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Policy Study No. 2

COLLABORATION IN SCIENCE AND TECHNOLOGY BETWEEN THE UK AND JAPAN

SCIENCE AND ENGINEERING POLICY STUDIES UNIT

THE ROYAL SOCIETY THE FELLOWSHIP OF ENGINEERING

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COLLABORATION IN SCIENCE AND TECHNOLOGY BETWEEN THE UK AND JAPAN

A report for the Cabinet Office and the UK–Japan 2000 Group

SEPSU Policy Study No. 2

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PREFACE

The impact of Japanese development is rapidly becoming very significant, not only for British commerce but also for British science and technology. Collaboration in science and technology is achieving increasing prominence in relations between the two countries. Recognizing this, the UK–Japan 2000 Group, at its 1987 annual meeting, decided to commission two surveys of S&T collaboration, one in each country. The UK Cabinet Office also has a strong interest in these matters and agreed to co-sponsor the UK survey. The UK–Japan 2000 Group and the Cabinet Office jointly commissioned the Science and Engineering Policy Studies Unit of the Royal Society and the Fellowship of Engineering to carry out the survey.

This report describes the findings of the survey. It takes as its definition of collaboration any activity involving exchange of scientific or technical knowledge between partners. It focuses mostly on the industrial and academic sectors, and reveals a complex picture of interactions. In both sectors there are many forms of collaboration and a wide range of objectives. Knowledge flows in either direction or in both, often changing as collaborations develop. Industrial collaborations are characterized by clear targets, precise agreements on intellectual property, long-term strategy. Collaborations between the UK academic sector and Japan—in one fifth of the sample, a Japanese company—are often relatively informal. In both sectors, a variety of benefits and of constraints is reported.

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The impression that there is a growing interest in the UK in Japanese science and technology, and that there is a growing awareness of the possibilities of collaboration, is confirmed by this report. We hope that the report will stimulate further interest, help those already involved in collaboration to reflect on their experiences and help others to assess what role collaboration might play in their activities.

Sir Roger Elliott, Sec.RS
Chairman, SEPSU Steering Group

Sir Kenneth Corfield, F.Eng
Vice-Chairman, SEPSU Steering Group

March 1988

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SUMMARY

This study is concerned with the nature of S&T collaboration between the UK and Japan. It covers all sectors—academic, industrial and Government—and many disciplines. It ranges over many different types of collaboration, and describes the key characteristics of each. We use 'collaboration' here to mean the sharing of scientific or technical knowledge between British and Japanese partners.

Data were gathered mostly by questionnaire; we also carried out a number of personal interviews. The study aroused considerable interest, and this was reflected in the high response rates we obtained: 76% in the industrial survey and 82% in the academic survey.

Respondents nearly all agreed on the growing significance of Japan, and of collaboration with Japan, for their enterprises. There were many reasons for this: Japan was a very large market for certain products; it would be a large market in the future for other products so now was the time to become established in it; it could be a useful partner in attacking a third market; it was a valuable source of science and, particularly, technology; it set high standards of performance; it was keen to acquire certain products and skills; it could provide additional resources for UK academics facing financial pressure.

Two key issues are the balance of flow of scientific and technical knowledge between the two countries, and the overall balance of benefit from the collaboration. These balances are not static: during the course of a developing relationship between two partners, the content and the character of collaboration can change considerably as the relative strength of the two partners changes or the technical objectives of the collaboration are modified. It should also be stressed that examples of knowledge flow in either direction are to be found within each broad disciplinary area that we examined.

It does appear, however, that the collaborations we studied involved S&T knowledge flowing to Japan more frequently than from Japan. Thus 14 industrial collaborations involved the granting of licences to Japanese companies, as opposed to 5 where the licence was granted to a British company. 42 British academics, and 80 of their Japanese partners, derived increased expertise from their collaborations; 28 British, and 39 Japanese, secured access to material, experimental data or equipment. Where an industrial collaboration involved two-way flow, it was often—but not always—the case that relatively basic knowledge flowed to Japan and manufacturing technology and product innovation flowed from Japan.

Measuring the balance of S&T flow does not in itself give a calculus of overall benefit. The range of objectives in collaboration mentioned earlier implies that many benefits other than acquisition of S&T knowledge can accrue from collaboration. Our data do not allow us to judge whether the two countries will, in the long term, benefit equally from their collaboration in S&T. Many—but by no means all—of our respondents appear to be pleased with their experiences and expect collaboration to grow in the future.

In 21% of collaborations involving UK academics, the Japanese partner was based in industry; three quarters of these collaborations were initiated, and half entirely paid for, by the Japanese company. UK companies reported considerable difficulty in setting up analogous collaborations with Japanese universities or research institutes.

Industrial collaboration could involve very large commitments. It could also be a way of spreading research or development costs, and the associated risk. Academic collaboration was generally cheap: 20% of cases were funded entirely by the Japanese partner, a further 44% cost the UK partner less than £1000 on top of normal running expenses and 71% less than £10 000.

We found many different routes to initiating collaboration. Some companies already had offices in Japan or well established trading links to provide a natural entrée to collaboration; others set out to establish collaborations from scratch. A number of collaborations involving

UK industry, and half the collaborations involving UK academics, were initiated by the Japanese partner. What approaches all have in common is the need for patience, demonstrable technical competence, goodwill, willingness to socialize and a long-term perspective in order to build up the mutual trust and esteem vital to successful collaboration. Good communication has to be worked at. The personal qualities of the individuals driving the collaboration on each side are central to the success of the collaboration.

The management of collaboration is also very varied. In the industrial survey, the 74 collaborations detailed to us included 18 joint ventures, 19 licence agreements and 24 R&D collaborations. In the academic survey, the great majority of collaborations involved individual academics acting personally. Very few academic collaborations made provision for intellectual property rights.

Numbers of Japanese undergraduates and postgraduates in UK universities were static during 1975-1985, averaging 97 and 212 respectively. In 1986 the numbers rose to 168 and 276. Only 19% of Japanese undergraduates and 21% of Japanese postgraduates were taking courses in science or engineering.

Of Government Departments and related bodies, the Department of Trade and Industry, the British Council and the Research Councils are the most actively involved in collaboration with Japan. Most other Departments have no contact beyond informal liaisons set up on an *ad hoc* basis by their research establishments, though one or two are now exploring the scope for collaboration. There appears to be little enthusiasm among Departments for an over-arching bilateral agreement with Japan on S&T.

Learned societies and institutions had fairly modest involvement in Japan. Two out of 25 had substantial schemes for exchange of scientists or engineers with Japan. Half had links with their opposite bodies in Japan, and some made efforts to disseminate information about Japanese research. It appears that Japanese researchers are more willing to make long visits to the UK than *vice versa*.

This study has provided an overview of collaboration in many sectors and disciplines. It has identified a number of issues that need to be understood if there is to be a properly informed debate about policy for collaboration with Japan. It provides a starting point for detailed investigation of these issues.

I. INTRODUCTION

Origins

This study has its origins in the January 1987 meeting of the UK–Japan 2000 Group, at which collaboration in science and technology was identified as an important focus for relations between the UK and Japan. It was decided that parallel studies should be carried out in the UK and in Japan; this report deals with the UK experience of collaboration.

The Cabinet Office has a strong interest in S&T collaboration with Japan. Jointly with the UK–Japan 2000 Group it therefore agreed to commission this report from the Science and Engineering Policy Studies Unit of the Royal Society and the Fellowship of Engineering. SEPSU began work in August 1987; a summary report was presented to the January 1988 meeting of the UK–Japan 2000 Group.

This report, which has been sanctioned by the Councils of the Royal Society and the Fellowship of Engineering, was prepared by Dr P.M.D. Collins and Mrs H.J. Moxham. The study was guided by a Task Group under the chairmanship of Dr D.S. Oliver, C.B.E., F.Eng; other members were Dr B. Bridges, Mr S.J. Cox, Dr A.W.C. Keddie, Professor J.E. Midwinter, O.B.E., F.Eng, F.R.S., Dr J.A. Richards and Dr P.T. Warren.

Aims

The report looks at collaboration mainly from a UK perspective. Data were gathered by sending questionnaires to organizations and individuals in the UK asking about their experience of collaboration; a number of personal interviews were conducted where time allowed. We are most grateful to those who responded. The objective was to find out as much as possible about the sorts of collaborative activity now under way: the questionnaires were therefore sent in the main to those known or thought to have experience of collaboration, rather than to statistically representative samples. This tactic maximized the amount of positive information obtained, at the expense of making it impossible to extrapolate our results to give a picture of the UK as a whole.

Content of the report

Our results are presented sector by sector. Chapter II deals with collaborations between UK industrial companies and their partners in Japan. Chapter III deals with collaborations involving the UK academic sector: the majority of their partners were Japanese universities, but significant numbers were Japanese companies or research institutes. Data on the numbers of Japanese-domiciled undergraduates and postgraduates in UK universities are presented in Chapter IV. In June 1986 the Cabinet Office conducted a survey of Government Departments' S&T collaboration with Japan: Chapter V updates that survey. Chapter VI looks at the collaborative activities of a selection of learned societies and institutions.

It has not been our objective in this report to make recommendations for changes in policy. Such recommendations should be preceded by a survey of current practice: our objective has been to carry out that survey. Its value lies first in bringing together an account of practice in all sectors so that one can, for example, compare industrial with academic experience; and second, within each sector, in highlighting the characteristic features of collaboration and helping actual or poten-

tial collaborators to deepen their understanding and make best use of the opportunities. Chapter VII therefore draws conclusions related to these objectives rather than to major changes in policy.

Indeed, it would be pretentious to imagine that, after only a few months' study across a very broad front, we could produce anything other than fairly general comments or add much to the insight of experienced collaborators. But we have been able to identify a set of issues where more detailed investigation may be expected to yield insights valuable to decision-makers at national and at corporate level, in industry or in academe. This report provides a starting point for such further investigation.

One aspect of collaboration that we have not examined, other than as part of our survey of learned societies and institutions, is exchange schemes. Information on the various schemes promoting exchanges between the UK and Japan is already easily accessible; some sources are mentioned under suggestions for further reading. Assessment of the effectiveness of the schemes in terms of stimulating research, promoting closer relations between the two countries or enhancing the careers of individual researchers was beyond the scope of our study.

Our questionnaire surveys achieved a very high response rate. This reinforces impressions gained from numerous conversations, that many people recognize the importance of the issues at hand for the future of their individual enterprises. Most of those we contacted were positive in their outlook: Japan's strong industrial performance and rapidly improving ability in scientific and technical research provided opportunities to be seized rather than threats to be resented or ignored. This may, of course, simply reflect the fact that our contacts were, deliberately, selected from those with experience of collaboration with Japan. But increasing numbers both of industrial companies and of academics are taking S&T collaboration with Japan seriously, and the indications are that this trend will continue.

S&T collaboration is one aspect of relations between the UK and Japan. In this report we have, of necessity, treated it in isolation, though ideally it should be set in the context of broader political, commercial, industrial and cultural relations. It may well be that these considerations will prove as important for future developments as the internal dynamics of S&T collaboration between the two countries.

II. INDUSTRY

(i) Introduction

Coverage

In the industrial part of our study the aim was to gather as much information as possible about the experiences of British companies entering into scientific or technical collaborations with Japanese companies. In order to cover sufficient breadth of companies in the time available, we used a questionnaire, supplemented by interviews where these could be arranged. The companies selected fall into five broad sectors: chemicals and pharmaceuticals, electrical and electronic, engineering (civil and mechanical), materials, and other (mostly energy).

Questionnaire and interviews

We identified some 75 companies known or thought to have relevant experience in Japan, telephoned them to establish their willingness to receive a questionnaire and confirm the identity of the key contact, and then sent out the questionnaire. The questionnaire asked for background information about the company itself and about the history of its dealings with Japan, and then looked in greater detail at specific instances of collaboration. We received replies from 57 companies (76%). Of these companies, 10 proved not to have relevant collaborative experience, or otherwise to be unable to complete the questionnaire; the remaining 47 provided analysable information about a total of 74 collaborations. We carried out interviews with ten of the 47 companies.

The questionnaire focused on collaborations involving exchange of scientific or technical knowledge. 'Purely commercial' collaborations were excluded. This phrase was intended to cover, for example, the marketing in Japan of products imported ready-made from the UK. Some of the companies we contacted proved to be involved solely in trading collaborations; one or two others took the line that their objectives were profit, hence 'purely commercial', hence excluded. But most respondents were able to provide information about collaborations that came within our terms of reference, and a quarter of them described more than one collaboration.

It was striking that nearly everyone we spoke to recognized the importance of the issues being addressed, and many went to considerable lengths to provide information. Responses were considered, if not drafted, at senior management levels within each company. We are most appreciative of the time and trouble that many people took to respond to our requests for information.

We asked about collaboration between British companies and Japanese organizations. Virtually all the collaborations reported were with Japanese companies rather than, for example, research institutes or universities.

One respondent warned about the dangers of over-generalization: each collaboration was a special event, driven by its own internal logic. Given the heterogenity of the companies that together constitute 'industry', one clearly needs to be aware of over-simplification. Indeed, even among the relatively small number of companies that we surveyed, a wide range of objectives, structures and experiences is apparent. The following analysis therefore aims to combine description of individual experience with elucidation of a few key themes that may

help readers reflect on the UK's collective experience in S&T collaboration with Japan and apply what is relevant from that experience to their own situations. The analysis is structured round three dimensions: objectives, management issues, and problems and pointers.

Coding

Individual companies are denoted below by a number between 1 and 99 : [99] indicates a UK company, and [99J] the Japanese company with which it is collaborating. Where a UK company has been involved in several collaborations, its partners are designated [99JA], [99JB], etc. The enumeration has not been arranged alphabetically, i.e. [99] does not necessarily denote a company towards the end of the alphabet.

It should be emphasized that our results relate to the selection of companies approached, and cannot necessarily be extrapolated even to the individual industrial sectors covered, let alone to British industry as a whole.

(ii) Objectives of collaboration

Profit

The prime objective for collaboration with Japan is profit. This emerges not only from responses to a direct question about objectives, but also from how companies evaluate the success of their collaborations and how they see the actual or expected benefits. That the objective should be profit is obvious, and to that extent uninformative. It is mentioned at the beginning of this section to make the point that the more detailed and specific objectives discussed below (market share, acquisition of technology, development of new products, etc) are essentially subsets of the profit objective and are usually judged by the contribution they make, in the short or long term, to that objective.

Many respondents stressed the need to take a long-term view on profit. Gaining the trust of the collaborative partner and establishing a good working relationship, building up confidence with customers, dealing with regulatory requirements, winning a market share, expanding the market share, responding to new opportunities, all come before making significant profits. The process can take upwards of ten years.

Exploitation of UK knowledge in the Japanese market

A little under half of the collaborations described to us involved exploitation of UK knowledge in the Japanese market, either directly by UK companies, or by Japanese companies or by some form of partnership.

A prime objective of collaboration, for British companies that have particular skills or knowledge to sell, is to secure or expand a position in the Japanese market. This is often at the initiative of the British companies themselves, but not always: one respondent [6] commented that Japanese companies were active and positive in seeking licences, particularly when they wished to diversify their product range.

Collaboration with a Japanese company is seen, by nearly all our respondents, as a prerequisite for penetrating the Japanese market. Why this should be so varies from case to case.

In the pharmaceutical sector, the complexities of the procedures for registering drugs in Japan, even after they have been registered successfully in other countries, place a special premium on local know-

ledge, which cannot readily be obtained other than via a Japanese company. This applies both to gaining safety clearance and to gaining a satisfactory price. In some cases (e.g. [22], [31]), the additional research needed to obtain registration is done jointly with the Japanese partner; in others (e.g. [23], [34A]), it is done entirely by the Japanese partner. On the other hand, [31] has now established in Japan its own facility for evaluating, prior to patenting, the potential of new products for the Japanese market; this will reduce its dependence on its Japanese partners for help in development. Marketing drugs, which are generally sold by the doctors who prescribe them, requires further special local knowledge and local contacts.

In other sectors, collaboration can be politically necessary for entry into a market ([1], [50B]). Licensing a Japanese partner to manufacture a UK product solely for the Japanese market can be an effective way both of attacking that market and of avoiding becoming overstretched financially. Some companies (e.g. [25]) have a policy of manufacturing products in the country in which they are to be sold: this implies setting up a company in that country, often in collaboration with an existing native company, and being able readily to provide technical assistance in support of sales.

Some collaborations ([62], [83]) were aimed at securing finance for development, with the UK company providing the initial knowledge base and the Japanese company providing the finance.

Sometimes the objective is sale of technology rather than market share as such. This is, obviously, the case for commercial R&D organizations whose 'product' is scientific or technical knowledge or technical services. For such companies 'collaboration' is a means to increasing their clientele. The technology on offer need not be new: one respondent has given licences to a number of Japanese companies in order to make money out of technology that it no longer exploits itself, or out of spin-off technology from its mainstream R&D. A second respondent granted a licence to the Japanese company, on request, to develop and manufacture a product that it regarded itself as of doubtful commercial potential. In another case, the 'technology transfer' took the form of a patent taken out in Japan by a UK company, that it had never exploited itself and that a Japanese company then bought in order to prevent its exploitation by any rivals. Technology might be transferred to Japan because, in that particular area, Japan was behind the West and thus a relatively penetrable market. [85] reported unsuccessful attempts to find partners in the UK to exploit a novel idea, before being approached by a Japanese company competent and keen to collaborate. [44], however, had to take its technology round half a dozen Japanese companies before being able to interest one; this was a strong contrast to [42], which could take its pick from numerous Japanese suitors bidding for an exclusive licence to develop its technology in the Japanese market.

Exploitation by UK companies of Japanese knowledge

Nearly one fifth of the industrial collaborations described to us involved science or technology flowing from Japan. This does not, of itself, prove anything about the relative strengths of British and Japanese S&T: the finding that a higher proportion of collaborations involved a flow of knowledge to Japan could be an outcome of our having spoken

only to British firms and not, for example, to Japanese firms setting up operations in the UK. Analysis of the division of labour within collaborations, however, does lend weight to the thesis that UK companies are often particularly strong at the more basic end of S&T and at early development, and Japanese companies are strong at later development, manufacturing technology and process engineering.

Some companies reported that they had approached Japanese partners in order to secure licence to manufacture a product needed to plug a gap in their own product range or to modernize their entire range ([65], [85B]). At least initially, these moves were aimed at rescuing the companies concerned from positions of some weakness. From a stronger position [68] wanted to expand its range: it identified [68JA] as the world leader in a particular technology and entered into a collaboration with it to set up a plant in Europe and tackle the European market. [21]'s collaboration, similarly, was aimed at using techniques unique to [21J] to develop a new product for the European market. [50A] entered into collaboration in order to gain access to state-of-the-art technology and thus become more competitive at the top end of the market. [30] has evaluated several products of [30J] for potential exploitation, under licence, in the European market, though so far the evaluations have yielded negative results; the same is true of other companies. [47] entered into a series of technical collaborations with [47J] in order to use [47J]'s knowhow to reduce costs and increase yields in its own production processes. Very substantial improvements had resulted, not only in costs and yields but also in the attitude of the workforce.

Contract research organizations dealing with Japanese clients increase not only their customer base but also their knowledge base. This is particularly important in those technologies where Japan is acknowledged to be the world leader.

Several companies had transferred technology to Japanese partners at least partly in the hope that they would be regarded favourably when the partner was looking to license some of its own innovations outside Japan.

A company that had a large wholly-owned operation in Japan made special efforts to identify Japanese manufacturing equipment that might be useful for its European activities.

Two companies reported that they had made use of the Visiting Engineers Scheme (see chapter V (i) below), enabling staff in one instance to broaden their experience by learning about Japanese technology, and in the other to study the manufacturing and quality control procedures of a Japanese supplier.

Two-way flow of scientific and technical knowledge

A good deal of collaborative activity occupies the middle ground between the poles of unidirectional flow of knowledge either to or from Japan. Moreover, many collaborations based initially on a one-way flow of information develop into two-way collaborations. Two-way flow takes a variety of forms.

A fairly typical example from the pharmaceutical sector is [23]: [23] gives [23JB] all necessary information about a new drug, while retaining full patent rights; [23JB] does the development work necessary for

registration in Japan and provides data derived from this process to [23]; [23JB] then buys the drug from [23], markets it in Japan and relays to [23] the results of further development work. In [24]'s collaboration, the UK partner does the research and early development, and the Japanese partner does the later development, clinical trials, manufacturing and marketing.

This pattern of one company (generally British) providing the initial information (basic/applied research) and the other (generally Japanese) doing the development work plus, importantly, the continuing post-launch innovations is repeated in other sectors. There were also some, albeit fewer, examples of the converse division of labour. These arrangements can prove very beneficial to both parties: [42]'s experiences of granting a manufacturing licence to [42J] were so positive that, when the licence expired after 21 years, it was replaced by a 10-year agreement for free exchange of technology between the two companies.

In other cases the two partners work together on the same phase(s). Following a successful collaboration in which the Japanese partner had developed and commercially exploited the UK partner's product, [23] and [23JA] agreed to mutual transfer of R&D information, licence option to exploit products arising from such research in Europe and Japan respectively, transfer of rights to improvement patents and trade marks, and supply of raw material if a licence agreement were initiated. [22], however, limits its collaborative research to specific regulatory objectives; in its case, cultural and cost considerations rule out joint research at any more general level for the time being. [26] and [26J] agreed to collaborate on research to find a manufacturing route for a new product; this subsequently evolved into a joint development operation, and is likely to be extended further into joint manufacturing and worldwide marketing. [34] and [34JB] have complementary research skills and research styles; in addition [34JB] is a unique source of a raw material that [34] is particularly well placed to develop into potentially useful products. The two companies have therefore entered into a research agreement for joint work exploiting the raw material. [63] and [63JB] are collaborating on the development of a product designed initially by [63JB] to which [63] has worldwide marketing rights. [65] has moved from essentially manufacturing [65J]'s product under licence to joint design and development work with [65J] on further products. [68] has two joint ventures with [68JB], coupled with technical agreements through which initial product design is done in Japan, then modified in the UK and tested in Japan, with the associated production engineering being based on best practices in both companies.

Nearly simultaneous patenting can lead to collaboration. [34JC] had organized a collaboration with another Japanese company to develop a product that it was about to patent; it then discovered that [34] had already patented the same product, and was therefore obliged to seek a licence from [34]. [31] and [31JB] developed the same new product independently and simultaneously; they decided to collaborate rather than fight over patents, and drew up an agreement covering marketing rights, royalty payment and access to improvements made by each other during subsequent development of the product.

Two-way flow of information can sometimes be limited to just that. [43], for example, has no specific S&T collaboration with Japanese companies, but has established friendly relations with several and has mutual exchanges of views with them about the manufacturing process and the marketplace. [81] has an agreement with [81JB] that provides for two-way exchange of experience in the first instance, with the possibility of joint R&D and joint exploitation of consequential developments. [10]'s experience is more positive: alongside two very active collaborative R&D agreements, [10] and [10JB] have formally agreed to hold annual technical meetings for exchange of information: these have led to the signing of two further collaborative R&D agreements.

Informal objectives

We asked respondents to identify both their formal (i.e. official) and their informal objectives in collaboration. Many ignored the question about informal objectives or said they were the same as the formal objectives. However, seventeen respondents admitted to having a hidden agenda, with one or more of the following items on it:

— to establish a position in a market seen as having great importance in the long term;

— to establish a good working relationship with the Japanese partner, again for strategic commercial reasons such as securing favourable access to other technologies or being able to call on the partner's help when needed;

— to assess the suitability of the Japanese partner for more important collaboration in the future (Japanese companies were said sometimes to be testing out their British partners in the same way);

— to keep a close watching brief on the relevant sector of Japanese industry from the inside;

— to achieve sales of other components to the Japanese partner and to other Japanese companies;

— to become known to potential customers through exchange visits;

— to be seen by other potential customers to be dealing with the technological leaders;

— to help a wholly-owned subsidiary in Japan to gain in stature by being associated with a major Japanese company;

— to head off potential long-term competition by entering into collaborative product development jointly with Japanese companies in the sector;

— to keep up to date with developments;

— to gain a better understanding of Japanese managerial systems;

— to be able to send teams from the UK workforce into Japanese plants to see how their high levels of performance are achieved;

— to obtain a better understanding of the scientific and clinical development requirements of the Japanese authorities who give marketing authorization;

— to develop skills usable in other contexts;

— to gain experience of clinical efficacy with an unfamiliar ethnic group;

— to achieve a better understanding of the general approach to advanced research in the relevant field.

Why Japan?

We asked respondents to indicate why they had chosen to collaborate with Japan rather than another country, and how they rated Japan against other countries from a commercial perspective and from an S&T perspective. In a number of cases, there was nothing special about the Japanese connexion: it was simply a question of extending to the Japanese market the sort of operation that the company had already established in other countries. Such extension might coincide with an appreciation of the sheer size of the Japanese market (e.g. in pharmaceuticals) or of its strategic commercial importance in the long term (e.g. electronics, mechanical engineering).

There was growing regard for Japan's importance from the science and technology perspective. This was true for collaborations involving transfer of knowledge into Japan no less than for those involving transfer from Japan. In some cases it was a matter of establishing good relations now from a position of relative S&T strength, as a hedge against a time when relative strengths were at least more even, if not reversed. In others, access to Japanese technology was seen as essential for survival: 'Any organization related to [a particular field], and claiming international status, needs to penetrate the Japanese market in order to keep abreast of developments.' The number of companies keeping watching briefs on developments in Japan, whether as the main objective of a collaboration or as an informal objective, is evidence of recognition for Japan's growing S&T competence. Several companies regarded Japan as a valuable source of new products, either *ab initio* or subsequent to an input from the UK partners.

Japan was seen by some companies as a highly sophisticated market, setting demanding technical standards, responding rapidly to new opportunities and readily accepting technical innovations. Operating in such a challenging environment had a catalytic effect on the companies' performance in other parts of the world.

A number of collaborations were with companies that happened to be Japanese rather than because they were Japanese. In these cases, world-wide searches for a suitable partner had identified a company in Japan, perhaps because of a specific unique technical capability, possession of a product ripe for development, links to a major customer or mutual compatability over a range of factors. Some respondents commented that the Japanese company had come out ahead of the competition because it had reacted promptly and positively.

Benefits to the Japanese partner

The two partners in a collaboration may have motives and expectations in common, but they may also have distinct motives. It is therefore interesting to collect information on the views of both partners. We asked respondents (i.e. British companies) what the Japanese partner would regard as a successful outcome from the collaboration, and what benefits they thought the Japanese partner would secure.

A common theme in the expectations of both British and Japanese partners was income and profit, though several remarked that the Japanese partner was prepared to wait somewhat longer for the profit. The Japanese partner more often than the British partner was said to be gaining a new product or a substantial push up the learning curve of a new technology: this is consistent with the preponderance of collaborations in our survey that involved transfer of UK knowledge to Japan. The learning curve argument is particularly pertinent in areas where Japan faces increasingly stiff competition from its neighbours at the lower end of the technology market. Good relationships and exposure to alternative ways of doing things were also mentioned. The gaining of international experience through association with major UK companies was important for the less experienced Japanese companies. More than one respondent commented that this could result in its Japanese partner becoming a more effective competitor in the international marketplace, with potentially damaging consequences for the long-term well-being of the UK company.

One respondent stressed that, when the Japanese began seriously to develop a newly acquired technology, they had sufficient sense of purpose, accumulated financial resources and ability to protect the new idea or product to make a real success of it.

It would be useful to be able to compare what British respondents say about their partners' motives with what the Japanese say about their own motives.

(iii) Management issues

Organizational type

Industrial S&T collaborations tend to have a much more clearly defined structure than academic collaborations. We encountered a variety of structures, with joint ventures (JVs), licences and various forms of R&D agreement predominating. [29] had been involved in four separate JVs since 1968 and a further three R&D collaborations since 1985 (though since they were all covered by secrecy agreements, no details were available). [83] mentioned seven current JVs with Japanese partners. One contract research company, [27], had work from 40 Japanese companies, representing 20% of its turnover. Most of our respondents had been involved in rather fewer collaborations. The collaborations on which we collected detailed information (counting, for example, [27] as a single collaboration) included:

— 18 joint ventures, ranging from 37:63 to 91:9 shares;

— 19 licences, of which 14 were granted *to* Japanese and 5 *by* Japanese companies;

— 24 R&D collaborations (in the sense of both sides working together to advance or exchange knowledge), of various degrees of intensity.

One of the JVs included an explicit Technical Agreement through which the Japanese company provided technical information to the JV company. Another was concerned with the exploitation in Japan of two products of the UK company: when the Japanese partner decided that one of the two products could not usefully be exploited in Japan, the JV was changed to a licence arrangement. Two R&D collaborations included or developed into licence options for the Japanese partner to commercialize the results in the Japanese market.

Our data do not point to any very clear correlation between type of organizational structure and either industrial sector or objective, though it may be that some pattern would emerge from a larger sample. In some cases it appears that company style is a stronger influence than the circumstances of the individual collaboration. In other cases, speed of operation may favour a licence arrangement over a JV. Precedent may be important. One respondent suggested that degree of long-term commitment was a relevant factor: it would favour a licence arrangement for developing a one-off product or a product to which it was not strongly committed, and a JV for developing major products or a series of consecutive products. It was noticeable, however, that companies with a major commitment to Japan in the form of a permanent office or a wholly-owned subsidiary in the country did not necessarily favour JVs over other collaborative structures.

It was suggested that a JV gave more control over future developments to the company owning the initial intellectual property than did a licence arrangement. There were several instances in which the company with the stronger bargaining position was able to negotiate very favourable terms. For example, more than one UK company had to agree to make all future products available to a JV; conversely, other UK companies were able to secure first refusal to the marketing rights outside Japan of future products from their Japanese partners. One company, hoping for a JV, had to settle for a technology transfer agreement as the route for selling its know-how to its Japanese partner. As the balance of bargaining power changed between partners, the arrangements could be renegotiated: there were several cases where the UK share of a JV was now considerably higher than it had been initially, and one or two where the Japanese partner had been bought out completely. The organizational structure of a collaboration is not immutable.

One company whose normal mode of operation overseas was to establish wholly-owned subsidiaries had been advised thirty years ago that a JV was the best entry route to Japan. It had followed this advice, but commented that in similar circumstances it would not now do so unless it could be sure of being able to control the JV.

Infrastructure and introductions

Two of the companies responding had been active in Japan for fifty years or more, and many had been there for at least ten years. The collaborations detailed to us were, in these cases, simply among the more recent of a considerable history of collaborations. The established companies sometimes maintained permanent offices in Japan (usually Tokyo); six companies mentioned such offices, ranging in staff numbers from 4 to 42. Ten other companies mentioned wholly-owned subsidiaries in Japan. While the Japan offices channelled information in both directions and served numerous other functions, formal negotiations about collaborations tended to be conducted by the head offices of the companies concerned. Japan offices and subsidiaries could play important roles in monitoring and advising collaborations after they had been set up.

A fairly common pattern is for a UK company to begin exporting to Japan and to seek the assistance of a Japanese general trading company in distributing its products and establishing a niche in the market.

The general trading company is then the source of advice and introductions when a Japanese partner is being sought for a subsequent collaborative venture. Importing from Japan is another route to establishing contact.

For UK companies that do not already either have an intimate knowledge of the Japanese scene or have a close relationship with someone that does, other options are available. One company found Japanese partners by advertising in the technical/professional press. Another selected from a list of Japanese companies that had expressed interest in its product. A third made two extensive tours of Japan with help from the Commercial Department of the British Embassy in Tokyo before appointing an agent (general trading company) able to open the appropriate doors. A fourth knew its partner to be not only outstandingly competent but also the largest relevant company in Asia. Others conducted systematic searches for partners with specific technical skills. The marketing side of a company could sometimes identify potential partners for S&T collaboration. For one respondent, S&T collaboration followed a strategic decision to develop closer relations with the Japanese partner. In another, the partner had a product already targeted for acquisition. At least three respondents used management consultants to identify potential partners.

A successful collaboration is very likely to lead to further collaborations between the same partners. It can easily take two or three years to build up sufficient mutual trust and confidence to get a collaboration off the ground; between partners that already know each other, this groundwork has already been done. Since many collaborations are intended to establish a competitive position for the partners in the marketplace and, in addition, have fixed durations determined by the expiry dates of the relevant patents, the time that can be saved by dealing with a familiar partner is highly significant.

Scale, organization, assessment

The level of resources being committed to collaboration varied a great deal from case to case, and also from partner to partner. Some JV companies employed hundreds of people, whereas licence arrangements could involve just one or two man-years per year from the licensing company once terms had been agreed. Many R&D collaborations were quite small, involving fewer than 20 staff from the UK end; others involved multi-million pound investments.

Management systems were equally varied. Formal meetings between a JV and its owners to review progress and/or policy would typically be held quarterly, with routine progress reports submitted monthly; but in one or two cases, the formal meetings were every two years.

Nearly all JVs described were located in Japan and the great bulk of staff were therefore Japanese; the senior management would be drawn from one or both partners. In two cases, however, the JV had been established in order to attack a third market and was therefore located in that market.

In many instances, one or two people in a UK company would be identified as the focal point for communication between the collaboration and the company. In major joint R&D collaborations, communication between the partners would occur at many levels.

Assessment was always judged in terms of progress towards the pre-defined goal —usually a specific technical objective or a marketable product and market share/sales/profit.

Intellectual property rights (IPR)

We asked explicitly about arrangements for IPR. In every case IPR featured in the agreement. In some R&D collaborations each company was responsible for the IPR relating to its own discoveries; in others, the IPR for results during the collaboration was held jointly. [5] had a relevant patent applied for before the start of a joint R&D project; a joint patent was filed during the project; [5J] later applied for a patent on the basis of improvements it had subsequently made, which it went on to commercialize in Japan. Separate patenting could be more efficient (i.e. faster) than joint patenting and could accommodate different patenting philosophies in the two companies. In licence arrangements, the partner offering the technology would generally retain full IPR and have privileged access to any improvements made by its collaborator—e.g. first refusal rights to exploitation outside the other's territory. In JVs, one pattern was for each partner to hold the IPR for its own work but to grant the other free use for purposes connected with the JV.

(iv) Problems and pointers

Satisfaction

Most respondents pronounced themselves satisfied with their collaborative experiences, some extremely so. Satisfaction could be gauged by such criteria as market share, profit, royalty income and repeat business. There were also less tangible causes for satisfaction. Several companies found that S&T collaboration had been the means to building up a close and enduring relationship with their Japanese partner, such that each would naturally turn to the other when contemplating collaborative activity in future. [63] looked forward to growing cooperation with [63J] across a wide range of activities. [34] found that the enthusiasm of staff involved directly in an R&D collaboration had a positive effect on the attitudes of other staff towards Japan. In some R&D collaborations ([5], [10B]), the competitive spirit of the Japanese participants spurred the UK team to raise its own standards. By seeing how [47J] operated, [47]'s workforce adopted more positive attitudes and increased its productivity over and above the improvements arising from the technical developments that were the collaboration's explicit objective. [42A] and [42JA] enjoyed a continuing constructive exchange of technical information beyond the formal life-time of their agreement.

But there were dissenters. In one case, a hoped-for extension of an initial one-year collaboration did not materialize. In another, a ten-year collaborative R&D agreement generated no exploitable products. A third company felt itself held back by the relative Japanese weakness in its field, though the situation was improving. A fourth had a technology exchange agreement to which neither side was wholeheartedly committed and from which neither gained much benefit. A fifth had derived few benefits from extended efforts to exploit its products in the Japanese market. A sixth commented that its R&D collaborations with one company had been a barrier to associations with other Japanese companies. A seventh 'would not rush to do another similar deal with

a Japanese company. We did receive royalty income, but the cooperation we hoped for never really materialized.'

Culture

[61] pointed to the need to understand Japanese attitudes and industrial culture. Several companies were helped to do this by having Japanese employees. Another commented on the importance of personality in selecting staff to deal with the Japanese partner. Personal formality could prove an obstacle to establishing relationships for those accustomed to operating in a very informal style. [3] observed that one had to respect as well as understand the ways of others. One respondent felt that it was always the UK side that had to adapt itself to Japanese culture, rather than vice versa.

Distance

Distance was mentioned by few respondents. One effect of distance was that unexpected difficulties had to be dealt with by letter and telex rather than face-to-face meetings. Another was the associated time shift. The time shift need not be a serious problem: a telex or fax message could be sent from the UK at the end of one working day, and the reply would arrive by the beginning of the next.

Language

Language *per se* caused some problems, but fewer than might have been expected. The Japanese were said often to speak good English. Language barriers could be overcome by taking on Japanese employees. Those going on exchange visits were advised to learn Japanese before going. Delays in translating technical reports originally prepared in Japanese were a source of frustration to more than one company. One of the less satisfied companies regarded language as 'a barrier which they conveniently hide behind'.

Communication

There were problems with communication at a more fundamental level than the technicalities of language—problems that were not confined to companies with negative experiences of collaboration. These were succinctly expressed by a company with long and generally positive experience in Japan: 'The Japanese invariably agree with and to everything. The Japanese invariably say they understand you. In fact, they frequently disagree and seldom understand first time around; this can be very misleading.'

The problem of knowing how far the message received by the listener is the same as the message put out by the speaker, inherent in all communication, can thus be particularly acute in communication between the UK and Japan. It is exacerbated by a second factor noted by some respondents, that their Japanese partners do not readily negotiate face-to-face and rarely comment on any facet of the work during progress meetings: they prefer to listen rather than talk. This could be related to the observation that Japanese negotiators appear to have less delegated authority than UK negotiators and need to refer back to their superiors to secure consensus.

When misunderstandings arise, as under these circumstances they must, one comes up against the 'loss of face' syndrome: the Japanese partner can be reluctant to admit to the misunderstanding. This means that simple misunderstandings can remain unresolved for a long time, creating frustration and wasting resources.

A further aspect of communication involves understanding one's partner's hierarchical structure and going in at the right level. One has to field individuals of sufficient status (not merely calibre) in order to get results.

Companies with permanent offices in Japan found them often very helpful in improving communication with their partners.

The problems of communication just described are not insuperable: they were mentioned by successful and unsuccessful collaborators alike. The point is to be aware of them, or else they may well prove insuperable.

Relationships between partners

Good communication is one aspect of building up a relationship between partners. Another is mutual trust. No fewer than nine respondents commented, spontaneously, on the importance of trust: it took perseverance, straightforwardness and integrity on the one hand, and demonstrable technical competence and delivery reliability on the other, to secure the trust of a Japanese partner. Once trust was established, however, the Japanese commitment was whole-hearted and enduring.

Conversely, respondents generally had positive experiences about the trust-worthiness of their Japanese partners. The Japanese would be omnivorous in their appetite for information, but above board in gathering it. We were not told of any collaborations in which one side had broken the agreement to the disadvantage of the other. One respondent did, however, suggest that a degree of judicious caution on the part of the British partner could be appropriate even after Japanese commitment had been secured, and two or three respondents clearly retained at least some of their initial wariness about collaborating with Japanese partners.

Trust has at least two aspects. One is professional: an undertaking to provide a given product to given specifications by a given date must be met in full, even if the product is only on the drawing board at the time the undertaking is made. Reliability is crucial. The other is personal: the individuals directly involved must be of a type with which the partner feels comfortable. This entails a willingness to conform, when in Japan, with Japanese social customs and expectations, irrespective of personal preferences.

Management issues

Some respondents expressed concern about the quality of senior staff put in by Japanese companies to manage Joint Ventures. It was suggested that second-rate staff were selected for these posts, and that they tended to see JVs as a career backwater. But this feeling was not universally shared.

Managers of Japanese companies (as opposed to Japanese managers of JVs) were said to be competent and well educated scientifically right up to presidential levels. One respondent found it difficult to persuade his partner to act quickly and in a commercially responsible manner to problems encountered in the development process; another, however, found his partner to be a very quick decision-maker.

British companies sometimes experienced difficulties in recruiting middle management staff in Japan. The 'job-for-life' tradition inhibited

the movement of good personnel between companies. Loyalty acted as a constraint against working for a foreign company.

Individualistic management styles that might be found in European companies had to be considerably softened before they could fit alongside Japanese styles of management.

In some British companies the individual pushing forward the collaboration experienced marked resistance from colleagues to the idea of sharing work with the Japanese. This resistance could be found at any level of management. The 'not-invented-here' syndrome applied both to making use of Japanese technical knowhow and to developing a collaboration where the individual who had set up the collaboration was not part of the team charged with exploiting it.

It was important when entering a collaboration to have a clear idea both about overall objectives and about milestones on the way that could indicate the rate of progress. [34B] remarked that, because the objectives of its research agreement had been precisely defined in such a way that both parties would benefit equally from the collaboration, there had been no temptation for one partner to try to gain an advantage over the other. At the same time, one had to be flexible and to adopt a long-term view.

The Japanese passion for excellence, noted approvingly by some commentators, was for others an obsession about detail that could become frustrating.

The importance of patience, perseverance and a long-term approach has been stressed already. This applies both to the process of setting up a collaboration and to making the collaboration bear fruit. One must recognize the Japanese style of negotiating and allow time for consensus-building. And one must be prepared to negotiate for as long as necessary, even if that means cancelling a return flight from Japan. Several respondents commented on the dogged persistence of Japanese negotiators.

Several respondents commented on the value of getting a second opinion, either in assessing a potential partner or in helping to resolve a dispute with the partner. Offices or subsidiaries in Japan could effectively help UK-based colleagues in this way; the British Embassy in Tokyo was another source of help. Some companies employed consultants, either British or Japanese, to carry out confidential fact-finding missions. Similar problems arose with monitoring collaborations once in progress.

One company with extensive experience of collaborating with the academic sector in the UK commented on the difficulty of collaborating with the Japanese universities or research institutes, adding that Japanese companies experienced similar difficulties. It was now trying the 'old boy' network, appointing a recently retired senior Japanese researcher to renew his academic contracts and identify possible openings for collaboration. Another company, however, had been able to contract out clinical trials to universities, and had asked one academic to repeat a piece of basic research in order to convince its Japanese partner of a particular scientific result. The difficulty in setting up collaborations with Japanese universities appears to be most acute

at the basic end of research. It was suggested to us that Japanese universities were beginning to relent their policy of not collaborating with either Japanese or foreign private sector companies.

The incompatibility of Japanese standards and the British or international standards familiar to British companies could be a source of difficulties.

To conclude on a lighter note with a comment from a company that has been operating in Japan for over thirty years: 'There are few problems if one has a strong constitution in terms of travel, fatigue and digestion.'

III. ACADEMIC SECTOR

(i) Introduction

Questionnaire

Our aim was to collect data about the nature of scientific collaboration between the UK and Japan within the academic sector over a range of disciplines. Questionnaires were sent to heads of at least one department in every UK university and in selected polytechnics and equivalent institutes. Principal targets were those already known to have links with Japan, identified mainly through the British Council survey of 1986 (carried out prior to the Royal Society/British Council symposium on Japan/UK Scientific Collaboration in September 1986) and through the records of the Royal Society/Japanese Society for the Promotion of Science (RS/JSPS) exchange scheme. We then included further departments to achieve an overall balance between the numbers in each discipline approached. A total of 154 questionnaires were sent out, comprising section A, requesting information at departmental level, and section B, concerning individual collaborations, separate copies of which were to be completed for each collaboration. We are very grateful to all who responded.

The questionnaire asked for information on collaborations that had been in progress at any time during the last two years. The questions were concerned with general details, management aspects and benefits.

Coverage

The departments surveyed covered nine broad disciplines: biochemistry/biotechnology (BB), chemistry (CH) , electronics/computer science (EL), earth science (ES), materials science (MS), mechanical engineering (ME), physics (PH), physiology/pharmacology (PP), space/astronomy (SA). There were similar numbers in each discipline (18–23), except for MS and PH (32 and 33), and SA (2).

It should be stressed that our results relate to a sample of departments selected as likely to be involved in collaboration with Japan. They cannot be extrapolated to cover the academic sector as a whole.

(ii) Departmental survey

From the 106 Section A forms returned, we were able to establish the proportion of staff currently working in collaboration with Japan, at four different levels of seniority within the nine disciplines (see table 3.1). The majority of collaborations involved staff on the levels of senior lecturer and above (60% of all collaborating staff) and lecturer/assistant lecturer (26%). These represented 11% and 4% of the total staff on each respective level. Outside of MS and PH, a senior member of staff was at least twice as likely to be involved in collaboration with Japan as a lecturer or assistant lecturer. Rarely was any PhD student working in collaboration with Japan, except in SA, where one collaboration was a group venture involving staff on all levels, particularly postdoctoral research assistants and PhD students.

(iii) Individual collaborations

Response

Of the 154 departments approached, 127 (82%) responded. 29 respondents had not been involved in collaborative projects during the

Table 3.1 ACADEMIC SECTOR : STAFF IN DEPARTMENTS SAMPLED

Discipline	Senior lecturer level and above		Lecturer/ assistant lecturer		Post-doctoral research assistants		PhD students	
	Total	Colla-borating	Total	Colla-borating	Total	Colla-borating	Total	Colla-borating
Biochemistry/ biotechnology	118	16 (13.0)	144	5 (3.5)	189	0 (—)	407	0 (—)
Chemistry	182	13 (7.0)	137	4 (3.0)	218	1 (0.5)	819	1 (—)
Electronics/ computer science	224	15 (6.5)	219	2 (1.0)	190	1 (0.5)	480	1 (—)
Earth science	77	11 (15.0)	91	4 (4.5)	74	2 (2.5)	280	1 (0.5)
Mechanical engineering	140	21 (15.0)	221	7 (3.0)	124	1 (1.0)	447	5 (1.0)
Materials science	92	13 (14.0)	94	14 (15.0)	190	3 (1.5)	564	0 (—)
Physics	178	14 (8.0)	139	7 (5.0)	200	0 (—)	550	0 (—)
Physiology/ pharmacology	125	16 (13.0)	154	8 (5.0)	182	3 (1.5)	396	1 (—)
Space/ astronomy	9	3 (33.0)	20	2 (10.0)	27	4 (15.0)	38	6 (16.0)

* Figures in parentheses show number in collaboration as a percentage of total (to the nearest 0.5%)

last two years, though nine of them mentioned some marginal contact with Japan, or previous collaboration. The remaining 98 departments produced completed questionnaires describing 195 collaborations.

Japanese partner's base

We examined the information on the Japanese partner's institutional base in relation to discipline (see table 3.2). In 60% of collaborations the base was in a university department, the proportion being higher in ES (86%) and PP (72%) and lower in EL (39%). In over a fifth of collaborations the Japanese partner was based in industry, the most likely disciplines being EL (50%) and MS (44%). No collaborations in ES or SA involved an industry-based partner. Remaining collaborations were with other institutes (12%) or with a combination of two or three of the various bases (7%). Within disciplines, the proportion of Japanese partners based in institutes ranged from 0% (ME) to 22% (CH and PH). The institutes were further categorized according to the funding body—Science and Technology Agency (STA), Ministry of International Trade and Industry (MITI), University-attached, Monbusho, other. None was STA funded, one was MITI funded, and the others were evenly spread over the latter three categories.

Experience of other collaborations

We asked respondents to list any countries with which they had undertaken collaborative projects, to give an idea of the frequency of collaboration in their experience. 70% of respondents were collaborating with Japan for the first time, and of these 81% had already worked with at least one other country. Of respondents collaborating with

Table 3.2 ACADEMIC SECTOR : ESTABLISHMENT IN WHICH JAPANESE PARTNER IS BASED, BY DISCIPLINE

Base	Discipline									Total
	BB	CH	EL	ES	ME	MS	PH	PP	SA	
Industry	4 (19.0)	2 (8.7)	9 (50.0)	—	6 (27.3)	16 (44.4)	2 (6.1)	2 (11.1)	—	41 (21.0)
University	13 (61.9)	15 (65.2)	7 (38.9)	19 (86.4)	13 (59.1)	15 (41.7)	21 (63.6)	13 (72.2)	1 (50.0)	117 (60.0)
Other institute	3 (14.3)	5 (21.8)	1 (5.6)	1 (4.5)	—	3 (8.3)	8 (21.8)	2 (11.1)	1 (50.0)	24 (12.3)
Combination	1 (4.8)	1 (4.3)	1 (5.6)	2 (9.1)	3 (13.6)	1 (5.6)	2 (6.1)	1 (5.6)	—	13 (6.7)
Total	21 (100)	23 (100)	18 (100)	22 (100)	22 (100)	36 (100)	33 (100)	18 (100)	2 (100)	195 (100)

Figures in parentheses show percentage from each base within each discipline

BB = Biochemistry/ biotechnology
CH = Chemistry
EL = Electronics/ computer science
ES = Earth science
ME = Mechanical engineering
MS = Materials science
PH = Physics
PP = Physiology/ pharmacology
SA = Space/astronomy

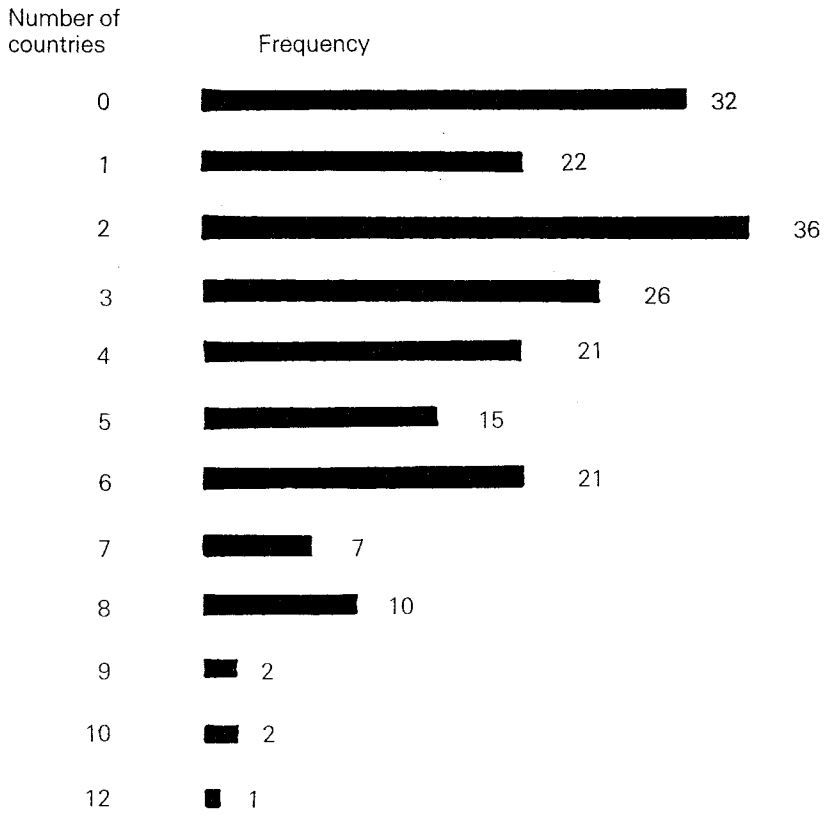
Japan for the second or subsequent time, 87% had worked with at least one other country. A third of respondents had worked with at least five other countries and one respondent with 12 others (see figure 3.1). The regions most often involved were Western Europe (mentioned by 68% of respondents), USA/Canada (49%) and Eastern Europe (22%) (figure 3.2). Six other regions were also mentioned by between 8% and 14% of respondents.

Though our questionnaire was concerned only with projects that had been in progress at some stage during the past two years, we asked respondents to give the starting date of their collaborations. We found that some had been continuing for many years, one from as far back as 1959 and 10% from 1975 or earlier. However 67% dated from 1985 onwards. One respondent, who has been working with the same Japanese research group for nearly 17 years, mentioned the loyalty the Japanese show to their UK partners, and said that once a collaboration had been established, they preferred to continue with the same partner or research group than to look elsewhere for their subsequent joint projects. There appeared to be no incentive to 'try out' other places either for a new project or to broaden experience. In this collaboration the Japanese loyalty continued through from Professor to student over the years; 'Professor X is following closely in the footsteps of his PhD supervisor Professor Y. He now has a high international reputation in A [same specialisation as his supervisor] and more recently in B' thereby strengthening the UK/Japan link.

Establishing contact

We asked about the routes used to initiate collaborations (see table 3.3). The most common single reply was that the Japanese partner had made the initial approach: this applied to 40% of cases where the Japanese partner was based in a university and 75% of cases where he was based in industry, particularly where he was also bearing all the

Figure 3.1 ACADEMIC SECTOR : NUMBERS OF OTHER COUNTRIES WITH WHICH RESPONDENTS HAVE PREVIOUSLY COLLABORATED



Total respondents: 195

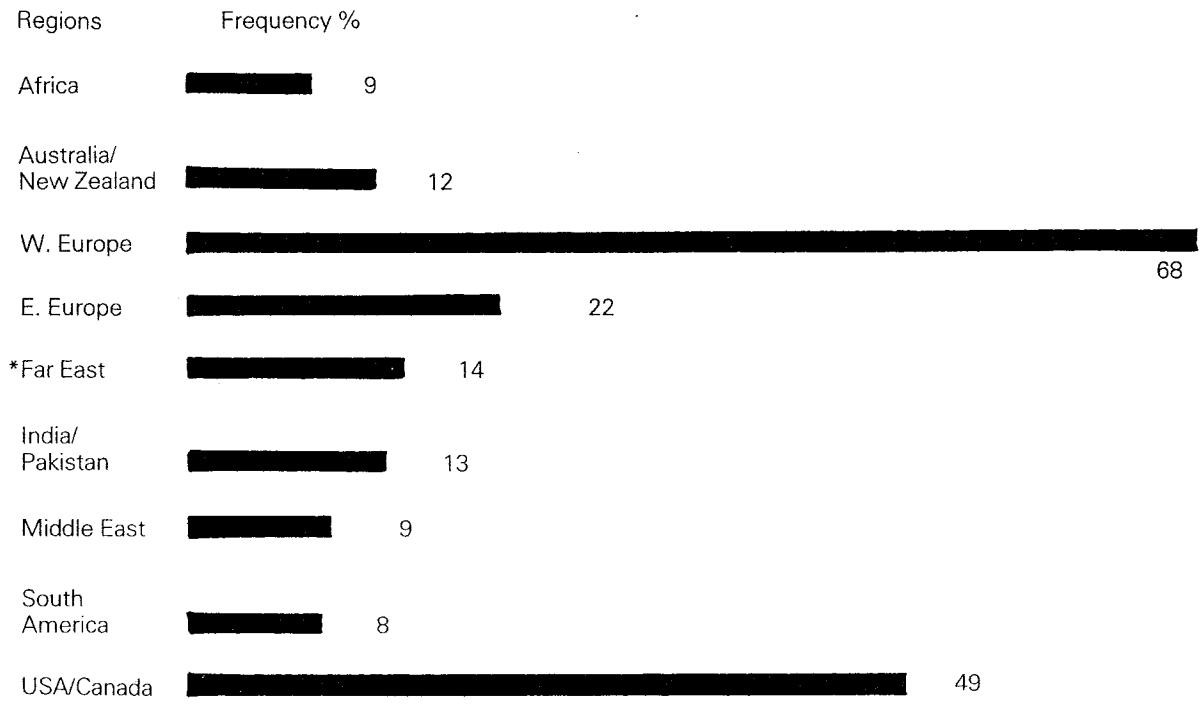
cost. In university–university collaborations, personal introductions, conferences and the research literature were also mentioned frequently as routes to initiating collaboration. These methods of approach were not mutually exclusive and with some respondents combinations of up to three were involved. The British Embassy played a very minor role in providing the contact, being mentioned by only four respondents, and in only one case was the initial approach made through the British Council.

Nature of collaboration

Three quarters of the collaborations comprised joint research intended to lead to joint publications, and 60% had already resulted in at least one paper published or in preparation. Some collaborations had been very productive, six generating at least 10 papers, and one generating no less than 40 jointly authored papers (see figure 3.3). Where collaborations had not produced any publications, this was often because the project had only recently begun, and the work was not sufficiently advanced. Occasionally UK partners published in Japanese journals, with sole authorship, particularly where they had carried out the work during a visit to Japan. Similarly, there were some instances where the Japanese partner was the sole author of a paper resulting from the collaborative work.

Data flow occurred in both directions. Sending data to Japan was involved in half the collaborations, as was receiving data from Japan.

Figure 3.2 ACADEMIC SECTOR : PROPORTION OF RESPONDENTS HAVING PREVIOUS EXPERIENCE OF COLLBORATION WITH COUNTRIES OTHER THAN JAPAN



(No previous collaboration) (16)

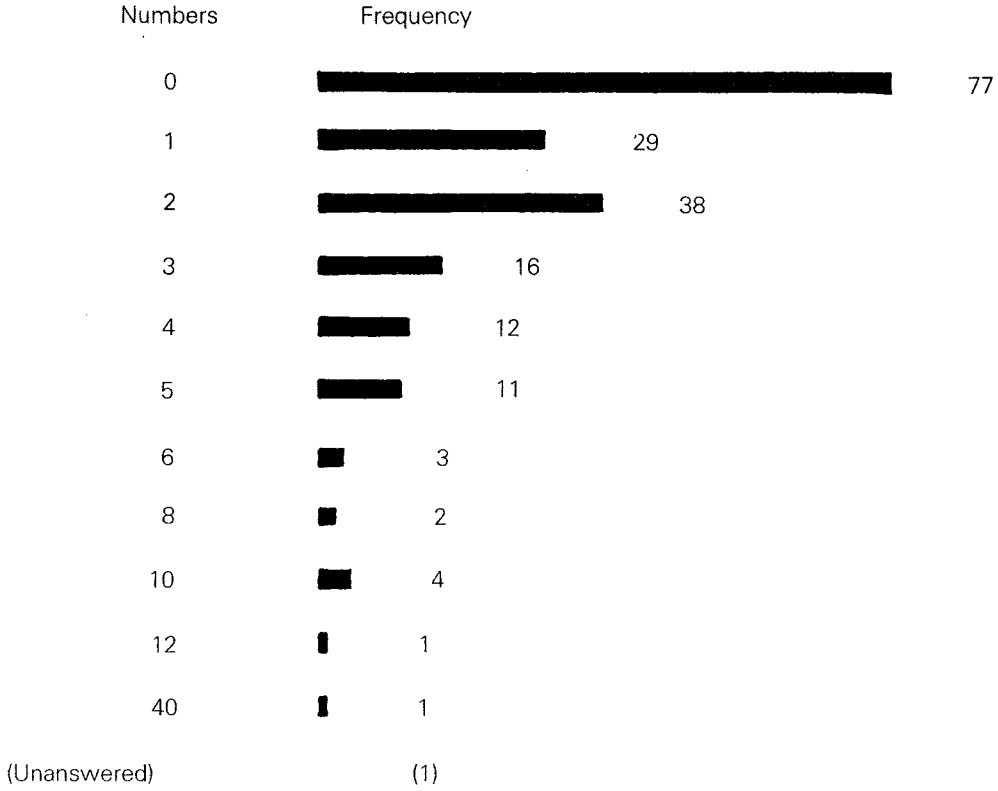
*Excluding Japan

Table 3.3 ACADEMIC SECTOR : MODE OF APPROACH, BY JAPANESE PARTNER'S BASE

Approach	Japanese partner's base				
	Industry	University	Other institute	Combination	All bases
Personal introduction	6 (14.6)	44 (37.6)	6 (25.0)	6 (46.2)	62 (31.8)
Met at conference	5 (12.2)	35 (29.9)	6 (25.0)	4 (30.8)	50 (25.6)
Through research literature	2 (4.9)	31 (26.5)	3 (12.5)	5 (38.5)	41 (21.0)
Japanese partner approached	31 (75.6)	47 (40.2)	9 (37.5)	3 (23.1)	90 (46.2)
Other	3 (7.3)	4 (3.4)	2 (8.3)	2 (15.4)	11 (5.6)
Total approaches *(total collaborations)*	47 *(41)*	161 *(117)*	26 *(24)*	20 *(13)*	254 *(195)*

Numbers in parentheses are percentages based on the total number of collaborations shown in the last row. Some collaborations were initiated by more than one mode of approach.

Figure 3.3 ACADEMIC SECTOR : NUMBERS OF JOINTLY AUTHORED PAPERS ARISING FROM THE COLLABORATION



Also, 45% of collaborations were concerned with 'keeping up with general developments'. Two respondents indicated that over half their research activity now involved collaboration with a Japanese partner. For the great majority, 77%, under 10% of their research activity involved Japanese collaboration; a further 18% conducted 10-25% of their research jointly with Japanese partners. In 18% of collaborations, the British partner acted as a consultant to the Japanese partner: in 10% of cases the consultancy was in the opposite direction.

The Japanese were more likely than their British colleagues to travel and twice as likely to make regular (at least yearly) rather than occasional visits. 66% of respondents mentioned visits from Japan, and these mainly by senior staff (45% of all Japanese visitors) and middle staff (45%), often one from each level coming on the same visit. For these staff, the duration of the visit did not appear to be dependent on their grade: short visits of up to two weeks, medium length visits of two weeks to six months and long visits of over six months were all mentioned with similar frequency (each about 33% of all visits). In contrast, though half the collaborations involved visits to Japan, the number of UK visitors was significantly less than the number of Japanese visitors, as rarely did more than one member of staff go on any one visit. Senior staff were the most likely to travel to Japan (66% of total visitors), followed by middle grade staff (24%). Visits were mostly on an occasional basis, either of short (35% of total visits) or of medium duration (57%). These data on relative number and duration of visits are consistent with the finding that 23% of collaborations

Table 3.4 ACADEMIC SECTOR : OBJECTIVES OF COLLABORATION, FROM THE UK PARTNER'S POINT OF VIEW (UK) AND, HIS OPINION, FROM THE JAPANESE PARTNER'S POINT OF VIEW (J)

Discipline	Gaining technical knowhow		Increasing current research		Engaging in mutual projects/ exchange		Broadening horizons		Access to materials/ data/ equipment		Other	
	UK	J	UK	J	UK	J	UK	J	UK	J	UK	J
Biochemistry/ biotechnology	1	5	9	3	10	10	1	0	1	6	4	5
Chemistry	0	2	1	1	18	18	1	2	6	5	0	0
Electronics/ computer science	5	5	2	1	3	3	2	4	3	4	6	5
Earth science	2	6	7	3	7	7	2	5	5	5	2	2
Mechanical engineering	4	8	2	1	11	9	2	4	1	3	5	3
Materials science	6	14	12	1	13	12	2	6	2	6	9	12
Physics	4	7	1	1	21	20	2	3	3	3	4	4
Physiology/ pharmacology	6	3	1	2	11	10	0	2	2	2	3	3
Space/astronomy	0	2	0	0	0	0	0	0	0	0	2	1
Total (% of total collaborations)	28 (14)	52 (27)	35 (18)	13 (7)	94 (48)	89 (46)	12 (6)	26 (13)	23 (12)	34 (17)	35 (18)	35 (18)

involved use by the British partner of equipment in Japan, whereas 52% involved use by the Japanese partner of equipment in the UK.

Objectives and benefits of the collaboration

We asked respondents about the objectives of collaboration, both from their own perspective and, so far as they could judge, from that of their partner (see table 3.4). From both UK and Japanese perspectives, engaging in mutual projects/exchange of personnel and ideas was the most common objective, featuring in nearly half the collaborations. Gaining technical knowhow was judged to be an important objective more often for the Japanese partner (27% of cases) than for the UK partner (14% of cases); and the Japanese partner appeared twice as likely to view the collaboration as a way of broadening his horizons as did the UK partner. The Japanese partner was interested in gaining access to materials, data or equipment slightly more often (17% of cases) than the UK partner (12%). Continuing and increasing current research appeared to be a stronger motive for the UK partner (18%) than for the Japanese partner (7%). Other objectives outside these categories were mentioned with equal frequency from both points of view, but were extremely variable, ranging from 'division of cost and effort' (from both partners' perspectives) to 'involvement in a project that the UK could not do alone', 'contact with Western scientists' and 'internationalization of younger Japanese scientists'.

We found that from the Japanese partner's point of view, gaining technical knowhow was most important in MS, and to a lesser extent ME and PH; access to materials, data or equipment was mentioned most often in BB and MS; broadening of horizons featured strongly in ES and

MS. From the UK partner's perspective, apart from engaging in mutual projects, access to materials, data or equipment was predominantly the objective in CH, and increasing current research was mentioned more often in MS, BB and ES. In ES, access to materials data or equipment was mentioned equally from both perspectives, and largely reflected each partner's making available to his counterpart geological samples and related data to which he would not otherwise have access.

Where Japan was considered to be behind the UK in the research field, gaining technical knowhow and access to materials, data and equipment appeared to be more important objectives for the Japanese partner than where Japan was considered to be ahead (see table 3.5). But generally the objectives of the collaboration from the Japanese partner's perspective were independent of the position of Japan in the research field.

A parallel study conducted by Professor Kaya found that, of a sample of Japanese research institutes most of which received or were willing to receive guest researchers, 59% cited new ideas and stimulation as the main benefits to be derived from foreign researchers, 17% cited the building up of an international network and 15% thought that interchanges with British researchers would be particularly valuable in advancing basic research.

We also asked about the benefits actually derived from the collaboration. These did not necessarily echo the objectives, nor was categorization as straightforward. The Japanese partner was said to have gained increased expertise in 41% of cases, and access to materials, data and equipment in 20% of cases. The corresponding figures for the UK partners were only 21% and 14% respectively (see figure 3.4). However, the UK partner secured high quality manpower in 19% of cases,

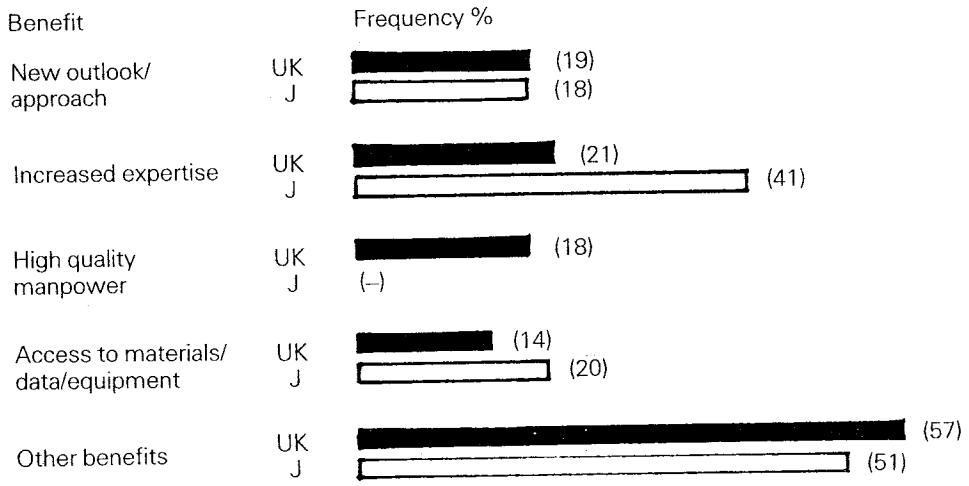
Table 3.5 ACADEMIC SECTOR : OBJECTIVES OF JAPANESE PARTNER (IN UK PARTNER'S OPINION) BY PERCEIVED POSITION OF JAPAN IN THE RESEARCH FIELD, EXPRESSED AS PERCENTAGE OF TOTAL COLLABORATIONS

Objectives of Japanese partner	Position of Japan in research field					Total
	Ahead	Behind	On a par	Combination	Unanswered	
Gaining technical knowhow	3.1	6.7	11.8	4.1	1.0	26.7
Increasing current research	—	3.1	3.1	0.5	—	6.7
Engaging in mutual projects/exchange	12.3	8.2	20.0	3.1	2.0	45.6
Broadening horizons	2.6	1.5	4.6	4.1	0.5	13.3
Access to materials/ data/equipment	2.1	5.1	6.2	3.1	1.0	17.4
Other	5.1	2.6	7.2	2.6	0.5	17.9
Total	25.1	27.2	52.8	17.5	5.0	127.6

Totals exceed 100% as some respondents listed more than one objective.

'Combination' : in some fields, Japan was regarded as ahead in some specialisms and behind in others.

Figure 3.4 ACADEMIC SECTOR : BENEFITS RECEIVED THROUGH COLLABORATION, FROM THE UK PARTNER'S POINT OF VIEW (UK) AND, IN HIS OPINION, FROM THE JAPANESE PARTNER'S POINT OF VIEW (J)



a benefit rarely mentioned from the Japanese partner's point of view. In many cases international collaboration appeared to be the only available route for getting an extra pair of hands at the bench, given the restricted availability of funding for UK personnel. UK and Japanese partners each gained a new outlook in their research in nearly one fifth of cases.

In over 50% of cases, from both partners' perspectives, responses were assigned to the 'other benefits' category, the range of which was very broad. Some, whose collaboration had proved unsuccessful—even 'disastrous' in one case—listed their benefits as 'little' or 'cannot imagine'. Mostly, the collaborations were successful, and positive comments were made, such as 'increased productivity', 'problem solving', 'potential new products'. Both partners benefited from interaction, stimulus, joint publications and the contacts and personal friendships arising from the collaboration. They also gained an insight into each other's research methodology, the UK partner benefiting from an insight into Japanese industrial research, the Japanese partner enjoying a greater freedom for innovative research when working in the UK. The association with a western country was considered to be an advantage in enhancing status or promotional prospects for the Japanese partner, and in two cases the UK researchers considered their partners would benefit from the 'cachet' associated with time at Cambridge.

We looked at whether the type of benefit derived was influenced by the Japanese partner's institutional base. From the Japanese partner's perspective, the most important benefit was in gaining increased expertise, regardless of whether he was based in industry or a university department. Where the Japanese partner was based in industry, the major gain to the UK partner was in high quality manpower; where he was university based, the UK partner did not benefit more in any one particular category.

Costs and organizational aspects

We asked respondents to indicate any additional costs to them or their department incurred as a result of the collaboration, and the source of their funds (table 3.6). Generally the excess expenditure was

below £1000 (43% of collaborations) or between £1000 and £5000 (21%), but in three cases the cost exceeded £50 000. In a further 20% of collaborations the Japanese establishment paid all the expenses, though it was not possible from our data to ascertain the scale of the costs borne by the Japanese partner. Where respondents had stated the sources of additional funding, the Science and Engineering Research Council was mentioned most frequently, contributing towards 46% of the collaborations that cost the UK partner more than £5000. The British Council, the Royal Society, the University Grants Committee and departmental funds were also important sources of money for collaborations in this cost range. 14% of total collaborations cost the UK partner more than £5000. Generally the source of funds was not given for sums below £5000.

Table 3.6 ACADEMIC SECTOR : ESTABLISHMENT IN WHICH JAPANESE PARTNER IS BASED, BY COST OF COLLABORATION

Establishment in which Japanese partner is based	Cost of collaboration						Total
	Under £1000	£1000-£5000	£5000-£10 000	£10 000-£50 000	Over £50 000	Japan pays all	
Industry	11 (5.6)	6 (3.1)	1 (0.5)	1 (0.5)	0	21 (10.8)	40 (20.5)
University	56 (28.7)	28 (14.4)	7 (3.6)	9 (4.6)	2 (1.0)	12 (6.2)	114 (58.5)
Other institute	13 (6.6)	3 (1.5)	2 (1.0)	2 (1.0)	1 (0.5)	3 (1.5)	24 (12.3)
Combination	4 (2.1)	3 (1.5)	2 (1.0)	1 (0.5)	0	3 (1.5)	13 (6.7)
Total (%)	84 (43.1)	40 (20.5)	12 (6.2)	13 (6.7)	3 (1.5)	39 (20.0)	191* (97.9)

* Cost unspecified: 4

Figures in parentheses show percentages based on the total 195 collaborations.

The Japanese paid all expenses in one half of the collaborations where the Japanese partner was in industry, but in only 10% of collaborations where he was university-based. Professor Kaya reported in his above-mentioned study that half of the research institutes responding 'said they could somehow or other furnish the entire amount', i.e. living expenses plus air fare.

The extent to which either Japan or the UK funded the collaborative projects appeared to be independent of the position of Japan, relative to the UK, in the research field (see table 3.7).

Our data do not show how often the collaboration actually reduced costs, by allowing the UK partner to share the expenditure, though some collaborations involved both Japanese and UK funding bodies. In some instances where the costs of purchasing and using equipment were extremely high, such as in SA, a joint project was the only means of undertaking a particular piece of work at all.

The collaborations were predominantly arranged on an informal basis, only 15% being subject to any formal agreement. Most arrangements

Table 3.7 ACADEMIC SECTOR : POSITION OF JAPAN IN RESEARCH FIELD (AS PERCEIVED BY UK PARTNER), BY COST OF COLLABORATION

Position of Japan in research field relative to UK	Cost of collaboration						Total
	Under £1000	£1000-£5000	£5000-£10 000	£10 000-£50 000	Over £50 000	Japan pays all	
Ahead	14 (7.2)	12 (6.2)	4 (2.1)	2 (1.0)	1 (0.5)	8 (4.1)	41 (21.0)
Behind	20 (10.3)	7 (3.6)	6 (3.1)	1 (0.5)	—	8 (4.1)	42 (21.5)
Combination	8 (4.1)	3 (1.5)	1 (0.5)	3 (1.5)	—	8 (4.1)	23 (11.8)
On a par	37 (19.0)	16 (8.2)	1 (0.5)	6 (3.1)	2 (1.0)	15 (7.7)	77 (39.5)
Unanswered	5 (2.6)	2 (1.0)	—	1 (0.5)	—	—	8 (4.1)
Total	84 (43.1)	40 (20.5)	12 (6.2)	13 (6.7)	3 (1.5)	39 (20.0)	191* (97.9)

* Cost unspecified: 4

Figures in parentheses show percentages based on the total 195 collaborations

were with the individual researcher (84%) and some were also on a departmental level (18%). In contrast to industry, agreements over intellectual property rights (IPR) were non-existent in 86% of collaborations. Where agreements did exist, the IPR were usually held mutually, often by 'gentleman's agreement'. In only one case did Japan hold all rights, and in five collaborations the UK held all rights.

(iv) Future developments

Position of Japan relative to UK

We asked respondents to assess the position of Japanese research in relation to UK research in their own particular field, and to indicate how that position might change over the next five years. Equal numbers (22%) stated the Japanese to be ahead as stated them to be behind, though this was dependent on discipline, Japan being ahead in CH, MS and PH and behind in ES and PP (see table 3.8). In 40% of cases Japan was considered to be on a par with the UK. In 12% of cases, the response was a combination of ahead and behind, according to specific aspects of the research field: for example, in EL in a collaboration concerned with logic programming, the Japanese were considered ahead in hardware and behind in software; in PH, in neutron scattering studies, the Japanese were considered ahead in volume of work, but behind in quality of their best work.

The general view throughout all disciplines was that over the next five years, where Japan was behind the UK it would close the gap, and where it was already ahead it would increase its lead. Some respondents were quite specific in their opinions: 'Britain's relative position will deteriorate', 'Japan moving ahead as access to computer hardware becomes important', 'Japan will probably move ahead because of good funding'.

Table 3.8 ACADEMIC SECTOR : POSITION OF JAPAN IN RESEARCH FIELD (AS PERCEIVED BY UK PARTNER), BY DISCIPLINE

Discipline	Position of Japan relative to UK					Total
	Ahead	Behind	On a par	Combination	Unanswered	
Biochemistry/ biotechnology	3	5	10	2	1	21 (10.8)
Chemistry	7	3	10	2	1	23 (11.8)
Electronics/ computer science	6	4	6	1	1	18 (9.2)
Earth science	2	9	5	4	2	22 (11.3)
Mechanical engineering	4	3	11	4	0	22 (11.3)
Materials science	10	4	15	5	2	36 (18.5)
Physics	10	5	13	4	1	33 (16.9)
Physiology/ pharmacology	1	9	7	1	0	18 (9.2)
Space/astronomy	0	1	1	0	0	2 (1.0)
Total	43 (22.1)	43 (22.1)	78 (40.0)	23 (11.8)	8 (4.1)	195 (100)

Figures in parentheses show percentages based on the total 195 collaborations.

'Combination' : in some fields, Japan was regarded as ahead in some specialisms and behind in others.

Future collaboration

35% of respondents expected an increase in collaboration with Japan over the next five years, regardless of the position of Japan in the research field. The disciplines where an increase was most likely to occur were CH and MS. 28% saw their collaborations continuing on the same level, and a quarter of respondents thought that collaboration with Japan would decrease over the next five years, especially in PH (see table 3.9).

Most respondents considered the future of collaboration with Japan from a personal viewpoint, relative to their particular projects. Some mentioned a decrease because of a change in circumstances, such as retirement or transfer to a new research field. One mentioned an increase because he was preparing to organize a conference concerned with Japanese collaboration. The Japanese interest and their availability of funds were mentioned by many researchers as strongly influencing the decision to establish a collaborative project, particularly as steadily decreasing UK funding was forcing departments to look elsewhere for the means to continue their research. One respondent seeking additional funding said that the nationality of the sponsor was irrelevant: he would collaborate with any country willing to provide the resources. One department, in MS, already dependent to a large extent on industry for the funding of its research, expressed concern

Table 3.9 ACADEMIC SECTOR : FUTURE RESEARCH IN COLLABORATION WITH JAPAN (AS PERCEIVED BY UK PARTNER), BY DISCIPLINE

Discipline	Future collaboration				Total
	Increase	Decrease	Remain on same level	Unanswered	
Biochemistry/ biotechnology	9	6	6	0	21 (10.8)
Chemistry	10	5	8	0	23 (11.8)
Electronics/ computer science	9	2	6	1	18 (9.2)
Earth science	8	5	5	4	22 (11.3)
Mechanical engineering	8	7	6	1	22 (11.3)
Materials science	12	5	9	10	36 (18.5)
Physics	7	13	7	6	33 (16.9)
Physiology/ pharmacology	6	4	6	2	18 (9.2)
Space/astronomy	0	1	1	0	2 (1.0)
Total	69 (35.4)	48 (24.6)	54 (27.7)	24 (12.3)	195 (100)

Figures in parentheses show percentages based on the total 195 collaborations.

that the industrial influence was leading the projects away from fundamental and towards developmental research; collaboration with another country interested in the same field of specialization provided a means of continuing basic research. Another department, now in its fourteenth year of collaboration with Japan, was experiencing such severe financial cutbacks that its future was uncertain: closure seemed likely, and with it a cessation of collaboration.

The general impression given by our respondents was that collaboration with Japan would, if anything, increase in the coming years, partly in recognition of Japan's improving competence in scientific research and partly in an attempt to maximize resources at a time of severe pressures on funding for scientific research in the UK.

IV. JAPANESE STUDENTS IN UK UNIVERSITIES

The Universities Statistical Record, which collects a wide range of statistical data from all UK universities (but not other sectors of higher education), kindly supplied us with data on the numbers of Japanese students in UK universities. 'Japanese' in this context means those whose normal country of domicile (residence) is Japan. The data cover the years 1975-1986.

Undergraduates

The number of Japanese students on full-time undergraduates courses in UK universities averaged 97 between 1975 and 1985, with little variation from year to year. In 1986 the number rose to 168 (see table 4.1). An average of 14 Japanese students each year were taking part-time undergraduate courses.

Some 19% of Japanese undergraduates were studying science or engineering. The most popular courses were economics, politics, law, business studies and related courses. It may be that an overseas qualification in one of these latter subjects is seen as particularly valuable for those who want to pursue a career in a Japanese organization with international interests.

There is evidence from Professor Kaya's report that UK students in Japan are, similarly, studying language and culture rather than S&T.

Table 4.1 FULL-TIME UNDERGRADUATES WITH JAPANESE DOMICILE ON TAUGHT COURSES IN UK UNIVERSITIES

Year	Subject category				
	III Eng & tech	IV Agriculture	V Science	III-V	All subjects
1975	6	–	11	17	99
1976	6	–	14	20	98
1977	4	–	13	17	92
1978	5	–	22	27	102
1979	6	–	14	20	107
1980	4	–	13	17	102
1981	6	–	15	21	98
1982	5	–	16	21	80
1983	3	–	18	21	81
1984	1	–	16	17	98
1985	2	–	13	15	109
1986	4	–	16	20	168

Source: Universities Statistical Record

Postgraduates

The number of Japanese students on full-time postgraduate courses in UK universities was also fairly constant between 1975 and 1985, at an average of 212. In 1986 the number rose to 276 (table 4.2). Most of this increase came in the numbers of those taking taught higher degrees, which averaged 115 over 1975–1985 and rose to 171 in 1986 (table 4.3). Numbers taking research higher degrees averaged 98 over 1975–1986 (table 4.4). 60% of those on taught courses and 38% of those on research courses were taking masters degrees.

The numbers of Japanese students taking part-time higher degrees rose from 30 in 1975 to 61 in 1980 and then remained constant at that level for the rest of the period. Three quarters of part-timers were on research courses.

Of Japanese students on full-time higher degree courses, 11% of those on taught courses and 32% of those on research courses were studying science or engineering.

Table 4.2 FULL-TIME POSTGRADUATES WITH JAPANESE DOMICILE ON TAUGHT OR RESEARCH COURSES IN UK UNIVERSITIES

Subject category	Type of course Masters	Other higher	Other	Total	Type of course Masters	Other higher	Other	Total	Type of course Masters	Other higher	Other	Total
	1975				1976				1977			
III Eng & tech	13	14	4	31	23	6	4	33	18	12	8	38
IV Agriculture	2	–	–	2	2	–	–	2	2	–	–	2
V Science	5	4	1	10	8	3	2	13	12	4	1	17
III-V	20	18	5	43	33	9	6	48	32	16	9	57
All subjects	82	46	85	213	91	29	99	219	90	39	73	202
	1978				1979				1980			
III Eng & tech	26	10	3	39	24	7	5	36	13	10	5	28
IV Agriculture	1	–	–	1	–	–	2	2	2	–	1	3
V Science	4	7	3	14	6	8	5	19	4	10	6	20
III-V	31	17	6	54	30	15	12	57	19	20	12	51
All subjects	99	40	83	222	106	32	75	213	97	38	76	211
	1981				1982				1983			
III Eng & tech	12	9	5	26	14	5	2	21	18	8	3	29
IV Agriculture	1	–	–	1	–	–	–	–	1	–	–	1
V Science	4	4	2	10	3	5	4	12	5	5	4	14
III-V	17	13	7	37	17	10	6	33	24	13	7	44
All subjects	94	31	71	196	121	25	71	217	115	23	70	208
	1984											
III Eng & tech	15	8	3	26								
IV Agriculture	2	–	1	3								
V Science	8	4	1	13								
III-V	25	12	5	42								
All subjects	132	24	48	204								
	1985				1986							
VII Eng	13	6	2	21	13	3	4	20				
IV Agriculture	–	–	–	–	1	–	–	1				
III & V & VI)	6	7	4	17	10	6	2	18				
Sci/Math)												
Total	19	13	6	38	24	9	6	39				
Total all subjects	123	24	82	229	166	30	80	276				

Source: Universities Statistical Record. Subject categories were redefined from 1985.

Table 4.3 FULL-TIME POSTGRADUATES WITH JAPANESE DOMICILE ON TAUGHT COURSES IN UK UNIVERSITIES

Subject category	Type of course Masters	Other higher	Other	Total	Type of course Masters	Other higher	Other	Total	Type of course Masters	Other higher	Other	Total
	1975				1976				1977			
III Eng & tech	6	–	2	8	8	–	–	8	7	–	3	10
IV Agriculture	2	–	–	2	2	–	–	2	2	–	–	2
V Science	2	–	–	2	6	–	2	8	9	–	–	9
III - V	10	–	2	12	16	–	2	18	18	–	3	21
All subjects	48	9	41	98	50	7	60	117	59	4	32	95
	1978				1979				1980			
III Eng & tech	9	–	1	10	11	–	3	14	4	–	–	4
IV Agriculture	1	–	–	1	–	–	2	2	1	–	1	2
V Science	1	–	1	2	3	–	1	4	2	–	–	2
III - V	11	–	2	13	14	–	6	20	7	–	1	8
All subjects	57	–	43	100	66	–	42	108	67	1	46	114
	1981				1982				1983			
III Eng & tech	6	–	–	6	7	–	–	7	5	–	–	5
IV Agriculture	–	–	–	–	–	–	–	–	1	–	–	1
V Science	2	–	1	3	3	–	3	6	3	–	2	5
III - V	8	–	1	9	10	–	3	13	9	–	2	11
All subjects	67	–	44	111	89	–	50	139	74	–	44	118
	1984											
III Eng & tech	6	–	2	8								
IV Agriculture	2	–	1	3								
V Science	3	–	1	4								
III - V	11	–	4	15								
All subjects	87	–	33	120								
	1985				1986							
VII Eng	7	–	1	8	4	–	1	5				
IV Agriculture	–	–	–	–	1	–	–	1				
III & V & VI) Sci/Math)	2	1	2	5	3	–	–	3				
Total	9	1	3	13	8	–	1	9				
Total all subjects	85	1	56	142	117	3	51	171				

Source: Universities Statistical Record. Subject categories were redefined from 1985.

Table 4.4 FULL-TIME POSTGRADUATES WITH JAPANESE DOMICILE ON RESEARCH COURSES IN UK UNIVERSITIES

Subject category	Type of course Masters	Other higher	Other	Total	Type of course Masters	Other higher	Other	Total	Type of course Masters	Other higher	Other	Total
	1975				1976				1977			
III Eng & tech	7	14	2	23	15	6	4	25	11	12	5	28
IV Agriculture	–	–	–	–	–	–	–	–	–	–	–	–
V Science	3	4	1	8	2	3	–	5	3	4	1	8
III - V	10	18	3	31	17	9	4	30	14	16	6	36
All subjects	34	37	44	115	41	22	39	102	31	35	41	107
	1978				1979				1980			
III Eng & tech	17	10	2	29	13	7	2	22	9	10	5	24
IV Agriculture	–	–	–	–	–	–	–	–	1	–	–	1
V Science	3	7	2	12	3	8	4	14	2	10	6	18
III - V	20	17	4	41	16	15	6	37	12	20	11	43
All subjects	42	40	40	122	40	32	33	105	30	37	30	97
	1981				1982				1983			
III Eng & tech	6	9	5	20	7	5	2	14	13	8	3	24
IV Agriculture	1	–	–	1	–	–	–	–	–	–	–	–
V Science	2	4	1	7	–	5	1	6	2	2	5	9
III - V	9	13	6	28	7	10	3	20	15	13	5	33
All subjects	27	31	27	85	32	25	21	78	41	23	26	90
	1984											
III Eng & tech	9	8	1	18								
IV Agriculture	–	–	–	–								
V Science	5	4	–	9								
III - V	14	12	1	27								
All subjects	45	24	15	84								
	1985				1986							
VII Eng	6	6	1	13	9	3	3	15				
IV Agriculture	–	–	–	–	–	–	–	–				
III & V & VI) Sci/Math)	4	6	2	12	7	6	2	15				
Total	10	12	3	25	16	9	5	30				
Total all subjects	38	23	26	87	49	27	29	105				

Source: Universities Statistical Record. Subject categories were redefined from 1985.

V. GOVERNMENT DEPARTMENTS AND RELATED BODIES

We invited individual Government Departments, the British Council and the research councils to outline their collaborative activities in science and technology with Japan. The results are summarized in this chapter. Much the most active bodies are the Department of Trade and Industry, the British Council and the research councils: their activities are described first, with other Departments following in alphabetical order.

Department of Trade and Industry

The DTI's objective in S&T collaboration with Japan is to help improve the competitiveness of British industry by increasing the inward flow of exploitable technology from Japan, by gaining a timely knowledge of products and processes about to enter the market and of future trends in Japanese R&D, by ensuring a reasonable balance of advantage in respect of access by each country to the research institutions of the other, and by identifying technological gaps. To this end DTI runs a number of schemes.

— Visiting Engineers Scheme, funded by DTI and managed by the Fellowship of Engineering, through which British engineers, employed full-time in industry, are seconded for periods of up to one year to work in a Japanese company. Five engineers participated in the Scheme in 1987.

— Overseas (Science and Technology) Export Missions Scheme (OSTEMS), which enables small teams of industrialists to make studies overseas on specific problem areas identified by industry. The scheme was launched in 1986. Of 43 missions so far, 23 have gone to Japan.

— Every twelve months teams of senior officials from DTI and the Japanese Ministry for International Trade and Industry (MITI) meet to review and promote industrial collaboration. There is also contact at senior official level with the Agency of Industrial Science and Technology (AIST) and the Science and Technology Agency (STA).

— Exports to Japan Unit which, in its role of helping exporters, can provide market information and through its Anglo-Japanese Industrial Cooperation Service can help identify a possible Japanese partner for collaborative R&D in the UK.

— Overseas Technical Information Service, which disseminates technical information gleaned through, inter alia, the British Embassy in Tokyo.

DTI has experienced difficulties in finding British participants for schemes involving attachments of three months or longer to Japanese organizations, though it expects this to change as Japan plays a bigger role in international cooperation in S&T and gains increasing recognition.

The British Council

The British Council has worked in Japan since 1952 and has maintained a Science Officer there since the late 1970s. The Science Officer's role is to develop relations between the two countries' academic and basic scientists (in contrast to the Science Counsellor at the Embassy, who is charged with monitoring governmental and industrial developments

in science and technology). Of the British Council's total budget for Japan, about 12% (i.e. a little over £400 000) goes to science and technology activities.

The bulk of the Council's S&T budget for Japan goes on exchanges of individuals between the two countries. In 1986/87, the British Council funded 77 visits to Japan and 35 visits from Japan; it also provided local support, information and introductions to many other visitors. The Council's exchange programme ranges from full one-year scholarships for young scientists to shorter research scholarships and a variety of travel grants.

The British Council plays an important role in helping bodies such as the research councils and the Royal Society develop their collaborative activities with Japanese partners.

Agricultural and Food Research Council

Because of the socio-economic and climatic differences between the UK and Japan, collaboration in areas relevant to AFRC has tended to be concentrated mainly at the basic end of research. Organizational differences have led to a preference for informal modes of collaboration. In the 16 months from June 1986, five Japanese scientists visited and worked at AFRC Institutes, and four Institutes collaborated with Japanese organizations. An Institute director visited Japan to assess opportunities for S&T collaboration.

Medical Research Council

MRC, like AFRC, prefers to conduct its collaboration with Japan on an informal basis. There are currently six Japanese visiting workers in MRC Units and five Japanese nationals holding short-term appointments. The Council also receives fact-finding missions from time to time. About ten MRC scientists per year attend conferences in Japan, and some stay on for short working visits. British scientists tend to make only brief working visits to Japan, in contrast to Japanese scientists who may stay a year or so in the UK. There is a greater demand for Japanese medical scientists to spend time in the UK than for British scientists to go to Japan. MRC is involved in the development of the UK's response to the Japanese Human Frontiers Programme.

Natural Environment Research Council

NERC contacts have hitherto been mostly on an informal, individual basis. Five Japanese postdoctoral fellows are working at one NERC Institute; a second Institute is collaborating on a modest scale with a Japanese research laboratory. The British National Space Centre (in which NERC participates) is discussing collaboration with Japan in Earth observation missions. NERC is exploring the scope for multilateral collaboration with other countries, including Japan, in providing access to research vessels and marine equipment. Two senior NERC officials have recently visited Japan to identify areas for potential collaboration between NERC and Japanese scientific institutes.

Science and Engineering Research Council

SERC has, in the past seven years or so, given special encourageament to collaboration with Japan. Following initial discussions in 1980 and a start to collaborative programmes in 1981, an aide memoire with Monbusho was signed in 1982. The disciplines in which collaboration with Japan had been most prominent are space science, molecular science (including materials science), ground-based astronomy, biotechnology, use of neutron sources, lasers, biomaterials and theoretical

atomic and molecular physics. No special funds are set aside by SERC for its Japan programme. Applications that include requests for funds to support some level of cooperation with a Japanese research group are considered in the normal competition with all other applications either wholly UK based or involving some collaboration elsewhere in the world.

SERC helps in the administration of the Toshiba Fellowship Scheme, through which awards are made each year to two UK scientists or engineers to enable them to undertake research in Toshiba research establishments.

Department of Energy

The Department of Energy has no bilateral arrangements for S&T collaboration with Japan, though it is involved, alongside Japan, in some multilateral collaborations. It is, however, exploring with MITI, at MITI's initiative, the scope for an S&T agreement on renewable energy.

Department of the Environment

The DoE has no formal S&T agreements with Japan. The Building Research Establishment, however, maintains links with relevant bodies in Japan.

Department of Health and Social Security

The DHSS has no formal S&T links with Japan. It does, however, have some involvement in a Japanese programme of cancer research, and in an international programme on chemical safety to which the Japanese also contribute. An official from the DHSS Supplies Policy Division visited Japan during 1987 to look at computer control of manufacturing systems in the pharmaceutical industry.

Department of Transport

The Department of Transport has no formal S&T links with Japan. The Transport and Road Research Laboratory does, however, have informal contacts with Japanese representatives on relevant international bodies.

Foreign and Commonwealth Office

The FCO, with the Central Office of Information, annually arranges visits to the UK for about half a dozen individuals or groups of scientists or engineers.

Health and Safety Executive

The HSE has no S&T collaboration specifically with Japan: it sits alongside Japan on a number of international bodies and it exchanges publications with five Japanese organizations.

Home Office

The Home Office has a few informal liaisons with Japan, but no collaborative links in S&T.

Ministry of Agriculture, Fisheries and Food

MAFF has had irregular and limited contacts with Japan, but no formal agreement. The Japanese have shown considerable interest in MAFF's fisheries environmental monitoring programme, but the flow of information has been almost entirely towards Japan.

Ministry of Defence

MoD has very little formal or informal contact with Japan in scientific or technical research.

VI. LEARNED SOCIETIES AND INSTITUTIONS

We sent a questionnaire to 37 learned societies and professional institutions in various fields of science and engineering. Replies were received from 25 (68%).

Exchange schemes

Two of the organizations responding have substantial schemes for promoting exchange of researchers specifically with Japan. The Royal Society has four schemes specifically connected with Japan, three of which are run jointly with the Japan Society for the Promotion of Science or the Japan Academy. The schemes range from postdoctoral exchanges of up to two years' duration to study visits of a few weeks. The Society also runs a variety of schemes promoting collaboration with overseas countries generally. The Fellowship of Engineering administers the Visiting Engineers to Japan Scheme sponsored by DTI (see chapter V above), and administers and sponsors an Overseas Visiting Fellowship Scheme for engineers in industry and academia to work in engineering companies overseas, including Japan, for up to three years. Two other organizations have exchange schemes that could be used for Japan as well as for other countries.

Other links

Most of the organizations responding have some members resident in Japan, but in no case do they exceed 1% of the total membership. Half the organizations have links of a greater or lesser degree of formality with their opposite numbers in Japan. Some make explicit efforts to disseminate information about Japanese research in their field.

Many of the organizations publish journals and accept Japanese papers for them. In only two cases do Japanese papers constitute more than 5% of the total: the Pharmaceutical Society of Great Britain (11%) and the Royal Society of Chemistry (15%). The Institute of Energy mentioned that 20% of overseas subscribers to its journal are Japanese.

VII. CONCLUSIONS

Collaboration between the UK and Japan in science and technology takes many forms, from joint ventures between industrial companies to joint research between academics, from collaboration between Government departments to cooperation between learned societies, from exchange of students to exchange of publications. The objectives, the benefits, the management issues, the degree of commitment, the costs are equally varied. Few conclusions can usefully be drawn that are valid across the whole range of this experience. Moreover, because we focused our attention on those involved in collaboration, we cannot extrapolate our findings to individual sectors as a whole: we did not ask why some companies had decided not to collaborate, nor whether they had even considered the question. Our comments necessarily relate just to the particular sample of organizations that we contacted.

Nevertheless, the approach we adopted furnished us with a good deal of information about those who have entered into collaboration with Japanese partners, and does allow us to draw some conclusions of general interest.

Importance of Japan

Our respondents nearly all agreed on the growing significance of Japan for their enterprises, and accepted, with greater or lesser enthusiasm, that collaboration with Japan was important now and would become more important in the future. It is not surprising that those who have collaborated (i.e. our respondents) should attach some importance to collaboration. But we were able to identify some of the reasons why they did so. There was often a straight commercial motive: for example, the Japanese pharmaceuticals market was said to be the second largest in the world (and rapidly approaching the size of the US market), so pharmaceutical companies with international ambitions had to aim at that market, and the best way of so doing was by collaboration with a Japanese company. The Japanese markets for certain materials and for nuclear power were said to be among the largest in the world. In other sectors respondents noted that Western Europe or North America were more important to them commercially, if only because of greater ease of access, but that Japan was still sufficiently important to be worth the effort.

The commercial importance of Japan to our respondents was often said to have increased over the last decade. The same is true of its importance from an S&T point of view: most notably in a variety of specialized materials, in steel, in mechanical engineering, in advanced manufacturing technology, in biotechnology and in electronics, among the areas in our survey, there was obvious respect for Japan's S&T abilities.

A number of industrial collaborations were undertaken essentially for long-term aims, with a view to being in a favourable position when the stakes were raised from their current levels. There were other intangible reasons for attaching importance to collaboration with Japan: the high technical standards and challenging environment set by some Japanese companies, the chance to study Japanese management

skills and working practices, the kudos associated with collaborating with a major Japanese partner.

In the academic sector, collaboration could be an important means of stretching one's resources, for example by providing an extra pair of hands or a piece of equipment, or by assembling the critical mass of resource needed for a large-scale piece of research.

In a fair number of collaborations, there was nothing particularly significant about the fact that the partner was Japanese: it might simply be a case of extending to Japan arrangements already made with other countries, or it might be that a particular company or individual, who just happened to be Japanese, had been identified as a specially suitable partner.

Balance of benefit

Collaboration might involve flow of S&T knowledge mainly from the UK to Japan, or mainly from Japan to the UK, or more or less equally in both directions. The balance could change during the course of the collaboration, typically from one-way flow of knowledge to two-way flow. We found no straightforward connection between the direction of flow and the relative S&T strengths of the two countries, at least at field level. There were cases of flow in either direction in each of the five broad industrial sectors we examined. University collaborations involved receiving information from Japan as frequently as they involved sending information to Japan. In virtually all the fields covered by the academic questionnaire, 'gaining technical knowhow' was an objective of collaboration for both UK and Japanese participants.

On the whole, however, it does appear that the collaborations we studied involved S&T knowledge flowing to Japan more frequently then they involved S&T knowledge flowing from Japan. Thus 14 industrial collaborations involved the granting of licences to Japanese companies, as opposed to 5 where the licence was granted to a British company. 42 British academics, and 80 of their Japanese partners, were said to have derived increased expertise from their collaborations; 28 British, and 39 Japanese, secured access to material, experimental data or equipment. Where an industrial collaboration involved two-way flow, it was often—though by no means always—the case that relatively basic knowledge flowed to Japan and manufacturing technology and product innovation flowed from Japan.

This finding does not necessarily point to unequal benefit, since access to science and technology is not the only outcome of collaboration that needs to be taken into account. British companies transferring technology to Japan may gain considerable income from royalties or direct sales, benefit from product innovations made subsequently by the Japanese, have favourable access now or in the future to Japanese technology and establish a base for future expansion in the Japanese market. Collaboration provides British academics with access to skilled assistants and colleagues at a time when sources of funding in the UK for research assistants or additional research posts are under severe pressure. Such considerations mean that, while there may be a net flow of S&T from the UK to Japan, there may also be a compensatory flow of some other benefit in the opposite direction—at least in the short term. Whether this is actually so, for individual collaborations and, even more, from the national point of view, is not something we can

judge. Still less can we judge the long-term balance of benefits. However, the evidence from the industrial survey is that most UK companies are well pleased with their experience of collaboration and many expect to maintain or expand their collaborative activities in the future. Academics, too, mostly expect collaboration either to grow or to remain at present levels, and some Government Departments are exploring opportunities for collaboration.

There is an interesting asymmetry in UK-Japan collaboration. In 21% of collaborations involving UK academics, the Japanese partner was based in industry (and three quarters of these collaborations were initiated, and half entirely paid for, by the Japanese partner). However, all the collaborations reported to us by UK companies were with Japanese companies, and one respondent commented on the severe difficulties his company had experienced in trying to collaborate with Japanese universities or research institutes—a difficulty said to be shared by Japanese companies. To the extent that academic collaborations are generally very informal affairs—for example, few (even of those with an industrial partner) contain any provision for dealing with intellectual property rights—this institutional asymmetry might give some advantage to Japanese industry.

Related to mutuality of benefit is the question of value for money. We have little quantitative evidence on value, but we do have some on money. The Japanese partner bore the full additional cost in 20% of academic collaborations, including half of those where the Japanese partner was based in industry. In a further 43% of academic collaborations, the additional cost of the collaboration to the UK partner was under £1000, and in 70% it was below £10 000. Academic collaboration can thus be had for quite small sums of additional money. Industrial collaboration is on a different scale: some respondents reported joint ventures with hundreds of employees and/or multimillion pound investments. We were not able to obtain useful data on how much Japanese partners were spending on collaboration.

Management and organization

Several management and related issues have emerged during the study. One is that there are many ways of getting started in a collaboration, but virtually no ways of doing so in a hurry. There is no 'best' way of identifying potential partners—the individual circumstances of each collaboration will determine the process. The roles played by previously established sales offices in Japan, by wholly-owned subsidiaries, by management consultants, by Government agencies (apparently fairly small) and, in academic collaborations, by conferences would be worth exploring in greater detail. A point that emerges strongly, particularly on the industrial side, is that a great deal of time and energy may need to be spent in establishing the conditions of mutual trust and respect needed for collaborations to flourish. One corollary of this is the need to take a long-term view when assessing progress. Another is that once successful collaboration is established, further work may follow: having made the effort needed to get to know a partner, there is a clear incentive to continue with that partner. Indeed, both British and Japanese partners may see the initial collaboration as a test bed for subsequent collaboration on a much larger project.

The great majority of academic collaborations were with the British academics as individuals, with little or no formal structure. Collaborations between British and Japanese companies took a variety of structures, mostly joint ventures, licences or R&D agreements of various sorts. In most cases the objectives of the collaboration and how they were to be achieved were spelled out in detail at the outset. Sometimes a change or enlargement of objectives would lead to a change in structure. Sometimes, too, a change in the relative bargaining power of the two partners would lead to a change in structure, for example with one partner increasing his share of a joint venture or renegotiating the terms of a licence. Structure is not immutable.

Intellectual property rights were defined precisely in every industrial collaboration reported to us. By contrast, in only 14% of academic collaborations was there any mention of intellectual property rights, and then it was most often a matter of a gentleman's agreement to share intellectual property rights equally.

Communication is obviously a central feature of any collaboration, and one that looms large in collaboration between two countries as far apart spatially and culturally as the UK and Japan. Distance itself appears to cause relatively few difficulties, other than increasing the expense and reducing the immediacy of communication. It is interesting that Japanese academics appeared to be more able to undertake both short and extended visits to the UK for collaborative research than were their UK colleagues to visit Japan. Several respondents commented on the high costs of travelling to, and living in, Japan. Language does cause difficulties, though generally these can be overcome. The biggest problem is communication at a more basic level: from the UK perspective, learning how the Japanese typically use language in a formal context, conduct negotiations, reach decisions, resolve misunderstandings. Patience is essential.

The role of local contacts and other agencies in helping to initiate collaborations has been mentioned already. They can also be useful in monitoring the progress of collaboration. Most companies rely on frequent meetings, both formal and informal, to assess progress, but this can stretch the resources of small companies. A third party can be valuable in helping to resolve disputes or misunderstandings that may arise.

There can initially be resistance, at any level within a company, to the idea of collaboration with a Japanese competitor. A measure of the success of a collaboration is the degree to which this resistance is overcome as the collaboration proceeds.

Students

In 1986 there were some 444 full-time Japanese-domiciled students in British universities, of whom 168 were on undergraduate courses and 276 on higher degree courses. These figures were about 30% up on the 1985 figures, though in the previous ten years there had been little variation. There were a further 77 on part-time courses. In 1986, 20 countries, including 8 outside the Commonwealth and EEC, sent larger numbers of full-time students to British universities than did Japan.

Over the period 1975–1986 as a whole, 19% of full-time Japanese undergraduates, 11% of Japanese postgraduates on taught courses

and 32% of Japanese postgraduates on research courses were studying science or engineering. For comparison, the corresponding figures for all full-time students in British universities in 1985 were 39%, 23% and 62% respectively. Japanese students come to the UK not so much for science or engineering as for subjects like economics, politics and law, where a qualification gained in the UK can be valuable for a subsequent career in Japanese organizations with international interests.

Government departments

The Department of Trade and Industry, the British Council and the research councils are the Government or related bodies most actively engaged in S&T collaboration with Japan. Most other Departments have no contact beyond informal liaisons set up on an *ad hoc* basis by their research establishments or by similar bodies. One or two Departments in addition to the DTI are, however, exploring the scope for collaboration.

There was a unanimous wish to keep collaboration generally informal and *ad hoc*. Thirteen countries, including France, FRG and USA, have broad bilateral agreements on cooperation in S&T with Japan, and a further six countries have 'exchange of notes'; the UK prefers to organize specific agreements on a case-by-case basis and to operate informally whenever possible.

Concern that collaboration should generate mutual benefits and not one-way flow of S&T knowledge towards Japan emerges more strongly from Government Departments than from the other sectors we surveyed. This concern is expressed both by Departments that are actively collaborating and by those that are not.

Government-funded schemes promoting exchange with Japan appear to be experiencing some difficulty in attracting British scientists and engineers on to long-term (i.e. longer than three months) postings to Japan. Japanese researchers need less persuading to accept postings in the opposite direction.

Learned societies and institutions

Relatively few learned societies and professional institutions have very substantial links with Japan. Two in our sample run exchange schemes with Japan, and two others have exchange schemes that are sometimes used for Japan. Only about half the societies responding have links with their opposite numbers in Japan; the remainder have minimal involvement in Japan. It may be symptomatic that our survey of learned societies achieved a lower response rate than the industrial and academic surveys.

Issues arising

A number of policy issues arise from the findings presented in this report. In particular:

- What is the overall scale of collaboration with Japan and how does it compare with other countries? Have some companies made explicit decisions not to collaborate with Japan? If so, why?
- How can one most effectively initiate collaboration? What is the role of intermediaries in initiating, and in monitoring, collaboration?
- What determines the structure of a particular collaboration, and what are the advantages and disadvantages of different structures?

— How can one assess the benefits and the costs of collaboration, to the individual collaborator and to the wider UK community, in the short and the long term?

— What are the reasons for, and the implications of, the low priority given in academic collaborations to intellectual property rights?

— Are there identifiable, generalizable factors that determine the success of collaboration?

— What are the special characteristics of collaborations between different sectors (e.g. industry and academe)?

— How far can the lessons from Japan be applied to collaboration with other countries?

— How do industrial companies see R&D collaboration with Japan developing in the future? How will this be affected by completion of the European internal market?

These issues deserve closer attention if there is to be an adequately informed debate on policy for S&T collaboration with Japan, whether at national, corporate or individual level.

ANNEX A: FURTHER READING

J.C. Abegglen & G. Stalk, *Kaisha, The Japanese corporation* (New York: Basic Books, 1985)

Advisory Council for Applied Research and Development, *Improving research links between higher education and industry* (London: HMSO, 1983)

Anglo-Japanese Economic Institute, *Britain and Japan* (London: Anglo-Japanese Institute, 1988)

Anglo-Japanese Economic Institute, *Japanese addresses in the UK* (London: Anglo-Japanese Economic Institute, 1988) (regularly updated list of over 650 Japanese business connections in the UK)

Anglo-Japanese Industrial Cooperation Committee, *List of publications in English on the industrial technology of Japan* (London: Japan Trade Centre, 1985)

C. Bradley, 'R&D: a strategy for more international collaboration', *British Business* (29 May 1987), 16–20

British Chamber of Commerce in Japan, Science and Technology Action Group: *A strategy for Japan* (London: BOTB, 1986)

British Chamber of Commerce in Japan, *Research and development in Japan* (Tokyo: BCCJ, 1987)

British Council, *Japan: a science profile* (London and Tokyo: British Council, 1988)

British Council, *Japan/UK collaboration in science and technology—examples of recent links* (London: British Council, 1986)

British Council, *Schemes and scholarships* (Tokyo: British Council, 1987) (deals with exchange schemes between the UK and Japan, whether or not organized by the British Council)

British Overseas Trade Board, *Success in Japan* (London: BOTB, 1985)

R. Clark, *Keeping abreast of Japanese technology* (London: Technical Change Centre, 1985)

Commission of the European Communities, *Relations between the Community and Japan* (COM (88) 136; Brussels: CEC, 1988)

C. Freeman, *Technology policy and economic performance: lessons from Japan* (London: Frances Pinter, 1987)

W.J. Gillan, *The Japanese secret—are they winning?* (London: Department of Trade and Industry, 1986; revised 1987)

C.T. Hill, *Japanese technical information: opportunities to improve US access* (Washington: Congressional Research Service Report 87-818 S, 1987)

J. Irvine, *Evaluating applied research—lessons from Japan* (London: Frances Pinter, 1988)

K. Ishiwata, ed., *Export to Japan guidebook for UK exporters* (London: JETRO/EJU/BOTB/JCCI, 1986)

Japan Society for the Promotion of Science, *Scientific research institutes under the jurisdiction of Monbusho* (Tokyo: Monbusho, 1980)

C. Johnson, *MITI and the Japanese miracle: the growth of industrial policy, 1925–1975* (Stanford: Stanford University Press, 1982)

Y. Kaya, *The present state and future prospects for scientific and technological cooperation between Japan and the United Kingdom* (London and Tokyo: UK-Japan 2000 Group, 1988)

F. Nann & D. Olivastro, *Identifying areas of leading edge Japanese science and technology* (CHI Project No. 8510-R; Haddon Heights, NJ: 1988)

NSF, *Directory of Japanese company laboratories willing to receive American researchers* (US National Science Foundation, Tokyo Office, Report Memorandum No 92, 1986)

Science and Technology Agency, *National laboratories and research public corporations in Japan* (Tokyo:STA, 1987)

L. Turner, *Industrial collaboration with Japan* (London: Royal Institute of International Affairs/ Routledge & Kegan Paul; Chatham House Papers No 34, 1987)

UK–Japan 2000 Group, *Current exchange activities between the United Kingdom and Japan* (London: UK–Japan 2000 Group, 1987)

Universities' Statistical Record, *University Statistics 1986-87: Students and staff* (Cheltenham: USR, 1987)

N. Valery, 'Clash of the titans', *The Economist* (23 August 1986), special survey

ANNEX B: USEFUL ADDRESSES

Some of the publications listed in Annex A (e.g. British Council, *Schemes and scholarships*) give the addresses of relevant contacts for those wanting further information about particular initiatives. This Annex sets out, for convenience, some addresses that may be useful for UK scientists and engineers, whether in industry or in academe, who are considering collaboration with Japan. It is not intended to be comprehensive: for example, it omits many of the individual exchange schemes given in the above-mentioned British Council paper.

(i) **UK bodies in the UK**

Advisory Council on Science and Technology
70 Whitehall
London SW1A 2AS — Contact: Mr P. Finch — 01-270 0197

British Council
10 Spring Gardens
London SW1A 2BN — Contact: Dr D. Constable — 01-930 8466

British Overseas Trade Board
1 Victoria Street
London SW1H 0ET

– Exports to Japan Unit — Contact: Ms D. Roberts — 01-215 4799
– Japan Trade Advisory Group — Contact: Mr Y. Uchinaka — 01-493 7226

Confederation of British Industry
International Affairs Directorate
Centre Point
103 New Oxford Street
London WC1A 1DU — Contact: Mr A.S. Lawson — 01-379 7400

Department of Trade and Industry
Overseas Science and Technology Expert Mission Scheme
Ashdown House
123 Victoria Street
London SW1E 6RB — Contact: Mrs D. Harris — 01-215 6654

Fellowship of Engineering
Engineering Support
2 Little Smith Street
London SW1P 3DL — Contact: Ms. J. Spring — 01-222 3912

Foreign and Commonwealth Office
Far Eastern Department
King Charles Street
London SW1A 2AH — Contact: Mr B. McLeary — 01-270 2949

Overseas Technical Information Service
PERA-OTIS
Melton Mowbray
Leics LE13 0PB — Contact: Mr G. Dyer — 0664-501501

Royal Society
6 Carlton House Terrace
London SW1Y 5AG — Contact: Miss K. Kimpton — 01-839 5561

Science Reference Library
Japanese Information Service
25 Southampton Buildings
Chancery Lane
London WC2A 1AW — Contact: Mr G.J. Sassoon — 01-323 7924

(ii) **UK bodies in Japan**

British Chamber of Commerce in Japan
3F Kowa No 1 Building
11–41 Akasaka 1-chome
Minato-ku
Tokyo 107 — Contact: Mr I. de Staines — (03) 505 1734

British Council
2-Kagurazaka 1-chome
Shinjuku-ku
Tokyo 162 — Contact: Dr J. Grote — (03) 235 8031

British Embassy
1 Ichiban-cho
Chiyoda-ku
Tokyo 102

Contacts
– scientific: Dr R.Hinder (03) 265 5511
– commercial: Mr M. Guest (03) 265 5511

(iii) **Japanese bodies in the UK**

Japan Association
Regis House
43–46 King William Street
London EC4R 9BE — Contact: The Director — 01-623 5324

Japan External Trade Organization (JETRO)
Leconfield House
Curzon Street
London W1Y 7FB — Contact: Ms P. Stern — 01-493 7226

Japan Foundation
35 Dover Street
London W1 — Contact: Mr T. Yano — 01-499 4726

Japan Information Centre
Embassy of Japan
9 Grosvenor Square
London W1X 9LB — Contact: Mr G. Kano — 01-493 6030

Japanese Chamber of Commerce and Industry in the UK
5th Floor Chronical House
72 Fleet Street
London EC4Y 1HY — Contact: Mr A. Wakasuge — 01-353 8166

Japanese Embassy
46 Grosvenor Street
London W1X 0BA

Contacts
– scientific: Dr S. Ueta 01-493 6030
– commercial: Mr T. Kitamura 01-493 6030

(iv) **Joint Anglo-Japanese bodies**

Anglo-Japanese Economic Institute
Morley House
314–322 Regent Street
London W1R 5AD — Contact: Ms A. Corby — 01-637 7872

Anglo-Japanese High Technology Industry Forum
Royal Institute of International Affairs
Chatham House
10 St James's Square
London SW1Y 4LE — Contact: Mr L. Turner — 01-930 2233

UK–Japan 2000 Group
Royal Institute of International Affairs
Chatham House
10 St James's Square
London SW1Y 4LE — Contact: Ms P. Seaward — 01-930 2233

(v) **European Commission**

EC–Japan Centre for Industrial Cooperation
Human Resources Training Programme (UK agents):
Price Waterhouse
Southwark Towers
32 London Bridge Street
London EC1 — Contact: Mr J. Crawford — 01-378 7200

EC Executive Training Programme in Japan (UK agents):
Peat Marwick McLintock
PO Box 486
1 Puddle Dock
Blackfriars
London EC4V 3PD — Contact: Mr M. Coney — 01-236 8000

Scientific Training Programme in Japan
Commission of the European Communities
DG XII/A
Rue de la Loi 200
1049 Brussels
Belgium — Contact: Ms H. Donoghue — (02) 236 0433