. But as regards financial

sources the breakdown is quite different: government finances 61.9% of national R&D, industry 30.0% and the higher education institutions have no capacity to self-finance at all. Where this structure contrasts more strongly with what happens in the "most advanced economies" is in the relative roles of Government and Industry. In these economies industry's share is usually much higher.

Table 4 also shows another problem of the PSTS: the very poor interaction between industry and other institutions. In 1982 the flow of financial resources from industry to the higher education sector was almost non-existent.

In 1982 more than 60% of R&D expenditure was to pay salaries of researchers and other staff (the figure was 63.1%, but no data is available for the non profit-making private sector) and the investment in capital goods was below 15% (JNICT 1985).

The breakdown of expenditure in terms of the nature of research (available data: State and Higher Education) shows that higher education research was concentrated on basic research while the public laboratories performed most of its scientific and technological activities in applied research and experimental development.

Another possible analysis concerns civil and militar R&D. In 1982 the share of militar research in the State expenditure was 5.0%, 2.0% of national expenditure.

Table 5

Human Resources Performing R&D Activities in Portugal (1982)

(in "full-time equivalent researchers")

	Researchers	Technicians	Auxiliars	TOTAL
Higher Education	1,266.7	564.3	498.8	2,329.8
State	996.2	1,744.4	1,334.4	4,075.0
Industry	594.3	620.6	519.2	1,734.1
Non-Profit P.I.	161.8	>	251.8 <	413.6
TOTAL	3,019.0	>	5,533.5 <	8,552.5

Source: JNICT 1985.

Concerning R&D employment in terms of "full-time equivalents" there was 8,552.5 jobs in 1982, representing a share of 0.19% of the national workforce. The distribution of this employment shows that the Higher Education sector had a structure with more than half of its personnel (55.4%) as researchers while the same ratio for all the R&D sector was 35.3%. This pattern is very similar to other countries.

Another indicator of the potential of the PSTS is the demand and registration of patents in the country.

The demand for patents (see Table 5 next page) shows no tendency to rise in the 1971-1981 period, while registration of patents shows no trend to increase in the 1971-1981 period; indeed the registration of patents tends to decline. But what is particularly negative is the trend in the registration of national patents that points to both a small rate of national invention and declining inventiveness in the country.

Table 6

Demand and Registration of Patents in Portugal

	DEMAND			REGISTRATION		
	Total	National		Total	National	
	(No.)	(No.)	(%)	(No.)	(No.)	(%)
1971-1975	9,086	561	6.2	10,374	526	5.1
1976-1980	7,753	464	6.0	8,097	342	4.2
1981	1,933	90	4.7	1,636	48	2.9

Source: Mil-Homens 1985.

The analysis of the potential of the PSTS could be performed through other indicators (bibliometric methodology, etc.) but I think that the analysis of further data would not lead to different conclusions as regards the the aims of this section.

Analysis of these quantitative indicators shows that the resources allocated to R&D are very small both in absolute and relative terms. The interaction between industry, government laboratories and higher education institutions is very weak. However when doing this analysis it should be said that all this data concerns 1982 or the period before 1982. It is acceptable to believe that the recent evolution of the PSTS has been towards an increase in the R&D expenditure and there are indicators (to be analysed in the next section) of an increasing interaction among the different performers of R&D in Portugal.

The weakness of R&D activities in Portugal has had a deep

impact on the structure of economic activities. The backwardness of the industrial structure, the character of the international specialization of the country, the incapacity to get on with the "most advanced economies", are the consequences of an inability to innovate that depends, into a certain extent, on the R&D activities.

The lack of autonomous R&D means that national industry has been largely reliant on external sources of technology. This technological dependence can be seen according to two main perspectives: (i) the imports of goods that are the outcome of complex technological processes; (ii) the transfers of technology (by direct foreigner investment or through contracts between resident and external companies).

Essentially the first perspective concerns the flows of external trade and affect the trade balance. They were shown in Chapter 1 when characterizing the commercial dependence of the Portuguese economy. The second issue involves the flow services and capital balances. In this section I will look only at the transfer of technology performed under the selling through contract of "technological services".

It can be seen from Table 7 (next page) that Portuguese industry (and particularly the manufacturing industry) relies much more on technology transfer from other countries than on domestic R&D. The value of these transfer was in 1980, for manufacturing industry, four times greater than the respective R&D expenditure. In addition to this, it can be seen that manufacturing firms with 50% or more of foreign capital were responsible for more than half of the total transfers in 1980, while manufacturing firms exclusively with

Portuguese capital were responsible for 73.7% of the R&D expenditure in their sector and had a share of 37.1% in the technology bought in other countries by manufacturing industry.

Table 7

Transfer of Technology (1980)

Firms >	TOTAL		Firms with national capital		Firms with <50% foreign capital		Firms with >=50% foreign capital	
	Absol. Figure	%	Absol. Figure	%	Absol. Figure	%	Absol. Figure	%
Expenditure on Foreign Technology	4,203	100.0	1,642	39.0	426	10.1	2,136	50.8
Idem in Manufacturing Industry only	3,490	100.0	1,291	37.1	346	9.9	1,853	53.1
Expenditure on R&D in Manufact. Ind.	863	100.0	624	73.7	27	3.1	200	23.2

Source: JNICT 1983.

The transfer of technology has several advantages for the buyers because it represents a small investment when compared with the cost of locally developing their own technologies. This investment is frequently seen as a variable cost of R&D. Furthermore the foreign companies usually facilitate access to the external financial markets. But the transfer of technology also has disadvantages for the domestic contracting firms: restrictive clauses on use of the technologies; on improvements; exports; etc. Besides this the

disadvantages should be assessed from a macroeconomic perspective. The use of foreign technology does not always mean that it is absorbed and diffused throughout the home industries and helps to inhibit the development of the national scientific and technological infrastructures.

A study (quoted in: JNICT 1983) of 34 manufacturing firms with exclusively Portuguese capital using foreign technology under contract concluded that those firms had in 1980 spent more than 85% of the total R&D expenditure in the manufacturing sector (543 M ESCS. out of 636.3 M. See table 7). The association found between technology transfer and R&D performed locally is a consequence of the nature of that R&D: its main objective is to adapt foreign technology to local conditions.

The disparity between technology transfer and local R&D has led analysts of the PSTS to conclude that: "similarly to what occurs in other developing countries and in certain developed countries, [Portugal] bases its innovative effort on the purchase of foreign technology; it can thus be said that in Portugal innovation is of an eminently dependent nature. This characteristic of dependence becomes greater if we bear in mind that more than half this dependent effort is made with a majority of foreign capital" (JNICT 1983, p.4). In addition it is observed in the same study (presented to an OECD workshop on "Policies of Technological Innovation in the Less Industrialized Member Countries") that the innovative effort channeled into industrial R&D "seems to be strongly oriented towards adaptation of foreign technology to local production conditions [...], the greater part of Portuguese R&D is channeled towards the generation of added innovation.

The production of independent technology is negligible" (JNICT 1983, p.4).

4.3. The Higher Education System

One of the components of the scientific and technological infrastructure is the higher education system. The supply of graduates is one of its main contributions to economic development and, as is known, there is a correlation between the quantity of graduates in a country and its level of development (when accounted through the GNP).

Table 8

Students Enrolled in Universities and Equivalent Institutions
in some DECD Countries (Students per 10,000 Inhabitants)
1961-1983

	1961	1975	1983
USA	154	202	518
Japan	69	203	536
France	50	197	225
W. Germany	37	168	229(1)
UK	22	131	157(1)
Spain	37	150	192(1)
Greece	36	122	126(2)
Ireland	38	144	173(3)
Portugal	25	85	96(3)

Sources: 1961: Nunes 1970;

1975 and 1983: UNESCO.

Notes: (1) 1982

(2) 1980

(3) 1981

Table 8 gives an idea of the expansion of higher education in the last 25 years. There is a dramatic contrast between the figures of the USA and Japan and Europe. The relative average university populations of the first two countries is more than twice that of their equivalent in Europe. Some care is, of course, needed in reading table 8 because different demographic structures require an analysis which relate the university populations to a specific age group (eg.: 20-24 years old) and not to the total population.

From table 8 it is possible to understand the dramatic differences in the higher education expansion in these countries. The country with the highest rate of relative expansion between 1961 and 1983 is Japan (9.8%/year). The more developed European countries also have good scores and, paradoxically, the less developed (Portugal, Greece) have lower rates of relative expansion.

The Portuguese higher education sector underwent considerable expansion between the 1940's and the 1970's but after that the number of enrolments dropped in the early 1980's, according to figures in Table 9 (next page).

From less than 10,000 students in 1940 to more than 80,000 in the 1980's there was an annual growth rate above 5% per year. But the great leap was in the 1960's and 1970's. Between 1962 and 1979 the higher education population was multiplied by a factor of 4 and evolved at a rate of 8.6% per year.

This expansion was a consequence of social, political and economic factors. Until the 1950s the system had been based on four traditional universities: Coimbra (founded in the XIIIth century); Oporto; and the other two universities in

Lisbon (the "Classica" and "Tecnica"). The social strata of the less than 20,000 students enrolled was the upper urban class (Lisbon and Oporto) and the upper rural class (mainly in Coimbra). The expansion of the 1960s was a natural consequence of the economic growth at that time, with an increasing demand from a few large industrial companies, the financial sector and also Public Services. This expansion was a good opportunity for the children of the middle class to explore the possibilities of social mobility in a rigid traditional system. The growth of the 1960s and early 1970s (before 1974's political changes) was all based on the four traditional universities. Other higher education institutions played little role, as can be seen in table 9.

Table 9

Students enrolled in Portuguese Higher Education (1940-1982)
(10³)

	Total	Universities	Other Higher Education
1940(1)		9.4	
1946(1)		12.0	
1956(1)		16.5	
1962(1)		22.6	
1966(1)	33.7	31.0	2.7
1970(2)	50.1	43.2	6.9
1973(3)	58.6		
1975(2)	79.7	51.5	28.2
1976(4)	86.2		
1979(2)	91.4	65.7	25.7
1980(2)	92.2	67.7	24.5
1981(2)	81.3	55.7	25.6
1982(3)	81.5		

The sources of Table 9 are: (1) Nunes 1970;

(2) UNESCO 1985;

(3) UNESCO 1984;

(4) Sampaio 198

In 1974 an educational reform was proposed, with the objective, in higher education, of framing further development along different lines from those of the expansion of the 60s. The traditional universities had reached a more than optimum level and new institutions had to be created. The expansion had to be diversified and new demand for higher education had to be met by a dual system of Polytechnics and university institutions. The expansion had to be supported by new "Institutos Politecnicos" (with a crucial role in supplying a skilled/trained workforce to industry) and by the "Universidades Novas" (on the line of the British New Universities) and "Institutos Universitarios". An additional objective of this policy was to contribute to regional development by setting up new institutions in other urban centres .

Some of these institutions had been created and others were planned when the 1974 political changes happened. The democratic character of the revolution and the dynamics of social movements immediately after the revolution made a profound change in the standards of entrance to universities and even in the "desirability" of the university. This led to a huge increase in the rate of enrolments between 1975 and the following years. Much of the Polytechnic system and the new universities were not created at the time and so the traditional universities had to absorb a part of the demand. It should be noted that the increase in "other higher education" (table 9) between 1970 and 1975 is not due to a real increase in these institutions' enrolments but to a change in criteria of institutional classification, thus adding to higher education other post-secondary institutions

that had not been considered until then as belonging to this level.

Much of the history of the 1980s and the visible fall in the enrolment rate (figure over 10% between 1980 and 82) are, to some extent, a consequence of the non-organised expansion of the 1970s and represent an attempt at stabilizing the system. The fall in enrolments is also a consequence of the general economic climate, of the impossibility to further extend a Public Budget that already corresponds to 40% of the National Income and that has created a Public Debt equal to one year's GNP. The demand for higher education continues to be very high and no response forthcoming.

But this demand is particularly for university education and not for other courses outside university. In a recent OECD review of the Portuguese policy for education the reporters stress that the question of access to non-university education "is an absolutely crucial point. Under the present system, the students admitted to non-university courses are, by definition, excluded from university. Access to non-university institutions is not the result of deliberate choice based on the student's inclinations on career aspirations, but based on academic criteria. This situation seems to us particularly regrettable in view of the no doubt excessive attraction of the university in Portugal as already mentioned" (OECD 1984b, pp.64-5). The university diploma ("licenciatura") is seen as an instrument for real, social mobility and so the demand for a place at university is much higher than the demand for other institutions.

The attempts of setting up a Polytechnic network have not

been successful because the institutions that currently taught at that level have attempted to obtain from the ministry an equivalent university level. Every study about Higher Education in Portugal in the last ten years or so has made recommendations to develop the system through diversification by creating a network of polytechnic institutes. The relation between higher intermediate level technicians and graduate engineers from the universities is 1/1.5 in Portugal while it is, for example, 2.2/1 in France and 4/1 in the US (Alpiarca et al. 1983, p.111). The provision of these intermediate technicians seems to be particularly suited to the Portuguese circumstances where intermediate technologies are used in a large range of medium and small firms. However all policies designed to ensure such development have failed.

The second vector of educational policy for higher education has been the striving for quality and an emphasis on teacher training (see next section, on how the current law on the teachers career is related to the possibilities of collaboration with industry). This line of policy has been quite successful in opposing the deterioration of university standards in the 1960s and 1970s. This deterioration was a consequence of the growth of the university staff (see next table) and of other factors that affected university life at the time (student movements against the authoritarian regime and the colonial war, etc.).

The expansion of staff went on in the early 1980's and still goes on, improving the ratio of teachers/students.

Table 10

Teaching Staff at the Universities

	(%)		
	1940	1961	1978
"Professores"	62.0	36.2	16.2
"Assistentes"	36.4	61.7	61.2
Other	1.6	2.1	22.6
Total (absolute figures)	552	-	5,083

Source: Sampaio 1980.

There is no recent data available on the qualitative structure of the staff but it is known that there has been an overall improvement in the academic quality of the staff and the success of the current policy could be assessed by the rate of new "doutorados" (PhD equivalent) and by the different fields of scientific interest in which these new PhDs have been obtained. In Chapter 5 this improvement will be assessed through the analysis of the data of the survey on the academic staff of the Universidade Tecnica de Lisboa. A great deal of those PhDs have been awarded by foreign universities and leading centres in specific fields of research. A fair amount of the resources of national institutions of science and technology (namely JNICT) has been put to training and bi-lateral agreements with other governments (US, UK, France) and the support of private foundations (namely the Gulbenkian Foundation) have contributed to the training programmes. Recently this policy has suffered a setback and the Ministry of Education and even the universities have pressed for the need to undertake research leading to academic degrees (MSc, PhD) within the

native country to avoid a form of "brain-drain", etc., and only research in specific areas of recognized domestic weakness is allowed to be carried out in other countries.

The problem of selecting areas of research has been controversial and if, in certain areas, the researchers have had autonomy to select and orientate their own research, in other areas there is the constraint of the JNICT or of the INIC (National Institute of Scientific Research, that funds the network of research centres to be found in some universities) which try to establish research priorities. There is little evidence of a visible policy aimed at stimulating the selection of areas of particular concern for the national economic development.

Table 11

Fields of Study	(%)		
	1966	1976	1982
Humanities and Teacher Training	25.3	20.0	26.2
Arts and Architecture	3.2	3.6	3.6
Law	11.8	7.7	12.1
Social Sciences and Management.	12.2	20.5	18.4
Natural Science and Mathematics	20.3	5.3	0.4
Medical Sc. and Health Related	14.9	15.4	12.8
Agriculture and Veterinary Surgery	2.4	3.5	3.1
Engineering	9.9	22.2	18.0
Others	-	2.0	5.4
Total	100.0	100.2	100.0
Total Enrolments (Abs.Fig.:10 ³)	33.7	86.2	81.3

Source: 1966-Nunes

1976-Sampaio 80

1982-UNESCO 1985

The way the structure of the higher education system evolved reveals the uncertainties and the lack of overall management of priorities in terms of subordinating the system to the needs of development. For a long time the structure of enrolments in different areas followed the social demand until the 1970s, and recently the evolution has been patterned more by criteria of available resources than by social and economic needs.

The relative and absolute drop in the number of students enrolled in engineering courses is an example of the distortions regarding the technological needs of the country.

4.4. University-Industry Relations in Portugal

In the 1984 OECD review of Portuguese Education the examiners pointed out that "By its very nature, higher education tends to serve and identify itself with the most advanced and modern fraction of Portugal. Because of this, higher education - and especially the old traditional universities - are somewhat remote from the Portuguese reality. This position is probably both useful and necessary, since it enables Portugal to keep its place in the international cultural community. On the other hand, it gives higher education a special responsibility in the pursuit of economic progress[...]" (p.62). The way this opposition - between the attempt to reach a level of excellence and "remoteness" from the economic reality - will be solved is at the core of the preoccupations of this dissertation. The policy - as seen above - has been quite successful in upgrading the global quality of the universities. On the other hand this striving

for higher standards has not encouraged the setting up of linkages between university and the external world.

In section I shall (i) analyse how some legal instruments have contributed to perpetuate the "remoteness" and (ii) how this isolation has been overcome by new experiments and efforts to create links with external organisations.

4.4.1. The Legal Framework

Until 1980 the laws regulating the university life did not allow for the possibility of contracting research with industry. After some pressure from the universities Law 66/80 established the departmental structure of Higher Education (The old universities are now built up in the shape of faculties or institutes and these unities are broken down into departments. The new universities are structured in departments). According to this law the department should:

- prepare conventions, agreements and contracts of service between the department and other public or private institutions;
- agree contracts with institutions or individuals, national or foreign, to carry out technical or scientific work or specific actions that can help the pursuit of the department's objectives;
- finance the acquisition of services and the carrying out of work for public or private institutions, national or foreign, related to departmental activities.

This law rules that any receipt from this co-operative work has to be managed by the department.

Similar legislation was promulgated (law 419/80) concerning

the activities of the INIC (the funding body of research centres at the university).

These laws represented a step forward by legally recognizing the possibility of university-industry collaboration.

At the same time legislation was promulgated as regards post-graduation studies (laws 263 and 264/80) and about personnel development in scientific and academic institutions (decree-law 448/79 and law 415/80). The first two laws are about the provision of the academic degrees of "Mestre" (Master) and "Doutorado" (PhD) in Portuguese universities. Until then master courses were not provided and now there is a large range of choices. These courses have a predominant academic orientation and aim to develop the capacity for research, which, in a second stage, will lead to the carrying out of a PhD research.

The second group of laws concern the career of the scientific researcher (law 415/80) and the academic career (decree-law 448/79 and further legislation introducing changes in the original decree: law 19/80; decree-law 1/83, decree-law 316/83; and decree-law 243/85). This second group of laws aims to make the scientific and academic careers more attractive, both in terms of personnel development and as well as remuneration conditions. The first aspect is guaranteed through the provision of Master and PhD courses and degrees in Portugal, and the second through a scheme, known as "subsidy of exclusivity" in which researchers in public institutions and public higher education teachers are paid a fraction more than civil servants at an equivalent career stage (in terms of years of service, etc.). But this

subsidy has been controversial because it is only received if researchers and academics work exclusively for their public institutions.

Some of the alterations introduced to the Statute of the Academic Career (decree-law 448/79) through new legislation on exclusivity (decree-laws 475/82, 1/83 and 243/85) have aimed to increase the amount of the subsidy, now ranging between 30% and 60% of the basic salary depending on the hierarchical level. But the subsidy is dropped if an individual receives any payment from external organisations (except if the payment concerns royalties, conferences or small courses). This means that the individual collaboration with external organisations (or even joint cooperation of university teams - if it means any payment to individuals) is clearly penalized and the establishment of linkages between university and external activities is not encouraged by the legislation. The Statute of the Academic Career states in article 4 that the functions of university staff are: (i) teach; (ii) to develop scientific research; (iii) to contribute to the democratic administration of the school and participate in university extension. But despite this statement, all the criteria defined to assess the individual careers of professional academics only concern scientific aspects and do not take into account any external work or collaboration with external organisations.

The inhibition inherent in any entrepreneurial activity can be understood in the context of a policy whose first priority is the development of qualified staff whose teaching quality is seen as a priority aspect of the university's contribution to social and economic development. The research activities

are seen as an instrument leading to the training of up-dated teachers as well as a way of keeping in touch with the scientific state-of-the-art.

But this inhibition can also be seen as a feature of a traditional culture and education that still prevail in terms of the idea that academic authorities and governments have in mind about what an university should be.

The expansion of the concept of university through an interaction in regional or national socio-technical communities, should take into account the attitudinal factors that inhibit collaboration. Among other recommendantions a 1984 OECD report about university-industry points out that "University career structures and, therefore, evaluation systems can ensure that researchers' involvement in non-academic affairs entails rewards rather than penalties in their subsequent professional development" (OECD 1984a). It was previously seen in Chapter 3 that the attitude of academic authorities towards activities of consultancy and other contacts with industry were crucial in lowering the threshold that separates university and industry.

M.Bullock (1983) in his study about the American experiments in this field stressed that "the critical factor in changing the attitude of academics towards the commercial exploitation of research is the creation of an environment in which there is freedom for academics individually to develop commercial ventures whilst continuing as members of the university" (p.8).

The study of the Cambridge experiment, where more than 400

small NTBFs were created, shows that "the university has indeed played a role but it has been contextual and indirect rather than central" (Cameron 1986, p.5). "How then did the University contribute to this process? The most important point is that the University adopted a positive attitude to the involvement of its staff in the formation and development of new science based companies. It made clear to its employees that provided they fulfilled their contractual obligations, the University would not seek to monitor, control or profit from their involvement with new companies either directly as founders and employees or more indirectly as consultants or associates" (p.6).

In another presentation to the 1986 Conference of the International Association of Consultants in Higher Education Institutions the Oxford Industrial Liaison Officer also stressed similar aspects: "the reason why Oxford has been so successful [in translating scientific expertise into commercial reality] is of course a simple one. Its tradition of excellence has enabled it to recruit and keep people of the very highest abilities [...]. The liberal attitude of the university towards their conditions of employment makes it comparatively simple for them to run businesses at the same time as retaining their academic posts, and enables them to remain at the forefront of international expertise in their fields" (Day 1986, p.59).

From these British experiments, from what happened in Boston around MIT or in Silicon Valley, or from what is happening in the new French "technopoles" (Campiegne, Sophia-Antipolis or ZIRST de Meylan in Grenoble) (Autrement 1985) it can be seen that academic excellence is not incompatible with

entrepreneurial activities of universities' staff and, on the other hand, there exists a complementarity. Portuguese legislation and the attitude of university authorities is right in which they intend to attain a level of excellence. But excellence is not synonymous of isolation inside any "ivory tower". There are positive forms of insertion in the community and there are alternatives to the dualistic views criticized by G.Danielou: "If I have understood what has been said here, the university has no choice: either it remains a cold virgin locked in some ivory tower, or it indulges in prostitution (with some perversity one could even imagine that the prostitution may take place inside the ivory tower)" (p.151).

4.4.2. Some experiments of University-Industry collaboration in Portugal.

My intention is not to make an extensive description of the experiences of collaboration. I just intend to highlight a strong will to collaborate that exists among the staff through a short account of some of the recent years' experiments.

Probably the most successful experiment has been the work carried out at INESC. The Institute of Systems and Computer Engineering was set up in 1980 as a private non-profit making institution and for its foundation contributed some individuals who had got their PhD at foreign universities (MIT, etc.). The current partners of INESC are CTT (the Portuguese Post Office), TLP (domestic telecommunications company), CPRM (long distance telecommunications company), UTL (the Technical University of Lisbon), IST (the Technical

Higher Institute-UTL) and UP (University of Oporto). The objectives of the INESC have been the provision of highly qualified engineers in the telecommunications field and the carrying out of research in digital communication, digital transmission, and digitalization of the telecommunication network. In 1985 219 people were working at the INESC (among them 22 with PhDs, 44 attending master courses or working for a PhD, 128 students of engineering attending first degree courses). Besides fourteen standard projects INESC has been working on four large projects: the development, with Centrel (a Portuguese components firm), of a PABX; development of a local network (LAN) in harmony with the national project of the "Electronic Office"; SIFO project, intending to develop digital "islands" of integrated services with optical technology; project for management of large fleets with several transport operators.

In 1982, at the Technical University of Lisbon, there was set up a central liaison office, the GAPTEC. It was expected that most of the joint research between the different university schools along with outside activities would be performed through GAPTEC. This office has managed some projects but the University staff (in each school/department) has opted for other alternative forms of collaboration with outside organisations through more decentralized mechanisms.

Other universities have recently set up their own liaison offices or joint-research structures (eg.: UNINOVA at Universidade Nova de Lisboa in 1986). At this University, for several years, collaboration has taken place between the team of Professor Moniz Pereira (with important contributions in

Computer Science, mainly in the field known as Artificial Intelligence, development of PROLOG language and its applications) and American universities and companies.

Some of the most interesting experiments have been set up at the new small regional universities. The Universidade do Minho, founded in 1974 with the intention of contributing to regional development, has been cooperating with local industries in "a large number of innovation initiatives" and in "a large programme of professional training courses" (Pereira and Freitas 1986, p.1276). A Centre of Information Technology was set up and also some Technological Centres (textile, plastics). At another regional university, the Universidade da Beira Interior, several projects have been developed in the field of textile engineering. Besides a system of spinning management that is being produced and marketed, they have several prototypes being developed (with local/national industry) of new devices in which laser technology is applied to the textile industry (cutting clothes and shaping them with a robot arm equipped with a laser, etc.). The main difficulties of this University have been in the move from the prototype to the commercialization stage.

The implementation of the Technological Development Plan after 1984 (see section 4.1.) lead to the approval of more than one hundred "contract-programmes" between LNETI/Ministry of Industry, industrial firms, universities and public laboratories. Of these programmes at least 36 have been run by universities and they have participated in most of the other run by industry. These "contract-programmes" have an overall value of 7,500 M Escs. (more than 30M Pounds) and

more than 40% was to be financed by the Ministry of Industry (data from Rodrigues 1986).

The links between individual staff members, their departments, and public and private institutions have been increasing. The conclusions of a Conference on "Innovation and Technological Development" held in Lisbon, February 1986, promoted by the Portuguese Industrial Association stressed that "considerable steps have been taken in the last few years in the linkage and dialogue between research structures and the productive sector" (p.4) and "the University-Industry cooperation on a contractual basis has led to very important experiments that should be stressed. There exist very remarkable capacities at the Universities and Research Centres that are performing innovative projects. The identification of needs, the conceptualization of innovative solutions and a rigorous control of project execution are necessary conditions for a successful cooperation. The stability of the rules is however fundamental if that cooperation is to be developed" (AIP 1986, p.7).

CONCLUSION CHAPTER 4

In this Chapter some of the weaknesses of the Portuguese Technological Infrastructure were discussed. The relative quantity of resources allocated to R&D activities is quite low but the weakest point, where easy improvements can be made, is the interaction between the different segments of the infrastructure (according 1982 data).

The higher education system is now in a period of consolidation. After the increase in enrolments (until the 1970s) and the period of institutional expansion (late 1970s and early 1980s) there is now a policy to improve the quality of teaching and, to a lesser extent, research functions. The development of a qualified professional body of university teachers has been seen as a priority task. The university's contribution to society depends mainly on the supply of highly skilled graduates to the labour market.

There are however some worrying aspects in this evolution. The fall in the enrolments rate and the likely fall in engineering graduates go against the long-term needs of the country.

The strengthening of the technological infrastructure should change in several ways. Interrelation between the different segments should be improved. These mechanisms can range from joint information systems (systematization and diffusion of scientific and technological information produced by the international scientific community concerning Portuguese industry and areas of research) to the establishment of direct links in collaboration, research, etc. The contribution of higher education institutions can be decisive.

both in expanding further and increasing the supply of graduates and in acting as a coordination and implementation centre of new initiatives aiming to dynamize the socio-technical community in Portugal.

Much of what has been written about the Portuguese technological infrastructure state that it should be developed further to improve the capacity to absorb foreign technology. Though recognizing that the country will necessarily rely on imports of foreign technology as a crucial source of innovation for many years I think these views are basically wrong when they assign to the technology. The country's capacity to innovate should be developed by trying to set up means of autonomous production of technology suited to the needs of national industries. The performance of Portuguese industries in the international markets will only obtain satisfactory results when the goods supplied cease to rely on "second-hand" technology but on really competitive and innovative developments of processes and products. The coherence of the infrastructure requires that the different stages of R&D are performed, demands a considerable increase in the resources invested in R&D (both by the Public and Private sectors), calls for an increased interaction among the different institutions performing R&D and, finally, a continuity and coherence in the industrial and innovation policies to be carried out.

CHAPTER 5 - CASE STUDY ON THE ATTITUDES
OF THE ACADEMIC BODY
OF THE UNIVERSIDADE TECNICA DE LISBOA
TOWARDS COLLABORATION WITH INDUSTRY

SUMMARY - CHAPTER 5

Chapter 5 is a case-study on the attitudes of the academic body of one of the largest Portuguese universities towards collaboration with industry. A survey on a sample of 25% of the academics working in the Technical University of Lisbon was carried out as well as some interviews of individuals with leading responsibilities in relation with external organisations. The questionnaire (see Appendix 1) aimed to assess the attitudes towards collaboration with industry, the role of the university in economic development, the relation between academic autonomy, State policies and a renewed integration in the community by improving responsiveness to social and economic needs. The levels of work satisfaction were also assessed to understand how they can limit/stimulate collaboration with industry. The technological potential and its prospective evolution are also assessed to understand its importance in an economy largely characterized by a backward technological profile. In the last section of this Chapter the tendency of academics to set up new research based ventures is assessed.

Note: In this Chapter the replies to a questionnaire sent to about 400 Portuguese Academics are analyzed. The majority of the questions had a scale ranging from A to E in which the respondents had to tick what their opinions were on the specific matter/variable of the questionnaire. The scale was always limited by two qualifying words (eg.: enough/not enough; satisfied/unsatisfied; intensive collaboration/nile collaboratin; etc.). The references that will appear in this Chapter (A+B, or D+E, etc.), thus, concern each question variable. In addition to this, there are also some references to tables (eg.: Table A5, Table A22, etc.) that are presented in Appendix 2.

5.1. The Survey Objectives, Methodology and Limitations

The initial intention was to survey the academic body of all Portuguese universities trying to determine the prevailing attitudes concerning the University role in economic development, its relation with the "external world" (all sort of economic activities and institutional sectors: agriculture; manufacturing industry; services; public service etc.) and also to determine the potential to start-up new ventures among Portuguese academics.

Different kinds of restrictions prevented such survey: (i) the MSc dissertation had to be produced during the Summer term, when the schools were almost all closed; (ii) the costs of carrying out such a survey would have far exceeded than the resources I had available; (iii) finally the different context of each university would require a preliminary work of several weeks (or months) to try to develop a lay-out suited to all specificities.

In view of these difficulties, I decided to perform the survey exclusively in one university where, from personal experience, I knew its general context and some of its specificities. Limitation to the Universidade Tecnica de Lisboa - U.T.L. (Technical University of Lisbon) implies that the survey does not represent the attitudes of the Portuguese University as a whole. The UTL is one of the four large traditional universities (with Coimbra, Oporto and the "Classica" of Lisbon), and is located in the more urbanized, developed region of Portugal. On the other hand, a survey limited to the UTL has some advantages: there is a greater uniformity of behaviour than in other universities as a

consequence of its "technological" characteristics; its concentration on technological subjects means that the problem of the relation with industry has probably greater importance than in other universities; the largest schools of engineering, economics and management, and agriculture science in Portugal are in this University.

The survey was carried out in five of the seven schools of the UTL:

- Instituto Superior Tecnico/IST (Engineering);
- Instituto Superior de Agronomia/ISA (Agricultural Science);
- Faculdade de Arquitectura/FA (Architecture);
- Instituto Superior de Economia/ISE (Economics and Management Science);
- Escola Superior de Medicina Veterinaria/ESMV (Veterinary Surgery).

From the survey I dropped the ISCSP (Social Science and Political Science) and ISEF (Physical Education and Sport Science), partly due to their relatively small size as well as to their non-technological characteristics.

The survey had to cover 25% of the overall population in the five selected schools, but with different rates of coverage according to the groups of the academic body. The academic career in Portugal is broken down into five major levels:

- Assistente Estagiario;
- Assistente;
- Professor Auxiliar;
- Professor Associado;
- Professor Catedratico.

The main differentiation is between "Assistentes" and

"Professores". To become a "Professor", according the 1980 legislation (Decree-Law 448/79, see chapter 4) a PhD degree or equivalent is required. The progression from "Assistente Estagiario" to "Assistente" is achieved through obtaining of a MSc degree or equivalent. All the "Professores" have a place in a Scientific Council that is responsible for outlining the scientific policy of the school and related decisions. The "Assistentes" have a subordinate role at this level and have statutory rights at administrative and pedagogic levels. In practice the group that has a leading role (or is expected to have) at all levels are the "Professores". In view of this structure and specific roles the survey covered the two major groups differently: the "Professores" were surveyed at a rate of 40%; and the "Assistentes" at a rate of 20%. The global percentage of persons surveyed meets the objective of 25% of the overall academic population.

Another important differentiation in the Academic body, that could lead one to expect a different profile of attitudes, is between those teachers whose professional basis lies in the university (Non-Invited/Ni) and those who have external employment and are invited (in view of their experience, etc.) to become teachers - mostly on a part time basis (Invited/I). There are no invited "Assistentes Estagiarios".

The survey was carried out in late July, August and early September 1986. There was a preliminary stage of preparation and definition of the questionnaire which lasted about one month. This stage was mostly occupied in designing the questionnaire in view of the dissertation hypothesis, in testing the survey on a small group of potential respondents

and discussing it with people having previous experience in survey-based research. The feed-back of this work led to a final draft of the questionnaire which, as I subsequently discovered, still had some imperfections that should have been polished up beforehand. The time pressure led to some biased questions, to some repetition (but which, on the other hand, enabled me to check the accuracy of the replies), and also to quite a long lay-out (more than 60 questions) that could have been reduced. Another point is that each questionnaire had to be numbered for statistical control, avoiding duplication of costs in sending the first and second reminders. The best solution would have been a questionnaire without any cheque number, but, in the present circumstances, it was impossible. Despite these weak points analysed the final assessment is that the questionnaire raised the relevant questions and enabled the survey to meet its major objectives.

In addition to the survey, some semi-structured interviews (five) were performed, in general covering the same items as the questionnaire, to some persons holding key responsibilities at the UTL, or in its relation with industry, and also to a member of the Science Policy-Making Board (JNICT). Those interviewed were: Professor D.Durao, President of Scientific and Directive Councils of IST; Professor Tribble, IST, director of INESC; Professor T.Lemos, director GAPTEC; Professor P.Amaro, President of Directive Council, ISC. Mr.F.Goncalves, JNICT. Shortage of time was again responsible for the small number of interviews.

5.2. The Population to Be Surveyed, the Sample,
and the Rate of Reply

The original data about the population concerned the 1984/85 academic year.

Table 12

UTL Academic Staff - 1984/85

	IST	ISA	FA	ISE	ESMV	ISCSP	ISEF	Total
Assistentes	522	118	49	343	38	53	79	1,202
Professores	219	54	10	37	23	12	12	367
Total	741	172	59	380	61	65	91	1,569

Source: UTL 1985.

These 1569 teachers in 1984/85 represent an increase of 8.4% in relation to the previous academic year and of 13.1% in relation to 1982/83.

Table 13

UTL Academic Body (five schools) - 1985/86

	IST	ISA	FA	ISE	ESMV	Total
Assistentes	570	120	102	378	38	1,208
Professores	258	52	17	44	20	391
Total	828	172	119	422	58	1,599

Source: UTL 1985.

The collected data represents an increase over the previous year, for the five selected schools, of 13.2%. Excluding Architecture (in process of integratition between 84 and 85 at the UTL) the rate of increase is 9.3% and, compairing with

1982/83, there was an increase of 16.6% in four years. While the academic body has been expanding the number of enrolments has remained relatively stabilized.

Table 14

The Selected Sample

	IST	ISA	FA	ISE	ESMV	Total
Assistentes	114	24	20	76	8	242
Professores	103	21	7	18	8	157
Total	217	45	27	94	16	399

From the 399 individuals of the sample there was 175 replies and 17 questionnaires sent back (wrong adress -8; out of the country - 4; other reasons - 5). This means an overall rate of reply of 48.1% that can be considered quite good in view of the period of the year in which the survey was carried out. The replies under analysis are 43.9% of the initial sample.

Table 15

Distribution of the Replies

	IST		ISA		FA		ISE		ESMV		Total	
	NI	NI+I	NI	NI+I	NI	NI+I	NI	NI+I	NI	NI+I	NI	NI+I
Assistentes	37	48	6	8	6	7	19	33	3	3	71	99
Professores	41	49	10	11	-	-	5	9	4	5	60	74
Total	78	99	16	19	6	7	24	42	7	8	131	175

Note : The difference (NI+I)-NI equals the number of respondents that are Invited Teachers.

The rate of reply is 47.1% among "Professores" and 40.9% among "Assistentes", despite no answers at all from the former group in Architecture. This school has the lowest rate of reply (25.9%) while the other four rank above 40% with Veterinary at the top with 50.0%. About 3/4 of the replies are from non-invited teachers and 1/4 from the invited teachers.

The tables concerning the structure of replies according hierarchical level in each school are presented in Appendix 2 (Tables A1 and A2).

The age profile of the academic body is noticeably young (see tables A3 and A4 in Appendix 2). About 60% of the non-invited teachers replying were less than 35 years old, while the equivalent percentage for the invited teachers' group is less than 20% (which agrees with the requirement of "experience" to contract new members to this group). Anyway the academic body has a young profile which corresponds to the rapid expansion of recent years.

5.3. Evolution of the Scientific Potential

The number and characteristics of academic degrees held by members of the UTL staff, as well as their trend over time, can act as a rough indicator of the scientific potential.

Using this "credentialist" measure, less than half of the repliers had been awarded any post-graduateon degree. The invited teachers have less academic credentials than the non-invited academics. Among these 12.6% had a MSc degree (or equivalent) , 22.3% a PhD degree (or equivalent) and 9.1% both a MSc and a PhD.

Table 16

Row: VAR15 (Hierarchical level (NI))
 Column: VAR17 (Academic degrees, etc.)
 N total: 175 N included: 175

Row %	1std +MSc	1std +PhD	1st+M Sc+Ph	Other	mis.	Total	N's
As. Est.:	10.0	.0	.0	.0	90.0	100.0	30
Asst.:	36.6	2.4	.0	2.4	58.5	100.0	41
Prof. Aux.:	.0	76.2	23.8	.0	.0	100.0	21
Prof. Ass.:	.0	55.6	33.3	.0	11.1	100.0	18
Prof. Cat.:	4.8	38.1	19.0	.0	38.1	100.0	21
missing:	6.8	9.1	2.3	15.9	65.9	100.0	44
Total	12.6	22.3	9.1	4.6	51.4	100.0	
N's	22	39	16	8	90		175

Table 17

Row: VAR16 (Hierarchical Level (I))
 Column: VAR17 (Academic degrees, etc.)
 N total: 175 N included: 175

Row %	1std +MSc	1std +PhD	1st+M Sc+Ph	Other	mis.	Total	N's
Assist.:	7.4	.0	.0	14.8	77.8	100.0	27
Prof. Aux.:	.0	22.2	.0	22.2	55.6	100.0	9
Prof. Ass.:	25.0	25.0	.0	25.0	25.0	100.0	4
Prof. Cat.:	.0	.0	50.0	.0	50.0	100.0	2
missing:	14.3	27.1	11.3	.8	46.6	100.0	133
Total	12.6	22.3	9.1	4.6	51.4	100.0	
N's	22	39	16	8	90		175

An important trend as regards degrees and hierarchy is that all the newly arrived to the non-invited "Professores" group ("Prof. Aux.") have got their PhDs. The oldest group ("Prof. Cat.") has a PhD award rate of 66.7%.

The dynamic towards a more credentiated academic body is clear. More than half of the MSc's were obtained in the last four years and more then 3/4 in the last nine years. Slightly below half of all PhDs were obtained in the last four years and more than 2/3 in the last nine years. The trend is for

all "Assistentes Estagiarios" to get a MSc in the next five year period and all the non-invited "Assistentes" get a PhD in the same period. An average new member of the academic body is expected to obtain a MSc in the first 3-5 years and a PhD in more 4-6 years.

Another important matter concerns the place where the degrees are awarded. This can reveal some signs of scientific and technological dependence. The trend here is clearly towards an autonomy in terms of new post graduateon awarded degrees. About 3/4 of the MScs and PhDs obtained by the respondents in the last four years period were awarded by Portuguese universities, while the equivalent proportion in the previous five year period was 36.8%. From the replies given one may conclude that the real trend should be a relative fall in foreign dependence whereas the absolute number of awards obtained in foreign universities should stabilize in the future.

Table 18

Row: VAR18 (Year MSc)
 Column: VAR19 (Country/MSc)
 N total: 175 N included: 33

Row %	Portugal	US	UK	France	Other	Total	N's
<5:	76.5	5.9	5.9	.0	11.8	100.0	1
5/9:	25.0	25.0	50.0	.0	.0	100.0	8
10/14:	.0	50.0	50.0	.0	.0	100.0	2
15/24:	16.7	16.7	33.3	33.3	.0	100.0	6
Total	48.5	15.2	24.2	6.1	6.1	100.0	
N's	16	5	8	2	2		33

Table 19

Row: VARI10 (Year PhD)
 Column: VARI11 (Country/PhD)
 N total: 175 N included: 57

Row %	Por tugal	US	UK	Fra nce	Other	Total	N's
<5:	75.0	3.6	17.9	3.6	.0	100.0	28
5/9:	45.5	9.1	36.4	9.1	.0	100.0	11
10/14:	33.3	.0	44.4	11.1	11.1	100.0	9
15/24:	42.9	.0	42.9	.0	14.3	100.0	7
>=25:	50.0	.0	.0	50.0	.0	100.0	2
Total	57.9	3.5	28.1	7.0	3.5	100.0	
N's	33	2	16	4	2		57

5.4. University, Economic Development and Autonomy

The opinion of the respondents about the contribution of the University to economic development is that it has been poor (46%: D+E) or at least not very good (30%:C) (Table A5). Almost all the respondents (96%: A+B) think that such contribution should be intensified in the future (Table A6), but such intensification should not affect the University's autonomy (54%: D+E) (Table A7).

The autonomy has been increasing in the last ten years (73%: A+B, Table A8) and it should increase further in the future (92%: A+B, Table A9). The respondents think that the autonomy will increase further if the collaboration with firms and other external organizations is intensified in the near future (69%: D+E) (Table A10). In addition to this, the diversification of finance sources will undoubtedly contribute for an increase in autonomy (85%: A+B) (Table A11).

To understand the context of these replies on autonomy / collaboration / economic development it should be said that at the Portuguese universities autonomy is basically

scientific and administrative while there is a quasi-total financial dependence. The Rector is elected by the Scientific Councils' members while until few years ago he was appointed by the Minister of Education. The internal structure of each school is democratically organized with regular elections for the scientific, pedagogic, administrative and departmental directive bodies. Such organisation did not exist before the political changes of 1974.

In the final section of the questionnaire some comments were made about the issue of university autonomy, particularly the nature, meaning and characteristics of the autonomy.

The respondents think that "there is no contradiction between autonomy and economic development", that "the contribution to economic development should not be programatically imposed but should be spontaneous and free". The autonomy should mean a "State withdrawal from the University[...] and the renewed Middle Age concept of autonomy (the "Universitas Magistrum et Scholarum") should enable the universities to adopt the policies they consider to be more qualified to many of the problems focused in the questionnaire". In one case there was a reference to "internal pressure groups limiting the professors' freedom". In a few cases there were warnings against the potential negative effects of intensified external relations on autonomy: "the relation with firms can increase autonomy with regard to the State but will create a new source of dependence"; "dispersion of external collaboration can mean a sharp decrease in autonomy, turning the university into some departments or branches of lobbies whose interests have little or nothing in common with the university's interests". Other commentaries pointed out the

need for autonomy but stressed that "the university should not be independent. People pay it to meet its social functions: produce new graduates and create a critical and innovative intelligence".

The notes made by the respondents - while not all in the same direction - reveal the importance given to this matter and how the autonomy is valued and should be protected. Almost all these commentaries are keeping with the general trend in the questionnaires replies - that autonomy should be preserved and further developed.

Some of the interviewees pointed out that their schools have been largely autonomous in designing their own policies. This autonomy has been a consequence of the absence of any external guidance both from the Public Departments of Education, Science and Technology or from the rectory of the University.

One further question in the section about autonomy and economic development was about the possibility of the University's performing additional roles, besides the traditional vectors of action (teaching, research) and the new role anticipated (collaboration with external organisations, etc.). More than 70% of the repliers (A+B) (Table A12) think that the University should perform such additional roles in social, political and cultural areas.

This attitude towards new areas of action seems to be very positive in terms of a renewed integration of the university in the community as a dynamic and innovative institution contributing to change and development.

5.5. Scientific and Educational Work at UTL and Levels of Work Satisfaction

5.5.1. Research Quality and Conditions of Scientific Work

It was seen that the scientific potential has been improving in the last few years. The relative and absolute numbers of degrees awarded in Portugal have also been increasing. But what have the conditions of research been? How do academics assess the research quality? The answer to these questions is partly given in the replies.

When describing research orientation in their schools the researchers are of the opinion that it has not been very good (43% think that it has been bad or quite bad and 23% that it has been good or very good). The analysis of the replies, according to each school, shows different situations, with the Engineering Institute scoring an overall positive opinion, much better than the other schools (Table A13).

In comparing the quality of research carried out at their schools with equivalent institutions in Portugal they consider it as being better (A+B: 43%) or similar (C: 34%). The exception is the school of architecture with a poor score (Table A14). The comparison with other countries' research is not so favourable. This question was however affected by not specifying what the "other countries" were to be compared with (Table A15).

The following group of questions was about the material resources available to perform research at UTL. The average idea in the replies is that they are insufficient, which can partially explain the assessment of research at UTL.

Bibliographic resources (D+E: 56%), available equipment (D+E: 66%), auxiliar personnel (D+E: 80%) and financial resources (D+E: 85%) are all lacking (Tables A16, A17, A18, A19).

On the other hand scientific contacts with other institutions, which can also be regarded as a research resource, are not so intense as the general wish. The absence of such contacts is similarly assessed where Portugal is concerned (D+E: 60%) (Table A20) and other countries (D+E: 60%) (Table A21). Anyway, the structure of replies concerning "other countries" is better than the one concerning Portugal. This means that the Portuguese universities and other national scientific institutions live separately without any contacts that could improve the synergy of the scientific and technological infrastructure as a whole.

5.5.2. Relation between Research and Teaching

The academics surveyed have devoted their working time to teaching functions (A+B: 50%) or sometimes dividing their time equally between teaching and research functions (C: 31%) (Table A22). This general profile is largely influenced by the Engineering Institute replies that contrast with the other four schools where teaching has been the central function (A+B ranging from more than 60% to 100% in Architecture).

The relation between time and resources spent in teaching and research functions should be changed, at least according the opinion of the respondents, who assess the present situation as inadequate (D+E: 56%) (Table A24).

The replies concerning the ideal relationship between

teaching and research in the future show a wish for a balance in which the resources are shared equally by teaching and research (Table A24).

This concern, which converges with the pressure to up-grade the whole level of "credentialism", reveals that academics are worried about the excellence of their institutions. The present mechanisms devised to enable the academics to progress in their career seem to provide an answer to these wishes but the aim of intensifying research can only be achieved if the quantity and quality of resources allocated substantially improves in the forthcoming years.

5.5.3. Levels of Satisfaction

The evaluation of the work satisfaction levels among UTL teachers shows that such levels differ as regards specific aspects.

Despite the negative assessment of research orientation and quality, scientific satisfaction among academics is not so bad (43% satisfied: A+B, and 20% not unsatisfied: C) (Table A25). The faculty environment, contacts with colleagues, and the research opportunities within the academic career certainly contribute to this mood. On the other hand individual scientific guidance is assessed negatively (50%: D+E) (Table A26).

The satisfaction level scores a fair rise on "specific advantages" of the academic career. Overall discretion in their jobs, the flexibility enabling one to share time between different tasks, etc., certainly contribute to a positive stance (72%: A+B) (Table A27). In the commentaries

section it is, however, mentioned that these advantages "are being suffocated".

Satisfaction reaches its lowest level as regards the salaries scale. More than 2/3 of the replies (67%: D+E) denote a dissatisfaction (Table A28).

Despite the relative degrees of satisfaction the probability of staying in the academic career is quite high and less than 1/5 of the respondents (D+E: 19%) (Table A29) express their intention of leaving university (among these 19% are included respondents reaching retirement age). The fact that the tendency to leave is not greater can be related to the difficulties in the external job market, as pointed out in some commentaries.

5.5.4. Salary Level, Academic Career and External Collaboration

It was seen that the salary level has a fair impact on the respondents' satisfaction. Further research on this point was undertaken in terms of the contractual procedures that govern the breakdown of teachers' incomes, as well as the impact that intensified collaboration with industry can have at this level.

The overwhelming majority of the respondents consider that the present salary level is not enough (87%: D+E) (Table A30). The annual salary of a full time university teacher can vary, according the position in the hierarchy, between 4,000 and 10,000 pounds (these figures represent more than their value in British money: in terms of parities of

purchasing power one can consider them to be about 1.5 times more).

These salaries are for those who work exclusively at the University and receive (as part of the above sums) a "subsidy of exclusivity" that amounts to a further 30% on top of the basic salary of each scale. Anyone who receives any external income (but not from royalties, short courses or conferences on scientific subjects) automatically loses this subsidy.

The dissatisfaction is particularly acute among the youngest groups of non-invited teachers (D+E: more than 80%) (Tables A31 and A32).

But what is an individual problem (the relative levels of income) can be a comparative advantage to Portugal in attracting research-based industries or research units from large companies. If other components of the technological infrastructure were to provide an improved environment this factor could be decisive in attracting such industries.

When asked about the continuity of such a "subsidy of exclusivity" in its present form or whether it should be more flexible, the majority of the respondents thought that it should have greater flexibility (C+D+E: 73%) (Table A33) and more than half of the respondents see external collaboration as a way of improving their individual incomes (A+B: 55%) (Table A34). But the possibility of imposing any limits on external incomes or not polarizes opinions (Table A35). The question as to how external contracts agreed by members of the staff for the school should account for the progressive differentiation of salaries at the same hierarchic levels concentrates once more the opinions (Table A36).

Finally there is general agreement (A+B: 77%) that work done as external collaboration should be counted as curricular evaluation to progress in the academic career ("if with scientific value") (Table A37).

* * *

This set of questions and answers reveals dissatisfaction among respondents with their salaries and the limitations that current legislation imposes on external collaboration. This point has been controversial in the Portuguese universities and the change (twice) of legislation concerning the subsidy of exclusivity in the last few years illustrates the dissatisfaction.

As regards the economic integration of the university such legislation heavily penalizes any remunerated contact with industry. In requiring the sacrifice of the subsidy should any paid collaborative research or consultancy be carried out, the legislation imposes a duty as regards the relationship with external organisations. In addition to the normal tax requirements the university teacher has to pay an additional tax equivalent to 1/3 of his basic salary if carrying out any external remunerated work.

The respondents produced plenty of commentaries on this subject. Opinion vary from those who think that the rules concerning the subsidy should be eliminated ("the subsidy is a reward for idleness") to those who agree it should continue, as well as its objectives, but on new grounds. The legislation and present practices "do not dignify" the academic career. The policy of stimulating exclusivity is only acceptable "if the exclusivity makes it possible to

remain in touch with the reality and the performance of productive tasks".

When the paid research is carried out through the university, the net income "should be shared between individuals and their departments to finance further research".

One of the commentaries suggests that the subsidy of exclusivity should be replaced by "research contracts", probably to be paid by the State or the private sector when contracting research.

5.6. Collaboration with External Organisations

5.6.1. The General Mood

The section of the questionnaire to be analysed now was in the core of the survey. Before analysing past experiments and what the respondents think about the future, I shall introduce the general mood concerning the role of the university as regards collaboration.

Nearly 90% of the respondents (A+B: 89%) think that collaboration should be intensified beyond the current level.

Table 20

Variable: VARIV9 (Future collaboration: intensity ?)
N total: 175 N included: 170

Label	Code	Freq	Marg%
A	1	78	45.9
B	2	74	43.5
C	3	15	8.8
D	4	1	.6
E	5	2	1.2
mis.	9	5	MD

The University should be very active (A+B: 49%) or moderately active (C: 47%) in seeking contacts with other organisations and can not adopt a passive stance waiting for any external demands.

Table 21

Variable: VARIV1 (Attitude: act./pas. ?)
N total: 175 N included: 169

Label	Code	Freq	Marg%
A	1	36	21.3
B	2	47	27.8
C	3	79	46.7
D	4	6	3.6
E	5	1	.6
mis.	9	6	MD

This positive stance is in keeping with the initial intention of intensifying contribution to economic development.

Some of the respondents commented that "entrepreneurs should assume the risk of financing R&D made in Portugal and believe in the existing capacities" and that "some reservation on the part of the firms can be explained by previous unsuccessful experiments".

This point in particular was discussed with the interviewees to try and reach some conclusions about who might or could be the driving-force in the process of building a solid liaison between university and industry.

The opinion of one interviewee with past responsibilities in collaboration is that it is not important to know who has the initiative. What is important is that both parts of the relationship share common concerns. Another opinion is that industry will be the driving-force of the relationship but

only in the long term (in 20 years or so). The entrepreneurial class is changing with the rise of professional management to direction (or even ownership) of firms, and they will help to bring university closer to reality. If the "Napoleonic university" does not change the market will produce new universities fitting the needs of both industry and students demand. A third opinion, from a different field (agriculture), pointed out that the large companies of the sector have not sought the university and the small agricultural unities do not even think in demanding any technological support from the university.

The collaboration that has been done, the interviewees agreed in this point, has not been framed by global policies and there has been a certain spontaneity in all process.

5.6.2. Past Collaboration

The collaboration of the respondents' departments has been nil (E: 52%) or very weak (D: 17%) in the last few years (Table A38).

From those whose professional base is at the university a little more than half (E: 51%) has no experience of external work at all. The proportion of those with intense external work is small (A+B: 22%) (Table A39). But on the other hand the group of invited teachers (1/4 of the respondents) think that their professional practice outside the university is closely related to their academic work (A+B: 85%) (Table A40).

The past collaboration has been pursued according to strictly scientific criteria (A: 23%) or at least they have been

influential in shaping the interaction (B: 36%). Only a small share of the collaboration has been mainly commercially orientated (D+E: 8%) (Table A41).

The dynamics of the co-operative actions has varied according each institute/faculty, each department and even each departmental section (IST). Certain respondents warned of the fact that university action has been competing with existing external consultancies in "areas of technical know how outside the university". But the overall direction of the cooperative work seems to be determined mainly by scientific criteria. This collaboration has been increasing, according the interviewees, and its tendency is to develop further. The school with most experience in this field is the Engineering Institute, where the research contracts already contribute to a fair amount of the school's budget. It is supposed that the new contracts that EEC institutions and programmes (SPIRIT, EUREKA, etc.) are proposing will substantially raise the financial resources from non traditional (State) sources. The other UTL schools have had less expressive past experiences and/or are now starting an organised action towards the economic environment.

5.6.3. Future Collaboration

As has been seen, the general attitude is towards collaboration. But what shape should should collaboration assume? In this section one will discuss: (i) how the collaboration should be linked up with teaching and research; (ii) the characteristics of the future collaboration (which institutions, "commercial" or "scientific" criteria, etc.); and (iii) what the nature of research in a collaborative

context should be (basic vs.applied).

Through a matrix where the traditional axis (teaching/
/research) was crossed by the new one (collaboration), one
has tried to locate in that space future activities.

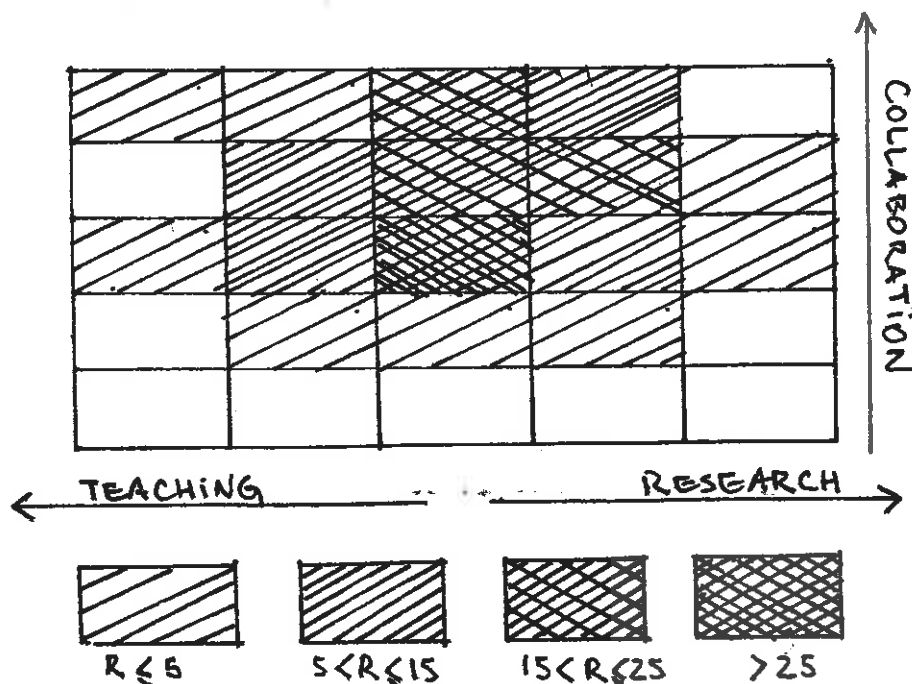
Table 22

Row: VARIIII8B (Collaboration/Future)
Column: VARIIII8A (Teaching/Research/Future)
N total: 175 N included: 175

Tot %	A	B	C	D	E	mis.	Total	N's
2:	.6	1.1	1.7	2.9	.0	.0	6.3	11
3:	.0	6.3	20.0	4.6	.0	.0	30.9	54
4:	1.1	6.3	13.7	12.0	.6	.0	33.7	59
5:	.0	2.3	13.1	4.6	2.3	.0	22.3	39
mis.:	.0	.0	.0	.0	.0	6.9	6.9	12
Total	1.7	16.0	48.6	24.0	2.9	6.9	100.0	
N's	3	28	85	42	5	12		175

The result expressed graphically shows a dark zone in the
centre of the matrix "moving" to the upper/right part of the
matrix.

Figure 7



The relationship between these three different dimensions is not one of exclusivity but, of course, there is a complementarity between them.

The ones who seek a more intensive collaboration are those who have had more external experience in industry in the past (including invited teachers) (Table A42).

The breakdown by schools and hierarchical groups is presented in the Appendix. One will also find in the Appendix the tables that associate the intentions regarding future collaboration and the opinion about the relationship between collaboration and individual income, limits to external income, etc. (Tables A43 to A49).

Despite the affirmative tone of the replies there are many warnings of the dangers that an open relationship with external businesses can represent to the university. People are worried about the negative effects on "the fundamental tasks of teaching, education, and fundamental research". "The first priority is to increase teaching quality and, after that let's think about collaboration". "The university should not be intoxicated with collaboration although collaboration is useful to help university to keep its feet firmly on the ground". Some respondents warn about the present weakness or even non existence of research in some areas. The university-industry relationship is, in a respondent's opinion, an "imported fashion" that does not fit the present characteristics of the local university. Other commentaries point out that the collaboration must not be a way of "exploiting young, and inexpensive researchers for the personal gain of some professors".

Of course, there are the positive commentaries about the characteristics that future collaboration should assume, the partners that have to be selected, the "need to give a practical direction to the university and a theoretical one to industry", etc.

The idea that stems from the replies and commentaries is that there is a will to collaborate (quasi-unanimity), but it should be carefully intensified without damaging the internal activities of the university. In certain scientific fields and departments there are no conditions at all to improve collaboration. In these situations resources should be concentrated on improving the quality of teaching while intensifying research practices. It is natural that the majority of resources will continue to flow into on teaching, but the will to improve research and intensify collaboration with the outside world cannot be frustrated. Otherwise the degree of dissatisfaction will not disappear and will moreover become greater and spread to those academics seeking a change in the present orientation.

A second aspect that the questionnaire raises for analysis concerns future criteria for contracting collaborative research. More than half (A+B: 55%) of the respondents intend that collaboration be on a scientific basis. Anyway when one compares this structure with the prevalent criteria in contracting past research, a slight move towards acceptability of commercial criteria is to be seen (Table A50).

The institutional profile of collaboration should favour Portuguese companies, public administration, non-profit

making institutions, other foreign institutions (universities, governments, etc.), and finally, with a lesser degree of priority, foreign firms (Tables A51 to A55).

Additional views by the respondents, found in the commentaries section, state that the university "should not compete with established firms" or that "when there is no innovative objectives in the collaboration it should be carried out only if there is no scientific expertise in the sector of technical firms". Tasks of quality control or similar operations should not be performed in university laboratories".

The possibility of the university providing services at a low cost (or even free of charge) was not approached by the respondents. But the general standpoint, among those who do not reject any collaboration, is that it should help to raise the income of the university (and possibly that of its members). Any collaboration with industry should be a partnership, with a certain amount of risk, but with a good chance of return. This does not mean that other services to the community should not be provided at a low rate, although the decision about this depends on the specific circumstances.

The third point to be analysed concerns the nature of research. To avoid the introduction of more variables in the questionnaire this problem has not been raised here. But some respondents reflected on the problem in the commentaries section and it was also discussed during the interviews. There were some notes on the possibility of an intensified collaboration affecting "participation in innovative and

leading-edge fields". This concern was mainly expressed by academics in "certain sciences [that] can get no contracts". One pointed out "that industrially funded research could contribute to a materialistic bias" in scientific research that should be avoided. The interviewees with whom this point was discussed have a different view. Research represents an investment and according to this view point both basic and applied research are important, though the former has a greater risk than the latter. There has been no deterioration in research quality in contracts with industry because researchers have been careful in stressing the scientific objectives when collaborating. Both basic and applied research are relevant in Portugal because the country needs people able to perform all stages of the research cycle. The quality of applied research, and its potential change into innovative products and processes, depends on the standards of fundamental research.

5.7. UTL and Research Based Firms

In Chapter 3 one saw the role of the so-called new technology-based firms (NTBFs) in revitalizing the economic tissue of depressed regions or in being a basis for a local/regional specialization in advanced technologies with firms concentrated around (or located near) research facilities and university campuses. The interaction between these firms and academics are generally very intense and sometimes the academics themselves perform the entrepreneur role.

In the questionnaire there was a final section intended to assess the potentialities among UTL academics to start up new

research-based ventures with the possible financial support of external partners.

The global support to the idea has a high rating (A+B: 71%) but is not so enthusiastic among the invited teachers' group (included in the "mis.data" row). In the non-invited teachers group the "Professores Auxiliares" give greater support to this idea.

Table 23

Row: VARI1 (Institute/Faculty)
 Column: VARV1 (NTBF's: future ?)
 N total: 175 N included: 168

Row %	A	B	C	D	E Total	N's
IST:	31.3	42.7	15.6	5.2	5.2:100.0	96
ISA:	41.2	41.2	17.6	.0	.0:100.0	17
FA:	33.3	50.0	.0	.0	16.7:100.0	6
ISE:	26.2	47.6	23.8	2.4	.0:100.0	42
ESMV:	28.6	28.6	28.6	.0	14.3:100.0	7
Total	31.0	43.5	17.9	3.6	4.2 100.0	
N's	52	73	30	6	7	168

The idea also receives more support among those who think that interaction with industry should be intensified in the future (Table A56) and again receives a higher support from the small groups that had more intensive contacts with industry in the past (Table A57).

The following question intended to assess how this positive attitude has been (or not) transformed into material actions. Those who have established contacts with colleagues to start-up new ventures are very few: 13% with intensive contacts (A+B); 27% with few contacts (C+D); and a majority of 57% without any contacts at all (E) (Table A58).

Those who have had intensive contacts to organize new ventures are, naturally, those who support the idea of

creating NTBFs with more intensity (Table A59).

The final questions were about the relationship between the University and the potential NTBF's to be created. A majority of the respondents think that these new firms should be independent from the University (A+B: 46%) or at least should not be that involved with university (C+D: 48%) (Table A60). The University should not perform any special role in attracting capital to fund such ventures (D+E: 52%) (Table A61), but the University can provide the use of its own laboratory equipment at low rates (even below the real cost of use) to support the new firms (A+B: 62%) (Table A62), whether this use "respect strict measures of control" thus avoiding "the abuse of public property".

Analysis of these replies enables one to conclude that while the attitude is clearly favourable to the establishment of NTBFs with academics leading their operational activities, these firms should encounter their own ways of surviving and expansion without relying very much on the efforts universities. The intention to make independence prevail is in keeping with the conclusions of studies on successful experiments (MIT, Cambridge Research Park, etc.) where a decisive factor was more the authorities' attitude and environmental culture than an active institutional stimulus and support.

Conclusion

The intention of this conclusion is just to stress some of the main aspects of Chapter 5, because the next chapter (Concluding Comments) will return to many of the points

raised in the analysis of the replies.

The general opinion of respondents is that the University should increase its contribution to economic development, while collaboration with industry (and even direct "scientific entrepreneurship" by academics) should simultaneously increase.

The collaboration should be made from a scientific view point. The warnings about eventual dangers of collaboration point to the need of concentrating the attention of the University on the science field rather than the supply of commercial services.

The time spent in research activities (as well as the resources spent in research) should increase. The respondents show a general concern for increasing the quality/ excellence of the Portuguese University by linking it up with the foreign centres of excellence. Certainly this wish is in keeping with the current trend of improving the "credentialist" level of the University.

The relative dissatisfaction of the academic body with certain aspects outlines a need for change. This dissatisfaction should be overcome through more research, more collaboration with industry, more interaction with other scientific/academic institutions, more resources, more income. The legal framework that determines teachers' incomes should be modified/dropped.

In short, there is a convergence between attitudes that favour collaboration and improvement of research levels while preserving academic autonomy.

CONCLUDING COMMENTS

In the Introduction of this project one stressed the need for a small open economy to get a positive integration in the World Economy. Now, through the main points arising from each chapter, I intend to point out how voluntaristic action by the University can contribute to this positive integration.

1. Portugal is a country of "brandos" customs. Change tends to occur slowly and softly and even when its pace increases the effects on the profound structures of the social conscience tend to be minor. Such was the case with the political changes of 1974. Following the close of the colonial cycle, the Portuguese came back to the mainland. Political democracy was introduced, freedom was gained and some of the major industrial-financial conglomerates were nationalised. Meanwhile the newly-established political class tried to manage the present/future, by taking the country into the EEC, but also by allowing a decline in the economic performance at almost all levels (external trade, technological dependence, financial dependence, etc.). The Portuguese have withstood the negative effects of the crisis through a particular ability to survive. But this resistance is, above all, individual. There has been no collective strategy commensurate with the individual survival strategies. There has been no collective project.

There was a historic momentum when the Portuguese were in the forefront of world achievements. The maritime discoveries of

the XVth and XVIth centuries contributed to a new (geographic, economic, cultural) concept of the world that still prevails. But the same causes that triggered off the maritime enterprise (poor conditions on the mainland) did not allow the benefits of the expansion to be felt domestically. Such benefits were passed away to other countries and regions better prepared to take advantage of the benefits stemming from colonial exploitation. Much of the wealth contributed to the industrialization of other nations.

The semi-peripheral role played by Portugal has some of its deep roots in the cultural attitudes and social psychology of the people. The attitudes towards organisation and systematization of activities, towards initiatives aiming at development, etc., have remained the same for a long time. Individual initiative, beyond immediate survival, is not fairly encouraged by the mechanisms of attitude formation. Of course, there are all the causes historians tend to outline (religion's role, etc.). The poor material conditions (absence of some strategic raw materials, etc.) have also helped to maintain the "mild" environment. The backwardness of economic structures has naturally been mutually reinforcing while prevailing attitudes do not stimulate new forms of economic/social organisation.

2. The absence of a clear leadership in Portuguese society in the last ten years and the inability to bring the country to a new qualitative stage of development and satisfaction of needs has meant that democracy has evolved the wrong way.

The dynamic elements of Portuguese society have to be diagnosed and interwoven to provide a sense of future.

It is here that the University can play a role. The University is/may be one of these dynamic elements, and the role I prescribe in this thesis can be very significant. Of course the University is not a homogeneous body and itself reflects the diversity existing in the society. There is not one University but several universities competing for scarce resources, political favour, prestige and influence in community life. The dominance of interest groups inside each university is related to what happens outside the walls of the institution and different groups influence different universities. Besides this, the aptitudes of each university also vary according the available faculties, with different weight of "technological" and "cultural" subjects, with different specializations, etc.

But if this heterogeneity can mean a difficulty in bringing the different universities closer in any project of greater intervention in the environment, the diversity also represents an advantage in adapting the action of each university to specific regional/cultural conditions. Above all the University should be aware that it can be itself an agent of innovation and positive change in a context where political instability and the relative passivity of other social actors requires from the largest concentration of scientific and cultural resources in the country its transformation into dynamic change.

Although the universities are in Portugal traditionally the

source of the political class, the intellectual elite that has continued to hold the academics posts uses to be very critical of the actions of its own "spin-off". The present conditions favour a move from this critical stance to an active role.

There are no reasons to unquestionably accept the "static" model inherited from history. The "industrialization" that universities have been undergoing in the "advanced economies" suggests some of the ways of increasing the responsiveness to socio-economic needs. In a context of uncertainty the university can adapt its structure and actions like any other organisation by trying to manage the environmental complexities through voluntaristic action.

3. This action should have two basic dimensions: (i) technology transfer; and (ii) cultural intervention (or "cultural transfer").

Rather than setting up specific mechanisms to achieve the transfer of technology, the success of university action will depend on the power of its attitude, on its capacity to affect and change the collective mind. Development can only be achieved through cultural change. The values to be promoted are:

- innovation;
- creativity;
- change;
- organisation;
- initiative;

- freedom;
- autonomy;
- self reliance.

4. The technological backwardness of the country can be overcome if industry develops mechanisms of technology absorption. Foreign countries have been seen as the main source of technology. As a consequence it has been recommended that the first priority of industry should be to develop mechanisms of absorption of that technology. I think this is only partly correct. Portuguese industry has in the University a largely unrealized asset. The technological infrastructure should be able to perform the different stages of the research cycle. The development of a domestic capacity of innovation should be the priority for action. Even if foreign technology remains the first source of both invention and innovation, the long term strategic effort should be in setting up local mechanisms of innovation. Otherwise Portuguese industry will always compete with "second hand" technology.

The intensification of interaction among the different segments of the technological infrastructure is a first step in such a strategic effort. It was seen how isolated the different institutional segments have remained. Bringing together university and industry in specific projects will increase the interaction of the infrastructure.

The creation of dynamic networks of innovation is central to this process. Links should be established among the different

performers of innovation: scientists; managers; entrepreneurs; engineers; public laboratories; government bodies of science and technology; local government and financial institutions. Seed and venture capital are a crucial resource to implement new projects of joint research, NTBFs, etc.

5. It was seen from the case study that the academics of one of the largest Portuguese universities want the University to increase its contribution to economic development. In addition to the supplying of highly skilled graduates such contribution should go through an intensification of contacts with industry and even through the encouragement of academic entrepreneurship.

The attitude is largely favourable to collaboration, despite the assessment of initiatives already implemented showing an important gap between attitudes and actions. Collaboration has been intensifying, particularly since 1983.

The respondents want collaboration to have a predominantly scientific character. They also wish that the balance between teaching and research move towards the research side. There is the will to improve the level of excellence in the University. Such a will is convergent with current trends of increasing academic credentialism.

The setting up of research-based firms is an opportunity to involve academics in industrial practices while preserving the scientific nature of their contribution.

Contact with industry can also help to increase the academic's income. As was seen, the present rules regarding academics salaries are too rigid and are one source of dissatisfaction. The change in the legal framework in this area can be both an easy and wise step towards the new attitudes that the university itself should promote in the environment. The replacement of the exclusivity law by research contracts is a possibility, in which the State funds the more basic areas to preserve the logical and strategic value of the research cycle.

While the degree of university credentialism increases, the courses and areas of research (MScs, PhDs, etc.) should move to some practical concerns. These degrees should not have an exclusive academic purpose but also an industrial purpose. The ratio of university PhDs/ industry PhDs should be brought to levels consistent with the needs of technological development in areas of high technology.

The awarding of such degrees can also provide an opportunity to increase the linkages between different institutions (university-university, university-industry, etc.) of the technological infrastructure.

6. Some of the respondents expressed their fears as to the possibility of autonomy being limited in the case of an intensified relationship with industrial partners. To a certain extent collaboration would, in their opinion, mean a shift, from State dependence to business dependence.

The negotiation of contracts on scientific grounds (not contracting services that can be supplied by existing consultancies) is in keeping with the strong feeling of improving autonomy. Pluralistic funding can only further financial autonomy. The diversification of partners (avoiding concentration into few large companies) can also avoid dependence.

Of course there is the possibility of industrial companies trying to take exclusive advantage of joint research developments. But a careful negotiation of contracts (with adequate legal advice on patents, payment of royalties, etc.) should provide specific clauses protecting the potential exploitation of research outcomes. The eventual profit from this kind of ventures can serve to finance research in areas that otherwise would not get industrial contracts. The freedom to publish should also be protected in such contracts avoiding clauses on industrial secrecy if this can affect further scientific developments.

7. The processes of technology transfer should adequately assess what objectives can realistically be sighted. The available resources (a pool of technological expertise at the universities) can be used both in up-grading the technological level of existing industries and in creating new high tech industries.

The need of improving Portuguese specialization, as well as diversifying the economic base, points to a great deal of effort to be put into research-based industries. As many of

the segments of the new industries are relatively young and yet untouched by the world high tech giants there are several market niches to be exploited, while the costs of entry into those industries remain low and do not require large scale economies to get in.

Only an adequate integration in the world economy with dynamic economic advantages, as was pointed out in the Introduction, can guarantee a small open economy to have a successful development.

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IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
(University of London)

Department of Social and Economic Studies

UNIVERSITY - INDUSTRY
RELATIONS IN PORTUGAL

Manuel Mira Godinho

Appendices 1 and 2

01-11-1987 00/6.304/4.510/4.5

APPENDIX 1

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY



From
Roderick Martin, M.A., D.Phil.
Professor of Industrial Sociology

Department of Social and Economic Studies,
53 Prince's Gate, Exhibition Road,
London SW7 2PG
Telephone 01-589 5111 Telex 261503

To Whom it May Concern

Dear Sir/Madam,

I am writing to request your help and co-operation with Mr Manuel Godinho who is carrying out a research project on 'The Role of the Technological University in National Economic Development'.

Mr Godinho is working here on a British Council Fellowship, part of which involves carrying out an extended piece of research.

Mr Godinho has undertaken to respect any confidential information given to him and I am sure he will faithfully keep to this undertaking.

Thank you for your co-operation.

Yours faithfully

A handwritten signature in black ink, appearing to read 'Roderick Martin'.

RODERICK MARTIN

Lisboa, 21 de Julho de 1986

Cara/o Colega docente da U.T.L.:

O inquérito que junto lhe envio tem o objectivo de determinar o perfil de atitudes do corpo docente da U.T.L. relativamente à colaboração entre a universidade e outras organizações com papel relevante na actividade económica (problema normalmente abordado como "relações universidade-indústria").

Os resultados deste inquérito integrar-se-ão na dissertação final de um curso de mestrado sobre "Aspectos Sociais e Económicos da Ciência e Tecnologia", que espero concluir este ano, no Imperial College / Universidade de Londres.

Os questionários são numerados para permitir o controle estatístico das respostas ao inquérito. Conforme o procedimento habitual nestes casos, as respostas serão tratadas confidencialmente, sendo a divulgação do seu conteúdo feita em termos agregados e nunca em termos individuais.

Sendo o assunto em análise matéria de actualidade, conto com o interesse e colaboração da/o colega na realização do inquérito. No fim do questionário há um espaço onde poderá assinalar se está interessada/o em receber um sumário das conclusões do inquérito e do projecto de dissertação. Agradeço antecipadamente o tempo dispensado a preencher o questionário.

Agradeço também que o questionário preenchido me seja enviado com a maior brevidade possível, utilizando para o efeito o envelope já endereçado e selado que segue conjuntamente.

Com os meus melhores cumprimentos

Manuel Mira Godinho,
Assistente Estagiário do I.S.E.

Nota sobre o preenchimento do questionário:

Relativamente à maior parte das questões aparecerá uma escala do seguinte tipo

	=====					
CONCORDO	A	B	C	D	E	DISCORDO
----->						

aonde as letras correspondem a:

- A : concordo totalmente
- B : concordo substancialmente
- C : indiferente
- D : discordo substancialmente
- E : discordo totalmente.

Deverá assinalar com um X a letra da escala que corresponde à sua opinião.

QUESTIONÁRIO SOBRE ATITUDES DOS DOCENTES DA UNIVERSIDADE TÉCNICA DE LISBOA RELATIVAMENTE A COLABORAÇÃO ENTRE A UNIVERSIDADE E ORGANIZAÇÕES EXTERNAS COM PAPEL RELEVANTE NA ACTIVIDADE ECONÓMICA

I - ASPECTOS GERAIS

1. Instituto/Faculdade _____
2. Departamento _____
3. Sexo M _____ F _____
4. Idade até 31 de Dezembro de 1986 _____
5. Há quantos anos é que exerce funções de docência e/ou investigação na universidade?

menos de 5	_____
menos de 10	_____
menos de 15	_____
menos de 25	_____
mais de 25	_____

6. Categoria na carreira docente

	Docente não convidado	Docente Convidado
Assistente-Estagário	_____	_____
Assistente	_____	_____
Professor Auxiliar	_____	_____
Professor Associado	_____	_____
Professor Catedrático	_____	_____

7. Licenciaturas concluídas e títulos Pós-Licenciatura

Área Científica	Grau concedido	Instituição em que foi obtido	Ano em que foi obtido
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

II - AUTONOMIA UNIVERSITÁRIA / RELAÇÕES COM O EXTERIOR

1. Em sua opinião como é que tem evoluído a autonomia universitária nos últimos dez anos?

tem-se ampliado	=====	tem-se reduzido
	A B C D E	

2. Acha que o actual nível de autonomia deverá, de futuro, expandir-se / reduzir-se?

expandir-se	=====	reduzir-se
	A B C D E	

3. A contribuição da universidade para o desenvolvimento económico e social tem sido muito bom / medíocre?

muito bom	=====	medíocre
	A B C D E	

4. De futuro deverá haver uma intensificação da contribuição da universidade para o desenvolvimento económico e social?

deve haver intensificação	=====	não existe necessidade de intensificação
	A B C D E	

será aceitável uma redução do actual nível de autonomia em benefício de uma maior contribuição para o desenvolvimento económico e social ?

é aceitável	A	B	C	D	E	não é aceitável
-------------	---	---	---	---	---	-----------------

Como será afectada a autonomia universitária por uma intensificação das relações com empresas e outras organizações externas ?

reduz-se	A	B	C	D	E	amplia-se
----------	---	---	---	---	---	-----------

Uma diversificação das actuais fontes de financiamento irá contribuir para uma ampliação / redução da autonomia ?

ampliação	A	B	C	D	E	redução
-----------	---	---	---	---	---	---------

Ensino e investigação fazem parte do campo de acção tradicional da universidade. Admite-se actualmente um terceiro vector de acção (colaboração com indústria, etc.). Admite que a autonomia venha a ser explorada para uma intervenção mais intensa noutras áreas (sociais, políticas, culturais) ?

intervenção mais intensa em domínios sociais, políticos e culturais	A	B	C	D	E	não deve haver intervenção nessas áreas
---	---	---	---	---	---	---

III - CARREIRA ACADÉMICA / RELAÇÕES COM O EXTERIOR

A) Níveis de satisfação com a carreira académica

1. Em termos científicos considero-me :

muito satisfeito	A	B	C	D	E	muito insatisfeito
------------------	---	---	---	---	---	--------------------

2. Em termos de remuneração (condições de contrato) considero-me :

muito satisfeito	A	B	C	D	E	muito insatisfeito
------------------	---	---	---	---	---	--------------------

3. Em termos de vantagens específicas (flexibilidade de horários, autonomia relativa no trabalho, etc.) considero-me :

muito satisfeito	A	B	C	D	E	muito insatisfeito
------------------	---	---	---	---	---	--------------------

4. Qualifique a orientação científica e pedagógica que tem sido dada no seu instituto / faculdade à carreira individual de cada docente.

muito boa	A	B	C	D	E	
-----------	---	---	---	---	---	--

5. Há alguma possibilidade de vir a abandonar a carreira académica ?

vou permanecer	A	B	C	D	E	vou abandonar
----------------	---	---	---	---	---	---------------

B) Ensino / Investigação / Colaboração

6. A sua instituição tem-se concentrado fundamentalmente em tarefas de ensino ou de investigação ?

ensino	A	B	C	D	E	investigação
--------	---	---	---	---	---	--------------

7. Qualifique o peso relativo que tem sido atribuído às tarefas de ensino e de investigação no seu instituto / faculdade

adequado	A	B	C	D	E	inadequado
----------	---	---	---	---	---	------------

2. De futuro, para além da afectação de recursos às tarefas de ensino e de investigação, deverão ser afectos recursos à colaboração com o exterior.
Assinale com um X no quadro seguinte o ponto em que acha que se deverá estabelecer o equilíbrio entre ensino / investigação / colaboração com o exterior.

A.5	B.5	C.5	D.5	E.5	Colaboração muito intensa
A.4	B.4	C.4	D.4	E.4	
A.3	B.3	C.3	D.3	E.3	
A.2	B.2	C.2	D.2	E.2	
A.1	B.1	C.1	D.1	E.1	Colaboração nula
=====					
Ensino			Investigação		
-----			-----		
<-----			----->		

3. Actividades de investigação / Trabalho científico

9. No seu instituto / faculdade a orientação das actividades de investigação tem sido :

		=====						
muito boa		A	B	C	D	E	muito má	
-----		=====					-----	
<-----		-----					----->	

- A qualidade da investigação realizada no seu departamento é melhor / pior do que em departamentos equivalentes noutras instituições universitárias / científicas :

10. Em Portugal

		=====						
muito melhor		A	B	C	D	E	muito pior	
-----		=====					-----	
<-----		-----					----->	

11. Noutros países

		=====						
muito melhor		A	B	C	D	E	muito pior	
-----		=====					-----	
<-----		-----					----->	

- Qualifique a disponibilidade de recursos para investigação :

12. Recursos bibliográficos (bibliotecas, revistas, livros, outra informação científica)

		=====						
suficientes		A	B	C	D	E	insuficientes	
-----		=====					-----	
<-----		-----					----->	

13. Equipamento disponível (laboratórios, processamento de dados, etc.)

		=====						
suficiente		A	B	C	D	E	insuficiente	
-----		=====					-----	
<-----		-----					----->	

14. Pessoal auxiliar

		=====						
suficiente		A	B	C	D	E	insuficiente	
-----		=====					-----	
<-----		-----					----->	

15. Recursos financeiros

		=====						
suficientes		A	B	C	D	E	insuficientes	
-----		=====					-----	
<-----		-----					----->	

- A frequência de contactos / cooperação com outras universidades e instituições científicas tem sido

16. Em Portugal :

		=====						
suficiente		A	B	C	D	E	insuficiente	
-----		=====					-----	
<-----		-----					----->	

17. Noutros países:

		=====						
suficiente		A	B	C	D	E	insuficiente	
-----		=====					-----	
<-----		-----					----->	

III - Níveis de remuneração

18. O actual nível de remuneração é suficiente ?

sim	=====	não
	A B C D E	
<-----	=====	----->

19. A regulamentação do "subsídio de exclusividade" deve manter-se no estado actual ou ser mais flexível ?

manter-se	=====	ser mais flexível
	A B C D E	
<-----	=====	----->

20. A colaboração com organizações externas deverá ser encarada como uma forma de aumentar a remuneração do pessoal das universidades ?

sim	=====	não
	A B C D E	
<-----	=====	----->

21. Deve existir algum limite aos "complementos salariais" possíveis de obter através da colaboração com o exterior ?

sim	=====	não
	A B C D E	
<-----	=====	----->

22. Concorda que se verifique uma diferenciação progressiva dos vencimentos de docentes na mesma letra da função pública, com base nos contratos que os docentes obtêm para o seu instituto/faculdade ?

concordo	=====	discordo
	A B C D E	
<-----	=====	----->

23. Os trabalhos realizados em colaboração / prestação de serviços a organizações externas devem contribuir para a promoção na carreira académica ?

sim	=====	não
	A B C D E	
<-----	=====	----->

IV - COLABORAÇÃO COM ORGANIZAÇÕES EXTERNAS À UNIVERSIDADE

1. A colaboração deve ser consequência de iniciativas da universidade ou a universidade deve procurar apenas responder a solicitações que lhe sejam feitas ?

iniciativa da universidade	=====	iniciativa do exterior
	A B C D E	
<-----	=====	----->

2. Como qualifica a colaboração que o seu departamento tem realizado com organizações externas à universidade ?

muito frequente	=====	nula
	A B C D E	
<-----	=====	----->

3. Com quem é que se tem verificado a colaboração (com contrapartidas materiais) ?

- a) Sector Público (Central / Local) _____
- b) Empresas Portuguesas _____
- c) Empresas estrangeiras _____
- d) Outras instituições nacionais de carácter não lucrativo _____
- e) Outras instituições estrangeiras (governos, universidades, etc.) _____

4. Esse trabalho tem obedecido a critérios meramente comerciais ou tem obedecido a critérios de carácter científico ?

objectivos científicos	=====	objectivos comerciais
	A B C D E	
<-----	=====	----->

[a questão 5 é apenas para docentes não convidados]

5. Qual tem sido a frequência do seu trabalho a título individual, não vinculado à universidade ?

muito frequente	=====	frequência nula
	A B C D E	
<-----	=====	----->

[Questão 6 apenas para docentes convidados]

6. Considera a relação entre o seu trabalho no exterior e as suas funções na universidade :

-----	=====	-----
multo intensa	A B C D E	nula
-----	=====	-----

7. Como é que qualifica os canais de comunicação e transmissão de informação com organizações externas ?

-----	=====	-----
multo bons	A B C D E	maus
-----	=====	-----

8. De futuro a colaboração com organizações externas dever-se-à orientar :

-----	=====	-----
por critérios científicos	A B C D E	relevância científica não é critério básico
-----	=====	-----

9. A colaboração com o exterior deverá intensificar-se ?

-----	=====	-----
deverá ser multo mais intensa	A B C D E	deverá manter-se ao nível actual
-----	=====	-----

Qual a intensidade que deverá ser posta na relação com os seguintes grupos de organizações / instituições ?

10. Sector Público (Central e Local)

-----	-----
grande intensidade	menor intensidade
-----	-----

=====
A B C D E
=====

11. Empresas portuguesas

=====
A B C D E
=====

12. Empresas estrangeiras

=====
A B C D E
=====

13. Outras instituições nacionais de carácter não lucrativo

=====
A B C D E
=====

14. Outras instituições estrangeiras (governos, universidades, etc.)

=====
A B C D E
=====

-----	-----
grande intensidade	menor intensidade
-----	-----

V - Como sabe existem bastantes empresas, em geral paequenas ou médias, formadas a partir da universidade (empresas de base científica, formadas a partir de contactos na mesma área ou em áreas disciplinares complementares, etc.). Esta última parte do que tionário destina-se a avaliar o potencial existente no meio académico para este tipo de iniciativas empresariais.

1. No futuro o número destas empresas deverá aumentar ?

-----	=====	-----
deve aumentar	A B C D E	não deve aumentar
-----	=====	-----

2. Tem de alguma forma estabelecido contactos com colegas para lançamento de iniciativas deste tipo ?

-----	=====	-----
contactos intensos	A B C D E	inexistência de quaisquer contactos
-----	=====	-----

3. A relação institucional entre a universidade e este tipo de iniciativas pode variar ao longo de uma escala, desde "total independência" passando por relações em "aspectos específicos" até uma colaboração mais formal, em termos de participação da própria universidade no capital dessas "firmas universitárias. Em sua opinião, onde se deve situar essa relação ?

-----	=====	-----
deve haver independência	A B C D E	deve haver grande relação formal
-----	=====	-----

4. A universidade deve tomar iniciativas para providenciar essas "firmas universitárias" com recursos financeiros (obtenção de capital- risco, actuar como avalizador, etc.)
- | agente financiador | A | B | C | D | E | não deve financiar |
|--------------------|---|---|---|---|---|--------------------|
| (-----) | | | | | | |
5. Admite que a utilização de equipamentos da universidade por docentes, a título individual, ou por pequenas empresas formadas por docentes universitários possa ser feita a custos inferiores ou próximos do custo real como forma de financiamento indirecto a iniciativas de "base científica"
- | concordo | A | B | C | D | E | discordo |
|----------|---|---|---|---|---|----------|
| (-----) | | | | | | |

VI - COMENTARIOS

Agradeço o tempo e atenção que dedicou ao preenchimento deste questionário. Assinale se deseja receber uma cópia das conclusões da minha dissertação, onde serão discutidos os resultados do presente inquérito.



APPENDIX 2

Tables concerning section 5.2.

Table A1

Row: VARI1 (Institute/Faculty)
 Column: VARI5 (Hierarchical level (NI))
 N total: 175 N included: 131

Row %	As. Est.	Ass t....	Prof .Aux.	Prof .Ass.	Prof .Cat.	Total	N's
IST:	21.8	25.6	24.4	12.8	15.4	100.0	78
ISA:	.0	37.5	6.3	18.8	37.5	100.0	16
FA:	33.3	66.7	.0	.0	.0	100.0	6
ISE:	41.7	37.5	4.2	12.5	4.2	100.0	24
ESMV:	14.3	28.6	.0	28.6	28.6	100.0	7
Total	22.9	31.3	16.0	13.7	16.0	100.0	
N's	30	41	21	18	21		

Table A2

Row: VARI1 (Institute/Faculty)
 Column: VARI6 (Hierarchical Level (I))
 N total: 175 N included: 42

Row %	Assi st...	Prof .Aux.	Prof .Ass.	Prof. Cat.	Total	N's
IST:	57.9	26.3	10.5	5.3	100.0	19
ISA:	66.7	33.3	.0	.0	100.0	3
FA:	.0	100.0	.0	.0	100.0	1
ISE:	77.8	11.1	11.1	.0	100.0	18
ESMV:	.0	.0	.0	100.0	100.0	1
Total	64.3	21.4	9.5	4.8	100.0	
N's	27	9	4	2		42

Tables concerning section 5.4.

Table A3

Row: VARI5 (Hierarchical level (NI))
 Column: VARI3 (Age)
 N total: 175 N included: 131

Row %	<30	30/34	35/39	40/49	>=50	Total	N's
As. Est.:	90.0	6.7	3.3	.0	.0:100.0		30
Asst....:	43.9	36.6	14.6	4.9	.0:100.0		41
Prof.Aux.:	9.5	52.4	33.3	4.8	.0:100.0		21
Prof.Ass.:	.0	16.7	27.8	50.0	5.6:100.0		18
Prof.Cat.:	.0	.0	4.8	19.0	76.2:100.0		21
Total	35.9	23.7	15.3	12.2	13.0	100.0	
N's	47	31	20	16	17		131

Table A4

Row: VARI6 (Hierarchical Level (I))
 Column: VARI3 (Age)
 N total: 175 N included: 41

Row %	<30	30/34	35/39	40/49	>=50	Total	N's
Assist....:	7.7	23.1	42.3	26.9	.0:100.0		26
Prof.Aux.:	.0	.0	11.1	33.3	55.6:100.0		9
Prof.Ass.:	.0	.0	.0	50.0	50.0:100.0		4
Prof. Cat.:	.0	.0	.0	.0	100.0:100.0		2
Total	4.9	14.6	29.3	29.3	22.0	100.0	
N's	2	6	12	12	9		41

Table A5

Variable: VARI13 (Contribution Dev./Past)
 N total: 175 N included: 171

Label	Code	Freq	Marg%
B	2	41	24.0
C	3	52	30.4
D	4	61	35.7
E	5	17	9.9
mis.	9	4	MD

Table A6

Variable: VARII4 (Contribution Dev./Fut.)
 N total: 175 N included: 172

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	135	78.5
B	2	30	17.4
C	3	6	3.5
D	4	1	.6
mis.	9	3	MD

Table A7

Variable: VARII5 (Relation auton./contribution)
 N total: 175 N included: 168

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	11	6.5
B	2	32	19.0
C	3	34	20.2
D	4	39	23.2
E	5	52	31.0
mis.	9	7	MD

Table A8

Variable: VARII1 (Autonomy/Past)
 N total: 175 N included: 171

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	9	5.3
B	2	115	67.3
C	3	37	21.6
D	4	9	5.3
E	5	1	.6
	9	4	MD

Table A9

Variable: VARII2 (Autonomy/Future)
 N total: 175 N included: 169

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	92	54.4
B	2	63	37.3
C	3	14	8.3
mis.	9	6	MD

Table A10

Variable: VARII6 (Relation auton./collab. fut.)
 N total: 175 N included: 166

Label	Code	Freq	Marg%
-----	----	----	-----
A	1	1	.6
B	2	19	11.4
C	3	32	19.3
D	4	63	38.0
E	5	51	30.7
mis.	9	9	MD

Table A11

Variable: VARII7 (Diversification of finance/autonomy)
 N total: 175 N included: 167

Label	Code	Freq	Marg%
-----	----	----	-----
A	1	76	45.5
B	2	66	39.5
C	3	15	9.0
D	4	10	6.0
mis.	9	8	MD

Table A12

Variable: VARII8 (Social/political/cultural action)
 N total: 175 N included: 169

Label	Code	Freq	Marg%
-----	----	----	-----
A	1	52	30.8
B	2	69	40.8
C	3	26	15.4
D	4	18	10.7
E	5	4	2.4
mis.	9	6	MD

Tables concerning section 5.5.1.

Table A13

Row: VARII (Institute/Faculty)
 Column: VARIII9 (Research Orientation at the I./F.)
 N total: 175 N included: 175

Row %	A	B	C	D	E	mis.	Total	N's
IST:	4.0	31.3	34.3	23.2	5.1	2.0:100.0		99
ISA:	.0	5.3	36.8	31.6	26.3	.0:100.0		19
FA:	.0	14.3	.0	28.6	42.9	14.3:100.0		7
ISE:	.0	7.1	28.6	42.9	16.7	4.8:100.0		42
ESMV:	.0	.0	25.0	37.5	37.5	.0:100.0		8
Total	2.3	20.6	31.4	29.7	13.1	2.9	100.0	
N's	4	36	55	52	23	5		175

Table A14

+Row: VARII (Institute/Faculty)
 Column: VARIII10 (Quality of research // Portugal)
 N total: 175 N included: 175

Row %	A	B	C	D	E	mis.	Total	N's
IST:	19.2	41.4	27.3	8.1	.0	4.0:100.0		99
ISA:	.0	21.1	52.6	10.5	5.3	10.5:100.0		19
FA:	.0	.0	28.6	42.9	.0	28.6:100.0		7
ISE:	.0	21.4	45.2	23.8	4.8	4.8:100.0		42
ESMV:	25.0	12.5	12.5	37.5	.0	12.5:100.0		8
Total	12.0	31.4	33.7	14.9	1.7	6.3	100.0	
N's	21	55	59	26	3	11		175

Table A15

Row: VARII (Institute/Faculty)
 Column: VARIII11 (Quality of research // o. countries)
 N total: 175 N included: 175

Row %	A	B	C	D	E	mis.	Total	N's
IST:	1.0	6.1	38.4	29.3	15.2	10.1:100.0		99
ISA:	5.3	15.8	.0	26.3	47.4	5.3:100.0		19
FA:	14.3	.0	28.6	.0	28.6	28.6:100.0		7
ISE:	7.1	.0	16.7	38.1	26.2	11.9:100.0		42
ESMV:	.0	.0	25.0	25.0	37.5	12.5:100.0		8
Total	3.4	5.1	28.0	29.7	22.9	10.9	100.0	
N's	6	9	49	52	40	19		175

Table A16

Variable: VARIII12 (Bibliographic resources)
 N total: 175 N included: 173

Label	Code	Freq	Marg%
-----	----	----	-----
A	1	12	6.9
B	2	41	23.7
C	3	23	13.3
D	4	56	32.4
E	5	41	23.7
mis.	9	2	MD

Table A17

Variable: VARIII13 (Available equipment)
 N total: 175 N included: 173

Label	Code	Freq	Marg%
-----	----	----	-----
A	1	4	2.3
B	2	23	13.3
C	3	31	17.9
D	4	50	28.9
E	5	65	37.6
mis.	9	2	MD

Table A18

Variable: VARIII14 (Aux. Personnel)
 N total: 175 N included: 173

Label	Code	Freq	Marg%
-----	----	----	-----
A	1	3	1.7
B	2	6	3.5
C	3	21	12.1
D	4	46	26.6
E	5	97	56.1
mis.	9	2	MD

Table A19

Variable: VARIII15 (Financial Resources)
 N total: 175 N included: 169

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	1	.6
B	2	8	4.7
C	3	16	9.5
D	4	56	33.1
E	5	88	52.1
mis.	9	6	MD

Table A20

Variable: VARIII16 (Scientific contacts / Port.)
 N total: 175 N included: 172

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	6	3.5
B	2	26	15.1
C	3	34	19.8
D	4	66	38.4
E	5	40	23.3
mis.			

Table A21

Variable: VARIII17 (Scientific contacts / o.countries)
 N total: 175 N included: 167

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	6	3.6
B	2	32	19.2
C	3	27	16.2
D	4	61	36.5
E	5	41	24.6
mis.	9	8	MD

Tables concerning section 5.5.2.

Table A22

Row: VARII1 (Institute/Faculty)
 Column: VARIII6 (Institution: teaching or research ?)
 N total: 175 N included: 175

Row %	A	B	C	D	E	mis.	Total	N's
IST:	8.1	22.2	41.4	21.2	5.1	2.0	100.0	99
ISA:	21.1	63.2	15.8	.0	.0	.0	100.0	19
FA:	57.1	42.9	.0	.0	.0	.0	100.0	7
ISE:	21.4	42.9	23.8	4.8	.0	7.1	100.0	42
ESMV:	50.0	37.5	.0	.0	.0	12.5	100.0	8
Total	16.6	33.1	30.9	13.1	2.9	3.4	100.0	
N's	29	58	54	23	5	6		175

Table A23

Variable: VARIII8a (Teaching/Research/Future)
 N total: 175 N included: 163

Label	Code	Freq	Marg%
A	1	3	1.8
B	2	28	17.2
C	3	85	52.1
D	4	42	25.8
E	5	5	3.1
mis.	9	12	MD

Table A24

Row: VARII1 (Institute/Faculty)
 Column: VARIII7 (Relative weight T./R.)
 N total: 175 N included: 175

Row %	A	B	C	D	E	mis.	Total	N's
IST:	5.1	24.2	18.2	43.4	7.1	2.0	100.0	99
ISA:	.0	15.8	10.5	36.8	36.8	.0	100.0	19
FA:	.0	28.6	.0	42.9	28.6	.0	100.0	7
ISE:	.0	14.3	23.8	50.0	4.8	7.1	100.0	42
ESMV:	.0	.0	12.5	25.0	50.0	12.5	100.0	8
Total	2.9	20.0	17.7	43.4	12.6	3.4	100.0	
N's	5	35	31	76	22	6		175

Tables concerning section 5.5.3.

Table A25

Variable: VARIII1 (Scientific satisfaction)
N total: 175 N included: 173

Label	Code	Freq	Marg%
-----	----	----	-----
A	1	11	6.4
B	2	62	35.8
C	3	34	19.7
D	4	48	27.7
E	5	18	10.4
mis.	9	2	MD

Table A26

Variable: VARIII4 (Satisfact./individual guidance)
N total: 175 N included: 170

Label	Code	Freq	Marg%
-----	----	----	-----
A	1	3	1.8
B	2	45	26.5
C	3	37	21.8
D	4	46	27.1
E	5	39	22.9
mis.	9	5	MD

Table A27

Variable: VARIII3 (Satisf./Specific Advantages)
N total: 175 N included: 172

Label	Code	Freq	Marg%
-----	----	----	-----
A	1	48	27.9
B	2	76	44.2
C	3	29	16.9
D	4	16	9.3
E	5	3	1.7
mis.	9	3	MD

Table A28

Variable: VARIII2 (Satisfaction/salary)
 N total: 175 N included: 172

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	2	1.2
B	2	16	9.3
C	3	39	22.7
D	4	70	40.7
E	5	45	26.2
mis.	9	3	MD

Table A29

Variable: VARIII5 (Leaving University?)
 N total: 175 N included: 171

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	52	30.4
B	2	42	24.6
C	3	45	26.3
D	4	20	11.7
E	5	12	7.0
mis.	9	4	MD

Tables concerning section 5.5.3.

Table A30

Variable: VARI118 (Salaries/Now)
N total: 175 N included: 173

Label	Code	Freq	Marg%
-----	-----	-----	-----
B	2	13	7.5
C	3	27	15.6
D	4	79	45.7
E	5	54	31.2
mis.	9	2	MD

Table A31

Row: VARI5 (Hierarchical level (NI))
Column: VARI118 (Salaries/Now)
N total: 175 N included: 131

Row %	B	C	D	E Total	N's
-----	-----	-----	-----	-----	-----
As. Est.:	6.7	10.0	56.7	26.7:100.0	30
Asst....:	.0	17.1	53.7	29.3:100.0	41
Prof.Aux.:	4.8	23.8	42.9	28.6:100.0	21
Prof.Ass.:	11.1	11.1	38.9	38.9:100.0	18
Prof.Cat.:	14.3	19.0	38.1	28.6:100.0	21
-----	-----	-----	-----	-----	-----
Total	6.1	16.0	48.1	29.8 100.0	
N's	8	21	63	39	131

Table A32

Row: VARI6 (Hierarchical Level (I))
Column: VARI118 (Salaries/Now)
N total: 175 N included: 41

Row %	B	C	D	E Total	N's
-----	-----	-----	-----	-----	-----
Assist...:	7.4	18.5	29.6	44.4:100.0	27
Prof.Aux.:	25.0	12.5	50.0	12.5:100.0	8
Prof.Ass.:	.0	.0	75.0	25.0:100.0	4
Prof. Cat.:	50.0	.0	.0	50.0:100.0	2
-----	-----	-----	-----	-----	-----
Total	12.2	14.6	36.6	36.6 100.0	
N's	5	6	15	15	41

Table A33

Variable: VARIII19 (Subsidy of exclusivity)
 N total: 175 N included: 167

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	24	14.4
B	2	21	12.6
C	3	23	13.8
D	4	43	25.7
E	5	56	33.5
mis.	9	8	MD

Table A34

Variable: VARIII20 (Collaboration / Individual Income)
 N total: 175 N included: 171

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	42	24.6
B	2	51	29.8
C	3	23	13.5
D	4	18	10.5
E	5	37	21.6
mis.	9	4	MD

Table A35

Variable: VARIII21 (Any limits to external income?)
 N total: 175 N included: 171

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	52	30.4
B	2	35	20.5
C	3	16	9.4
D	4	18	10.5
E	5	50	29.2
mis.	9	4	MD

Table A36

Variable: VARIII22 (Differentiation of salary in same level)
 N total: 175 N included: 169

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	33	19.5
B	2	50	29.6
C	3	13	7.7
D	4	17	10.1
E	5	56	33.1
mis.	9	6	MD

Table A37

Variable: VARIII23 (External work / Career)
 N total: 175 N included: 169

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	70	41.4
B	2	61	36.1
C	3	16	9.5
D	4	14	8.3
E	5	8	4.7
mis.	9	6	MD

Tables concerning section 5.6.2.

Table A38

Row: VARI5 (Hierarchical level (NI))
 Column: VARIV5 ((NI)/intensity collab./past)
 N total: 175 N included: 122

Row %	A	B	C	D	E Total	N's
As. Est.:	7.1	7.1	17.9	14.3	53.6:100.0	28
Asst....:	2.6	10.3	5.1	12.8	69.2:100.0	39
Prof.Aux.:	10.5	10.5	10.5	26.3	42.1:100.0	19
Prof.Ass.:	5.6	27.8	.0	22.2	44.4:100.0	18
Prof.Cat.:	22.2	16.7	16.7	16.7	27.8:100.0	18
Total	8.2	13.1	9.8	17.2	51.6 100.0	
N's	10	16	12	21	63	122

Table A39

Row: VARI1 (Institute/Faculty)
 Column: VARIV5 ((NI)/intensity collab./past)
 N total: 175 N included: 125

Row %	A	B	C	D	E Total	N's
IST:	8.1	5.4	8.1	20.3	58.1:100.0	74
ISA:	6.7	33.3	6.7	20.0	33.3:100.0	15
FA:	16.7	16.7	16.7	16.7	33.3:100.0	6
ISE:	8.0	24.0	12.0	8.0	48.0:100.0	25
ESMV:	.0	20.0	20.0	20.0	40.0:100.0	5
Total	8.0	13.6	9.6	17.6	51.2 100.0	
N's	10	17	12	22	64	125

Table A40

Row: VARI6 (Hierarchical Level (I))
 Column: VARIV6 ((I): relation external w./Univ.?)
 N total: 175 N included: 39

Row %	A	B	C	D	E Total	N's
Assist....:	16.0	68.0	8.0	.0	8.0:100.0	25
Prof.Aux.:	33.3	44.4	11.1	11.1	.0:100.0	9
Prof.Ass.:	.0	100.0	.0	.0	.0:100.0	3
Prof. Cat.:	50.0	50.0	.0	.0	.0:100.0	2
Total	20.5	64.1	7.7	2.6	5.1 100.0	
N's	8	25	3	1	2	39

Tables concerning section 5.6.3.

Table A41

Row: VAR11 (Institute/Faculty)
 Column: VARIV4 (Collab.past: criteria?)
 N total: 175 N included: 140

Row %	A	B	C	D	E Total	N's
IST:	24.1	30.1	36.1	8.4	1.2:100.0	83
ISA:	33.3	27.8	33.3	5.6	.0:100.0	18
FA:	.0	20.0	40.0	40.0	.0:100.0	5
ISE:	3.7	66.7	29.6	.0	.0:100.0	27
ESMV:	71.4	28.6	.0	.0	.0:100.0	7
Total	22.9	36.4	32.9	7.1	.7 100.0	
N's	32	51	46	10	1	140

Table A42

Row: VARIV5 ((NI)/intensity collab./past)
 Column: VARIV9 (Collaboration future: intensity ?)
 N total: 175 N included: 124

Row %	A	B	C	D	E Total	N's
A:	70.0	20.0	10.0	.0	.0:100.0	10
B:	64.7	29.4	5.9	.0	.0:100.0	17
C:	27.3	45.5	27.3	.0	.0:100.0	11
D:	31.8	59.1	9.1	.0	.0:100.0	22
E:	39.1	46.9	9.4	1.6	3.1:100.0	64
Total	42.7	44.4	10.5	.8	1.6 100.0	
N's	53	55	13	1	2	124

Table A43

Row: VAR11 (Institute/Faculty)
 Column: VARIV9 (Collaboration future: intensity ?)
 N total: 175 N included: 170

Row %	A	B	C	D	E Total	N's
IST:	34.0	52.6	10.3	1.0	2.1:100.0	97
ISA:	68.4	31.6	.0	.0	.0:100.0	19
FA:	71.4	28.6	.0	.0	.0:100.0	7
ISE:	55.0	35.0	10.0	.0	.0:100.0	40
ESMV:	71.4	14.3	14.3	.0	.0:100.0	7
Total	45.9	43.5	8.8	.6	1.2 100.0	
N's	78	74	15	1	2	170

Table A44

Row: VARI5 (Hierarchical level (NI))
 Column: VARIV9 (Collaboration future: intensity ?)
 N total: 175 N included: 128

Row %	A	B	C	D	E Total	N's
As. Est.:	31.0	55.2	13.8	.0	.0:100.0	29
Asst....:	43.9	43.9	12.2	.0	.0:100.0	41
Prof.Aux.:	40.0	40.0	10.0	5.0	5.0:100.0	20
Prof.Ass.:	55.6	38.9	5.6	.0	.0:100.0	18
Prof.Cat.:	65.0	20.0	10.0	.0	5.0:100.0	20
Total	45.3	41.4	10.9	.8	1.6 100.0	
N's	58	53	14	1	2	128

Table A45

Row: VARI6 (Hierarchical Level (I))
 Column: VARIV9 (Collaboration future: intensity ?)
 N total: 175 N included: 41

Row %	A	B	C Total	N's
Assist....:	44.4	51.9	3.7:100.0	27
Prof.Aux.:	55.6	44.4	.0:100.0	9
Prof.Ass.:	33.3	66.7	.0:100.0	3
Prof. Cat.:	50.0	50.0	.0:100.0	2
Total	46.3	51.2	2.4 100.0	
N's	19	21	1	41

Table A46

Row: VARIIII20 (Collaboration / Individual Income)
 Column: VARIV9 (Collaboration future: intensity ?)
 N total: 175 N included: 169

Row %	A	B	C	D	E Total	N's
A:	64.3	31.0	4.8	.0	.0:100.0	42
B:	41.2	54.9	3.9	.0	.0:100.0	51
C:	50.0	40.9	9.1	.0	.0:100.0	22
D:	27.8	66.7	5.6	.0	.0:100.0	18
E:	38.9	30.6	22.2	2.8	5.6:100.0	36
Total	46.2	43.2	8.9	.6	1.2 100.0	
N's	78	73	15	1	2	169

Table A47

Row: VARI1121 (Any limits to external income?)
 Column: VARIV9 (Collaboration future: intensity ?)
 N total: 175 N included: 169

Row %	A	B	C	D	E Total	N's
A:	38.5	48.1	9.6	1.9	1.9:100.0	52
B:	37.1	57.1	5.7	.0	.0:100.0	35
C:	31.3	50.0	12.5	.0	6.3:100.0	16
D:	52.9	41.2	5.9	.0	.0:100.0	17
E:	63.3	26.5	10.2	.0	.0:100.0	49
Total	46.2	43.2	8.9	.6	1.2 100.0	
N's	78	73	15	1	2	169

Table A48

Row: VARI1123 (External work / Career)
 Column: VARIV9 (Collaboration future: intensity ?)
 N total: 175 N included: 168

Row %	A	B	C	D	E Total	N's
A:	57.1	34.3	8.6	.0	.0:100.0	70
B:	41.0	54.1	3.3	1.6	.0:100.0	61
C:	40.0	46.7	13.3	.0	.0:100.0	15
D:	35.7	35.7	21.4	.0	7.1:100.0	14
E:	25.0	37.5	25.0	.0	12.5:100.0	8
Total	46.4	42.9	8.9	.6	1.2 100.0	
N's	78	72	15	1	2	168

Table A49

Row: VARI1122 (Differentiation of salary in same level)
 Column: VARIV9 (Collaboration future: intensity ?)
 N total: 175 N included: 167

Row %	A	B	C	D	E Total	N's
A:	69.7	30.3	.0	.0	.0:100.0	33
B:	51.0	42.9	4.1	2.0	.0:100.0	49
C:	15.4	76.9	7.7	.0	.0:100.0	13
D:	35.3	64.7	.0	.0	.0:100.0	17
E:	38.2	38.2	20.0	.0	3.6:100.0	55
Total	46.1	43.7	8.4	.6	1.2 100.0	
N's	77	73	14	1	2	167

Table A50

Row: VAR11 (Institute/Faculty)
 Column: VARIV8 (Criteria future ?)
 N total: 175 N included: 168

Row %	A	B	C	D	E Total	N's
IST:	16.5	36.1	27.8	15.5	4.1:100.0	97
ISA:	15.8	31.6	10.5	36.8	5.3:100.0	19
FA:	40.0	20.0	20.0	20.0	.0:100.0	5
ISE:	10.0	52.5	15.0	22.5	.0:100.0	40
ESMV:	28.6	42.9	.0	28.6	.0:100.0	7
Total	16.1	39.3	21.4	20.2	3.0 100.0	
N's	27	66	36	34	5	168

Table A51

Variable: VARIV10 (Public Adm.: Future collaboration)
 N total: 175 N included: 169

Label	Code	Freq	Marg%
A	1	73	43.2
B	2	72	42.6
C	3	21	12.4
D	4	1	.6
E	5	2	1.2
mis.	9	6	MD

Table A52

Variable: VARIV11 (Port. firms: future collab. ?)
 N total: 175 N included: 170

Label	Code	Freq	Marg%
A	1	86	50.6
B	2	69	40.6
C	3	12	7.1
D	4	3	1.8
mis.	9	5	MD

Table A53

Variable: VARIV12 (Foreign.firms: future collaboration ?)
 N total: 175 N included: 168

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	41	24.4
B	2	68	40.5
C	3	40	23.8
D	4	14	8.3
E	5	5	3.0
mis.	9	7	MD

Table A54

Variable: VARIV13 (Non-profit instit.: future collab.?)
 N total: 175 N included: 168

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	72	42.9
B	2	65	38.7
C	3	26	15.5
D	4	4	2.4
E	5	1	.6
mis.	9	7	MD

Table A55

Variable: VARIV14 (O.foreig.Instits.: future collaboration?)
 N total: 175 N included: 167

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	76	45.5
B	2	59	35.3
C	3	27	16.2
D	4	5	3.0
mis.	9	8	MD

Tables concerning section 5.7.

Table A56

Row: VARIV9 (Collaboration future: intensity ?)
 Column: VARV1 (NTBF's: future ?)
 N total: 175 N included: 165

Row %	A	B	C	D	E	Total	N's
A:	45.5	36.4	13.0	2.6	2.6:100.0		77
B:	16.7	55.6	19.4	4.2	4.2:100.0		72
C:	30.8	30.8	23.1	7.7	7.7:100.0		13
D:	.0	100.0	.0	.0	.0:100.0		1
E:	.0	.0	50.0	.0	50.0:100.0		2
Total	30.9	44.2	17.0	3.6	4.2	100.0	
N's	51	73	28	6	7		165

Table A57

Row: VARIV5 ((NI)/intensity collab./past)
 Column: VARV1 (NTBF's: future ?)
 N total: 175 N included: 175

Row %	A	B	C	D	E	mis.	Total	N's
A:	70.0	.0	30.0	.0	.0	.0:100.0		10
B:	35.3	41.2	17.6	5.9	.0	.0:100.0		17
C:	41.7	25.0	16.7	8.3	8.3	.0:100.0		12
D:	31.8	45.5	4.5	.0	4.5	13.6:100.0		22
E:	25.0	48.4	15.6	4.7	4.7	1.6:100.0		64
mis.:	22.0	44.0	22.0	2.0	4.0	6.0:100.0		50
Total	29.7	41.7	17.1	3.4	4.0	4.0	100.0	
N's	52	73	30	6	7	7		175

Table A58

Variable: VARV2 (Contacts / start up ?)
 N total: 175 N included: 170

Label	Code	Freq	Marg%
A	1	5	2.9
B	2	18	10.6
C	3	27	15.9
D	4	21	12.4
E	5	99	58.2
mis.	9	5	MD

Table A59

Row: VARV1 (NTBF's: future ?)
 Column: VARV2 (Contacts / start up ?)
 N total: 175 N included: 167

Row %	A	B	C	D	E	Total	N's
A:	7.7	23.1	17.3	11.5	40.4	100.0	52
B:	1.4	6.8	16.4	15.1	60.3	100.0	73
C:	.0	3.4	13.8	3.4	79.3	100.0	29
D:	.0	.0	.0	33.3	66.7	100.0	6
E:	.0	.0	28.6	14.3	57.1	100.0	7
Total	3.0	10.8	16.2	12.6	57.5	100.0	
N's	5	18	27	21	96		167

Table A60

Variable: VARV3 (Relation Univ./NTBF's (independence))
 N total: 175 N included: 170

Label	Code	Freq	Marg%
A	1	44	25.9
B	2	34	20.0
C	3	63	37.1
D	4	18	10.6
E	5	11	6.5
mis.	9	5	MD

Table A61

Variable: VARV4 (Relation Univ./NTBF's (finance))
 N total: 175 N included: 169

Label	Code	Freq	Marg%
A	1	5	3.0
B	2	37	21.9
C	3	39	23.1
D	4	24	14.2
E	5	64	37.9
mis.	9	6	MD

Table A62

Variable: VARV5 (Relation Univ./NTBF's (equipment))
 N total: 175 N included: 169

Label	Code	Freq	Marg%
-----	----	----	-----
A	1	37	21.9
B	2	68	40.2
C	3	21	12.4
D	4	19	11.2
E	5	24	14.2
mis.	9	6	MD

Table A62

Variable: VARV5 (Relation Univ./NTBF's (equipment))
 N total: 175 N included: 169

Label	Code	Freq	Marg%
-----	-----	-----	-----
A	1	37	21.9
B	2	68	40.2
C	3	21	12.4
D	4	19	11.2
E	5	24	14.2
mis.	9	6	MD