
The Management and Coordination of Biotechnology in the U.K. 1980-88 [and Discussion]

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The management and coordination of biotechnology in the U.K. 1980–88

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Government policy towards biotechnology has come a long way since the Spinks Report. Spinks advocated centralized coordination of policy, an approach deliberately rejected in 1981 by the Government in favour of continued pluralism, with each of the scientific research councils and various ministries 'doing their own thing'. This has led to considerable diversity of activity, and during these eight years more has in fact been achieved than is often recognized. But it also created an overlapping of responsibilities with concomitant friction and bad feeling that has wasted time and resources. The paper argues that some degree of friction is inevitable. By their nature new technologies cut across existing disciplines and blur institutional boundaries. The traditional approach has been to muddle through, allowing new institutions to emerge and adapting the old as seems appropriate. Lack of resources, however, argues against too brash a competitive approach. The paper suggests that strategic or precompetitive research should be seen as a complement to, rather than competitive with basic research, and cautions against too radical a restructuring of institutions at the present time.

INTRODUCTION

The management and coordination of biotechnology is an issue that is currently exercising some eminent minds in the U.K. For a number of reasons it is also a hot political issue and a minefield where even angels might fear to tread. The purpose of this paper is to avoid that minefield and instead to attempt to look at the issue across the perspective of the eight years since the Spinks Report was published. It looks first at what that report itself had to say, and then follows through to the White Paper response and the lines of coordination that have *de facto* been created since then. It ends by examining the state of pluralism which has emerged, raising the question of whether the assumption that many of us implicitly hold, that this pluralism is regrettable, is really the case.

THE SPINKS RECOMMENDATION

In a symposium commemorating the Spinks Report, it seems to me appropriate to begin by considering what the Report itself had to say on the issue of management and coordination. Others have already reminded us of the prescience and common sense of that report, and this spirit also imbued the recommendations about the management of biotechnology. The report, for example, argued:

A subject like biotechnology which at this stage straddles the division of responsibilities both among Government Departments and among Research Councils, and the arbitrarily defined fields of fundamental and applied research, is handicapped by the present structure of public and private support for research and development.... The problem lies in identifying a source of funds to carry

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a project forward from the point where primary research has been done, but commercial development has not yet begun – the predevelopment gap. (Spinks 1980, para. 4.4.)

Most of the Spinks recommendations were concerned with how best to promote biotechnology and bridge this pre-development gap. In all there were 24 recommendations, but top of the list came those concerning coordination, for the Committee rightly saw this as a crucial issue. The first recommendation was about the research councils where it highlighted the problems raised by the degree to which biotechnology cut across established responsibilities.

Balanced development will suffer if responsibility is perceived as resting with any one Council; equally it may suffer if it is perceived as a peripheral activity of each, or highlights gaps between them. As a result our first recommendation is that the Research Councils should set up a Joint Committee for Biotechnology with senior representatives from each Council. The Chief Scientist of appropriate government departments and industrialists with experience in biotechnology should also be members. A Director/Coordinator should be appointed by the Research Councils to support the committee and to stimulate the development of new projects in universities and elsewhere on their behalf. (Spinks 1980), para. 4.6.

The Committee was anxious to see the complementary establishment of a Whitehall coordinating group whose main task would be to develop ‘a programme of industrial research and development’. ‘We have some sympathy,’ the Report argued, ‘for the view held, for example, in West Germany, that R&D cannot be left to economic forces alone and that government intervention is appropriate for making industrial innovation feasible’ (Spinks 1980, para. 4.8.). It wanted to see the establishment of a strong interdepartmental committee led by the Department of Industry (DoI) (now the Department of Trade and Industry (DTI)) and with responsibility to promote industrial research and development (R&D), whereas the Research Councils were to promote pre-competitive R&D. Yet a further recommendation was that ‘the NEB (National Enterprise Board) in conjunction with the NRDC (National Research and Development Corporation) should investigate the possibility of establishing in the U.K., and with some public funds, a research oriented biotechnology company of the kind now taking shape elsewhere’. Who would have dreamt from this rather coy reference that plans for Celltech were already well advanced within the NEB†.

THE WHITE PAPER RESPONSE

It is no secret that the Spinks Report disappointed many potential ‘biotechnologists’ with the moderation of its proposals and, above all, its failure to call for a major injection of funds into the biological sciences. But if Spinks disappointed, the Government’s response, an eight-page White Paper published 12 months after the publication of the Report, brought fury. It failed to deliver on even the modest Spinks funding proposals and it passed the buck on biotechnology from government to industry. Its message, summed up by the following extract, was in philosophy very much at odds with the Spinks recommendations.

The main responsibility for turning the concepts and discoveries of underlying science into useful

† The National Enterprise Board (NEB) had by the late 1970s identified biotechnology as a potential growth area and had given its backing to a number of small biotechnology establishments. But it was also convinced that, just as in semiconductors the major British electronics firms needed the foundation of Inmos (by the NEB) to prompt them into recognition of important developments, so the foundation of an American-style new biotechnology firm, working on leading-edge techniques, would similarly serve to heighten awareness and prompt action by some of our major firms in the chemical, pharmaceutical and agri-food sectors.

products and services... lies with industry. The Government's financial and economic policies are designed to provide an environment in which private initiative and enterprise will be encouraged to take advantage of the opportunities as they emerge. (H.M. Government, 1981, para. 3.)

In the circumstances it is surprising that the Government gave its backing to the establishment of Celltech, which was actually launched before the publication of the White Paper and within nine months of the Spinks Report. Its survival owes much to John Ashworth, its product champion within the Cabinet Office (and perhaps more importantly with the Prime Minister), and Gerard Fairtlough, who had for several years been preparing for its launch within the NEB and subsequently became its chief executive. It is an interesting comment on how far the venture-capital market has come since 1980 that Fairtlough is convinced that *at that time* the enterprise could not have been launched without Government financial backing. Contrast this with the relative ease with which British Biotechnology, a firm with a pedigree analogous to that of Celltech, has succeeded in raising rounds in the last couple of years. That in 1981 the market needed to be supplemented by Government caused much anguish to Sir Keith Joseph, then Secretary of State for Industry and guru of the Thatcher industrial policy. The establishment of Celltech remains to my mind an aberration in the Government's predominantly free-market approach to industrial policy.

Celltech apart, it is fair to say that the Government ran away from the Spinks recommendations, and in particular that it funked the issue of coordination. An inter-departmental committee on which the Heads of the Research Councils were represented had been established, but it was not a strong committee with responsibilities for developing a 'programme' for biotechnology as envisaged by Spinks but a loose forum whose main function was information exchange. It took a change of minister and, for the Government, the disastrous hearings before the House of Commons Select Committee in 1982[†] before the DoI set up its Biotechnology Unit which took on some of these functions. As for the Research Councils, another loose coordinating committee, the Inter-Research Council Coordinating Committee on Biotechnology (IRCCCOB) was established, but, again, it lacked a clear remit, had no industrial members, and no clear linkage with government departments. Nor was there any question of appointing a Director or Coordinator to coordinate and stimulate joint initiatives.

Part of the reason for this minimalist response to the Spinks recommendations lay in philosophy. The Government did not believe, as had Spinks, that it had a role to play in helping promote this new area of technology. It saw its function purely as 'creating the right environment' by cutting taxes, raising profits, promoting the venture-capital market and supporting basic science, and it was up to industry to seize the opportunities opened up by science. In other words, the Government did not believe that there was such a thing as a 'pre-development gap' and no need therefore to take action to plug it. Nevertheless, the Government would have been happy to see rather more coordination of Research Council

[†] The House of Commons Select Committee on Education and Science under the chairmanship of Christopher Price, then M.P. for West Lewisham, held a series of hearings between April and June 1982 and issued in July a brief interim report on the funding of biotechnology research. The hearings served to pinpoint the Government's failure to support underpinning research in the universities and in particular the breakdown of the dual support system whereby the University Grants Committee (UGC) funded the 'well found' laboratory to support research activities. During the hearings the UGC announced the injection of an additional £1M into universities to support biotechnological research. Originally the idea had been to concentrate this money on three centres of biochemical engineering – University College London, Birmingham and Manchester – but pressure from the academic community led to far wider dispersion than originally envisaged. Although initially the funding was to have been for three years only, the posts established at that time have remained in being (see House of Commons (1982)).

effort. Indeed, John Ashworth put a good deal of effort at that time into trying to get the Joint Directorate proposed by Spinks set up. The stalling block was the Medical Research Council (MRC) which, in spite of its pre-eminent role in the development of biotechnology, neither wished to take the lead in such a body, nor was willing to participate in any such organization. And without the MRC, the notion of a joint committee and/or a coordinator made little sense.

The MRC's reservations about the Spinks proposals stemmed from a number of causes.

1. Sir James Gowans, MRC Secretary at that time, had spent much of the 1970s fighting the Rothschild customer–contractor principle which had linked the MRC to the Department of Health and Social Security (DHSS). To Sir James, the Spinks notion of industrialists sitting on a joint committee and helping to shape research priorities was reintroducing Rothschild through the back door.

2. The MRC likewise had considerable reservations about the notion of the pre-development gap (see IRCCCOB 1982), pp. 17–18). In general the MRC shared the Government's view that it was for the research councils to concentrate on basic research and for industry to seize the opportunities and develop that research as it saw best. It was not for Government, and above all not for the research councils, to subsidise industry's activities.

3. The MRC was, however, prepared to admit to the existence of an information gap – industry was often badly informed about developments in academic science – and for this reason had been pleased to go along with the establishment of Celltech as a bridge between its own research and industry. But with Celltech now set up, it saw little need for further efforts to bridge the gap.

4. Finally there was the question of resources. The MRC might have been prepared to go along with the establishment of a joint Directorate had it been clear that this was a means of injecting more resources into the MRC's research budget. But in the funding climate of the early 1980s this was not feasible. For the MRC, programmes for promoting strategic research, with priorities in part dictated by industrialists, meant less money for what it saw as its prime responsibility, namely the support of first-class fundamental research.

Argue as they might, neither John Ashworth nor Alfred Spinks could persuade the MRC at that time that the Spinks proposals for a joint directorate made sense. Nor was the Government prepared to impose such a solution. IRCCCOB therefore remained no more than a loose meeting ground for the research councils, little more than a forum for the exchange of information.

DEVELOPMENTS SINCE 1981

I have spent a good deal of time dwelling on the history of these early developments because I believe it is in the decisions taken at that time that the seeds of the present problems were sown. As I have made clear, the Spinks Committee argued that the promotion of biotechnology required a firm lead from Government and a coordinated programme of development. When that lead was not forthcoming, each organization 'did its own thing'. As Spinks had foreseen, given the degree to which biotechnology cuts across established disciplines and the traditional boundaries of pure and applied science, overlap was inevitable, and without an agreed mechanism for resolving boundary disputes this overlap would lead to friction. It is worth looking in a little more detail at the different strands of the pluralism that developed.

The main actors, as political scientists would call them, are identified in table 1, which sets out our best estimates of public support for biotechnology in the years 1981/2 and 1986/7.

TABLE 1. PUBLIC EXPENDITURES ON BIOTECHNOLOGY IN THE U.K.

(Sources: 1981/82 figures from House of Commons (1982). 1985/86 figures supplied by respective Research Councils and DTI.)

organization	expenditure/£M	
	1981/82	1985/86
MRC	18.7	31.0
AFRC	5.1	10.0
SERC		
Directorate	1.7	4.4
Biological Sciences Committee	6.8	7.3
NERC	0.8	0.8
DTI	0.6	6.2
other Government departments	0.2	1.0
total	33.9	60.7

The fact that these figures are estimates itself points up one deficiency arising from the lack of coordination: we have no agreed definition of biotechnology. The Spinks Report had suggested that the research councils were between them in 1979/80 spending some £3M on biotechnology. By the time of the Select Committee hearings in the spring of 1982 this sum had grown to £25.5M, the figures given in table 1 for 1981/2 being the figures declared by each research council in those hearings. In fact, whereas Spinks was counting only the applied end of biotechnology (what the MRC in its project grants lists as projects 'with clear intent to commercialize'), the MRC and the Agriculture and Food Research Council (AFRC) argue (to my mind rightly) that biotechnology is a set of techniques which have now become so widely used that a good part of their research work counts broadly as biotechnology. Hence the MRC figures quoted in table 1 include a good deal of the research sponsored by its Cell Board in the areas such as molecular biology and molecular engineering. The AFRC likewise argues that today some 25% of its science budget is devoted to broadly defined biotechnology. This, however, gives us problems when we try to compare this with the Science and Engineering Research Council's (SERC's) spending, as we ought by analogy to include a good part of the spending of its Biological Sciences Committee and the Chemistry Committee as well as a number of the Engineering Committees. And we also need to take account of the UGC contribution to research costs which, of course, only contributes to university spending and not research institute spending, boosting SERC figures more than those of the MRC or the AFRC. All in all, it is very difficult to compare like with like. At best, table 1 identifies the actors and relativities.

THE SERC'S BIOTECHNOLOGY DIRECTORATE

Although the SERC and the Directorate appear in table 1 as relatively minor spenders, I want to start by looking at the Directorate's role in the management of biotechnology in the U.K., partly because it has grown fast and has been an active player on the scene, and partly because in so doing it has been seminal in stimulating activity elsewhere.

The Evaluation Report on the Directorate which my colleague Dr Jacqueline Senker and I wrote in spring 1988 (Senker & Sharp 1988) gives full details of the development of the Directorate. This is neither the time nor the place to go into many of the issues raised in that report. I would like to highlight, however, a number of points that emerge and that relate to the broader issue of the management of biotechnology in the U.K.

First, I would like to highlight the issue of *strategic research*. The Directorate was deliberately established as a vehicle for promoting strategic research. Originally the idea had been to have within the SERC just a joint committee which would link the Engineering and Science Boards and include some industrialists among its members. When it became clear, however, that the Spinks proposals for an inter-research council joint committee were coming to nothing, Sir Geoffrey Allen, then chairman of the SERC, was anxious for the SERC to take a more proactive stance. The model of the Directorate, pioneered in polymer engineering, was adapted for this purpose. The Directorate was to be responsible to both the Engineering and Science Boards; it was to be run by a Management Committee composed 50:50 of academics and industrialists, and with a remit not just to fund projects put forward by academics, but to set priorities and actively promote research in areas seen to be of importance to biotechnology; additionally, it was to explore ways of building bridges between industry and academia. In other words, the Directorate took up, within the one research council, the role that the Spinks Committee had outlined for their joint Directorate.

Secondly, it is worth looking at the Directorate's *Management Committee*. This from the start has functioned smoothly. It has been chaired throughout by an industrialist, and included, first Dr Coleman, and subsequently Dr Dietz, from the DTI's Biotechnology Unit. Decisions have in general been arrived at after discussion and by consensus, with the main lines of policy often emerging after the annual two-day review when priorities and programmes are discussed and assessed. Where there have been differences of view, the Committee has not divided industrialists versus academics but has cut across these lines. Industrial views have probably been somewhat more influential than academic ones in determining the priority-sector programme, although the mechanisms for promoting priority sectors, which begin with round-table discussions and workshops and culminate in some cases in a Club programme, are mechanisms which constantly test 'the market' within both academic and industrial communities, offering the opportunity to drop a programme if it does not have fairly widespread support. An interesting feature has been the tendency for the priority sectors to shift away from the applied end of biotechnology – from fermentation technology, culture techniques, etc. – towards the more fundamental aspects: microbial physiology, protein engineering, recombinant DNA, mammalian cell culture. Industrial pressure, far from pushing research into applied areas, would appear to have done precisely the opposite.

Thirdly, I want to discuss the issue of *collaboration*. Collaboration has not come easily to the pharmaceutical and chemical industries, which are in the front line of biotechnology developments, for traditionally in these industries competition and inter-firm rivalry is intense. A number of factors, however, have put collaboration on the agenda: first the increasing costs of research combined with greater uncertainty about pay-offs; secondly, the publicity given to the small biotechnology firms in the U.S.A., which effectively act as collaborative research intermediaries between the large firms and the universities; and thirdly, the success of the Japanese experiments in collaborative pre-competitive research. In Britain we have been sceptical about these experiences, but the Club programmes of both the DTI's Biotechnology Unit and the SERC Directorate have given firms a taste of collaboration and it is interesting that many of those involved have shifted over time from lukewarm participants to enthusiastic proponents. The Directorate's programmes in particular have demanded active participation of Club members in shaping and guiding the research agenda. It has taken time for these collaborations to take root because collaboration is about working together and trusting people. Over time, however, the benefits for those participating have begun to emerge, not just

in terms of knowledge and access to people, but in terms of a genuine sparking and cross-fertilisation of ideas. As one of the industrialists whom we interviewed in the process of the evaluation put it, 'participation in the Directorate's activities has, for me, been an invaluable learning process in collaboration'.

Just as it has taken time for collaboration to mature, so, too, it took time for the Directorate to establish itself within the SERC. In 1981, it inherited a rag-bag of projects, not of its own choosing, for its project portfolio. It was not really until 1984 that we begin to see the Directorate emerging to shape its own place within the SERC and, as it did so, beginning to disperse some of the scepticism that originally greeted its foundation. As this has happened, the Directorate has developed more cooperative working relations with other SERC committees, which has in turn brought initiatives such as molecular recognition and the separations and membranes initiatives where cooperation has proved a catalyst to new activities by other committees.

THE DTI'S BIOTECHNOLOGY UNIT

Time does not permit me to do more than I have done with the Biotechnology Directorate and to highlight some of the salient features of the DTI's activities.

First, it is worth emphasizing that as originally conceived, the DTI's function was to support the *near-market or competitive end of R&D*, whereas the Biotechnology Directorate was to support pre-competitive R&D. Indeed, there was something of a logical progression as projects gradually evolved and moved downstream from, say, the Biological Sciences Committee, through the Directorate to DTI sponsorship. Two factors have affected this. First, the DTI unit, through its own market research to establish priorities, found itself moving upstream and supporting projects in the pre-competitive phase of research. Witness, for example, the decision to establish its own protein engineering programme through the Centre for Applied Microbiological Research (CAMR), and its support for the Plant Gene Tool Kit in plant biotechnology. Secondly came the Government's decision, announced in 1988, to abandon the near-market support of its Support for Innovation (SFI) Scheme, and to concentrate instead on pre-competitive R&D, particularly collaborative programmes of pre-competitive R&D (HM Government 1988). In fact, with the DTI's biotechnology programme pushing back into pre-competitive R&D, there had already been some linkage with SERC schemes. The DTI was a member of the Antibiotics and rDNA Club and the LINK programmes on Eukaryotic Molecular Genetics and Biotransformations were already in the pipeline before the January 1988 White Paper. The Drug Delivery LINK Scheme, which brings together the DTI, the SERC's Biological Sciences Committee and the MRC, and the AFRC/DTI/SERC initiative on Plant Biotechnology were also in preparation. In other words, in spite of its original commitment to downstream, near-market R&D, the DTI has pushed steadily upstream into areas where its interests overlap with those of the Research Councils. This was recognized *de facto* a couple of years ago when the LINK scheme was first mooted.

A second interesting feature of the DTI's programmes is the fact that, unlike the Directorate's programmes, they have *proved attractive to small firms*. This may reflect their (until recently) bias towards competitive R&D for almost by definition most small firms have little truck with long-term, pre-competitive programmes of research†. Moreover, the DTI Club Programmes, with their relatively low subscriptions and concentration on 'information

† The exceptions, of course, are firms such as Celltech and British Biotechnology which are in the forefront of research and accept both the risks and the rewards of that position.

dissemination' activities, which require little active participation from members, have been more attractive to small firms than Directorate Clubs, which require regular attendance by (for them) top management. Likewise, the consultancy support provided by the DTI, which effectively offers subsidised feasibility studies on smaller projects, has also proved a winner with small firms.

The third feature of the DTI Unit worth noting is that at present, more than any other institution within biotechnology, it has assumed a *coordinating role*. Explicitly, the DTI Unit retains its interdepartmental role, chairs the Interdepartmental Committee for Biotechnology (ICBT) and coordinates links with the European programmes. Implicitly, the growing number of LINK programmes means that the DTI is assuming an important, though separate, coordinating role with the research councils.

THE MRC'S SUPPORT FOR BIOTECHNOLOGY

Of the MRC's £31M devoted to biotechnology in 1985/6, only £1.5M was devoted to R&D where there was 'clear intent' to commercialize, the main part, £29.5M, being devoted to underpinning research†. This emphasizes one of the main features of the MRC's programme: it is *still predominantly concerned with supporting the more fundamental aspects of research* in this field. With the exception of the AIDS research programme which it has mounted in the past two years, it remains committed to the principle of curiosity-led research, and resistant to the notion of directing research according to a pre-established order of priorities. It therefore has little sympathy or liking for the methods of the Biotechnology Directorate which, as Dr Rees recently told the House of Lords, they consider to have led to the Directorate jumping aboard a series of fashionable bandwagons (see report in *Times Higher Education Supplement*, July 8 1988).

Besides Celltech, which many both inside and outside the MRC see as a great success, the MRC has recently established a *Collaborative Research Centre at Mill Hill* expressly to encourage technology transfer. This deliberately aims to be an inter-face research establishment, undertaking contract research either on a 1:1 or a collaborative basis, with technicians and researchers working under direction from staff either at the National Institute of Medical Research or at the Laboratory of Molecular Biology at Cambridge. As such it gets over a problem which some within both the MRC and the AFRC have long seen as a difficulty in participating in SERC Directorate-type Clubs, namely the conflict of interest that arises for those who are full-time public employees in undertaking research for private interests. This was the subject of much discussion in the early days of IRCCCOB but, with the increasing trend towards privatization and contracting out public services, seems a less insurmountable problem today‡. The MRC today has contact with over 100 private-sector firms and actively encourages its employees to take on consultancies (see Connor 1988).

THE AFRC AND BIOTECHNOLOGY

Like the MRC, the AFRC defines biotechnology broadly and, with the increasingly pervasive use of techniques associated with recombinant DNA, protein engineering and

† These figures are derived from the MRC's annual estimates of spending provided by MRC to the Biotechnology Advisory Group (BAG).

‡ This was discussed at length in the first IRCCCOB report (1982) pp. 15–16, and picked up again in the second report (1983), pp. 17–19.

hybridomas, sees itself as supporting a broad range of work at the more fundamental end of biotechnology in relation both to animals and plants. Since 1981/82 the emphasis has been increasingly on technology transfer and the AFRC has built up extensive industrial liaison facilities both within its institutes and, through the Agricultural Genetics Corporation (AGC) across its whole range of activities. Unlike Celltech, whose wide first-option rights originally caused considerable concern to industry and academia (which led to their subsequent amendment), the AGC still retains fairly wide first-option rights on AFRC work in this area. Rightly or wrongly this is seen by some firms as a complicating factor in their relations with the AFRC.†

In 1982/3 IRCCCOB held a series of discussions with industrialists at which the molecular biology and biochemistry of plants was identified as an area of priority in which there should be an inter-Research Council initiative (see IRCCCOB (1983), pp. 21–32). A joint SERC/AFRC plea to the Heads of the Research Councils for extra funding for such an initiative was, however, turned down. At the initiative of the SERC, the SERC, AFRC and DTI subsequently set up a series of workshops, hoping that with DTI money some kind of collaborative programme might be put together, but this too was to prove abortive when industry showed itself interested in only one of the three areas of discussion, namely host–vector systems. This interest was subsequently channelled into the DTI's Plant Gene Tool Kit: a Club programme involving 11 firms, the AFRC's Rothampsted and John Innes Institutes and the universities of Durham and Warwick. But it left the more fundamental parts of the programme unfunded and a number of researchers in this area very dissatisfied (see Senker & Sharp (1988), pp. 32 and 36–37). Only in the past year has a programme in this area finally been developed in the form of the LINK programme on Plant Metabolism which has been put forward jointly by the SERC's Biotechnology Directorate and Biological Sciences Committee, together with the AFRC. It is an apt indictment of the present system that, having been identified as long ago as 1982 as a priority sector, it has taken six years for a satisfactory programme to be developed.

IRCCCOB, BAG AND ALL THAT

At this juncture it is necessary to record briefly the demise of IRCCCOB in 1985/6 and its replacement by the higher level Biotechnology Advisory Group (BAG) boasting independent as well as Research Council members and reporting directly to the Heads of the Research Councils (HORCs). IRCCCOB had in fact never been a happy committee, and once the HORCs had turned down its 1983 initiatives for two inter-Research Council programmes in plant biochemistry and microbial physiology, it hardly met and issued only one further report (in 1986) covering the years 1983–85. It was finally wound up when the Reece Review of the SERC Biotechnology Directorate (Reece 1985) revealed the very deep divisions between the Research Councils, particularly the SERC and the MRC, on biotechnology. The hope was that a higher-level group would be able amicably to resolve these differences. So far this has not been the case. BAG has to date proved no better a mechanism than its predecessor for coordinating research council activities, or resolving their disputes.

† In the interviews conducted for the Biotechnology Directorate evaluation, this factor was mentioned on a number of occasions by firms in the agri-food sectors as complicating their relations with the AFRC. As with Celltech, old perceptions die hard and it may be that this view does not accurately represent current practice.

CONCLUSIONS: DOES PLURALISM MATTER?

From these brief descriptions of the different programmes of the four main U.K. agencies promoting biotechnology, it is apparent, as Spinks foresaw, that there has been increasing overlap of responsibilities. Broadly speaking one might sum it up by saying that the MRC and the AFRC have proceeded much as before, with continued emphasis on the more fundamental aspects of biotechnology, but because it is increasingly difficult to delineate where fundamental science ends and applied science begins, there is increasing overlap between the work of these two research councils and the programmes mounted by the SERC; and between the programmes of all the research councils and the interests of the DTI.

In one sense this overlap is inevitable. Looked at in the context of the long-run dynamics of new technologies, the new biotechnology that has emerged in the last two decades presents a classic text-book case of a new technology; breakthroughs in science creating a new technological paradigm that cuts across established disciplines and established institutional boundaries. As the new paradigm struggles to assert itself, new institutions emerge, and old institutions are forced to adapt and change. In the United States, the emergence of the new biotechnology firm is the new institution, which acts both as a catalyst for bringing together project teams from across disciplines, and as an intermediary between academic science and industry. As a strong dynamic force, it has brought in its wake major changes to the established régimes in both academia and industry.

In the U.K., the new biotechnology firm has not so far been dominant; therefore the need to develop some other mechanism for bringing the various disciplines together, for promoting pre-competitive research and for translating that research into industrial competence, has been all the greater. Spinks recognized this and suggested an appropriate mechanism. This was rejected. Instead, institutions are adapting higgledy-piggledy. And the SERC, which went furthest towards accepting the Spinks ideas in establishing the SERC Directorate as a new mechanism for promoting the new technology, has inevitably found that its new institution has been treading on the toes of others.

Does it matter? The historian would I think say no; pluralism does not matter. In the long run, institutions adapt and change and institutional friction is an inevitable part of the dynamic of adaptation. For the economist, pluralism and competition are part of the evolutionary process, which helps to ensure the survival of the fittest. Yet the rationalist in us all rejects the waste implicit in such competition. Take the question of protein engineering where we have the Directorate's Protein Engineering Club now showing considerable achievements for its four-year coordinated programme of research, but still with little contact or interaction with the frontier-breaking work going on in the MRC Laboratory for Molecular Biology at Cambridge. Is it not absurd, as some of the major firms have suggested, that these programmes are not brought together within a national programme to promote protein engineering? The experience of the SERC's Club would suggest that, if we could achieve this, the cross fertilization of ideas and approaches ensures that the whole would be greater than the sum of the parts.

This is a hot issue at the present time, and I do not wish to incur the odium of suggesting a definitive answer. I suspect in the long run it does not matter. Whether we go the Japanese route of coordinated pre-competitive research or the U.S. route of competition, it will make little difference to where we end up. Let me, however, conclude by leaving you with three thoughts on this question of pluralism.

First, it is important to point out that the competitive route demands free entry. If there is to be pluralism then you cannot simultaneously have pre-arranged market sharing. The MRC and the SERC, the AFRC and the DTI can all have their own protein engineering programmes and there should be no pre-ordained boundary rights.

Secondly, the U.S. competitive model is fed by very substantial expenditures on basic research, which provides, so to speak, the life blood of the system. As I have indicated, in the present phase of development in biotechnology, the boundaries between basic and applied research and the whole concept of strategic research are very fuzzy. What is, I think, clear is that the two are complementary. For years Britain has enjoyed a tradition of excellence in basic science, but a lamentable record in translating that basic science into commercial processes and products. I believe this is because we neglected this intermediate area of pre-competitive or strategic R&D. But the one feeds off the other. A healthy programme of pre-competitive R&D cannot exist without the precursor of strong and dynamic support for basic science. In present circumstances there are grave dangers that the Government is going overboard for the one and neglecting the other.

Finally, I would leave you with the thought that we should think carefully about the route we choose. In Britain we have too great a tendency to think that by changing institutions we can solve problems. We create a new institution but we are impatient for results and when we do not achieve these immediately, we then change that institution and start again. This in turn means you lose much of the 'institutional learning'. This institutional learning is not only a question of how to put programmes together, or how to attract industrial participation, but also a matter of building up groups of people – communities – who have learned to work with and trust one another. Such learning and trust is acquired over time. Switching the institutional framework too often means re-starting that learning process all over again. For this reason it is sometimes better to keep existing institutions, imperfect though they may be, rather than to destroy them and start again; and it is often better to build on what you have. Here perhaps we have something to learn from the French. They rarely destroy old institutions, but they are constantly creating new ones and allow a Darwinian process of evolution to do the weeding.

As I have made clear, I believe that the Government made a mistake in 1981 in not implementing the Spinks recommendations that there should be a strong Joint Directorate overseeing the development of biotechnology in the U.K. But that decision was taken eight years ago. The pluralism of institutions that we see today has emerged, and with it some very good things, as well as the friction and the quarrelling which we abhor. Time, however, is not reversible. If we opt for coordination and now try to implement the Spinks recommendation, we may find we lose some of the good things that have been created and much of the institutional learning of those eight years. We need to think of solutions that build on that learning rather than destroying it, and that help the presently separate institutions to grow together rather than trying to force the pace of amalgamation.

I should like to end with a brief, but I think apt, quotation from T. S. Eliot's *Four Quartets*.

What might have been is an abstraction
 Remaining a perpetual possibility
 Only in a world of speculation.
 What might have been and what has been
 Point to one end, which is always present.

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Discussion

D. A. REES (*Medical Research Council, London, U.K.*). I was interested in Mrs Sharp's remarks concerning inter-research council relations, and especially in her discussion of the two extreme alternatives for models of operating, namely pluralistic versus coordinated modes. I believe that she said that historians and economists might see some merit in the pluralistic mode (for example, in the efficiency that might derive from the competitive element), but then went on to say that 'the rationalist in all of us' must believe it would be much better if overall coordination could be achieved. Beyond the appeal to 'the rationalist within', she gave no justification nor indeed an indication whether there might be an optimum balance between total competition and total coordination. This suggests black and white but no shades of grey. Such appeal to intuition rather than reason is an aspect of the current debate on coordination in biotechnology that concerns me very much. It often goes beyond her own position as stated in her paper to assert that – the *end* of overall coordination being said to be self-evidently desirable – the *means* of some over-arching structure such as a 'Superdirectorate' must 'obviously' be needed. She has produced no arguments to persuade me from my fundamental scepticism about such points of view.

The Spinks Working Party, to the extent that it may be said to have leant towards a 'Superdirectorate' model, seems to have been influenced by its estimate of the timescale to major economic impact of biotechnology which, as Dr Coleman said (Coleman, this symposium), we can now see with hindsight as having been too short. The need for careful management of the 'continuing fundamental discovery phase' in the science underpinning biotechnology was correspondingly underemphasized. The views of that Report on the most appropriate inter-Research Council organization should not therefore be regarded as Holy Writ for 1988 and beyond.

Mrs Sharp spoke of the waste inherent in the competitive/pluralistic model, which she suggests should be set against the efficiency benefit from the drive of the competing structures to show that they perform best. Intense competition is inherent in the nature of academic research, especially in the areas of biotechnology and molecular biology which we are discussing, and nobody suggests that progress would be faster if this were removed completely; indeed, one fears that things would become more relaxed and sleepy. The 'coordinated model' – especially if operated through a Superdirectorate style – could lead to the inefficiency, inertia

and false comfort of an economic cartel, which indeed I believe we begin to see in some prototypes of it.

Having said all this, I would like to end by saying that I *do* believe that it would be desirable to harmonize the Research Council operations to a greater extent than at present. To achieve this successfully, however, will require careful preservation of the best features of the structures that we already have in place for encouraging and developing biotechnology and its exploitation. Where genuine structural incompatibilities exist, as they certainly do in aspects of the *modus operandi* of one Research Council and another, careful planning will be required to preserve the best features of each as they are moved into more reconciled relations. I do not believe that the problems have yet been examined in sufficient seriousness and depth. Nor, if I might say so, did they receive analysis in Mrs Sharp's paper.

MARGARET SHARP. I argued in my paper that there was logic in the idea of a 'Superdirector' when this was first proposed by Spinks because at that time no Research Council had put much thought into the development of biotechnology *per se*, and the need to promote interdisciplinary research and technology transfer. The existence of a Directorate does not exclude competition between research establishments; indeed, through its grant-giving powers it can encourage it. But what a Directorate can do, and has done in the case of the SERC Biotechnology Directorate, is to identify broad areas of science that need to be fostered and encouraged if the bounty of science is to be satisfactorily converted into a bountiful technology. Hence the term 'strategic science'.

Looking at it from the point of view of 'U.K. Inc.', I believe it would have been to the advantage of industry in this country if, in the course of the last eight years, there had been a pooling of resources for the strategic development of biotechnology. Of course, I cannot prove this statement. I can only point to the perennial failure of we British, with existing institutions, to convert the excellence of our science into technology, and to the benefits derived from the partial experiment which we see in the SERC Biotechnology Directorate and which have been documented in the evaluation of that Directorate undertaken by Dr Senker and myself.

However, I also argued that because the decision was taken in 1980 not to establish a Superdirector across all the Research Councils, and as each Research Council had in the meantime gone its own way, establishing institutions tailored to its own needs, I did not think there was any point now in trying to turn the clock back by trying to impose a Superdirector on them today. Rather I argued, as I think Dr Rees is suggesting, that it was better to build upon existing institutions, attempting to harmonize where feasible, but preserving rather than destroying the best features of the structures already in place.

I did not deal with the detail of how such harmonization might be achieved because I was asked to look back and survey what had taken place in the management and coordination of biotechnology over the years 1980–88. Nor do I have the knowledge of the MRC or the AFRC/NERC structures that I have of the SERC. However, I am sure I can speak for my own institution, the Science Policy Research Unit, at Sussex University, in saying that we should be delighted to advise the MRC on these issues if they wished to employ us in that role.

A. R. WILLIAMSON (*SERC, Swindon, U.K.*). One of the aims of the Club arrangement, and what I believe is one of the principle achievements of the Clubs, is that they have brought together a community of research workers, across academia and industry, and across disciplines. Having

worked for many years in an MRC institute and then for a similar period in a university I can vouch for the strengths, and weaknesses, of each.

Institutes at their best generate a communal arrogance, in the best intellectual sense of that word, an arrogance that leads to asking important questions and to tackling and to solving difficult problems. This stems from many things, but especially important is the concentration of talent and the interplay of different disciplines. The research community created within each Club, and this is well seen in the Protein Engineering Club, has led to these benefits for both the University and industrial participants. I agree fully with Margaret Sharp's assessment that the whole is greater than the sum of the parts. More importantly, this view is shared by the Club participants. Surely, to achieve such communal benefits is praiseworthy and justifies the mechanism. No-one should feel insulted to have it thought that they might gain from participating in a wider scientific community; a dispersed centre of excellence.

MARGARET SHARP. I agree with Dr Williamson that one of the advantages of institute over university-based research is the ability to put together multidisciplinary project teams without having to overcome the problems of interdepartmental funding, etc. One of the ideas behind the Club principle has been to create 'an institute without walls'; to bring together various research groups from different universities to work on an inter-related set of projects in such a way as they may benefit from the synergies implicit in the programme. The work I have done in my evaluating the Protein Engineering Programme (Club) of the SERC convinces me that this is being achieved in that instance and I hope I shall be able to document it when I come to write my 'end-of-term' report on the Programme, after the completion of Phase I in March 1989.

G. T. FAIRTLUGH (*Celltech Ltd, Slough, U.K.*). In her paper, Mrs Sharp mentions the Government's doubt that it could do anything about bridging the pre-development gap. I think this scepticism is to some extent justified, as the skills needed to construct these bridges are scarce. Within large companies those with these skills are called intrapreneurs (or product champions) and outside they are called entrepreneurs. They are the people who can assemble a credible package of scientific ideas and potential markets with management capable of running the project or company and then seek out financial support. Without the skill, flair and drive of intrapreneurs and entrepreneurs, effective exploitation of novel science will not usually happen.

If this is so, a pluralist approach to the development of a novel technology is to be welcomed as it will give scope for a variety of entrepreneurial activities. Government, academia, industry and the financial community should do what they can to encourage the emergence of people with these qualities. The 'meta-innovation' function, i.e. support of such entrepreneurial activities by corporate venture departments, seed and venture-capital organizations, etc., is greatly to be encouraged.

One contribution to this process (albeit only one) is the training of people in some of the skills needed. This ties in with another requirement I think is important, which is the training of coordinators within SERC and other programmes. Although the SERC has found that academics in mid-career can be seconded to coordinator positions with good results, I believe the results would be even better if training in project management and intellectual property matters were to be provided to all coordinators.

MARGARET SHARP. Mr Fairtlough and I have discussed before the potential for training the SERC project managers and I agree in principle with his suggestion, although I think the skills required of the intra- or entrepreneur range considerably wider than for, say, a Club manager's role in one of the Biotechnology Directorate Clubs. In practice, it may not prove easy. Those who have taken on these tasks see them as mid-career breaks and do not wish to devote more than 2–3 years at the most, often on a part-time basis given the need to maintain a research and publishing base. A short, 2–3 week, induction course plus the ability to call on outside experts on, for example, IPR or legal issues would probably be the most useful training we could give them. Given the extent to which the SERC and the other Research Councils are now getting involved in technology transfer programmes, I am amazed at the dearth of professional legal and accountancy advice within these organizations. What these coordinators need above all is the knowledge and resources to call on expert outside advice when required.