

COMMISSION
OF THE EUROPEAN
COMMUNITIES

SCIENCE
RESEARCH AND
DEVELOPMENT



MONITOR
SPEAR

**The Contract Research Business
in the United Kingdom**

- The European Dimension -

Research evaluation

EUR 14578 EN



Commission of the European Communities

The Contract Research Business in the United Kingdom

- The European Dimension -

Author: M.J. RINGE

MONITOR/SPEAR Coordinator
C. SEARLE

July 1992

**Published by the
COMMISSION OF THE EUROPEAN COMMUNITIES
Directorate-General
Telecommunications, Information Industries and Innovation
L-2920 LUXEMBOURG**

LEGAL NOTICE

Neither the Commission of the European Communities nor any person acting on behalf of the Commission is responsible for the use which might be made of the following information

Cataloguing data can be found at the end of this publication

Luxembourg: Office for Official Publications of the European Communities, 1992

ISBN 92-826-4610-6

Catalogue number: CG-NA-14578-EN-C

© ECSC—EEC—EAEC Brussels • Luxembourg, 1992

Printed in Belgium

CONTENTS

	page
Acknowledgements	v
Summary	vii
<i>I INTRODUCTION</i>	1
- Outline	
- Background	
- Definitions	
- Previous studies	
<i>II METHODOLOGY</i>	5
- General	
- The contract research organizations	
- The industrial customers	
<i>III THE VOLUME OF CONTRACT R&D PERFORMED IN THE UK</i>	7
- Outline	
- Defining the market boundaries	
- Contract research organizations	
- Higher education institutions	
- Research Councils	
- Government research laboratories	
- Summary	
<i>IV THE PERFORMERS OF CONTRACT R&D</i>	11
- Outline	
- Contract research organizations	
- Function and structure	
Customers	
Competitors	
Income and services	
Core research	

Membership
Staff
Government policy
Transnational work
European Community R&D programmes
The Single European Market

V	<i>THE INDUSTRIAL CUSTOMERS FOR CONTRACT R & D</i>	27
	- Outline	
	- Survey	
	- Company profiles	
	- Why contract out R&D?	
	- What is contracted out, and to whom?	
	- Links with HEIs	
	- Trends in volume of work contracted out	
	- Transnational contracting of R&D	
VI	<i>INTERNATIONAL COMPARISONS</i>	39
	- Outline	
	- The Bossard Report	
VII	<i>BUSINESS ISSUES AND THE EUROPEAN COMMUNITY</i>	43
	<i>Annex A: Questionnaires</i>	45
	<i>Annex B: Abbreviations</i>	57
	<i>Annex C: Bibliography</i>	59

ACKNOWLEDGEMENTS

We benefited greatly from the encouragement and practical help of the Task Group appointed to guide this study. Dr W.L. Mercer, F.Eng, chaired the Task Group; other members were Mr G. Adler O.B.E., F.Eng, Mr R. Bond F.Eng, Professor J. Hearn, Dr D.B. Thomas, Sir Richard Norman K.B.E., F.R.S. and Dr F. Steele.

A study of this sort would be impossible without the willing cooperation of many people: those who completed questionnaires, those who set aside time to be interviewed and to show us round their organizations, those who gave us expert advice. We are most grateful to all concerned.

The Confederation of British Industry much facilitated our enquiries among the industrial customers for contract research by conducting a questionnaire survey of a sample of its members.

The Europeanization of the UK contract R&D market investigated in this report was funded by a contract from the European Commission under the MONITOR/SPEAR programme.

Finally, I should like to thank all my colleagues in SEPSU particularly Dr Peter Collins and Ms Anna Zouga for their support during the study.

SUMMARY

The study

This report highlights the European aspects of a larger study which investigated a sector of research and development (R&D) capability within the UK that has remained rather in the background. As our report (*The contract research business in the UK*, SEPSU Policy No 6) shows, the UK has a large body of organizations able and willing to undertake contract research. These organizations are, in general, well established and technically sophisticated with close links with UK (and overseas) industry. They are well placed to disseminate new technologies rapidly and effectively to a wide industrial base.

In this report we restate the basic UK data and highlight the European dimension of the UK contract research market place.

The study set out to examine the market for contract research - both the organizations that provide such services and their customers. We did not include Ministry of Defence (MOD) procurement spend, nor did we include the large amount of contract work undertaken by industry for industry, although this is touched on in chapter 4. We concentrated on the major contract research organizations (CROs) in the UK, such as the member organizations of the Association of Independent Research and Technology Organizations (AIRTO) and similar bodies.

Size of the market

Contract R&D activity in the UK, as undertaken by the major R&D contract organization, was estimated to be worth about £670M in 1988/89. This excluded contract R&D performed by industrial companies for the MOD and other government departments and for other industrial companies. Indications are that the market is expanding, and will continue to do so over the coming years.

CROs

UK CROs believe they are world experts in particular fields, and undertake a significant amount of overseas work. Most CROs expect to increase such work as the Single European Market (SEM) develops.

Single Market issues

UK CROs are already active in European (and global) markets, and they see the Single European Market as facilitating

access. In general they do not expect significant increased competition from other Member States. However, some CROs are concerned that there will not be a 'level pitch' on which to compete. In many of the EC States considerable government money is directed at industrial innovation and technology transfer and UK CROs are worried about unfair competition.

Staff mobility and retention are an increasing concern for the CROs. High quality technical staff appear to be in short supply, and some CROs report difficulties in recruiting staff. A number believe such difficulties will increase if the standard of living for scientists and technologists became noticeably better in other Member States. At present only small numbers of non-UK EC technical staff are employed in UK CROs; numbers are expected to increase slowly after 1992.

Many CROs believe there will be an overall increase in the need for standards and quality assurance, as companies enter new markets. Some CROs are active in developing higher standards for the future.

Many CROs see a large new market if public procurement in the EC opens up to the extent it is expected.

Both CROs and industrial companies are involved in EC R&D programmes. Some point to examples of economic benefit from this involvement, either directly from the technology developed, or from further work or ventures with partners. Virtually all those involved report that they have gained enhanced contact with the partner organization. In the majority of cases there has been continued informal liaison with partners, but there is also evidence of continuing collaborative ventures.

There are, however, problems with being involved in these programmes. It takes considerable time and effort to set up a project with partners in different countries, with no guarantees that the projects will eventually qualify for EC funding. Bureaucratic procedures are regarded as unnecessarily cumbersome. However, most managers regard themselves as being on a learning curve, and most agree they are likely to become involved in future programmes.

HEIs

UK Higher Education Institutions (HEIs) are becoming increasingly involved in the contract R&D market. Some are developing full-time commercial activities, while others are 'testing the water' and have yet to decide how far to engage in competitive contract R&D.

While welcoming HEI interest in industry, many industrial R&D managers are concerned that the HEIs are moving too far towards industry at the cost of diminishing their effectiveness as truly innovative basic research centres and possibly leaving a 'research gap' in future years. CROs, and many industrial companies, have close links with HEIs, which they see as essential for bringing technological innovation into industry. The CROs in particular see part of their role as ensuring that the technology flow from academia to industry is enhanced where possible - in their view for the benefit of the academic institutions, industry and themselves.

Government laboratories

In a similar way, Government R&D laboratories are looking to contract R&D as a method of increasing revenue. At present contract revenue from industry is, in general, not large, but there is evidence that it is increasing.

The effects of the Next Steps Initiative on government laboratories is an issue that is attracting considerable attention. At present some 50 agencies have been set up (with another 18 under consideration). This includes most, if not all, of the Government's R&D laboratories. The Initiative aims to increase the effectiveness and efficiency of the Civil Service, and to provide a better service to the public. There is some evidence that in this strive for efficiency R&D facilities/services are being offered on a more commercial basis. In time will government agencies be competing against established CROs?

Customers

Industrial companies appear to be making increasing use of the various performers of contract R&D as a way of deploying their R&D resources more efficiently. There are several reasons for this. A major reason is the high cost of developing the wide spectrum of technology an individual company requires to compete in today's global markets. Many companies now concentrate their in-house effort on their main technological area, and buy in additional expertise as and when necessary. In the pre-competitive stages companies often look to club-type research projects where costs are shared.

Some industrial companies now offer out their own R&D expertise on a contract basis. This helps to increase revenue from an expensive piece of otherwise under-used equipment, and often acts as an additional service for their main customers. Specialized development work for such customers, on a contract or collaborative basis, may allow products to be developed jointly, which the first company is then ideally placed to produce.

Many industrial companies note that with the development of the Single European Market they will be looking further afield for expertise to contract, and that they will require 'on the spot' facilities in new export markets.

Highlights

The UK contract research market is a well established, and apparently healthy market. However, it is continually evolving, and those closely involved draw attention to a number of concerns:

- the European Community needs to ensure a fair, open and level 'playing field' for R&D services;
- the UK CROs are well established within the European Community and expect to increase work within the European Community over the short to medium term;
- HEIs need to decide how best to increase industrial revenue, and assess precisely how this will affect their role;
- the effects of the Next Steps Initiative on government laboratories;
- recruitment of qualified scientists and engineers is a problem that is expected to increase rather than ease.

CHAPTER I: INTRODUCTION

(i) Outline

In chapter I we introduce the contract research and development (R&D) market in the UK and define the boundaries of the study. Brief comments on previous studies of this market are included.

(ii) Background

Historical setting

The UK has a long tradition of collaborative or cooperative research organizations focused on industrial needs. Some have been geared to particular industrial sectors, others to a particular technological base. Research Associations (RAs), with a membership format, have been in existence since the 1920s, and a number of independent organizations since before then. These organizations have flourished, and withered, along with the fortunes of British industry during the century, and have evolved greatly from their original forms.

Technological innovation

Industrial need for technological innovation is increasing, as competition from all sources increases. British industry has, until recently, undergone a considerable revival, spurred in no small part by technological innovation. During this revival there has been, both in industry and throughout government, an emphasis on increased efficiency and profitability. This ethos has swept across the whole industrial spectrum, and its effects can be clearly seen in the contract research market.

Organizations willing to undertake contract research

This striving for efficiency has led to many changes. In the contract research organizations (CROs) themselves the number of services offered and the quality of the services have, according to many CRO managers, noticeably increased, partly also driven by increased competition and higher customer expectations. Universities and other higher education institutions (HEIs) have been under considerable financial constraints and are looking to making the best use of their expertise. One method is to offer such expertise, on a commercial basis, to paying customers. Government laboratories, under similar pressures, are looking (to varying extents) to paying customers to ensure efficient use of facilities, and increased revenue, without losing their main aims of providing Government with national expertise. With the privatization of many state industries a number of well-founded laboratories now operate on cost centre lines, and within truly commercial organizations. One method of retaining such facilities is to ensure that, when appropriate, they carry out profitable work for external customers. In addition, some private industrial concerns, which require well-founded R&D laboratories in-house, have looked to contracting out such facilities as a method of helping retain them.

This is not to suggest that such activity did not go on before, or that all examples of the above organizations are undertaking contract research (indeed much collaborative/joint work takes place with partner companies in similar fields), but the overall trend is towards many more organizations now able, and actively seeking, to undertake contract R&D of some form.

The European Perspective

UK CROs have a tradition of undertaking a sizeable amount of transnational contract research both for European and global customers. With the stimulus of the opening of the Single European Market such linkages are being strengthened and diversified.

The study

Our study therefore set out to look at the changing dynamics of the contract R&D business in the UK, from the perspective of both the performers of, and the customers for, contract R&D. In this report we highlight the European dimensions of the UK contract research market place and in particular the role of the EC R&D programmes within this market.

(iii) Definitions

Contract R&D

We have defined the term 'contract research and development', for the purposes of this report, as work of an innovative nature undertaken by one party on behalf of another under conditions laid out in a contract agreed formally beforehand. We have used this very broad statement to include work undertaken by government laboratories. Core funding from a government department to a laboratory within the department's own sphere has not been included (i.e. Department of Trade and Industry funding to the National Technology Centre (formerly the National Engineering Laboratory) or the National Physical Laboratory). However, government funding for specific projects is included as contract R&D when there is in principle a choice as to where the project is carried out. We have tried to include only those contracts that are open to competition.

However, we excluded the Ministry of Defence (MOD) spend on procurement, and made no attempt to systematically include the large amount of contract work undertaken in industry for industry, although where we came across examples of such activity it was noted (chapter 4). We therefore concentrated on those established CROs which derive a significant amount of their turnover undertaking contract research.

We specifically excluded organizations often referred to as 'testing houses', which undertake independent testing and accreditation services. Testing houses (of which there are some 10 000 in the European Community) may undertake applied development work, but few have the depth and breadth of the major CROs.

CRO

The acronym CRO covers a great variety of organizations in terms of turnover, staff employed, equipment, services offered, range of technology covered, customer base and organizational history. In the UK CROs can broadly be divided into two main types - those that are membership organizations of a non-profit making kind and those that are public limited companies.

We have concentrated on organizations that undertake R&D contracts, often as part of a wider technology based service. Much of the work undertaken by CROs in the UK is of a developmental, innovative, applied nature, although this is backed up by strategic research and is usually based on a long-standing relationship with the broad industrial base, or with particular industrial sectors.

(iv) Previous studies

Confederation of British Industry

A useful source of information in the UK is the Confederation of British Industry (CBI); similar organizations in other Member States can provide data on their respective industrial bases for approximate comparisons. The CBI undertakes a number of studies, many on a regular basis, which enable trends to be defined over time. In particular *Innovation Trends 1990* (1991) is the second annual survey looking at the way British industry undertakes industrial innovation. The survey asks industrial companies (over 300) how and why innovation takes place, both for the current year and the expected effort for the following 12 months. It asks companies, for example, for the trend in their current and expected expenditure on the use of individual consultants, Government research organizations and cooperation with academics. A number of findings from the survey are of interest to this report, particularly a slight trend towards industrial collaboration rather than contracting of R&D. The results also showed encouraging signs that companies valued innovation and were continuing, on the whole, to invest despite the recent recession.

The European Community dimension

In 1989 the European Commission (DGXIII) published a report by a French group (Bossard Consultants) entitled *Contract Research Organizations in the EEC*. The report consists of two sections: the first describes the overall contract research market in 10 Member States and highlights the major differences between them (such as government support for such activities and CRO working practices); while the second part is a directory of some 130 CROs and includes considerable data on the amount and funding of contract R&D undertaken in each organization. The report provides a useful snapshot of the CROs and highlights the usefulness of such organizations within the European Community (EC). The report reveals a number of points, the most important being that 97% of contract R&D undertaken covered in the survey is carried out in only 5 States: France, Germany, Holland, Italy and UK. It is also clear that the level of governmental financial assistance given to individual CROs varies significantly between Member States. For example in the UK CROs receive no direct grant/subsidy, and only partial funding on projects deemed by the Government to be of a pre-competitive nature, whereas in Germany and Holland some CROs receive direct subsidies and, with support for particular projects, may receive over 50% funding from their respective Governments. In the light of the opening Single European Market this has considerable implications for competition policy, and is a problem that UK CROs wish to see addressed. This is highlighted in our own report.

European Association of Contract Research Organizations (EACRO) The European Association of Contract Research Organizations (EACRO), recently set up with the encouragement of the European Commission, includes CROs from France, Germany, Italy, the Netherlands and the UK. It aims to raise the profile of European CROs and increase technology transfer through the Community. Membership is extended to organizations which are 'commercially independent of any industrial group or Government institution', and one of its aims is to 'defend the profession against unfair competition from establishments which practise contract research on a non-economic basis'.

The Association of Independent Research and Technology Organizations (AIRTO) The Association of Independent Research and Technology Organizations (AIRTO) has in recent years become a voice for UK CROs, both in the UK and overseas. It produces a newsletter and an annual Technology Review, and undertakes annual data collection of its member organizations and is thus building up a useful bank of statistics.

Federation of European Industrial Cooperative Research Organizations (FEICRO) AIRTO is the UK representative in the Federation of European Industrial Cooperative Research Organizations (FEICRO). This is a federation of national associations of technical centres and similar bodies engaged in cooperative research in Europe. One of its prime aims is the furtherance of R&D for industry, especially small and medium-sized enterprises. It also acts as a non-Governmental forum for communication with the European Commission and other European bodies on policy and technical issues.

CHAPTER II: METHODOLOGY

(i) Outline

General approach A questionnaire approach followed by interviews (in person, though sometimes by telephone) was the main method of collecting information. Data from annual reports and other, mostly published sources were used to substantiate questionnaire data. In addition, informal discussions at various meetings, seminars and similar events proved useful.

(ii) The contract research organizations (CROs)

The CROs Our selection of CROs was based on the membership of the Association of Independent Research and Technology Organizations (AIRTO), though the sample also included organizations that were not AIRTO members, some government laboratories and a small number of Higher Education Institutions (HEIs).

Responses Questionnaires were sent to 65 CROs within the UK. 9 explicitly declined to participate, 11 failed to reply, 8 replied partially, and 37 replied in full. The usable response rate was therefore 69% (45 of the 65 sent). The questionnaire is given in Annex B.

Interviews Interviews were undertaken with 21 CROs during 1989/90, many of them being conducted with the Managing Director or Chief Executive. With the majority of CROs being (relatively) small organizations (rarely more than 200-300 staff) these executives have the ability to discuss both the technical laboratory projects and the changing market conditions.

A number of visits were made to HEIs and interviews were mainly conducted with the industrial liaison officer or the managers/directors of the university/polytechnic companies. Data on the amounts of contract R&D undertaken in this sector were obtained from various published sources.

(iii) The industrial customers

Customers' response In spring 1989 1000 questionnaires were sent on our behalf by the CBI to a non-targeted selection of British industry (based on the Standard Industrial Classification List (SIC)). We received 138 replies, a response rate about normal for this type of such surveys. The responses covered 43 classes from the SIC. 10 classes had 5 or more respondents: the water supply industry, metal manufacturing, chemical industry, metal goods, mechanical engineering, electronics and electronic engineering, motor vehicles, food/drink/tobacco, footwear & clothing and other manufacturing.

Interviews Interviews were conducted with 18 industrial companies, selected from those who responded to the CBI questionnaire. Interviews were mostly held at the company's premises, usually with the R&D manager.

CHAPTER III: THE VOLUME OF CONTRACT R&D PERFORMED IN THE UK

(i) Outline

In this chapter we outline the main performers of contract R&D in the UK and give an estimate of the size of the UK market (1988/89) addressed in the study.

(ii) Defining the market boundaries

We set out to study one area of the contract research market in the UK. We made no attempt to assess the large amount of contract/collaborative R&D effort undertaken by industry for industry. Nor have we included government R&D procurement spent in industry. We have, however, attempted to estimate the amount of income derived from contract R&D by the HEI sector and Government laboratories. The bulk of the report is therefore focused on the established CROs in the UK, although we are aware this is only a significant fraction of the total contract R&D market in the UK.

(iii) Contract research organizations

There are approximately 70 CROs in the UK - bodies that earn a significant portion of their income by undertaking contract research. This excludes institutions of higher education and industrial companies that contract out any excess research capacity. 45 CROs belong to the Association of Independent Research and Technology Organization (AIRTO). In 1988/89 AIRTO total turnover was £305M, in 'real terms' a 2.3% increase on the total for 1987/88. This represents turnover derived not only from contract R&D but also from information services, consultancy, manufacturing, training courses, membership fees and other services. Membership fees provide up to 20% of total turnover in some CROs; contract R&D generates between 30% and 100% of the total turnover of each CRO.

Questionnaire data suggest that CROs on average derive in the region of 60% of their total turnover from contract R&D. This suggests a figure of £190M for the total volume of contract R&D conducted by AIRTO members in 1988/89.

In addition to the AIRTO members there are a number of other CROs based wholly or partly in the UK who, in 1988/89, undertook over £60M of contract R&D. However, this total is less well defined than the AIRTO figure.

The figure, however, is in line with that reported in the Bossard report on CROs within the EC, which identified some 76 MECU (approximately £50M) of R&D contracts undertaken by non-AIRTO members in the UK.

AIRTO members and similar CROs thus accounted for about £240 M - £250 M of contract R&D in 1988/89.

(iv) Higher education institutions

As has already been noted, universities and polytechnics are increasingly involved in undertaking contract research for paying customers. *It is difficult to collate data but a reasonable estimate would put the income received by UK universities in 1988/89 for contract R&D in science and technology disciplines, as defined in this study, at around £140-£150M*

In addition it is estimated that in the polytechnic sector institutions carried out a total of £80M of research in 1988/89, of which about £30M was contract research for industry within the meaning of this study.

(v) Research Councils

UK Research Councils run a number of specialist laboratories, which, like the universities, have found themselves under pressure to increase revenue from external sources where possible. Again a variety of services are being developed - the hiring of technical equipment, licensing/patenting of research ideas, and consultancy and commercial contract R&D.

As with the HEIs, it is difficult to estimate just what portion of external research income should be counted as contract research. *It would seem reasonable to give figures of £100M in 1987/88 and over £100M in 1988/89, for income received by research councils from external sources for contract R&D.*

(vi) Government research laboratories

Department of Trade and Industry The DTI runs five main laboratories, with a combined turnover in 1988/89 of £90M and employing some 2000 staff.

The role of all DTI laboratories was reviewed in the light of the 1988 Enterprise Initiative. This Initiative led to a move away from government funding of near market research (seen as the role of industry) towards funding of only pre-competitive, collaborative research.

It also led to the laboratories being run under 'agency' status, giving considerably more freedoms to the CEOs on the actual management of the laboratories and the type of work undertaken. As with the HEI sector, the need to increase revenue has led to more contract work being undertaken. On the whole the laboratories are undertaking government funded work for the public benefit. However, it is also true that some are under the same pressures as HEIs, and are looking to increase revenue from wherever it may be generated. In future such agencies may be given more freedom.

At present the DTI laboratories carry out no more than £9M of contract work per year, with less than half of this - say £4M - being contract R&D within the terms of this study.

Ministry of Defence In recent years there has been a considerable opening up of MOD R&D resources for civil industrial use. Following the Next Steps Initiative the five non-nuclear research establishments (Admiralty Research Establishment, Chemical Defence Establishment, Royal Aircraft Establishment, Royal Armament and Development Establishment, Royal Signals and Radar Establishment) became part of one 'agency' in 1991. It is expected that over time these will increase the amount of contract work undertaken.

In 1988 the defence establishments carried out £51M of work for other Government departments, and a further £22M for other customers. Of this, some 75% - £55M in 1988 - may be regarded as contract research.

Other Government departments/labs

A number of other Government departments also run R&D laboratories, such as the Transport and Road Research Laboratory funded mainly by the Department of Transport, and the Building Research Establishment funded by the Department of the Environment. These establishments also generate some 5-10% of income from contract work of a variety of different services. It is estimated that in 1988/9 the amount generated from contract work as included in this study is in the region of £4-5M.

One of the largest R&D organizations in the UK is AEA Technology, which now operates as a Trading Fund. AEA Technology has recently been reorganized into 9 main business areas, all of which are actively seeking to increase revenue from appropriate sources, particularly industry. The subsequent reorganization has given an added impetus to the role of contract work within AEA Technology as a whole. An approximate figure of £75 M for contract R&D undertaken in 1988 will now be considerably underestimated for AEA Technology as a whole.

(vii) Summary

Total income for contract research received by the various performers of contract R&D in 1988/89 is, approximately, as follows:

CROs

- AIRTO members	£190 M
- Others	£ 60 M
- TOTAL	£250 M

HEIs

- Universities	£150 M
- Polytechnics and colleges	£ 30 M
- TOTAL	£180 M

Research Council Institutes

- TOTAL	£100 M
----------------	---------------

Government Laboratories

- DTI	£4/5 M
- MOD	£ 55 M
- Others (including AEA Technology as Trading Fund)	£ 80 M
- TOTAL	£140 M

GRAND TOTAL **£670 M**

It should be noted that this does not include contract R&D carried out in industry, for which figures are not readily available. The largest single source of funding for this is the MOD, which in 1987/8 spent £1430 M in industry on R&D. Other Government departments also spent significant sums on R&D in industry, as highlighted below.

Extramural R&D expenditure by departments in industry, 1987/88

MOD	£1430 M
DTI	£ 206 M
(including c. £20 M spent in RAs)	
Energy	£ 12 M
Environment	£ 12 M
Others	£ 10 M

(Data from 1989 Annual Review of Government funded R&D)

Our total of £670 M for the volume of contract R&D performed in the UK thus excludes an unknown but very considerable amount performed in industry, funded by both industry and Government.

CHAPTER IV: THE PERFORMERS OF CONTRACT R & D

(i) Outline

In chapter III we presented an estimate of the volume of contract R&D performed in the UK. In this chapter we assess the contract R&D business from the point of view of the performers. In chapter V we examine the customers' perspective.

(ii) Contract research organizations (CROs)

(a) Function and structure

The changing role of CROs

The nature and role of CROs in the contract R&D market place has changed greatly in the last 25 years. Up to, and during, the 1960s the relationship between a CRO and its customer was, in many cases, a 'master - servant' relationship. The paying customer was the 'master', dictating how, why and when work was undertaken. Often interaction between a CRO and a customer was restricted to that necessary to solve an immediate problem. The majority of CROs were run as membership based research associations (RAs), generally working for the betterment of an industrial sector as much as for individual members.

During the 1960s, with new technologies emerging, a different form of CRO came to prominence. The focus of these organizations was the use of new technology and developing expertise in technology rather than particular industrial sectors. They marketed themselves as technology driven organizations able to improve customer's productivity through the introduction of new and appropriate technology, and also through reviewing, assessing and updating a customer's product design, marketing, processing and overall business planning. These organizations worked very much as equals to their customers - a customer brought in the CRO not to solve a particular problem in a prescribed way (although this was, and still is, one of the introductions a customer may have of a CRO), but to secure an informed analysis of the problem and to exploit the expertise and experience of the CRO in finding solutions, possibly in unexpected ways or areas.

This move towards technology consultancy is now common and most CROs, including the membership based RAs, have gone some way along this path. CROs are, in many cases, in a good position to assess a customer's technological capabilities in the light both of emerging technologies and his general position within the marketplace in relation to competitors and the general industrial market, and to then follow up such assessments by introducing/developing any required technology.

Reorganization of CROs

Some RAs have found their membership structure, and the Council and statutes to which they have to adhere, to be a constraint on corporate development. Because of this a small number have undergone management buyouts of their facilities, with the agreement of the members. In such cases the RAs (now

with money from the buyout but no facilities) are tied to the new company by agreement. The RA agrees to commission work for its members only from the new company, and not to set up new facilities in competition. The new company, with shareholders, is free to evolve however it sees fit, to invest where necessary and, of course, to make a profit. Other RAs are trying in less drastic ways to alter their constitutions to allow greater management flexibility. It was generally agreed that more management buyouts or similar quite drastic reorganization of a number of CROs could be expected in the medium term.

A few CROs have been the subject of takeover bids by larger companies. Being relatively small, generally successful and technically advanced, UK CROs in particular are an attractive target, for incorporation as the technical arm of a large company or simply to be taken over as successful businesses.

CROs with membership schemes use them in a variety of ways. Some undertake very little work for non-members, whilst for others non-membership is little or no barrier for placing a contract (though rates charged may be different). All the public limited companies are open to any paying customers.

*Reorganization
on a European
scale*

There was a perception among some CRO managers that the reorganization of CROs would develop on a European level. Some, but not all, believed there to be an excess of CROs within the European arena, and that subsequent reorganization on a medium timescale would be inevitable. There would, in their opinion, certainly be increased cooperation between European CROs and possibly takeovers/mergers of like-minded CROs. They could also foresee an overall decrease in the total numbers of organizations.

(b) Customers

The customer base

The customer base of CROs varies widely - from 10 to over 2500, reflecting the industrial sector in which the CRO works - from low-tech, small-medium enterprises (SMEs) such as in the furniture industry, to large, high-tech enterprises in aerospace or nuclear fields. AIRTO figures for 1988 indicate that in 1988 its 45 members had a client/member base of some 20 000 organizations. Of that total some 12 800 (64%) were companies of fewer than 200 employees and a further 3200 (16%) had 200-500 employees. This suggests that some 80% of the AIRTO client base consists of SMEs. The remaining 20% includes 93 of the UK's top 100 companies. However, it is thought that of the total AIRTO turnover some 80% is derived from the 20% of large enterprises, and 20% from the 80% of SMEs.

Type of customer

In the questionnaire, we asked what percentage of CROs' customers were industrial companies, government bodies or other types of organization. Of the 30 replies to this question, 24 (80%) noted that 70% or more of their customers were industrial companies. For only three organizations were industrial companies less than half of their customer base, and two of these three reported that the bulk of their work

was testing, quality and legal evidence work. Six organizations noted that 20%-35% of their customers were governmental, and two organizations noted that over 70% of their customers were central or local government. Other customers, in general less than 10% of total customers, included academic organizations, charities, 'information' groups and similar.

Geographical distribution of customers

We asked about the geographical location of the CROs' customers for the last financial year. 18 (60%) of the CROs reported that at least 90% of their customers were based in the UK, and a further 8 (27%) that UK organizations accounted for 70%-90% of their customers. 5 (16%) organizations reported that overseas customers constituted over 30% of their total customers, and 3 (10%) that over 70% of their customers were based overseas. However, a number of organizations commented that although numbers of overseas customers were small, the amount of revenue they brought in was often significantly higher, and growing.

Attracting customers

Contract research is a business, and the same marketing ploys are used to attract customers as in any other business. Mailshots, attendance at trade fairs, publishing of news-sheets and direct advertising were standard practice. Some organizations had overseas agents, and a small number of CROs had daughter organizations based overseas.

A number of CROs believed they had developed a high tech image that actually scared off smaller customers, and were concerned to counteract this ('we're not as expensive as you may think'). One CRO manager noted he tried to encourage the high tech smaller companies, for the reason that 'next year a few will be very successful'.

All CRO managers agreed that the personal touch with clients was vital. Considerable time was spent in building up a stable working relationship with a customer, with the aim of ensuring repeat work in the future (which is often the case in practice) - CROs aimed to be the customers' 'friends'. One CRO manager reported they were particularly attentive if the customer was new, or the CRO was moving in an area in which it may actually not know much more than the customer.

However, no matter how hard a CRO sold itself and got in front of the industrial 'eye', no contracts could be signed until technologists from the customer had talked with technologists from the CRO, and agreed a work programme.

The reputation and professional integrity of any CRO were of paramount importance. Great efforts were made to ensure nothing was allowed to blemish their record or associate the CRO with 'dubious' dealings. All CROs realised their reputation for quality, confidentiality and general professional standing had taken a long time to build but took very little to erode. Protecting a reputation had, on occasion, led to court action.

(c) Competitors

We asked CROs to identify their five main competitors from a list, and to prioritize their answers on a scale of 1 to 5. We analysed the replies by allocating five points for the most important answer, down to one point for the 5th placed competitor. 27 companies prioritized their answers, with an additional three noting 'all are competitors'.

The results are given in figure 4.1.

In-house R&D departments

The customer's in-house R&D departments were always mentioned as a major competitor - it is this department the CRO has to beat to win a contract.

'Other CROs'

'Other CROs' also featured high on the list of competitors. This usually referred to one or two CROs in similar specialist technological areas. Generally though CROs, because of their specializations, were not in competition with each other.

Universities

Most CROs thought that universities, in general, were of little threat to their mainstream activities (based on specialized experience of the industrial market). However, most CROs did note that for testing/using sophisticated equipment and some consultancy work universities had entered the market and were in competition.

Industrial companies

A number of engineering based CROs noted that there had been a distinct move by engineering companies to offer their own specialized facilities on a contract and/or collaborative basis. This was perceived as an economic necessity for a few companies, but more usually as a result of the general increased 'business' awareness leading to pressure to provide additional services for a company's main customers.

Government laboratories

As with the universities, Government laboratories were not, in general, thought to be seriously challenging the CROs' industrial base, although in particular areas the CROs were watching and attempting to become partners with such organizations rather than competitors. However, where such laboratories were strongly moving into the independent contract R&D business (such as AEA Technology and NEL (now known as The National Technology Centre)) they were seen by CRO managers as having a distinct competitive advantage. This was particularly so for AEA Technology, which as part of the former UKAEA has entered the CRO market in a major way with laboratories and staff built upon government funds.

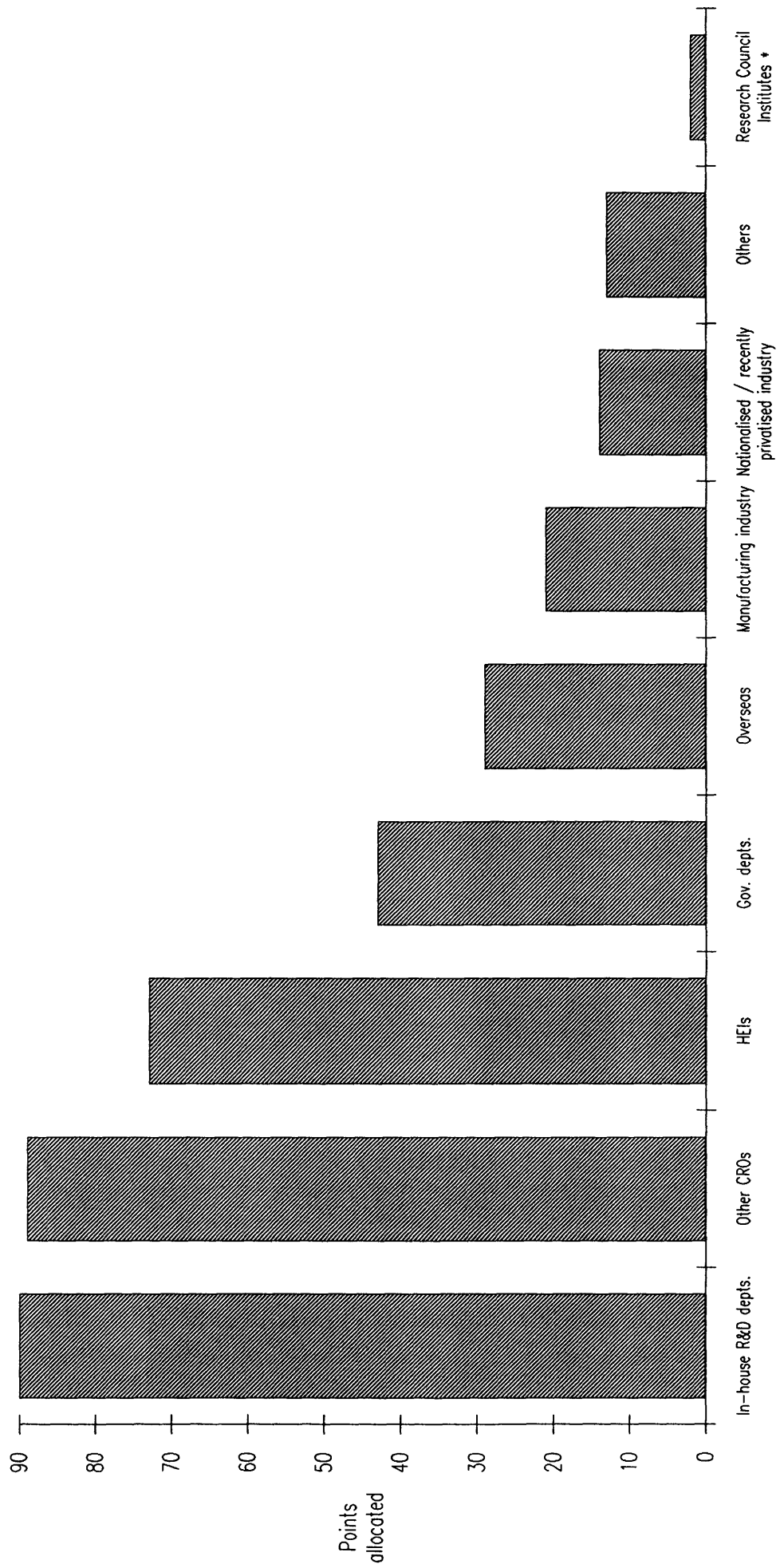
(d) Income of CROs and services offered

Turnover

The turnover of the 37 CROs in our sample varied considerably, from £0.75 M to £112 M. Only four organizations had turnovers in excess of £20 M; the majority had turnovers of between £2.5M and £10M. Many of the UK CROs were relatively small organizations. As such they were prone to changes in their particular markets and in the economy in general.

Figure 4.1

Perceived competitors to the UK CROs



<i>Sources of income by activity</i>	<p>We collected data on total income and on the services that brought this in. Responses varied tremendously and only a brief overview is given below. CROs offered a wide range of services, with managers noting they were constantly looking for new areas, services and approaches to increase revenue.</p>
<i>Major R&D contracts</i>	<p>Income from major R&D contracts ranged from 5% to 98% of total income, with 7 companies reporting over 80% of their income was earned by such contracts, 13 reporting 50% - 80%, 10 reporting 35% - 50% and the remainder reporting less than 35%.</p> <p>Such R&D contracts formed the bulk of CROs' workload, whether applied or strategic research or single or multi-client funded, and were based on experience of the industrial market place.</p>
<i>Testing and short term consultancy</i>	<p>Income from short-term contracts/consultancy ranged from 2% to 65% of total income, although the majority fell between 20% and 35%. This included routine testing and short-term technical assistance, often trouble-shooting, which formed a core of work that CROs could generally rely on, and often led to further work.</p>
<i>Application of appropriate technology</i>	<p>All CROs applied 'appropriate' technology - not necessarily the <i>latest</i> technology but that which was appropriate for the industrial need. This often entailed transferring technology from one industrial sector, with adaptations, to another, rather than developing new technology.</p>
<i>Research clubs</i>	<p>Only 10 CROs reported that the running of research clubs brought in income. The amount of income generated by this service ranged from 4% to 49% of total income.</p>
<i>Manufacturing</i>	<p>'Manufacturing' included the sale of finished (usually specialized) products, and the manufacture/hire of specialist equipment.</p> <p>Of 15 CROs that gave data, only 4 reported this accounted for more than 10% of total income, 2 reported that it generated 7%-10% of total income and the rest that it generated less than 7%. Such CROs had a small but steady market for precision testing equipment, generating up to 10% of income. In addition a few CROs manufactured finished products, having developed an idea to the product stage, rather than sell it to a manufacturer to exploit. In some cases spin-off companies had been set up to manufacture the product, leaving the CRO free to continue as a CRO and not diversify.</p>
<i>Patents and licences</i>	<p>Only 2 organizations reported that patenting, and subsequent licensing, generated more than 5% of their total income; for most it generated less than 1%. Many organizations did not respond to this question.</p>
<i>Information/computer services</i>	<p>15 CROs reported that information/computing services generated income, ranging from 0.5% to 38% of their total income (including sales of computer software). All bar 3, however,</p>

reported that income generated by these services totalled less than 10% of their total income.

Some CAD/CAM services were offered as an extension of the technical facilities, whilst software packages had been designed specifically for particular markets, e.g. the USA or Germany. Some CROs saw this internationalization of services as very important for the future.

Membership fees For the 18 organizations that reported income from membership fees, the range was from 2% to 42%, with the majority between 20% and 30% of income.

Training courses 15 organizations reported income from organizing courses, ranging from 2% to 15% of total income. Of these 9 noted that less than 7% of their turnover originated from courses.

Expert legal advice Most CROs offered specialist expert legal advice and were often involved where unbiased, factual evidence was required.

Other services A few CROs had acted as project managers to sizeable industrial projects, overseeing development of new plant, with technical input where appropriate. Some offered business consultancy, marketing advice and economic planning. Such skills were being utilized as part of the Government's Enterprise Initiative.

Some CROs offered unique testing and pilot plant facilities (where new products/processes could be tested on a commercial scale), which were highly regarded by a number of industrial R&D managers.

Sources of income by sector 32 CROs gave data enabling a good breakdown of the sources of income (other replies were incomplete). In summary, the amounts of income generated from the UK Government, UK commercial organizations and overseas in 1988 were as follows.

- Income from the UK Government ranged from 0% to 89% of total income. 8 CROs earned more than 30% of their total income from government, 11 earned 20%-30% and 11 earned less than 20%.
- Income from UK industry: 15 CROs earned more than 60% of their total income from UK industry, 8 earned 30%-60% and 9 earned less than 30%.
- Income from overseas contracts: 4 CROs earned more than 60% of their total income from overseas customers, 4 earned 30%-60%, 5 earned 20%-30% and 19 earned less than 20%.

We also asked for analogous data for 1983. Of the 29 CROs that gave data on the proportion of their total income that was earned from UK industry for both 1983 and 1988, 25 reported an increase, 2 reported no change and 2 reported a slight decline in percentage terms.

Only 18 CROs gave data for both years on turnover originating from the EC (although, of course, in some cases this reflected no turnover originating from the EC in 1983). Of the 18 respondents, 11 reported an increase in the percentage of turnover from EC sources, 6 reported the same percentage and 1 reported that the % of turnover from EC sources was less than five years ago.

Nearly all CROs now had a more diverse customer base than five years ago. A small number of CROs had closed and others had merged in order to strengthen the combined organizations. A number of CROs managers reported that the period of change had been very difficult, but that their organizations were now 'leaner and fitter' than they were before.

In virtually all CROs, overseas work brought in a significant amount of income. All but one visited reported that the amount of overseas work being undertaken was increasing, although they had always undertaken a significant amount of overseas work. Individual CROs reported they had particular growth areas, such as the USA, Japan and south east Asia. Many reported that income directly from the European Community programmes had increased in the last five years (partly because it is only in that time they had become actively involved in such schemes). All commented that, despite the problems associated with these schemes, they would continue to be a small but distinct part of their overseas contracts. Some, but by no means all, reported they were now undertaking more work for European countries in general (2 reported that they seemed to be moving away from the USA to Europe), but this included all countries of Europe, including Eastern Europe, and not just members of the European Community. Indeed some reported they had long worked for and with EC countries and as such did not expect major increases in the amount of this work in the short term.

(e) Core research

Core research - keeping up to date

The RAs with membership schemes all ran some form of core programme of research, to help keep the RA, and its members, up to date with emerging technology. These were usually run on a club-type basis.

The non-RA CROs spent varying amounts of turnover on a core programme of R&D not under direct contract to a customer. Some reported that 8%-10% of turnover was spent in developing ideas which in the short term cost money, but in general proved cost effective when translated into technical know-how in customer contracts. However, many CRO managers reported that it was difficult to put a figure to this in-house R&D. Most contracts involved the CRO investigating an area for a customer, in the process of which the CRO built up knowledge useful somewhere along the way.

All CRO managers stressed their relationships with individual academics in HEIs as a method of keeping in touch with research developments. This was both via an informal network of acquaintances, attendance at meetings, seminars etc, and by contracting, sponsoring or co-working in areas of mutual interest.

In general CRO managers saw involvement in EC R&D programmes as part of their overall core technology programmes. Occasionally they acted as a focus for other UK organizations to gain access to the EC R&D programmes, or more often they undertook the research to ensure they remained at the 'leading edge' of technology, which they could either then pass onto their members, or incorporate into further developmental contracts.

(f) Membership

Membership

Some RAs were seeking to increase membership numbers, seeing this as a method to increase total custom. However, within the RAs there was a view that a 10-15 year period membership was going to become less significant. The level of fees contributed by this route (20%-25% of total income in some RAs) was thought likely to diminish (in percentage terms) over the period.

(g) Staff

Number of QSEs

Numbers of qualified scientists and engineers (QSEs) varied significantly: the smallest RA had a scientific complement of only 14 and the largest organization had some 3800 qualified staff. AIRTO members (45 CROs) noted a total staff of 9800 (of which approximately 50% were QSEs). A rough estimate of QSEs in CRO type organizations, including those who were not members of AIRTO, must be in the region of 10 000 - a significant manpower resource.

Of the 33 respondents giving data on staff numbers, 23 (70%) had QSEs making up 30%-60% of their total workforce. The range, as a percentage of total workforce, was from 23% to 91%, with an average near 50%.

The allocation of QSEs between activities varied considerably between organizations. In some, major R&D projects employed the vast majority, whilst in others there was a more even division between scientists working on major R&D projects and those employed on consulting and testing services. A few organizations had a significant number of QSEs working on library/information database systems.

*Non-UK EC
scientists and
engineers*

Few CROs employed significant numbers of non-UK EC nationals. One organization reported it employed 30 non-UK EC staff, but the majority of these were employed in an offshoot in another EC country. Most CROs had fewer than 5 non-UK EC staff.

The questionnaire asked whether the number of non-UK EC national staff had increased, decreased or remained the same in the last five years. Of the 38 CROs replying to this question, 14 (37%) reported that there had been an increase in non-UK EC staff and 24 (63%) reported that numbers had remained the same (very low or zero).

Recruitment

CROs were asked whether they had problems recruiting QSEs. 35 (94%) answered 'Yes'. Of these, 26 indicated that the problem had increased in the last five years, and 8 that it had remained the same. Nearly all were prepared to recruit staff of virtually any nationality. Many commented that they had difficulty attracting staff because of prevailing salary levels, house prices etc. This was especially so for attracting overseas staff.

Isolation

Many CRO managers stressed the technical expertise of their workforces and the strong links with both the industrial base, where the technology was applied, and the academic environment, from which technical breakthroughs often emerged. CRO scientists (often working on several projects at once) therefore, over time, liaised with a wide spectrum of technologists through the natural course of contracts. In addition many CRO managers stressed the efforts made to maintain and enhance these contacts, particularly in academia. It would appear therefore, that, far from being isolated, CRO scientists/engineers had well established links with both academic and industrial scientists. It was clear from interviews that CRO managers valued such contacts and many agreed that they would like to do more to enhance them further, but, they noted, they had businesses to run.

(h) Government policy

The move from near-market research

Since the introduction of the DTI's Enterprise Initiative in 1988 there has been a distinct move away from government funding of near-market research to funding of pre-competitive, generally collaborative research. CRO managers had directly felt the effects of this change, on both their own organizations and industry in general. Many felt that much of the work that the Government used to pay for as near-market joint projects was highly beneficial to the industrial base as a whole. From the CROs' viewpoint such near-market projects, on a joint basis, meant that the technology was quickly distributed, to the benefit of industry in general. This itself produced a return for the Government in more profitable industry, and subsequently tax income. As a result of the Government funding only pre-competitive research, near-market research was now being funded mainly by individual companies (and only those that could afford to) which, because they were paying full costs, wanted to keep any advantage for as long as possible. This, according to the CRO managers, meant that UK industry as a whole was being held back, particularly the smaller companies.

This cutback also had an international aspect - the UK Government was seen to be one of the few not giving direct support to industry, to ensure it remained generally competitive, particularly in the run-up to the Single European Market. Whatever the merits of this policy, many CRO managers felt that UK industry was going to find it difficult to compete in overseas countries where considerable 'aid' was available to companies, if not in subsidies then in government support for high quality industrial infrastructure, publicly funded S&T and so on.

Figure 4.2

Perceived reasons why UK CROs undertake transnational contract research

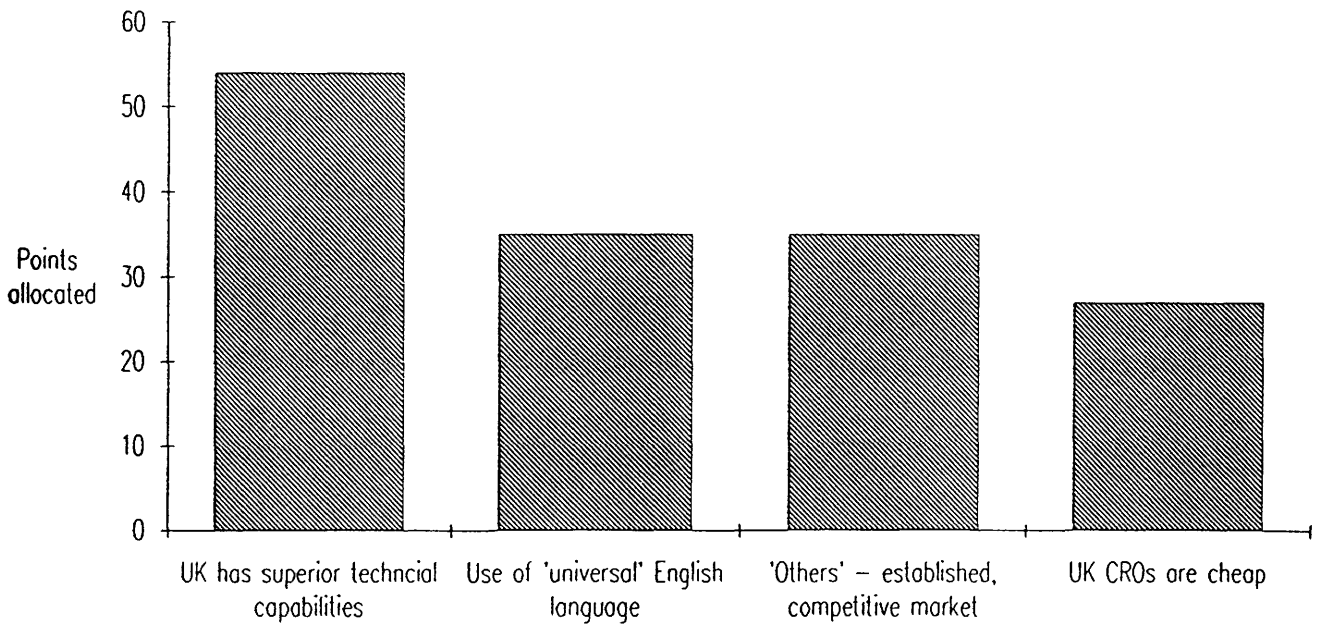
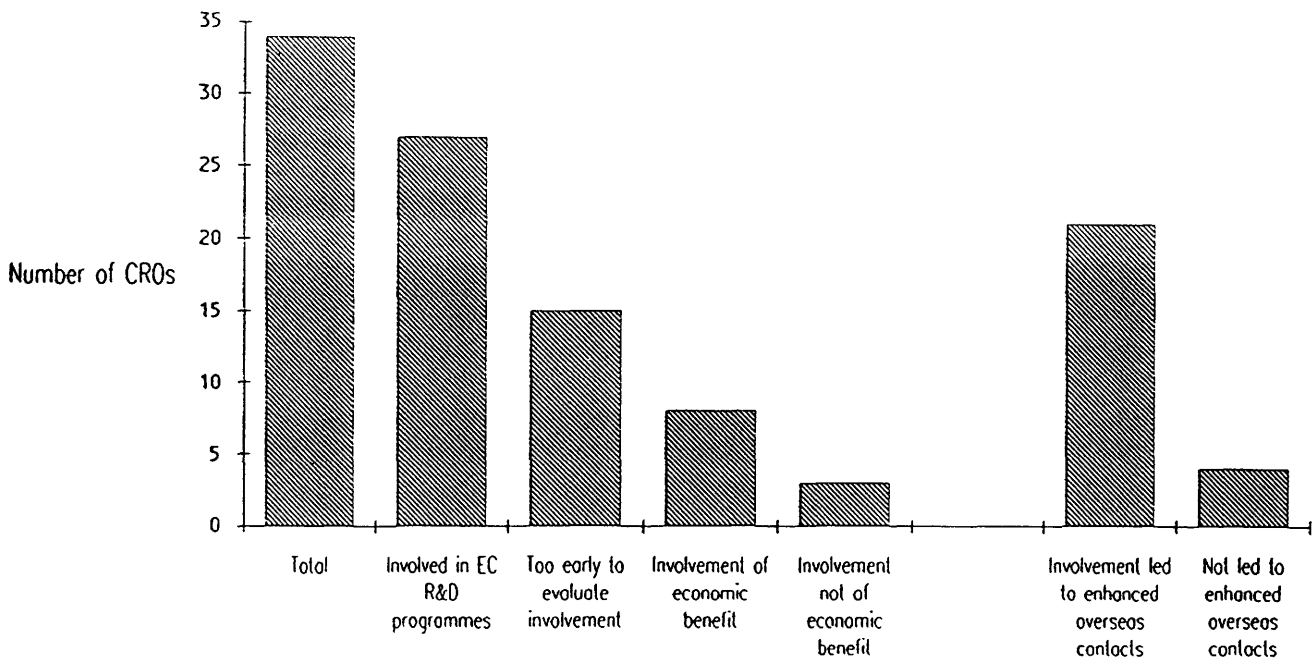


Figure 4.3

UK CRO involvement in EC R&D programmes



Many CRO managers were aware that the EC had a policy of controlling state aids, but were also aware of the complexity of the problem, particularly as to where R&D services fitted with this, and where state aids for R&D merged with aid for regional development. The CRO managers were sceptical that the Single European Market was going to open up on a 'level playing field'.

(i) *Transnational work*

Reasons for UK success

We asked CROs what they felt were the reasons for the UK CROs undertaking a considerable amount of overseas contract R&D. We suggested three possible reasons, plus 'others', and again asked respondents to prioritize their answers. With 3 points allocated to the primary reason, and 2 points to the second and so on, the points allocation was as in Figure 4.2

In the eyes of the CRO managers the major reason for attracting transnational work was the UK's superior technical capability, although the open, competitive market and the relative cheapness of UK research were also important.

These points were reiterated in interviews - the breadth of competence in a single organization in a particular industrial sector was often quoted as, if not unique, then at least rare in Europe. Many managers believed the closeness of the CRO to industrial companies, both in personal links and through general working with industry, was a major factor. The open competitive market was mentioned, not so much because a customer had a large choice of CROs in a particular field, but because the general market conditions had honed the CROs to industry-led businesses, which again appeared to be rare in the rest of Europe. Most UK CROs looked upon themselves as world class experts, and many had a world-wide customer base to back the claim.

Although the CRO managers were aware that an international client base showed their expert standing, they were also aware that this actually meant that their expertise was being exported, relatively cheaply, and often to the detriment of 'UK Limited'. If overseas companies saw the potential of emerging technologies, then why not more UK companies ?

CRO managers saw few overseas organizations capable of undertaking the same type of industrial R&D found in the UK. Many believed this reflected the fact that in many countries most industrial research centres were funded largely by governments, and run along the lines of government/university laboratories. Good work was being produced from these organizations, but they did not have the commercial knowledge or attitudes found in UK CROs. For this reason CROs felt that transnational work would become even more important as they fully exploited the SEM.

(j) European Community R&D Programmes

Participation in EC programmes

We asked a series of questions about participation in European Community (EC) R&D programmes. Of the 34 respondents who replied to some or all of these questions, 27 (80%) indicated that they had been involved in such programmes in the last year (1988/89). Results are shown in Figure 4.3.

Of these 27, 8 (30%) reported that involvement had been of economic benefit to the CRO or to industry in general, 15 (56%) commented that it was too soon to evaluate the projects and 3 (11%) reported that involvement had not led to economic benefit. (1 CRO gave no answer.) Of the 27 CROs involved, 21 (78%) reported that involvement had led to enhanced contact with overseas organizations (the partners in the projects), 4 reported that involvement had not led to enhanced contact and 2 did not reply.

5 CROs reported that they had been involved in work that, although it did not receive EC funding, still went ahead with some form of collaboration with other partners. 23 CROs noted they had not followed up any rejected proposals.

6 CROs reported that they had been, or were about to become, involved with follow-up projects related to EC programmes. 5 gave an indication of the scale of this follow-up work: for 2 the follow-up project was worth more than 300% of the original contract, for 1 it was worth 100%-300% of the original contract, for 1 it was worth 10%-50% of the follow-up work, and for the last it was worth under 10% of the original contract.

The responses showed that while many CROs had been involved in EC R&D programmes, few, however, had been involved as project leaders, and many had only limited knowledge based on one or two contracts. Despite the various grievances noted below, there was overall enthusiasm for the programmes and what they were trying to achieve, and many managers were looking at a learning curve (which they were slowly moving up) of involvement with the EC and overseas partners. Many saw the eventual benefits of involvement in the programmes as outweighing the problems initially faced in setting them up.

Difficulties with EC programmes

The task of 'Project leader' was often regarded as a merciless task - 'having to go through a phenomenal amount of red tape, not once but four, five or many more times for each partner', and the lead organizations 'almost certainly lost money' because of the amount of effort needed to set up the projects. A typical comment was: 'If they're foolish enough to do it (the leaders) then let them get on with it, we will benefit in the short term, and learn lessons on how to act as leaders in the future'.

Many CRO managers had similar attitudes of becoming involved in the programmes in the easiest way possible, before fully committing themselves on a major contract of their own. Many CROs were, apparently, initially involved in EC programmes 'on the back' of a larger industrial partner, sometimes as a full partner or sometimes as a sub-contractor.

Problems highlighted by CRO managers included the following:

- finding and communicating with potential overseas partners (although this was already reported as not as big a problem as 3-4 years ago);
- ensuring the project specification agreed by the partners met the requirements of the EC, and having to change project details at short notice to accommodate divergent views;
- difficulties in finding out how contracts were allocated, when, who assessed projects and how, to what criteria. Some CROs noted they found out about tenders too late, although this was also said to be less of a problem now;
- the time taken by the Commission to decide on contract tenders;
- paper work seemed to be required 'yesterday' by the Commission, and then sat on for 6 months;
- very large amounts of time and effort had to be expended on setting up a contract, with no guarantee of anything at the end (many thought this was particularly off-putting for the smaller CROs and companies who could not afford such 'lotteries');
- EC bureaucrats were the subject of many comments such as 'often totally the wrong sort of people, with little experience or expertise of a sector', 'more concerned with making sure the money when finally distributed is allocated with a distinct bias to the poorer countries, regardless of whether the project will actually be undertaken satisfactorily'.

However, in opposition to some of the above comments, it was also noted that 'Eurocrats' were often more knowledgeable than national bureaucrats. There was also, in some minds, an understanding that 'Eurocrats' were trying to achieve (at least) two targets - one of a purely technical nature, and the of increasing cohesion through the Community. Linked to this was the fact that the EC technical contracts were (usually) quite specific - if the tender was at variance to this (i.e. the tendering organizations wanted EC funding for their own purposes rather than for the particular programme) there could be a problem in coordinating the call for tender and the tender proposal itself.

Despite the problems, CRO managers in general agreed that they would continue to become involved in the programmes, and could see such involvement becoming easier. They believed that such contracts were a useful way of becoming involved in emerging technologies (eventually cheaply), making overseas contacts and eventually developing new markets/collaborative projects. In addition involvement was looked on as enhancing their business reputations, and great play was made of such work in annual reports, newsletters and journals.

Funding of EC contracts

The part funding of EC contracts was not a major problem (once contracts were finalized), although costs were very carefully controlled. The fact that the CRO had to pay partial costs of the project was occasionally put forward as a stumbling block, particularly for the smaller CROs. A number of CRO managers reported that costs sometimes did not fully cover the expected programme, and all noted that they kept tight control on financial input, both during the contract, and by careful and detailed planning before the contract was agreed, to ensure the contract was economically viable. Some CROs funded such work from in-house funds, others used membership fees and incorporated such projects into their core research programme. One was looking at a club type funding scheme whereby members or customers paid to become associate members of the contract, although this was not yet in operation.

(k) *The Single European Market (SEM)*

The Single European Market

Most, if not all, CROs saw the opening of the SEM as making their path into Europe easier. Most were already active in other EC countries; the SEM would allow them to compete even more favourably. One RA manager did note that his constitution was worded to allow work only for the betterment of British industry, and by undertaking overseas work he was in breach of the letter, if not the meaning, of the wording. Hence he was using the 1992 banner to bring about these (and other) changes.

Movement of scientists

Most CROs, on the look-out for good scientists, thought there would be a natural increase of non-UK EC nationals on their payrolls, both based in the UK and as agents, sub-units and such like based overseas. This was seen as a natural progression of the Europeanization, and indeed globalization, of R&D and of industrial activities more generally. Some managers did express fears that the UK could have difficulties in attracting and keeping the best scientists and engineers as more became aware of the better standards of living available to their professions elsewhere.

Industrial standards

Many CROs were involved in the formulation/harmonization of standards for the EC. Some were putting considerable effort into this, in their own right, via trade associations or the British Standards Institution, in the knowledge that their expertise would be required by industry when new standards came into force. Many CROs also saw an increasing need for overall quality control (i.e. a BS 5750 quality assurance gave a company more leverage in the export market) and they were gearing services to meet this need, from both UK and overseas companies.

Public procurement

Many CRO managers saw the possibility of increased EC public sector work as the market for public procurement opened up, although only in the medium term. If this market did become fully open the CROs saw that they were favourably poised to undertake work for the various local and national governments which would be forced to put such contracts out to tender.

CHAPTER V: THE INDUSTRIAL CUSTOMERS FOR CONTRACT R & D

(i) Outline

In chapter IV we discussed the main performers of contract R&D in the UK. In this chapter we take a look at the customers for such R&D - why contract, when and to where?

(ii) Survey

Types of customers In the UK contract research market there are three broad categories of customer. These are UK industry (including those multinational organizations that have a substantial presence, including R&D facilities, in the UK); the UK Government, both in the guise of direct contracts and in the 'support of UK R&D contracts' specially organized by the DTI in an attempt to stimulate cooperation and investment by industry; and overseas organizations, both governmental and industrial.

Questionnaire survey The data presented in this chapter are derived from the questionnaire survey carried out on our behalf by the CBI (see chapter II). They therefore, concern only the first of the above categories of customer for contract R&D - UK industry.

(iii) Company profiles

Turnover Of the companies responding to our questionnaire, 55% had UK turnovers of less than £25 M, and 46% had world turnovers of less than £25 M. The sample thus included a sizeable proportion of small companies, many of which had a turnover of less than £10 M. 15% of the respondents had UK turnovers of between £25 M and £100 M, 17% had UK turnovers of £100 M - £500 M and 12% had UK turnovers of in excess of £500 M. 16% of the respondents had world turnovers of more than £1 billion.

R&D facilities The questionnaire asked how many companies had access to company R&D facilities in the UK or overseas, (Figure 5.1). Of the 138 respondents, 97 (70%) had access to some sort of facilities in the UK, and of these 33 also had access to overseas facilities. Of the remaining 41 that had no UK facilities 7 had access to overseas company R&D facilities.

Of the 97 companies with UK R&D facilities, 78 (80%) were members of Research Association (RA) or other research/information clubs. Of the 41 organizations without UK based R&D facilities, 20 (49%) were members of Research Associations or other information/research clubs. In total 98 (71%) of all respondents were members of at least one RA or information/research club.

Figure 5.1

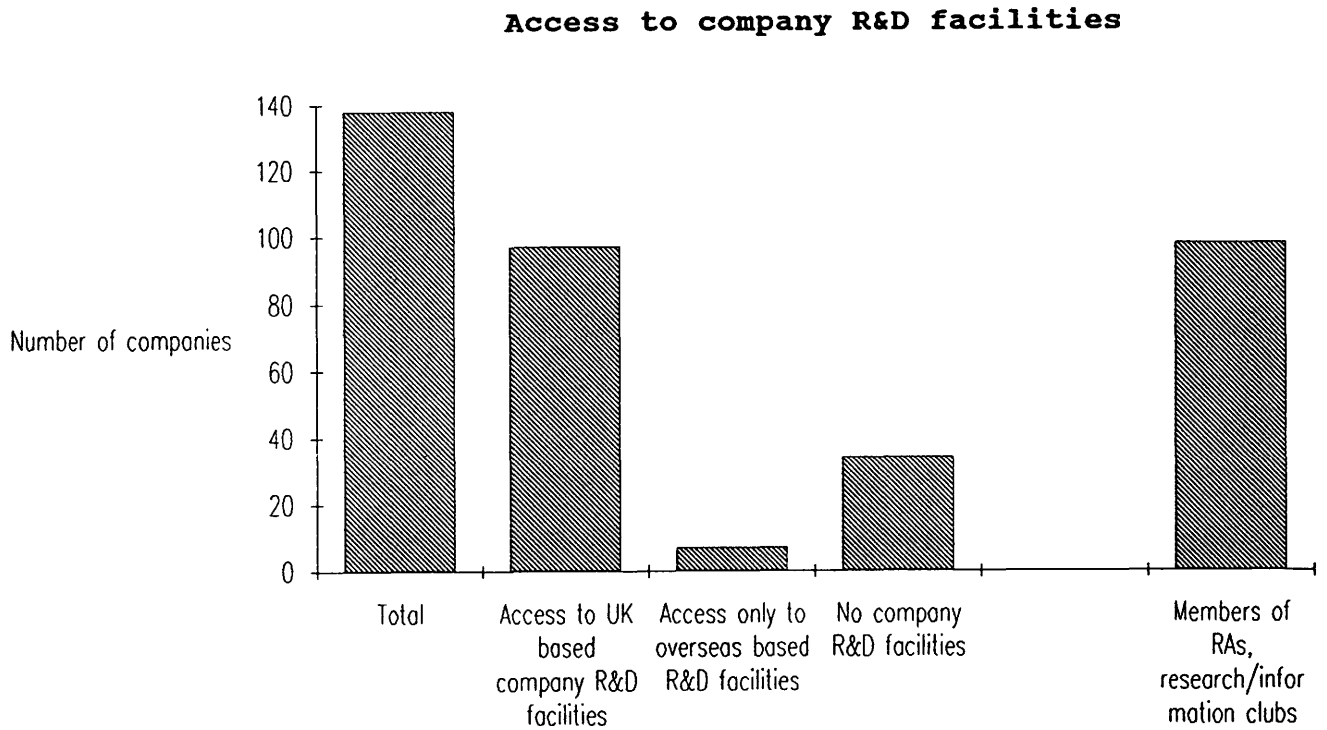
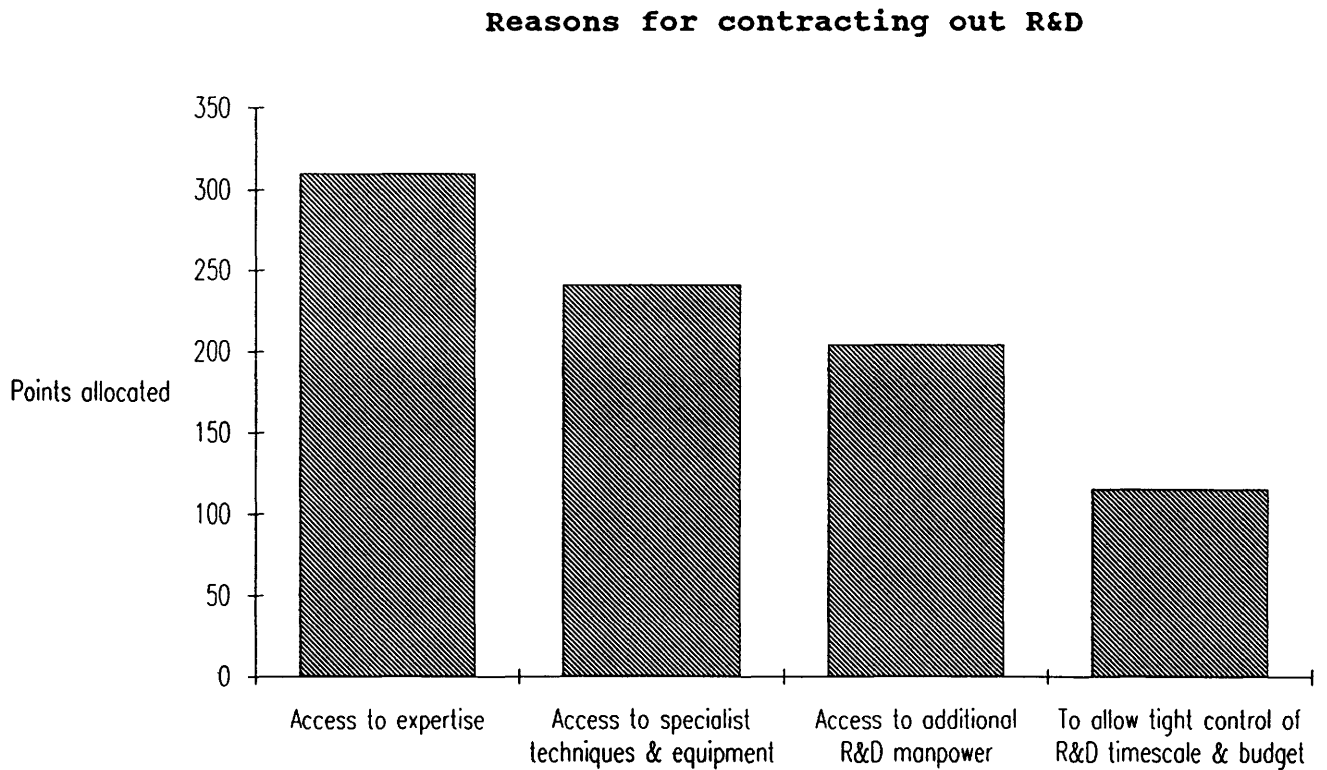


Figure 5.2



The majority of companies which replied thus had some form of R&D laboratory available for company development. The in-house company R&D facilities varied from simple quality assurance testing of production lines to fully dedicated laboratories. In addition, half of those that did not have R&D facilities were involved in some form of research association or club.

External R&D

63 (53%) of companies spent less than 10% of their total R&D budgets on contracted and collaborative research combined; 16 (13%) spent 10%-20%, and 11 (9%) spent 20%-30%. Companies spending more than 30% on contracted or collaborative R&D tended to be those that had no direct access to company-owned R&D facilities.

(iv) Why contract out R&D?

Questionnaire results

Our questionnaire suggested four broad reasons why an industrial company might contract out R&D work. By using a points system (1st place = 4 points, 2nd = 3, 3rd = 2, 4th = 1 we ranked the replies as shown in Figure 5.2.

*Expertise/
equipment*

By far the most frequently stated motive for contracting out R&D was to gain access to specialist expertise. This usually went hand in hand with the second motive, access to specialist techniques/equipment.

Manpower

The motive of gaining additional R&D manpower, although less significant than access to expertise or equipment, was important for some respondents. This was especially true in two types of companies. In smaller companies there was occasionally a need for additional personnel, laboratory space and equipment to develop or test a product. Work rated for reasons of speed and efficiency - "to get the job done". Other companies required a large amount of long-term testing/trials. Some companies were geared to undertaking this type of work in-house, but in many organizations (because of the amount of such work) it was contracted out, to UK CROs but also overseas.

Relationships with CROs

In interviews, respondents stressed the importance of establishing and nurturing good relationships between themselves and CROs. The industrial customers needed to be able to get their work done, and if an organization had worked well for/with them and provided a generally satisfactory service they were inclined to repeat their business. On its part, the CRO was keen to build such relationships, partly simply to gain business, but also because, by building up a relationship, it could serve the customer better and hence gain more work. Both organizations therefore had incentives to build such relationships, to their mutual benefit.

Budgetary control Budgetary control was not seen as a significant motive for contracting out R&D: where control was important, the work was more likely to be carried out in-house.

Contracting out vs collaboration 119 respondents gave data on the percentage of their overall R&D budgets spent on contracted and collaborative R&D projects. 53 (45%) spent a higher percentage of their budgets on contracted work than on collaborative work, 30 (25%) spent about equal amounts and 36 (30%) spent more on collaborative than contracted work.

Use of the results How the results of contract research were used depended on their nature. Much of the product and process development performed under contract was of direct relevance to companies' production processes and would be incorporated accordingly. Work of a more strategic nature was usually fed into on-going in-house projects, whether it be testing of a potential new product/material or something of a broader nature. In these circumstances close liaison between the technical experts of the CRO and the customer was required if both teams were actively to work towards a desired goal.

Truly strategic work, undertaken in HEIs, CROs etc is a way for a company to keep a watching brief over potentially promising areas relatively cheaply. This might entail sponsoring research students (often collaboratively) to look into emerging or novel areas of science.

(v) What is contracted out, and to whom?

Trouble shooting Industrial customers often used CROs for trouble shooting, for example when they had problems with their basic process/production plant. If production was down, or not to standard, the company was losing money and hence any faults needed to be rectified quickly and efficiently. A number of companies reported they had built up a close working relationship with particular CROs over a number of years, who because of their customer knowledge, were able to trouble shoot very effectively.

Production processes Related to this quick response mode was the on-line development of production processes. Again, as the CRO often knew the customer's processes and products, it was well suited to refining processes to increase production or the quality of products. This work was often on a small scale, but helped maintain the relationship.

CROs were also used to assess, and suggest, potential new developments or innovations, which might be introduced from other industrial sectors. Such work was often in conjunction with the customer's in-house R&D department. Sometimes this was of a technical nature, or it might involve assessing the cost-benefit of a particular technology for a company or its market impact.

<i>Product design</i>	Industrial customers increasingly used CROs for product design/development. This often related to the expertise in the CRO, such as CAD/CAM design, or new materials.
<i>Strategic work</i>	Strategic work, either under contract or on a collaborative basis, usually related to work going on in-house. Such work was usually not so sensitive as to be commercially vulnerable and hence could be undertaken on a collaborative basis. In many cases companies were members of 'clubs', often organized by CROs, both to undertake research in conjunction with their in-house departments, and to make contacts and keep a watching brief on developments in fields possibly not directly related to their own.
<i>Basic research</i>	Truly basic research is rarely undertaken by industrial companies. Certainly all but the very largest companies reported that all their research activities had some long-term strategic potential. Even those large organizations who could point to some research projects with no obvious benefits reported these were only a very small portion of their total effort and any true blue sky research was the domain of a few researchers who had proved their inventiveness in their fields. In addition these researchers generally had close links with HEIs and their research was often linked with outside research projects.
<i>Management consultancy</i>	Some CROs now offer various management consultancy services, with the customer industrial companies willing to accept their advice and act on it.
<i>Types of body to which R&D is contracted out</i>	We asked about the distribution of contract expenditure between universities, CROs, government laboratories and other manufacturing industries. 74 respondents provided data for both 1983 and 1988, allowing an assessment of changes between these two dates. Of these 74 respondents, 15 reported that in 1988 they were spending a bigger percentage of their total expenditure on contract R&D with universities than in 1983, while an equal number reported that they were using universities less. 12 companies reported that they were using CROs less than five years ago, while 16 reported that they were using these organizations more. Only 1 company reported that it was using government laboratories more, while 7 reported that they were using them less. 2 companies reported they were using other companies' facilities less than they were in 1983, and 5 reported they were using them more.
	(vi) Links with HEIs
	Virtually all the industrial customers interviewed had some form of link with HEIs in the UK. These links served a variety of purposes.
<i>Providers of qualified manpower</i>	A number of companies held strong views on the role of universities (and HEIs in general) in providing educated,

trained manpower. In particular it was noted that whilst the move of HEIs towards providing courses with industrial relevance was welcomed, it was also clear that industry required well educated, thinking graduates with a firm grasp of the basics of science and technology. Industry, on the whole, appeared willing to fund further specialized training be it in-house or run by outside bodies, for staff who required such additional skills.

Providers of sophisticated equipment/techniques

HEIs have always been used to a certain extent by industry as providers of sophisticated equipment and techniques. Often, because of costs, HEIs, along with the government laboratories, were the only place where such equipment was located in the UK. This was usually because industry could not justify the costs involved.

Many HEIs now offered expertise on a contract basis, in competition with the testing houses and CROs. The work placed was not (usually) commercially vulnerable, nor urgently required. Most R&D managers were of the impression that the HEIs were good for the strategic, new ideas/suggestions work, but not for commercially sensitive material. If such work was required and could not be undertaken in-house, then virtually all managers reported they would place the work at an established CRO rather than an HEI.

Providers of a network of experts

The academic network of experts (both within the UK and on wider global network) was seen to be of great potential benefit both to individual companies and to the country as a whole. Every R&D manager interviewed reported that the universities were where much of the truly innovative research was undertaken and that it was their job as R&D managers to tap into this (cf the CRO managers). All spent considerable amounts of time and effort forging links with universities and HEIs. Some companies noted that as more HEIs became involved in EC R&D programmes this network was being strengthened for European contacts.

Threat to basic research in HEIs

As noted above many managers (both industrial customers and CRO managers) expressed concern that the network of experts was changing, because of the need for HEIs (particularly in the university sector) to earn additional income. They believed there was a need for an industrial input into the HEI sector, but there was a fear that the balance had moved too far in industry's direction.

(vii) Trends in volume of work contracted out

Increase in contracted R&D

Industrial customers were asked whether they were commissioning 'more', 'less' or 'about the same amount' of contract research as 5 years ago. Of the 121 responses, 49 (40%) stated they were commissioning more contract research than 5 years ago, 65 (54%) were commissioning the same amount, and only seven (6%) were commissioning less, as shown in Figure 5.3. These results imply that the contract research market is growing in the UK.

Some of the reasons for this apparent increase in the use of contract research emerged during our interviews.

Rationalization of in-house R&D facilities

Many companies during the late 1970s and early 1980s reorganized their R&D facilities in a drive for greater economy and efficiency. Companies could not afford to be in-house experts in all the areas of technology they required to develop their business fully. They had therefore, been defining the areas of R&D essential for in-house development and shedding other areas where they did not need equipment/facilities on a full-time basis, on the understanding that where necessary work could be contracted to a CRO.

New technologies

In recent years there has been a vast increase in new technologies affecting industrial companies. How does a company cope with being master of all these new technologies, which it may need for production, but could not afford to develop on its own? Many companies had identified particular speciality areas and contracted in experts (or bought in to clubs and other collaborative ventures) to help develop such areas. This was particularly true when a company involved itself in a new area outside its traditional technical capabilities.

Demand for higher quality

Another reason for the increasing amount of contract work was reported both by CROs and by a number of their industrial customers. As the UK economy had developed there had been demand for higher quality goods and services. To meet this demand companies had been designing products to higher standards, with better materials, and had required rigorous testing of them along the way. Therefore the use of CROs has increased both because of the general increase in higher quality products and the technology required to develop them, and also from the testing/quality control aspects of their work. The increase in quality, particularly of services, had also affected the CROs, prompting them to offer more professional services.

Overseas markets

More recently the move towards a Single European Market had opened the eyes of many industrial managers to wider markets and how to get into them. One essential aspect was to ensure that the standards required by the target countries for the products were at least met if not exceeded. Industrial R&D managers saw that this required testing to high the standards equired for the product development in the UK, but also reported that the easiest way of getting around any local restriction was to have their products, where possible, tested in the local test centres, thus generating an increase in overseas work. Although R&D managers recognized that the Single European Market should enable the product to be tested in one Member State only and then sold throughout the Community, they did not believe that this would actually happen (at least on an industrial time scale required to ensure profitability) for a considerable time to come. Therefore, if by having the product tested in the local country it enabled a product to be quickly launched, they would continue to send products for testing.

(viii) Transnational contracting of R&D

Geographical distribution of contracted R&D

We asked industrial customers where contracted work was carried out, i.e. in the UK or overseas. Of the 112 responses to the question, 87 (78%) reported that over 90% of their expenditure on contracted work was spent in the UK (75 (66%) gave the figure of 100% spent in the UK). A further 21 (19%) reported they spent 70%-90% of their contracted expenditure in the UK.

24 (21%) of the companies placed some work in the EC countries, ranging widely from 1% to 75% of total contracted work. Only two companies in our sample placed work in non-EC European countries. 15 (13%) of the companies placed work in the USA, again amounts varying widely, and only 7 (6%) placed work elsewhere in the world.

It is clear from our survey that the majority of contracted R&D was placed at UK-based CROs. UK companies were more likely to place work at a UK CRO because they were, in general, perceived to be of a high standard of technical competence. In addition it was easier to build up a close working relationship with a company within easy reach rather than a considerable distance away. However, there would appear to be some movement away from automatically placing work in the UK, without looking further afield. This appears to have been brought about partly as a result of improved communications in recent years, and partly from a greater awareness of overseas markets and facilities, stimulated by the moves towards the Single European Market. Company R&D managers reported that they would be open to overseas CROs that could technically and economically compete with the UK CROs, and would also be actively seeking them for certain amounts of 'in-country' expertise that would enable a company to achieve greater penetration into a new export market.

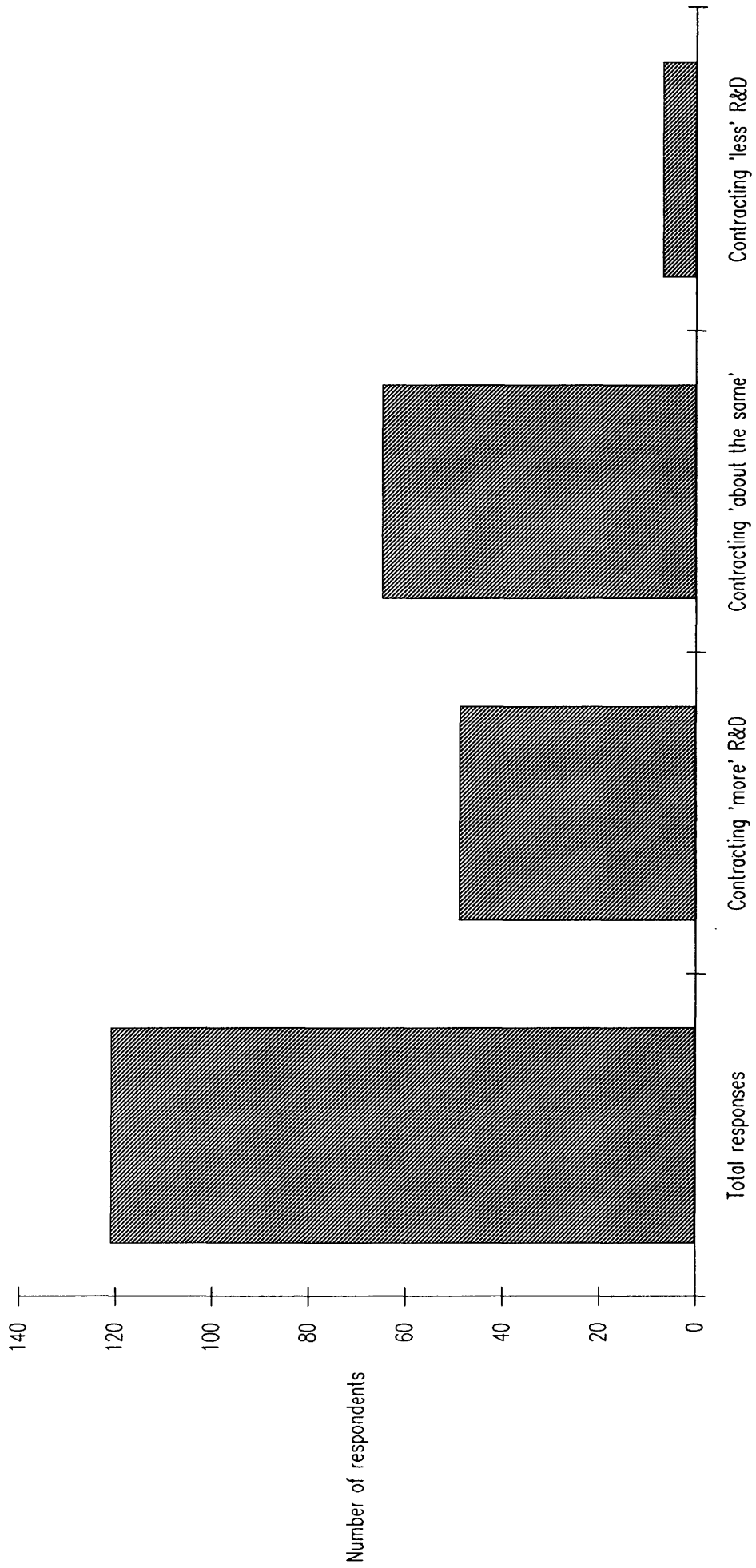
Involvement in European initiatives

Of the 138 respondents to our questionnaire, 20 had been involved in one or more EC R&D initiatives in the last five years (Figure 5.4). 6 reported that involvement in the schemes had led to a noticeable economic benefit to their organizations or industry in general, and 13 that it was too soon to evaluate the schemes. Only one organization stated that involvement in a particular scheme had not led to economic benefit. Furthermore, of the 20, 19 stated that involvement in the schemes had led to enhanced contact with their European partners, and only one stated it had not.

Six of the organizations involved in EC schemes also had some involvement with pan-European R&D initiatives, such as EUREKA or COST. A further three organizations had involvement with the pan-European schemes but not the EC ones. Of the nine organizations involved in the pan-European schemes, eight stated it was too soon to evaluate potential economic benefit from the involvement and one organization, involved in more than one project, reported both yes and no to this question. In addition seven reported that involvement had led to enhanced contact with their European partners (the other two gave no answer to the question).

Figure 5.3

Number of companies undertaking 'more', 'about the same' or 'less' contract R&D than 5 years ago



Industrial R&D managers drew attention to 'red tape' involved in EC schemes, and to the time taken to organize projects. All who had been involved commented that the projects had taken considerable effort to set up, and had suffered long delays whilst the partners were organized and consulted, and then further delays while the project was assessed by the Commission. It was felt that in general only the larger companies could stand such delays and additional costs.

However, once involved, most companies had gained enhanced contact with the partner organizations within the Community, and, as seen from the questionnaires, a number thought that involvement had led to economic benefit either for themselves or for industry in general.

Many of the companies we visited had no central method of collecting information concerning EC schemes and projects, and information was often gained from the DTI, from journal articles or similar. However, a number of organizations (particularly the larger ones) reported they had personnel dedicated to collecting and assessing information from the EC, covering all aspects of the Single European Market, EC schemes, policy and monetary data.

*Non-UK EC
nationals employed
on R&D staff*

We asked what proportion of a company's R&D staff were non-UK EC nationals, and how this had changed over the last five years (Figure 5.5). Of 102 companies that gave some answer (either numbers or 'same', 'increased' or 'decreased'), the vast majority had few non-UK EC staff. 80 (78%) companies reported they had no non-UK EC nationals. Of the 60 (59%) respondents that employed the 'same' number of non-UK EC nationals in 1988 as in 1983, 45 employed none in either year. In addition to these 60 companies, a further six reported an increase in the number of non-UK EC staff, and seven reported a decrease. There were 13 companies that gave percentage numbers of staff other than zero: one company reported that 15% of its R&D staff were non-UK EC nationals, while the other twelve reported up to 5% each.

It is clear that there are few non-UK EC nationals on the R&D staffs of industrial companies in the UK at present. However in interviews, the majority of companies (both customers and CROs) expressed the expectation that as the whole process of Europeanization developed in the coming years there would be an increase in the number of non-UK EC staff employed in all aspects of company life. To some extent such staff were currently concentrated in the areas where profits were to be made, e.g. the sales force, as agents who knew and understood the foreign markets. Some of the major companies, faced with a shortage of graduate recruitment in the UK, were actively recruiting in continental universities and colleges of higher education. This would enhance integration of the European workforce.

Figure 5.4

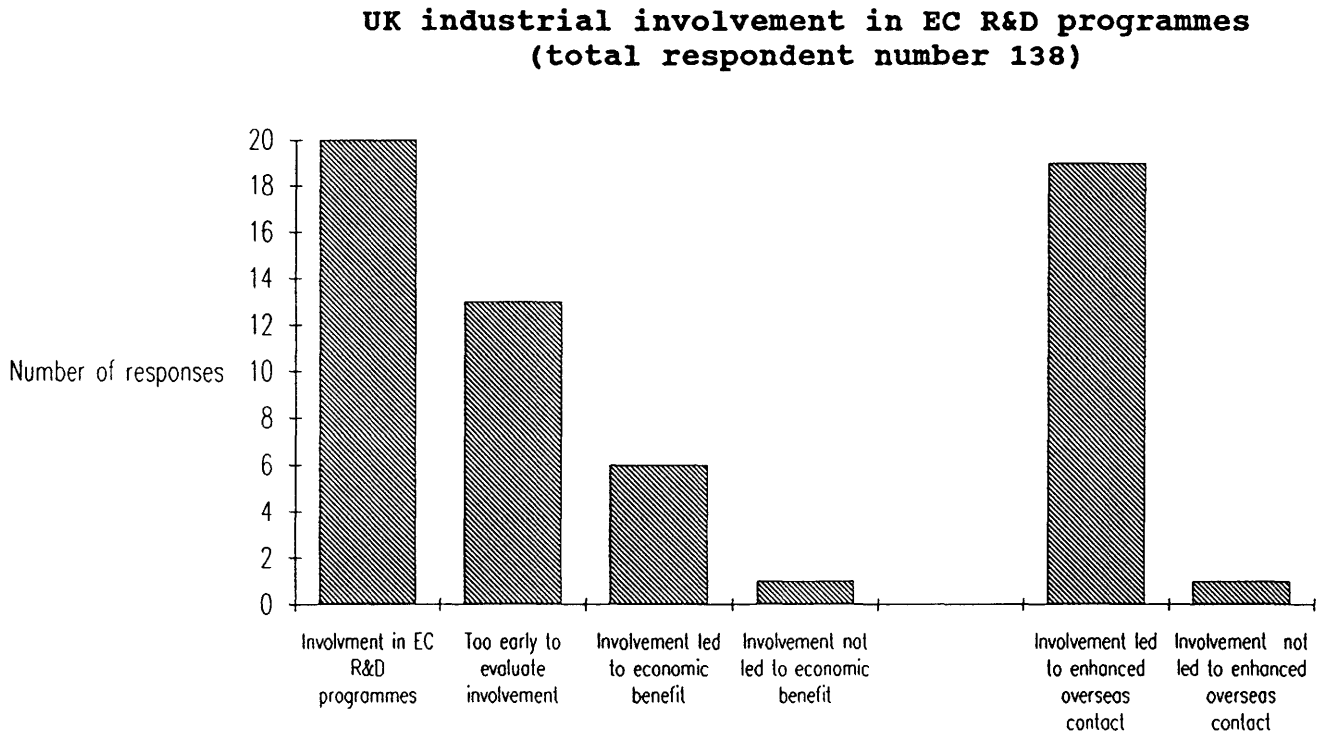
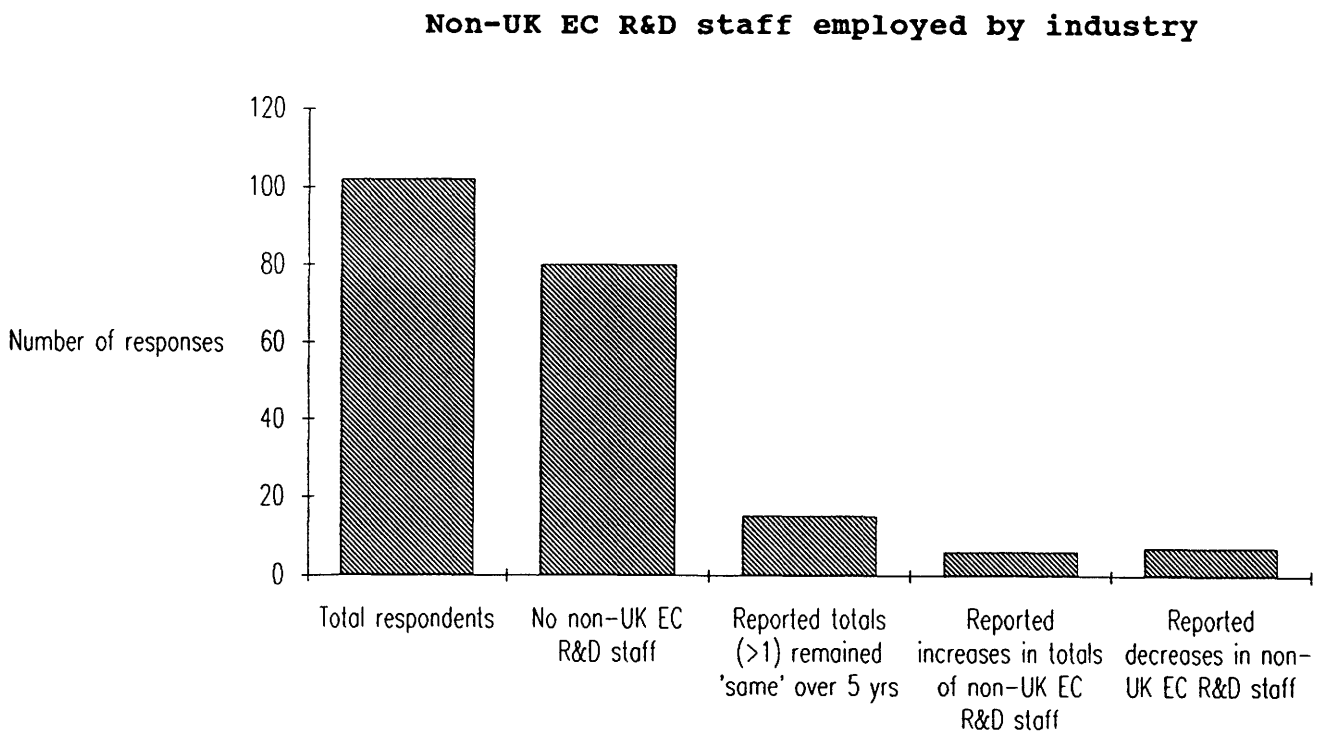


Figure 5.5



Most organizations did not see their attitude to contract research changing because of the Single European Market - they would still go to the organizations they believed could do the work. A few noted that in particular fields this already meant going overseas, and such a policy would be continued. However, similarly to European staff, most R&D managers did see there was a distinct possibility that as their organizations became more international/European there would be a general move to use overseas organizations, including overseas CROs.

Some managers thought that the SEM might lead to increased use of CROs particularly in the standards and quality assurance fields, both in the UK, but also overseas if it were more prudent to comply with the local standards in addition to any UK or more general standards. Some R&D managers were also conscious of the increasing importance of EC-wide standards, and were actively involved in the setting of these standards, either through CROs, some of which were acting as UK representatives, or more generally through trade representations to the British Standards Institution.

Many R&D managers felt that the UK Government was not giving as much support to industry as other European Community governments were, particularly in support of industrial technology.

CHAPTER VI: INTERNATIONAL COMPARISONS

(i) Outline

In this chapter we briefly examine the standing of UK CROs within the European Community. We attempted no data collection of our own outside the UK, but frequently discussed the European Community dimension in interviews. Data given below are from the Bossard Report (1989).

(ii) The Bossard Report

Contract R&D in the Community

The Bossard report (1989) on the contract R&D market in the European Community found that 863 MECU of contract R&D was commissioned in 1987/8. 97% of this total was divided between five countries - France, Germany, Italy, the Netherlands and the UK. The UK share of the total was 28% (approximately £160M).

Basic data

Table 6.1 shows the basic Bossard data. Care must be taken when using this data (there are internal inconsistencies in the report) and one requires some background information before drawing any conclusions. For example, the table shows Germany and the UK having approximately equal numbers of CROs (39 & 38 respectively). However, AIRTO itself has 45 members, and there are a number of other UK CROs that are not members of AIRTO. Hence the Bossard data do not include all CROs in the UK, nor probably other Member States.

Moreover, of the 38 German CROs, 20 are institutes of the Fraunhofer Gessellschaft. Of the 3 CRO organizations reported in the Netherlands (total contracts 140.1 MECU) TNO dominates (total contracts 125 MECU) the other two. This is similar to the Fraunhofer Gessellschaft. Both these large organizations receive considerable amounts of public funding for technology innovation, far more than their UK counterpart CROs. The only organization of similar scale in the UK is AEA Technology, which was not included in the Bossard study.

Public vs private funding of contract R&D.

Table 6.1 also shows the proportion of income derived from the public and private sectors in each country. In Germany the CROs identified by Bossard derived 60% of their revenue from public funds, while the Netherlands was even higher at 76%, with Italy at 41%. France and the UK were funded 27% and 25% respectively by the public purse. This reflects the differing types of organizational funding between the countries and the wide range of organizational structure represented in the table. It also represents the degree of interventionism practised by the respective Governments - with the UK Government playing a relatively non-interventionist role.

Table 6.1 Bossard Report Contract Research Statistics

	Number of CROs	Value of contract research MEcu	% domestic	% EC	% non-EC	% private sector	% public sector	value domestic MEcu	value EC MEcu	value non-EC MEcu	value private sector MEcu	value public sector MEcu
Germany	39	322.1	81.0%	10.5%	8.5%	39.0%	61.0%	261.0	33.9	27.2	125.7	196.4
UK	38	242.5	61.4%	15.0%	23.6%	74.6%	25.4%	149.0	36.3	57.2	180.9	61.6
Netherlands	3	140.1	82.8%	6.3%	10.9%	23.7%	76.3%	116.0	8.9	15.2	33.2	106.9
Italy	11	87.7	92.1%	4.0%	3.9%	58.3%	41.7%	80.7	3.5	3.4	51.2	36.5
France	25	73.7	94.9%	4.2%	0.9%	72.8%	27.2%	69.9	3.1	0.6	53.6	20.1
Denmark	7	12.3	89.5%	5.8%	4.7%	41.0%	59.0%	11.0	0.7	0.6	5.0	7.3
Spain	6	7.5	98.3%	0.6%	1.1%	43.0%	57.0%	7.4	0.0	0.1	3.2	4.3
Portugal	1	7.3	50.0%	50.0%	0.0%	35.0%	65.0%	3.7	3.7	0.0	2.6	4.7
Belgium	2	0.6	84.2%	5.8%	10.0%	16.7%	83.3%	0.5	0.0	0.1	0.1	0.5
Ireland	1	0.1	60.0%	30.0%	10.0%	97.0%	3.0%	0.1	0.0	0.0	0.1	0.0
TOTAL	133	893.9	78.2%	10.1%	11.7%	51.0%	49.0%	699.2	90.2	104.4	455.6	438.3
"Big 5"	116	866.1	78.1%	9.9%	12.0%	51.3%	48.7%	676.7	85.7	103.7	444.6	421.5

*Sources of contract
R&D funding*

Figure 6.1 shows the proportion of R&D contract income derived from domestic, EC and non-EC sources. Of the big 5 countries the UK was the only country to derive over 20% of funding from non-domestic sources (in fact, it received 38.5% from non-domestic sources). This confirms the international standing of UK CROs, and illustrates well the level of contracts UK CROs undertake for overseas organizations.

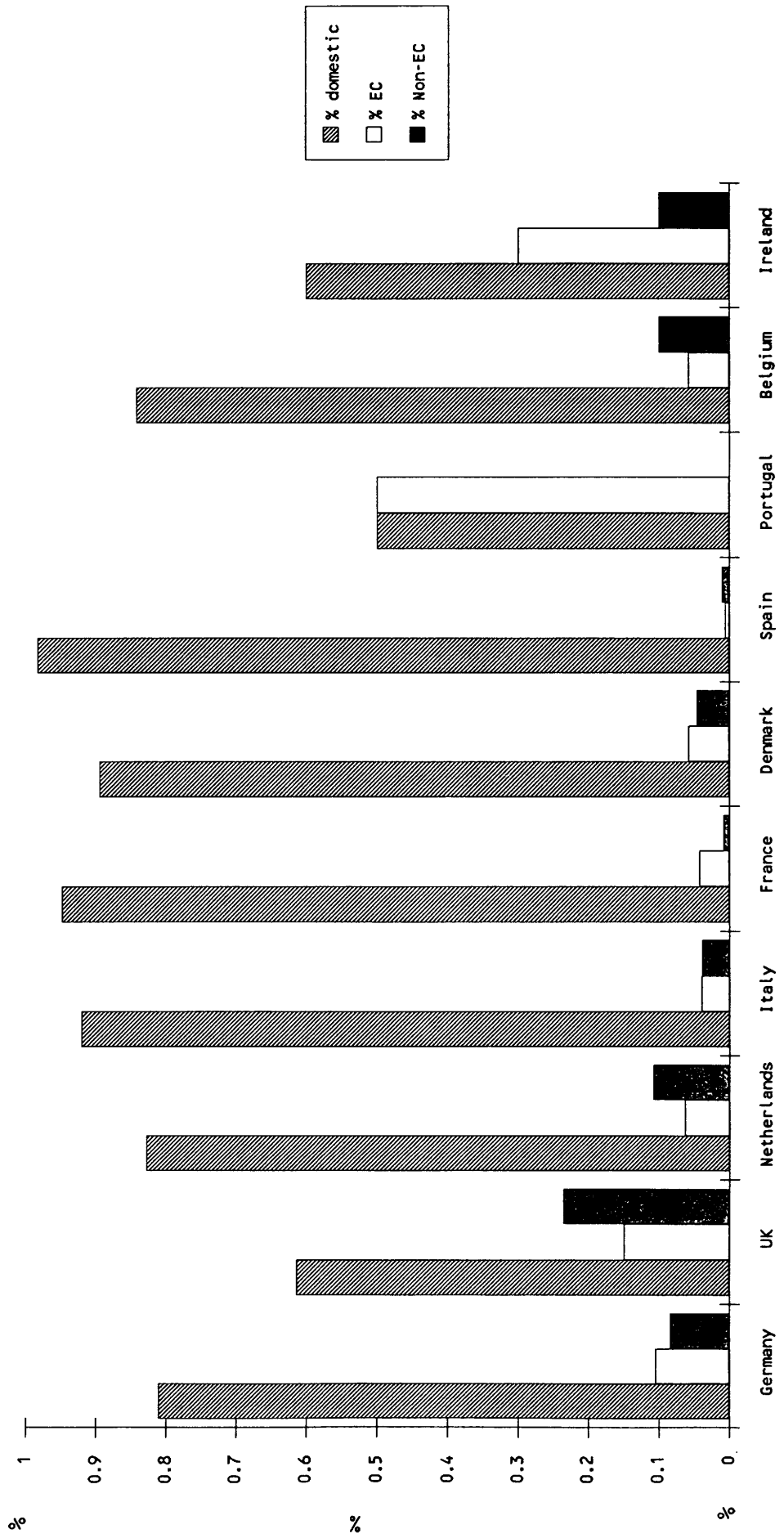
UK fears

The private vs public funding data from the Bossard report help explain why UK CROs are worried about unfair competition in the SEM. When organizations such as TNO receive such large public subsidies (16% of TNO's turnover is subsidy to renew the technological base) and earmarked funds, they can build up a firm base from which to undertake contract R&D. Some of these organizations are also large (TNO is reported to have a staff of 5200), with correspondingly broad expertise. In comparison UK CROs (with the possible exception of AEA Technology) are relatively small organizations and importantly receive no state subsidies.

Although UK CROs believed they were world experts, competitively priced and working directly to the requirements of industry (claimed as major advantages over many CROs in other EC countries), they did not believe that they should be made to compete on such unequal terms. Of course, they were already competing in this market (and apparently successfully), but with the freedoms of the SEM, and the stimulus to the 12 economies, competition from all quarters was expected to increase. UK CROs believed this would leave them at a distinct disadvantage.

Figure 6.1

Sources of funding of contract research: domestic,
from EC countries and from non EC countries



CHAPTER VII: BUSINESS ISSUES AND THE EUROPEAN COMMUNITY

The contract market and the level playing field

Both the size of the market and the number of organizations offering R&D services on a contract basis in the UK have increased over the last decade, and the market has become highly competitive. Within the UK independent CROs receive no direct government support. However, they are increasingly facing competition from public sector and quasi-government bodies that are beginning to act as CROs from publicly funded bases. Similarly on a European Community (and wider) scale CROs are increasingly facing competition from organizations that receive considerable financial assistance from their respective governments (by a variety of means). Not surprisingly UK CROs expressed concern as to the unfairness of the situation and were keen to see the European Community ensure a 'level playing field' as the Single European Market develops. Future competition policy, both within the UK and the EC, will have considerable impacts on the contract market - such impacts need to be fully investigated before implementation.

Mergers and re- organization

As the contract R&D market becomes more competitive, a number of organizations have taken steps to strengthen their positions. This has resulted in mergers of CROs and the changing of status from a Research Association to a private limited company (along the lines of management buyout). A number of CROs have also been threatened with takeover by larger consortia and some CRO managers see such bids becoming more prevalent in the future, particularly as most UK CROs are relatively small, well-run technological organizations that could be incorporated into a consortium, to both work on particular projects and to remain as a profitable technological arm. There was also the belief that such reorganizations/mergers would take place on a wider, European scale, with some CRO managers seeing too many CRO type organizations within the European arena.

Overseas contracts

UK CROs undertake an increasing amount of contract work for overseas organizations. In the short term this shows the excellence of UK innovation and technical development. However, (linked with the comment below on patents and licensing) many managers also feel disquiet about the situation. They see such contracts as part of the technology 'drain' of the UK - UK CROs develop new technology only for it to be used overseas to produce products in direct competition to, and to the detriment of, UK industry. CRO managers believe that there is a need for UK industry to become more aware of CROs' capabilities in order to serve UK industry rather than its competitors.

Staff and mobility The major UK CROs employ a force of some 10 000 qualified scientists and engineers with considerable industrial experience and expertise - a valuable national asset. The nature of contract R&D means that this expertise permeates a considerable part of the UK industrial base. One of the effects of the Single European Market (and general Europeanization and globalization) is to increase movement of qualified personnel. QSEs have been relatively mobile throughout recent years and it is debateable whether there will be a 'sudden' flourish of mobile technologists in the near future. However, some R&D managers think that in the medium term there may be a gradual loss of the best UK contract QSEs, due to the ability to command a higher standard of living in other Member States, and staff recruitment is expected to become harder than at present.

EC Programmes CROs are often involved in EC programmes. CRO managers are climbing the learning curves of 'contract' knowledge and the Commission's requirements for both technical advancement and promoting European cohesion. CRO managers believe involvement (on the whole) worth the effort and helps enhance their European contact base and their involvement in emerging technologies. Industrial customers have a generally more limited knowledge of EC contracts (with some exceptions) and on the whole are further down the learning curves of tackling such contracts. However, both CRO managers and industrial R&D managers expected the experience to become easier and more worthwhile in future years.

Standards harmonization UK CROs are actively involved in the harmonization of European standards. This is seen as one of the most important aspects of the Single European Market, and there are thought to be considerable financial advantages to be gained by involvement. There is a feeling that other EC Governments are doing considerably more than the UK government to promote the involvement of their national and industrial bodies in harmonization of standards.

Patents and licences Although UK CROs have a good technical reputation, by their own admission, many do not make the most of their own technological developments by way of patenting and subsequently licensing. This is also a problem facing HEIs and publicly funded laboratories, and indeed is often noted as one of the reasons for poor exploitation of UK innovation. There may therefore be a need for some form of enhanced link/support system between CROs and other innovative bodies and organizations specialising in the transfer and exploitation of technology.

ANNEX A

THE QUESTIONNAIRES

A THE CONTRACT RESEARCH ORGANIZATIONS

Asterisks() by individual questions indicate that they are particularly relevant to the European Commission.*

I BACKGROUND DATA CONCERNING YOUR ORGANIZATION

1. What is the legal status of your research centre/company?

- a) Public Limited Company []
- b) Private Limited Company []
- c) Company limited by guarantee []
- d) Trading Fund []
- e) Other - please specify []

2. Do you specialize in particular technical or industrial areas?
(Please specify)

.....

3. What services do you offer?

- a) Strategic research without immediate industrial application []
- b) Applied research, development and design []
- c) Testing to standards, controls []
- d) Consultancy - site visits, damage report, technical assessments []
- e) Information / library services []
- f) Manufacturing of products []
- g) Pilot plant facilities []
- h) Software and database facilities []
- i) Project management []
- j) Other - please specify []

.....

4. Are your services :

- a) For any paying customer []
- b) Exclusively for members []
- c) Exclusively for some customers []
- d) Full services to members, with some services available to all customers []
- e) For any paying customer, with additional benefits and services to members []
- f) Other - please specify []

.....

II YOUR CUSTOMER BASE

5. How many customers have you worked for in the last year, including any members for whom you have carried out specially commissioned tasks but excluding those who have received only those benefits common to all in their membership category?

Total customer base []

6. How many of these customers were :

- a) Industrial companies []
- b) Government bodies []
- c) Other - please specify []

.....

7. How many of the customers you have worked for in the last financial year were based overseas, and how has this geographical distribution changed over the last 5 years?

Customers based in UK [%] Customers based overseas [%]

Of the overseas customers, what percentage were based in :

	1983	1988
a) Countries of the European Community (excluding UK)	[]	[]
b) Non-EC European countries	[]	[]
c) USA	[]	[]
d) Rest of the world	[]	[]

If data are not available, please state any perceived changes in your overseas customer base that you think are notable :

.....

8. If possible, please divide your industrial customers between :

	UK based organizations	Overseas organizations
a) Small (<50 employees)	[]	[]
b) Medium (>50-<500 employees)	[]	[]
c) Large (>500 employees) organizations	[]	[]

If you have a membership scheme :

9. How many members do you have? []

What types of membership schemes do you run, and how many members of each type do you have?

	Type of Membership	Number of Members
a) Industrial/company	[]	[]
b) Government	[]	[]
c) Academic	[]	[]
d) Individual	[]	[]
e) Other - please specify	[]	[]

.....

10.* How many of your total membership in the last financial year were overseas-based organizations and how has this geographic distribution changed over the last 5 years?

1988 Members based in UK [] Members based overseas []
 1983 Members based in UK [] Members based overseas []

	1983	1988
a) Number of members from EC (excluding UK)	[]	[]
b) Number of members from non-EC European countries	[]	[]
c) Number of members from the USA	[]	[]
d) Number of members from the rest of the world	[]	[]

If data are not available, please state any perceived changes in your overseas customer base that you think are notable :

.....

11. If possible, please divide your industrial membership into numbers of :

	UK based organizations	Overseas organizations
a) Small (<50 employees)	[]	[]
b) Medium (>50-<500 employees)	[]	[]
c) Large (>500 employees) organizations	[]	[]

12. What is the approximate range of costs of membership for a UK and an overseas based organization?

	UK-based costs			Overseas-based costs		
	<u>Lower</u>	<u>Average</u>	<u>Upper</u>	<u>Lower</u>	<u>Average</u>	<u>Upper</u>
a) Industrial	£	£	£	£	£	£
b) Academic	£	£	£	£	£	£
c) Government	£	£	£	£	£	£
d) Individual	£	£	£	£	£	£
e) Other	£	£	£	£	£	£

If industrial company membership is related to the size of member company, please give an approximate membership fee for UK-based organizations and overseas-based organizations.

	UK-based costs			Overseas-based costs		
	<u>Lower</u>	<u>Average</u>	<u>Upper</u>	<u>Lower</u>	<u>Average</u>	<u>Upper</u>
a) Small	£	£	£	£	£	£
b) Medium	£	£	£	£	£	£
c) Large organizations	£	£	£	£	£	£

III FINANCE

13. Please state total turnover in 1987-88, or the latest year for which figures are available.

YEAR	TURNOVER
1987-88	£ _____
19 -	£ _____

14. Please indicate the proportion of turnover derived from :

	%
a) R&D contracts	[]
b) Short-term technical assistance / consultancy	[]
c) Patents and licences	[]
d) Membership fees	[]
e) Training courses	[]
f) Manufacturing of products	[]
g) Running of research and information "clubs"	[]
h) Information / library services	[]
i) Other - please specify	[]

.....

15.* What percentage of your company's turnover originates from the following sources and how has this changed over the last 5 years?

	% turnover 1983	% turnover 1988
a) UK Government sources	[]	[]
b) UK commercial organizations	[]	[]
c) EC sources	[]	[]
d) EC-based commercial organizations (excluding UK organizations)	[]	[]
e) Non-EC European countries	[]	[]
f) USA	[]	[]
g) Rest of the world	[]	[]
	----- 100%	----- 100%

16. Of the R&D contracts, what % by value (£) is :

a) Single client funded	[]
b) Multi client funded	[]

Of the single client funded projects, what % by value (£) are funded by :

a) UK Government departments	[]
b) Industry	[]

Of the multi-client funded projects, what % were funded by:

	%
a) Wholly UK industry	[]
b) UK industry plus UK Government funds	[]
c) UK industry plus overseas industrial partners	[]
d) UK industry, European industry and EC funds	[]
e) UK industry, European industry and UK Govt. funds	[]
f) UK industry, European industry plus non-EC funds (<i>i.e.</i> EUREKA)	[]
g) Wholly non-UK	[]
h) Other - please specify	[]

.....

IV. STAFF

17. How many staff do you employ? []
How many of these are qualified scientists and engineers? []

Of the scientific personnel, please give approximate numbers involved in :

- a) Large scale R&D projects []
- b) Testing/consultancy []
- c) Library/information []
- d) Administration/clerical []
- e) Other - please specify []

.....

18.* How many European Community nationals (excluding British) do you employ on your staff?

Total European staff []

Of this total, how many are :

- a) Qualified scientists and engineers? []
- b) Scientific (technical) support staff? []
- c) Administration/clerical staff? []

In the last 5 years, has the total of European staff (excluding British nationals) changed in a significant manner?

Increased [] Decreased [] Remained the same []

19. Do you have problems in recruiting qualified scientific staff to your organization?

Yes [] No []

If Yes, has the problem increased, decreased or remained the same over the last 5 years?

Increased [] Decreased [] Remained the same []

V. COMPETITION

20. Who are your main competitors?

(Please prioritize your answers using the numbers 1 to 5 with 1 being your major competitor.)

- a) Your customers' own in-house R&D facilities []
- b) Independent contract organizations []
- c) Government run laboratories []
- d) University departments and related companies []
- e) Research Council Institutes []
- f) Large manufacturing industries []
- g) Nationalized (and recently privatized) industries []
- h) Overseas organizations []
- i) Other - please specify []

.....

21. What methods do you use in the UK, Europe and worldwide to attract your customers?

	UK	Europe	World
a) Advertisement/mailshots	[]	[]	[]
b) Word of mouth	[]	[]	[]
c) Attendance at trade fairs, exhibitions, seminars, etc.	[]	[]	[]
d) Publishing in learned journals, general articles	[]	[]	[]
e) Publishing of trade journals, newsletters	[]	[]	[]
f) Overseas offices/agents	[]	[]	[]
g) Collaboration with overseas organizations under EC or UK Government initiatives	[]	[]	[]
h) Other - please specify	[]	[]	[]

.....

Which of these methods do you think are the most effective?

.....

22.* We are aware that UK contract organizations attract a higher amount of transnational work than do their European counterparts. Why do you think this is?

(Please prioritize your answers using the numbers 1 to 3 with 1 being the most important reason.)

a) Superior technical competence	[]
b) Relatively lower manpower costs	[]
c) Use of English as a "universal" language	[]
d) Other - please specify	[]

.....

VI EUROPE

23.* Have you undertaken contracts for, or as part of, EC funded schemes?

Yes [] No []

If Yes, please specify the initiatives :

.....

.....

Has participation in these schemes led to a noticeable benefit for your organization in the longer term (i.e. has the technology developed in these projects been of actual use in application to the industrial base?)

Yes [] No []

Have you been part of an unsuccessful bid for EC funds for a particular project where that project has, nevertheless, gone ahead without these additional funds?

Yes [] No []

Have you been involved in follow-up projects to EC funded contracts?

Yes [] No []

If Yes, what was the approximate value of the follow-up work in relation to the initial project you were involved in?

£ _____

Again, if Yes, what was the value of this work in relation to the initial project?

0 - 10%	of initial project costs	[]
10 - 50%		[]
50 - 100%		[]
100 - 300%		[]
Over 300%		[]

24.* Have you undertaken contracts for, or as part of, Europewide initiatives, e.g. EUREKA?

Yes [] No []

If Yes, please specify the initiatives :

.....

.....

Has participation in the schemes led to a noticeable economic benefit for your organization in the longer term (i.e. has the technology developed in these projects been of actual use in application to the industrial base?)

Yes [] No []

Has the involvement in such schemes led to continued or enhanced contacts with the European partners?

Yes [] No []

.....

Thank you for your cooperation in filling in this questionnaire. We would be grateful if you would indicate your willingness to allow a follow-up interview to discuss in greater detail some of the issues raised above and more broader issues relating to the changing market for contract research.

The company **IS / IS NOT** willing to allow a follow-up interview.

B THE INDUSTRIAL CUSTOMERS

Please pass this questionnaire to your Technical Director or the appropriate member of your staff best qualified to answer.

I YOUR COMPANY

1. Does your company have its own R&D facilities in the UK?

Yes [] No []

Do you have access to company R&D facilities overseas?

Yes [] No []

2. If your company has no access to company R&D facilities either in the UK or overseas, please give brief reasons why (e.g. no perceived need for R&D, a perceived need but your company cannot justify or afford an R&D department, all your R&D requirements can be (and are) met by outside contractors, etc.)

.....

3. Is your company a member of a research association(s), information or research club(s), or similar?

Yes [] No []

If Yes, please give details.

- a) Member of a research association []
- b) Member of an information or research club []
- c) Other - please specify []

.....

II YOUR COMPANY'S RELATIONS WITH OUTSIDE ORGANIZATIONS

4. What percentage of your total R&D expenditure is spent with outside organizations, either under direct contract or in a collaborative effort?

	%
Direct, explicit contract	[]
Collaborative efforts	[]

Is your company now undertaking more, less or about the same amount of contract research than it was 5 years ago?

More [] Less [] About the same []

How much of your contracted R&D budget is spent in the UK or overseas?

- | | |
|---|------------|
| | % spent in |
| a) UK | [] |
| b) European Commission countries (excluding UK) | [] |
| c) Non-EC European countries | [] |
| d) USA | [] |
| e) Rest of the world | [] |

5. What percentage of the R&D you contract out to UK organizations is contracted to the organizations below, and how has this changed in the past 5 years?

	1988 %	1983 %
a) Universities	[]	[]
b) Independent contract research organizations	[]	[]
c) Government laboratories	[]	[]
d) Other manufacturing companies	[]	[]
e) Other - please specify	[]	[]

6. What type of organization would you use to undertake basic, strategic and applied research?

	(a) Basic	(b) Strategic	(c) Applied
a) University (departments or related companies)	[]	[]	[]
b) Independent contract organizations	[]	[]	[]
c) Government laboratories	[]	[]	[]
d) Other manufacturing organizations	[]	[]	[]
e) In-house	[]	[]	[]
f) Other - please specify	[]	[]	[]

7. What are your reasons for contracting out R&D?
(Please prioritize your answers using the numbers 1 to 5 with 1 being the most important reason.)

a) To gain access to specialist techniques/equipment	[]
b) To gain access to specialist expertise	[]
c) To gain access to additional R&D manpower	[]
d) To allow tight control over the timescale and budget of the project	[]
e) Other - please specify	[]

III CONTRACTS FROM OUTSIDE ORGANIZATIONS

8. Does your company contract out any of its R&D services/facilities to other organizations?

Yes [] No []

If Yes, approximately what percentage of your total company turnover does this contracting bring in?
[] %

If your answer to Question 8 is Yes, please go on to Question 9. If No, please go on to Question 11.

9. Have you always contracted out your R&D facilities where appropriate, or is this a recent development for your company?

Always [] Recently []

10. What are the main reasons for contracting out your R&D facilities?

- a) To make more efficient use of your existing facilities []
- b) To ensure that your own facilities and R&D are up to date with the latest technology? (maintain contact with outside organizations?) []
- c) Other - please specify []

.....

IV EUROPEAN ASPECTS OF YOUR R&D WORK

11. Has the R&D department of your company undertaken contracts as part of any of the EC research initiatives in the last 5 years?

Yes [] No []

If Yes, please specify the initiatives.

.....

Has participation in these schemes led to a noticeable economic benefit for your organization in the longer term (i.e. has the technology developed in these projects been of actual use in application to your industrial base)?

Yes [] No [] Too soon to evaluate []

Has involvement in such schemes led to continued or enhanced contact with the European partners?

Yes [] No []

12. Has your R&D department undertaken contracts as part of non-EC European R&D initiatives, such as EUREKA?

Yes [] No []

If Yes, please specify the initiatives.

.....

Has the participation in these schemes led to a noticeable economic benefit for your organization in the longer term (i.e. has the technology developed in these projects been of actual use in application to the industrial base)?

Yes [] No [] Too soon to evaluate []

Has involvement in these schemes led to continued or enhanced contact with the European partners?

Yes [] No []

13. What percentage of your R&D staff in the UK are EC nationals (excluding British personnel)? Has the number increased, decreased or remained the same over the last 5 years?

% of EC nationals on your R&D staff []

Increased [] Decreased [] Remained the same []

4. What do you think the main effects of the completion of the Single European market in 1992 will have on your policy towards use of contract research?

.....

BACKGROUND DATA ABOUT YOUR COMPANY

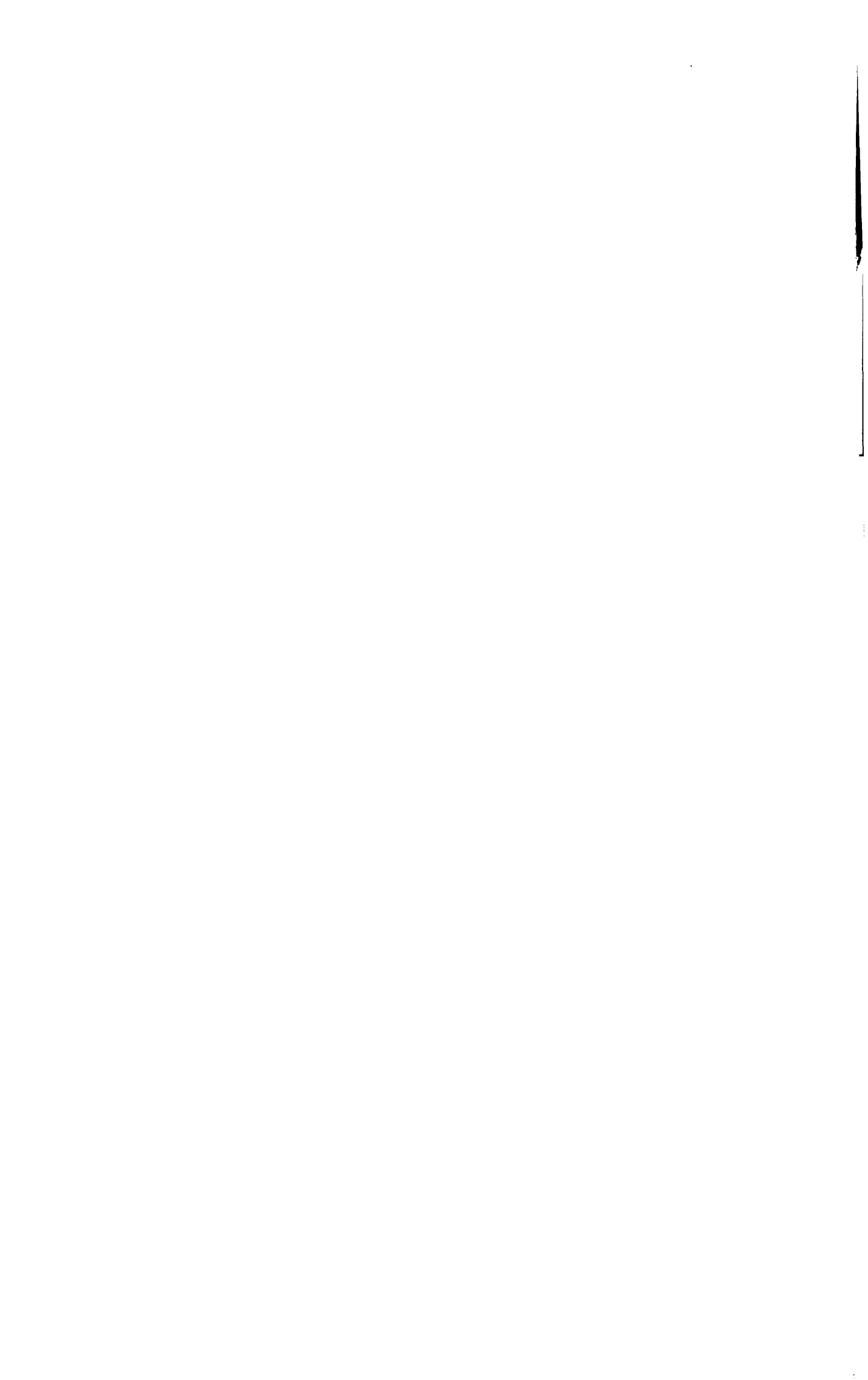
5. What is the total size, in terms of staff and turnover, of your operation in 1987-88?

	Worldwide	UK
Staff numbers	[]	[]
Turnover	[£]	[£]

6. Please indicate your main operational activity/activities using the attached Standard Industrial Classification Codes.

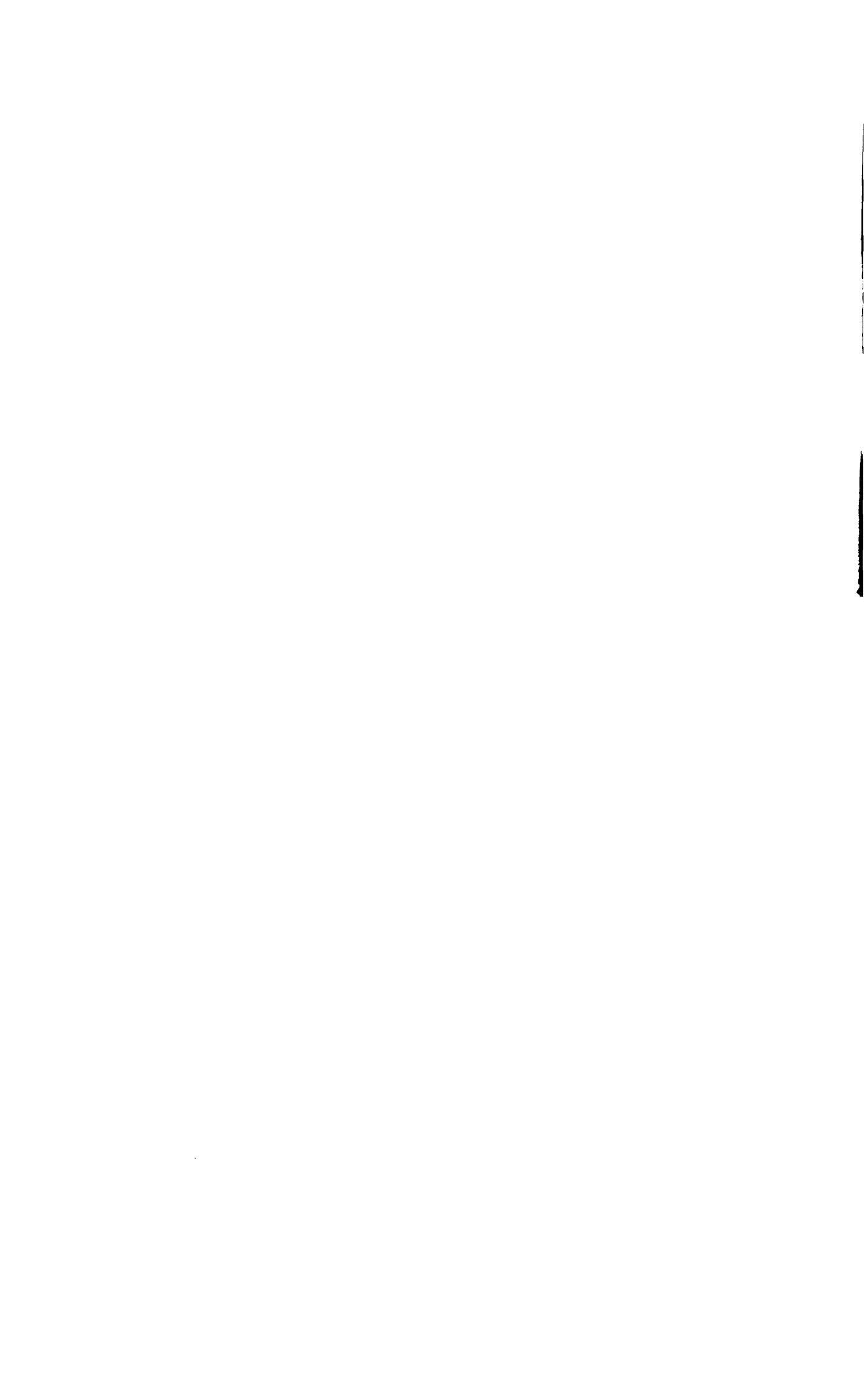
.....

.....



ANNEX B: ABBREVIATIONS

AFRC	Agricultural and Food Research Council
AIRTO	Association of Independent Research and Technology Organizations
CAD	Computer-aided design
CBI	Confederation of British Industry
COST	European Cooperation in the Field of Scientific and Technical Research
CRO	Contract research organization
DES	Department of Education and Science
DTE	Defence Technology Enterprises
DTI	Department of Trade and Industry
EACRO	European Association of contract research organizations
EC	European Community
ESRC	Economic and Social Research Council
EUREKA	European high technology programme
FEICRO	Federation of European Industrial Cooperative Research Organizations
GDP	Gross domestic product
HEI	Higher education institute
IPR	Intellectual property rights
MECU	Million European Currency Units
MOD	Ministry of Defence
MRC	Medical Research Council
NDL	National Physical Laboratory
NEL	National Engineering Laboratory
NERC	Natural Environment Research Council
PCFC	Polytechnics and Colleges Funding Council
PGA	Parliamentary Grant-in-Aid
QSE	Qualified scientists and engineers
RA	Research association
R&D	Research & development
SEM	Single European Market
SERC	Science and Engineering Research Council
SIC	Standard Industrial Classification
SME	Small and medium sized enterprise
UGC	University Grants Committee
UFC	Universities Funding Council
WS	Warren Springs Laboratory



ANNEX C: BIBLIOGRAPHY

Contract research organizations in the EEC
Bossards Consultants, Commission of the European Communities, 1989

Innovation trends 1990
The Confederation of British Industry, 1991

The contract research business in the UK
The Science and Engineering Policy Studies Unit, Policy No 6, 1991

Commission of the European Communities

EUR 14578 - **The Contract Research Business in the United Kingdom.**
- **The European Dimension** -

M.J. Ringe

Luxembourg: Office for Official Publications of the European Communities

1992 — X, 59 pp. — 21.0 x 29.7 cm

Science and Technology policy series

EN

ISBN 92-826-4610-6

Catalogue number: CG-NA-14578-EN-C

Price (excluding VAT) in Luxembourg: ECU 7.50

The report by SEPSU, Royal Society, London highlights European aspects of a larger study investigating a particular facet of the UK R&D scene. The report also investigates Contract Research Organizations (CROs) activities in other Member States.

The number of CROs in the UK was estimated at 70, with 45 of these belonging to the Association of Independent Research and Technology Organization (AIRTO). Income is derived from information services, consultancy, manufacturing, training course, membership fees and other services.

The UK civil market for CROs was estimated at 670 million in 1988/89 and growing. UK CROs believe they are world experts in particular fields and this allows them to undertake a significant amount of work outside the UK. At present 97% of such work carried out in the EC takes place in only 5 Member States — France, Germany, Holland, Italy and the U.K.

Some 75% of CROs linked to AIRTO are involved in EC R&D programmes primarily as participants, the task of project leader/co-ordinator being viewed as being too onerous. Two main problems associated with participation were identified as:

- finding and communicating with potential overseas partners;
- and
- ensuring project specifications met EC requirements.

The Single European Market is seen as an opportunity for CROs to expand their business and client base. However, some CROs expressed concern that competition will not be on an equal basis in all Member States.

Venta y suscripciones • Salg og abonnement • Verkauf und Abonnement • Πωλήσεις και συνδρομές
Sales and subscriptions • Vente et abonnements • Vendita e abbonamenti
Verkoop en abonnementen • Venda e assinaturas

BELGIQUE / BELGIË

Moniteur belge / Belgisch Staatsblad
 Rue de Louvain 42 / Leuvenseweg 42
 1000 Bruxelles / 1000 Brussel
 Tél. (02) 512 00 26
 Fax 511 01 84
 CCP / Postrekening 000-2005502-27

Autres distributeurs /
 Overige verkooppunten

**Librairie européenne/
 Europese Boekhandel**

Avenue Albert Jonnart 50 /
 Albert Jonnartaan 50
 1200 Bruxelles / 1200 Brussel
 Tél. (02) 734 02 81
 Fax 735 08 60

Jean De Lannoy

Avenue du Roi 202 / Koningslaan 202
 1060 Bruxelles / 1060 Brussel
 Tél. (02) 538 51 69
 Télex 63220 UNBOOK B
 Fax (02) 538 08 41

CREDOC

Rue de la Montagne 34 / Bergstraat 34
 Bte 11 / Bus 11
 1000 Bruxelles / 1000 Brussel

DANMARK

J. H. Schultz Information A/S

EF-Publikationer

Ottiliavej 18
 2500 Valby
 Tlf. 36 44 22 66
 Fax 36 44 01 41
 Girokonto 6 00 08 86

BR DEUTSCHLAND

Bundesanzeiger Verlag

Breite Straße
 Postfach 10 80 06
 5000 Köln 1
 Tel. (02 21) 20 29-0
 Telex ANZEIGER BONN 8 882 595
 Fax 20 29 278

GREECE/ΕΛΛΑΔΑ

G.C. Eleftheroudakis SA

International Bookstore
 Nikis Street 4
 10563 Athens
 Tel. (01) 322 83 23
 Telex 219410 ELEF
 Fax 323 98 21

ESPAÑA

Boletín Oficial del Estado

Trafalgar, 27
 28010 Madrid
 Tel. (91) 44 82 135

Mundi-Prensa Libros, S.A.

Castelló, 37
 28001 Madrid
 Tel. (91) 431 33 99 (Libros)
 431 32 22 (Suscripciones)
 435 36 37 (Dirección)
 Télex 49370-MPLI-E
 Fax (91) 575 39 98

Sucursal:

Librería Internacional AEDOS

Consejo de Ciento, 391
 08009 Barcelona
 Tel. (93) 301 86 15
 Fax (93) 317 01 41

**Librería de la Generalitat
 de Catalunya**

Rambla dels Estudis, 118 (Palau Moja)
 08002 Barcelona
 Tel. (93) 302 68 35
 302 64 62
 Fax (93) 302 12 99

FRANCE

**Journal officiel
 Service des publications
 des Communautés européennes**
 26, rue Desaix
 75727 Paris Cedex 15
 Tél. (1) 40 58 75 00
 Fax (1) 40 58 75 74

IRELAND

Government Supplies Agency

4-5 Harcourt Road
 Dublin 2
 Tel. (1) 61 31 11
 Fax (1) 78 06 45

ITALIA

Licosa Spa

Via Duca di Calabria, 1/1
 Casella postale 552
 50125 Firenze
 Tel. (055) 64 54 15
 Fax 64 12 57
 Telex 570466 LICOSA I
 CCP 343 509

GRAND-DUCHÉ DE LUXEMBOURG

Messageries Paul Kraus

11, rue Christophe Plantin
 2339 Luxembourg
 Tél. 499 88 88
 Télex 2515
 Fax 499 88 84 44
 CCP 49242-63

NEDERLAND

SDU Overheidsinformatie

Externe Fondsen
 Postbus 20014
 2500 EA 's-Gravenhage
 Tel. (070) 37 89 91 1
 Fax (070) 34 75 778

PORTUGAL

Imprensa Nacional

Casa da Moeda, EP
 Rua D. Francisco Manuel de Melo, 5
 1092 Lisboa Codex
 Tel. (01) 69 34 14

**Distribuidora de Livros
 Bertrand, Ld.ª**

Grupo Bertrand, SA
 Rua das Terras dos Vales, 4-A
 Apartado 37
 2700 Amadora Codex
 Tel. (01) 49 59 050
 Telex 15798 BERDIS
 Fax 49 60 255

UNITED KINGDOM

HMSO Books (PC 16)

HMSO Publications Centre
 51 Nine Elms Lane
 London SW8 5DR
 Tel. (071) 873 2000
 Fax GP3 873 8463
 Telex 29 71 138

ÖSTERREICH

**Manz'sche Verlags-
 und Universitätsbuchhandlung**

Kohlmarkt 16
 1014 Wien
 Tel. (0222) 531 61-0
 Telex 11 25 00 BOX A
 Fax (0222) 531 61-39

SUOMI

Akateeminen Kirjakauppa

Keskuskatu 1
 PO Box 128
 00101 Helsinki
 Tel. (0) 121 41
 Fax (0) 121 44 41

NORGE

Narvesen information center

Bertrand Narvesens vei 2
 PO Box 6125 Etterstad
 0602 Oslo 6
 Tel. (2) 57 33 00
 Telex 79668 NIC N
 Fax (2) 68 19 01

SVERIGE

BTJ

Box 200
 22100 Lund
 Tel. (046) 18 00 00
 Fax (046) 18 01 25

SCHWEIZ / SUISSE / SVIZZERA

OSEC

Stampfenbachstraße 85
 8035 Zürich
 Tel. (01) 365 54 49
 Fax (01) 365 54 11

CESKOSLOVENSKO

NIS

Havelkova 22
 13000 Praha 3
 Tel. (02) 235 84 46
 Fax 42-2-264775

MAGYARORSZÁG

Euro-Info-Service

Budapest I. Kir.
 Attila út 93
 1012 Budapest
 Tel. (1) 56 82 11
 Telex (22) 4717 AGINF H-61
 Fax (1) 17 59 031

POLSKA

Business Foundation

ul. Krucza 38/42
 00-512 Warszawa
 Tel. (22) 21 99 93, 628-28-82
 International Fax&Phone
 (0-39) 12-00-77

JUGOSLAVIJA

Privredni Vjesnik

Bulevar Lenjina 171/XIV
 11070 Beograd
 Tel. (11) 123 23 40

CYPRUS

**Cyprus Chamber of Commerce and
 Industry**

Chamber Building
 38 Grivas Dhigenis Ave
 3 Deligiorgis Street
 PO Box 1455
 Nicosia
 Tel. (2) 449500/462312
 Fax (2) 458630

TÜRKIYE

**Pres Gazete Kitap Dergi
 Pazarlama Dağıtım Ticaret ve sanayi
 AŞ**

Narlibahçe Sokak N. 15
 İstanbul-Çağaloğlu
 Tel. (1) 520 92 96 - 528 55 66
 Fax 520 64 57
 Telex 23822 DSVO-TR

CANADA

Renouf Publishing Co. Ltd

Mail orders — Head Office:
 1294 Algoma Road
 Ottawa, Ontario K1B 3W8
 Tel. (613) 741 43 33
 Fax (613) 741 54 39
 Telex 0534783

Ottawa Store:

61 Sparks Street
 Tel. (613) 238 89 85

Toronto Store:

211 Yonge Street
 Tel. (416) 363 31 71

UNITED STATES OF AMERICA

UNIPUB

4611-F Assembly Drive
 Lanham, MD 20706-4391
 Tel. Toll Free (800) 274 4888
 Fax (301) 459 0056

AUSTRALIA

Hunter Publications

58A Gipps Street
 Collingwood
 Victoria 3066

JAPAN

Kinokuniya Company Ltd

17-7 Shinjuku 3-Chome
 Shinjuku-ku
 Tokyo 160-91
 Tel. (03) 3439-0121

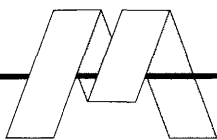
Journal Department

PO Box 55 Chitose
 Tokyo 156
 Tel. (03) 3439-0124

**AUTRES PAYS
 OTHER COUNTRIES
 ANDERE LÄNDER**

**Office des publications officielles
 des Communautés européennes**

2, rue Mercier
 2985 Luxembourg
 Tél. 49 92 81
 Télex PUBOF LU 1324 b
 Fax 48 85 73/48 68 17
 CC bancaire BIL 8-109/6003/700



NOTICE TO THE READER

All scientific and technical reports published by the Commission of the European Communities are announced in the monthly periodical '**euro abstracts**'. For subscription (1 year: ECU 110) please write to the address below.

Price (excluding VAT) in Luxembourg: ECU 7.50

ISBN 92-826-4610-6



OFFICE FOR OFFICIAL PUBLICATIONS
OF THE EUROPEAN COMMUNITIES

L-2985 Luxembourg



9 789282 646106 >