Equipping UK universities : an evaluation of the Wellcome Trust's equipment scheme / M. O'Driscoll and J. Yates.

Equipping UK Universities

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PRISM
Unit for Policy Research in Science and Medicine

EQUIPPING UK UNIVERSITIES

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CONTENTS

With the ability to carry out innovative scientific research increasingly dependent on access to advanced instrumentation, the provision of equipment is now an important policy issue for funding agencies. The Wellcome Trust's equipment scheme was established in 1992 for an initial period of three years in response to concerns over the state of research equipment in UK universities.

This report presents the findings of an evaluation of the scheme. In the course of the evaluation, a number of issues came to the fore which were relevant to the wider problem of equipping UK universities.

The evaluation was carried out by Dr Mairéad O'Driscoll and Dr Joe Anderson from the Unit for Policy Research in Science and Medicine (PRISM) at the Wellcome Trust, in association with the Mr John Yates and Professor Luke Georghiou from the Programme of Policy Research in Engineering, Science and Technology (PREST) at the University of Manchester.

A total of 79 interviews were carried out as part of the study. We would like to thank all those who took the time to talk to us and everyone who provided valuable background data.

The ability to carry out innovative scientific research has become increasingly dependent on access to advanced instrumentation. The provision of equipment is now an important policy issue for research funding agencies, both nationally and internationally. In the UK, changes to the way that Government funds are allocated to Higher Education Institutions over the past decade have had a profound influence on support for research equipment.

A number of funding bodies, notably the Medical Research Council and the Biotechnology and Biological Sciences Research Council, have recently launched equipment or infrastructure initiatives. This report presents the findings of an evaluation of the largest equipment funding scheme in the UK, namely the Wellcome Trust's Equipment Scheme. The scheme was established in 1992 for a three-year period in response to concerns over the state of research equipment in UK universities. Although equipment is supported through a number of funding mechanisms at the Trust, this special scheme is targeted at items of equipment costing in excess of £60 000. Applications for staff and maintenance costs may also be made. Applications are considered by a multidisciplinary panel and peer reviewed in the normal way.

The evaluation collated quantitative data on the scheme and canvassed the views of grant holders, unsuccessful applicants, referees and panel members on the appropriateness of a specialized scheme for the support of research equipment. Alternative sources of funds for equipment were also assessed.

Main findings

Perceived needs for equipment

- Access to equipment continues to be a cause for concern among the research community. With the decline of the dual support system, basic research equipment, in particular, is difficult to obtain and provision of funds for expensive, innovative items is patchy.
- The strategy of dedicating a specialist panel (i.e. a committee with an allocated budget) to the support of equipment was highly popular among the grant holders and unsuccessful applicants interviewed. The main reason given was the need to 'protect' equipment from cost cutting; the perception was that faced with budgetary pressures, awarding committees often cut the equipment portion of a grant application.
- Most equipment grants requested and granted were for the purchase of the latest technology or to update existing equipment. The most commonly requested/ granted instruments were automated DNA sequencers and imaging equipment such as electron microscopes.
- The most commonly perceived needs in the future were for the latest technology and the replacement of basic equipment. Some interviewees were also concerned about access to equipment at the top end of the scale (>£1 million) such as 750 MHz NMR spectrometers.

Sources of support for research equipment

- The Trust's equipment scheme is the largest such scheme in the UK by amount spent. Between 1992 and 1994, the Trust spent £12 344 892 through the scheme. In that same time period, through all funding modes (e.g. project grants, programme grants, fellowship awards), the Trust spent in excess of £40 million on equipment in UK universities.
- Both the MRC and the BBSRC have recently launched equipment/infrastructure initiatives, but eligibility is confined to institutions already receiving substantial support from these agencies.
- The national science budget for 1995–96 included a further £3 million allocation to the BBSRC, the EPSRC and the MRC for 'expensive equipment', to be supplemented by matching funds. This would then be used to provide 50% funding to universities who are able to bring forward industrial partners prepared to fund the other 50%.
- The Government supports equipment directly through the Higher Education Funding Councils. In 1994, the total HEFCE equipment grant for all 130 Higher Education Institutions in England was £210 300 722. This figure appears to be declining although administrative changes make trend data difficult to confirm. The HEFCE equipment funds, which may be allocated to all subject areas, may be used for capital expenditure on assets needed for teaching, research and/or administration.
- A number of small equipment schemes are available through other charities and funding bodies.

Status of the Wellcome Trust's equipment scheme

- By October 1994, there were 77 grants under the Trust's scheme at a total value of £12.4 million. The success rate of applicants by number was 49% and by amount was 32%. Over 80% of the funding went to ten institutions.
- The universities contributed in excess of £1.5 million in extra funding to complement that provided by the Trust under the equipment scheme.
- By October 1994, six technicians and 13 research assistants (2 postgraduates and 11 postdoctorates) had been supported through the equipment scheme.
- A paradox of the scheme is that, despite expressions of concern over equipment in universities, applications to the scheme fell in the first two years. However, awareness of the scheme among a sample of universities contacted was very low.
- There was some confusion among applicants, both successful and unsuccessful, about the criteria on which applications were judged. Much of this related to the 'weight' given to each applicant on a multiple application and the problem of assessing 'need' where the application was to update an existing item of equipment.

- Both panellists and referees judged applications almost entirely on the quality of the science described and the reputation of the applicants.
- There were mixed views among grant holders, unsuccessful applicants and panel members on the value of peer review for equipment grants, particularly where the application was for a basic (albeit sophisticated) laboratory tool.
- Most of the grant holders and panel members agreed that outputs from the scheme should be measured. The most popular choice of assessment was a short, factually based form.

Conclusions

In general, access to funds for equipment was a source of concern among the researchers contacted in this study. Support from central government funds appeared to be either static or in decline, giving cause for concern over the ability of university research departments to update equipment. Special equipment schemes that allow researchers from different groups or disciplines to make a multiple application for a specific item would appear to be a good mechanism for maximizing the use of the equipment, as well as an efficient use of a funding body's resources. Other advantages include the ability to draw on special technical expertise in a multidisciplinary awarding committee and the scope for leverage with the host institution and suppliers. It is unlikely, however, that such schemes can address the more fundamental problems of under investment in basic equipment and infrastructure in UK universities.

1.1 The role of instrumentation in scientific research

The ability to carry out innovative scientific research has become increasingly dependent on access to advanced instrumentation. Although the dependence of high-quality science on equipment is not a new phenomenon, policy studies suggest that the dominant trend in research has been away from theoretical work in favour of experimental, instrument dependent research.

A study by McAllister and Narin for the National Science Foundation in 1982 evaluated the contribution that equipment had made to the research findings in 500 highly cited papers. The expert panels, who rated the relative importance of instrumentation in the research, judged that 95% of biochemistry, botany and organic chemistry publications were 'instrument dependent' (i.e. required access to essential equipment). A study by Betz and Kruytbosch (1982) concluded that in the 20 years between 1955 and 1975, progress in chemistry, astronomy and the earth sciences was dependent on the availability of novel equipment.

In 1992, Kruytbosch analysed the nature of the scientific breakthroughs that led to the award of 274 Nobel Prizes in physics, chemistry and physiology/medicine between 1945–91 and concluded that there has been a shift in the types of scientific advance for which prizes were awarded away from theoretical discoveries and towards experimental work. He also noted subject differences, however, concluding that equipment policies should reflect the specific requirements of different disciplines. In the biosciences, he concluded that the main requirement in the future would be to ensure future investment budgets are adequate for purchasing state-of-the-art equipment with less emphasis than in the physical sciences on equipment development. However, other work has suggested that an important factor in scientific progress is the deployment of powerful instruments initially developed by physicists in other areas of science. Rosenberg (1992) argued that this migration of instruments has played a crucial role in scientific advances and that future policies might need to promote rapid diffusion of novel instruments and techniques across disciplines.

Although the increasing cost of equipping scientific research is highlighted most dramatically in 'big science' fields such as high-energy physics, nuclear research and astronomy, researchers in traditionally 'small science' disciplines such as biomedicine are also demanding access to expensive equipment. Coinciding with a levelling off in the growth of national funding for science, the problems of equipping research have become more acute. Analysis of the Wellcome Trust's project grants suggests that equipment costs have grown more rapidly than other costs, reflecting the tendency for research to become more capital intensive and less labour intensive.

In 1989, the Advisory Board for the Research Councils commissioned a survey of all research equipment, excluding computers (Georghiou *et al.*, 1989)

in UK Higher Education Institutes (HEIs). This produced a database containing 16 000 items of research equipment with detailed data on condition and usage. Among the findings were that 37% of the national equipment stock was over ten years old, 14% was no longer adequate in terms of technical capability and that 17% was in poor condition or inoperable. The survey included seven cost centres relating to the biomedical sciences: Preclinical Studies, Anatomy and Physiology, Pharmacology, Pharmacy, other studies allied to Medicine, Biochemistry and Other Biological Sciences. Clinical departments were not included in the survey. In all, 200 departments fell within these cost centres and returns were received for 4769 items of equipment, or approximately 30% of the total. The findings from these costs centres alone were typical of the results overall, though a slightly lower percentage of instruments (33%) were over ten years old.

The authors concluded that large scale action was needed to restore the international competitive position of UK science. A further study carried out in 1992 (Halfpenny *et al.*) looked at the possibility of increased sharing of equipment as a possible solution to growing costs. However, they concluded that there was limited scope for this with existing research equipment in UK HEIs without significant organizational change. This would require additional investment that may not be justifiable in terms of the likely cost savings. They also concluded, however, that there was potential for introducing sharing arrangements for new acquisitions. This should not be seen merely as a cost saving exercise; other benefits such as the transfer of technical skills and the development of group cohesion could also be gained.

1.2 The dual support system and the 'well found laboratory'

The 1989 survey (Georghiou *et al.*) also addressed the question of sources of funding for equipment in the UK, concluding that the direct grant from government through the dual support system was the largest source (46%). However, changes in the way that this system has operated since 1989 led to a fundamental shift in support for university research with serious implications for the provision of basic equipment.

The basis of this system is the provision of a block grant from Government to Higher Education Institutes (HEIs) which is then supplemented by grants from research councils, charities, or industrial and commercial organizations. The block grant contributes to the cost of premises and permanent staff, and in that way contributes to the infrastructure costs that underpin the dual support arrangements. It also contributes to the substantial fixed costs of training research students, in particular, staff, premises, equipment, libraries and other essential facilities. In short, it has traditionally underpinned the 'well found laboratory'.

Before 1992, the size of the grant received by individual HEIs was calculated according to research based and teaching based criteria. Following abolition

of the distinction between universities and polytechnics after April 1993, responsibility for funding HEIs was transferred to the new Higher Education Funding Councils (HEFCs) for England, Scotland and Wales, and to the Department for Education Northern Ireland (DENI). Under the new boundary for dual support introduced in 1992, universities now meet the costs of permanent academic staff and premises for Research Council projects, while the Research Councils meet all other costs. It should be noted that while Research Councils were allocated the 'overhead' element of HEFC funds, charities were not, a problem that is particularly relevant to the biomedical sciences that receive proportionally more charitable funding than other areas of research. The size of the block grant is related directly to the volume and quality of research, as measured in successive Research Assessment Exercises. The allocation of resources is now heavily weighted towards selective allocations while that component which related to the numbers of students (used as a proxy for the number of staff engaged in research) has been reduced.

The decline in the proportion of funds allocated to the HEFCs relative to the Research Councils is shown in Table 1. One result of this is that support for research in universities, has become more dependent on research council grants while the ability of universities to support research at their own discretion has been weakened.

Table 1 **Source of funding (in real terms[†]) for research and development**

Year	General university funds (£million)[††]	Research Council funds (£million)
1990/91	953	909
1991/92	986	869
1992/93	963	961
1993/94[e]	895	1027
1994/95[p]	873	1042

Source: *1994, Forward Look of Government-funded Science, Engineering and Technology.*

[†] Base year 1992–93.

[††] Funds that come directly from Government through the Higher Education Funding Councils.

e = estimate

p = provisional

1.3 Support for equipment through the Higher Education Funding Councils

The annual block grant allocated to each HEI by the Funding Councils includes funds for equipment. Equipment grants from the HEFCE may be used for capital expenditure on assets needed for teaching, research, and/or administration (other than buildings). Since 1993, support for information technology has been included in the equipment allocation. Once allocated, the distribution of equipment funds between departments or subject areas is a matter for individual HEIs.

The formula used to determine the equipment grant to each institution was agreed in 1993, following the abolition of the Universities Funding Council (UFC) and the Polytechnics and Colleges Funding Council (PCFC) and the establishment of the HEFCs. The formula has three main elements. Table 2 shows the resulting distribution of equipment funding by HEFCE for the academic year 1994:

Table 2 **Distribution of HEFCE equipment funding in 1994**

Purpose	£million	Percentage
Floor provision	21.0	10
Teaching related	132.5	63
Research related	56.8	27
Total	210.3	100

Source: *'Capital funding: equipment and estate formula funds', Circular 13/94, Higher Education Funding Council for England, 1994.*

Allocation of the research related component of the equipment grant (£56.8 million in 1994) is now heavily influenced by the research quality rating awarded in the Research Assessment Exercises. The teaching element of equipment funding (£132.5 million in 1994) is allocated according to student numbers (weighted according to the mode and level of funding) and a differential weight per academic subject category. The floor provision allocation (£21 million in 1994) relates to student numbers (unweighted) and is thought to be important for those institutions with limited or no research activity and a high proportion of low cost subjects that would otherwise receive little or no equipment funding.

Because of changes in the administrative structure of the higher education sector, it is difficult to obtain comparable trend data for equipment funding. The data for 1991 to 1994 are summarized in Table 3. Adjusting the figures for inflation (i.e. taking 1992/93 as the base year), there appears to have been a decline in overall support since 1991; however, it should be noted that the figures for 1993 and 1994 refer to the Higher Education Funding Council for England and do not include universities in Scotland or Wales.

Table 3 **Equipment grants allocated by the UFC and PCFC (1991, 1992), and the HEFCE (1993, 1994)**

Year	UFC £ million	PCFC £ million	HEFCE[1] £ million	Total £ million	Total £ million (1992/93=1)
1991/92	121.5 (equipment) 18.5 (IT)[2]	69.3	n/a	209.3	217.3
1992/93	135.4 (equipment) 19.0 (IT)[2]	70.6	n/a	225	225
1993/94	n/a	n/a	203.5	203.5[3]	196.9[3]
1994/95	n/a	n/a	210.3	210.3[3]	195.8[3]
1995/96[3]	n/a	n/a	220.1	220.1[3]	197.5[3]

Notes:

[1] UFC and PCFC were merged in 1993; HEFCE data for England only.

[2] IT Information technology; after 1992 this was included in the equipment grant.

[3] Estimated figure.

Source: *UFC, PCFC, HEFCE.*

In summary, changes over the past five years in the way in which universities are funded has led to greater selectivity in the allocation of resources and tilted the balance in favour of project specific items of equipment.

1.4 The Wellcome Trust Equipment Scheme

Against this background, in 1992 the Wellcome Trust launched a new initiative to support equipment in biomedical research. The rationale behind the establishment of the scheme was the perception that the need for larger, individual items of multi-user equipment was not being adequately met by the standard research council funding modes such as project and programme grants. The Trust was also experiencing a large increase in income that enabled it to take a proactive stance.

Most research grants from the Wellcome Trust are issued via four committees; Physiology and Pharmacology, Molecular and Cell, Neurosciences, and Infection and Immunity. In addition, a number of special interest groups award grants in subjects selected for special development and a variety of personal support schemes are available at different career levels. Until 1992, all requests for equipment were judged in competition with other grant applications. Although committees had a budget for awarding equipment, this was often used for other project grants. In addition, the increasing complexity and expense of larger items of research equipment presented difficulties in the assessment and prioritization of research proposals.

The Equipment Working Party (EWP) was established as an expert funding committee in 1992 for an initial three-year period. Most requests for research equipment over £60 000 are currently assessed by the EWP

unless they form part of a larger research proposal (typically a programme grant), in which case they are assessed through the pre-existing channels. Items of equipment costing less than £60 000 are normally considered as part of a project or programme grant application, or (if equipment alone is being requested) in competition with project grant applications. Proposals to the EWP need not be based on a single research project, or limited to a single piece of equipment. Application can also be made for funding for staff required to operate the apparatus and for essential running and maintenance costs. Expertise on the EWP includes specific knowledge on instrumentation and proposals are subject to refereeing in the normal way.

1.5 Aims of the evaluation

This report presents an evaluation of that scheme and its role in the context of support for research equipment in the UK. The aim was to consider the value of a specialist scheme in meeting equipment needs, as well as reviewing the case for its continuation.

In doing so, a number of issues emerged with wider implications for the UK research system including the importance of access to up-to-date research equipment, the role of peer review for basic, albeit sophisticated, items of equipment, the difficulties of replacing and updating existing equipment, and the question of cost sharing for large, multi-user items.

2.1 Evaluating the equipment scheme

The remit of the evaluation included:

- the extent to which the scheme was still needed,
- the effectiveness of the scheme, and
- its future role within the Trust funding portfolio.

This section describes the approach and the methodology employed.

2.2 Terms of reference

The review of the equipment scheme addressed three issues:

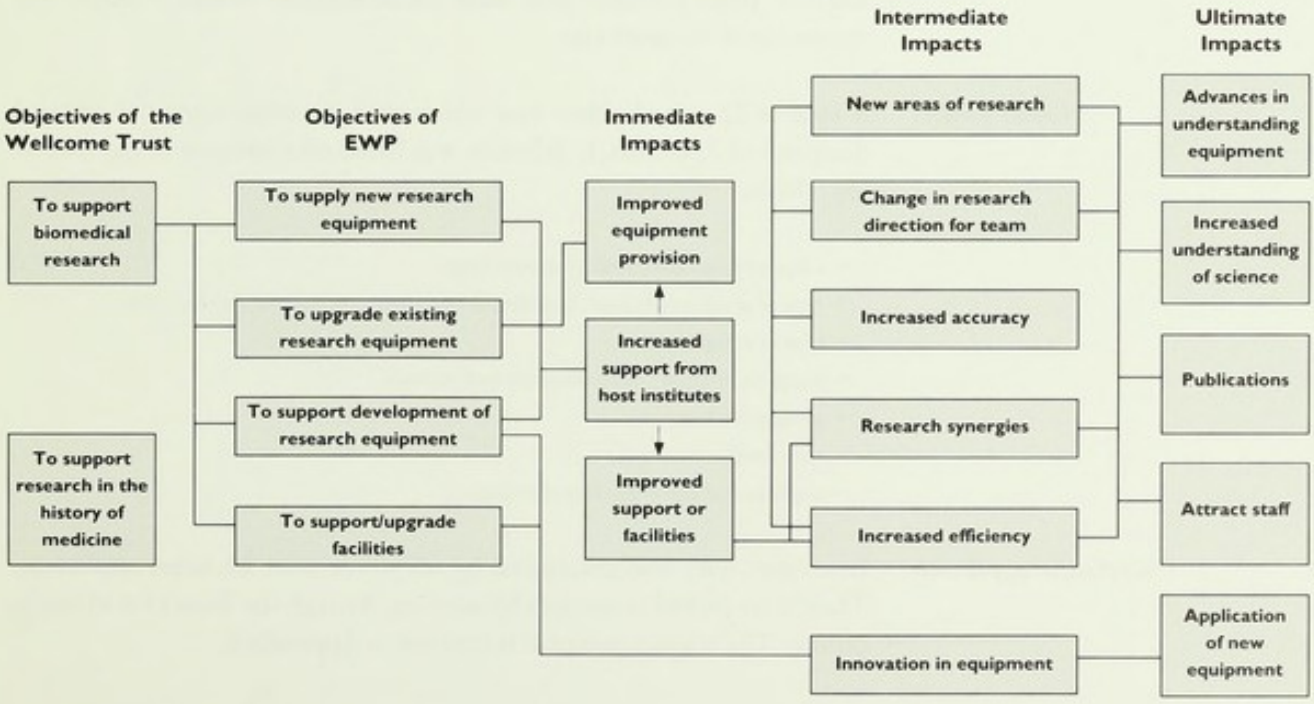
- Is there a need for a specialized equipment scheme?
- Is the Trust scheme an effective means of providing support for equipment?
- What other schemes are available for the support of research equipment?

The review aimed to revisit the original case for establishing the Equipment Scheme, to assess the process by which the scheme was run and to explore the function of the scheme in the overall context of UK research funding.

2.3 Approach

The first step taken in the study was to model the objectives and impacts of the equipment scheme in the context of the Wellcome Trusts' objectives. The 'logic diagram' (see Scheme 1) shows the objectives of the equipment scheme and the way in which these objectives may be linked to impacts. Although the scheme is at an early stage and many of these impacts (e.g. publications, innovation in equipment) might not yet be in evidence, the model provided a framework for the evaluation process.

Scheme 1 **Logic diagram for the Wellcome Trust EWP Scheme**



The study was divided into three phases of activity:

- analysis of data,
- interviews to canvas opinions on the scheme,
- a review of other UK funding sources for equipment.

2.4 Quantitative data

The first phase of the evaluation involved analysis of data on past applications. This included success rate, size of grant, types of request and geographical spread of both applications and grants. The number of applications to the scheme was also analysed in view of the perception of falling demand. Grant records were also examined to assess the additional contribution made by the universities as a consequence of an equipment grant.

2.5 Interviews

The second phase involved face to face, and telephone interviews. Protocols were devised for four groups of interviewees:

- grant holders,
- failed applicants,
- EWP members,
- referees (see Appendices 1–4).

Heads of non-participating departments were also contacted to assess awareness of the scheme.

The issues covered in interviews included the background to applying to the scheme, the applicant's needs, their experiences of the application process, outcomes of the award and views on the relative merits of the scheme. In addition, panel members were asked about selection criteria, expertise and the quality of the applicants.

Grant holders

A total of 22 grant holders were interviewed in person using the protocol described in Appendix 1. Selection was based on a mixture of the following criteria:

- range of grant size: small, medium, large;
- type of grant: single item, facilities, shared items, equipment development;
- type of equipment;
- duration of grant (when the grant had started);
- geographic location;
- start date;
- applications: site visits, reapplications.

Unsuccessful applicants

Interviews were also conducted by telephone with 20 failed applicants. These were picked at random by working through the Trust's list of applications. The relevant protocol is attached as Appendix 2.

Members of the grant's committee (the Equipment Working Party)

All EWP members were interviewed in person using the protocol attached as Appendix 3.

Referees

A random sample of referees (eight) were interviewed by telephone using the protocol attached as Appendix 4.

Non-participating Heads of Department

The final part of this phase consisted of contacting university Heads of Department (18) that had not applied to the scheme, to assess awareness.

2.6 Other funding sources

The third phase involved gathering information on other schemes providing research equipment. The aim was to assess 'supply' of equipment sources in the UK. The agencies contacted included the Medical Research Council (MRC), the Engineering and Physical Sciences Research Council (EPSRC), the Biotechnology and Biological Sciences Research Council (BBSRC), the Royal Society, the National Health Service (NHS) and the National Institutes of Health (NIH) in the USA.

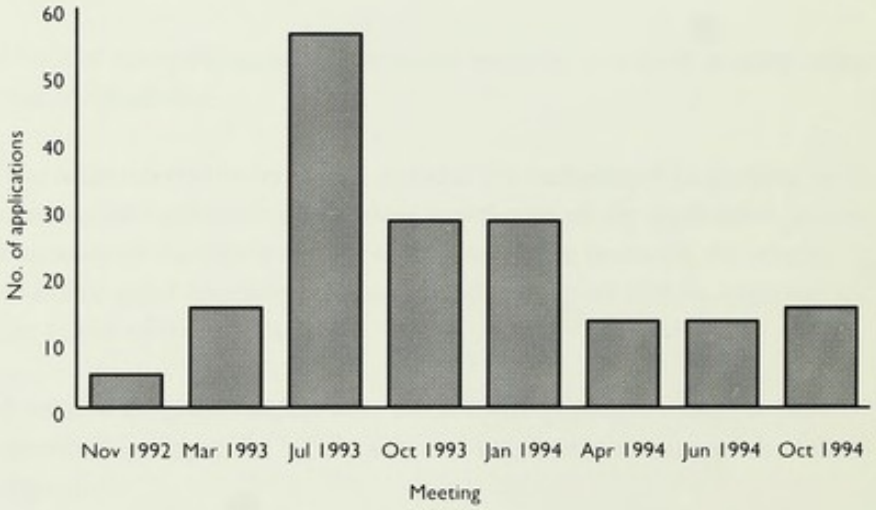
3.1 Number of applications/ success rate

This section presents the results of a quantitative analysis of current equipment grants and applications to the scheme.

The total number of applications received by the Equipment Working Party in its first two years was 155. The amount requested was £38 376 452. Of these applications, 77 were awarded at a cost of £12 344 897. The success rate, therefore, was 49% by the number of grants awarded and 32% by amount. In the same period of time, the total amount of money spent by the Trust (i.e. through all funding modes and panels) on equipment was in excess of £40 million. The equipment scheme, therefore, accounted for 31% of all equipment funded by the Trust in that period.

However, a notable feature is that the number of applications to the EWP fell from a peak of 56 in July 1993 to only 15 in October 1994 (Figure 1). Formal efforts to disseminate information about the scheme were confined to one advertisement in *Nature* and the *Lancet*. The scheme is also described in the Trust's grants handbook, *Grants and Support for Biomedical Research.*

Figure 1 **Applications to the EWP by panel meeting**

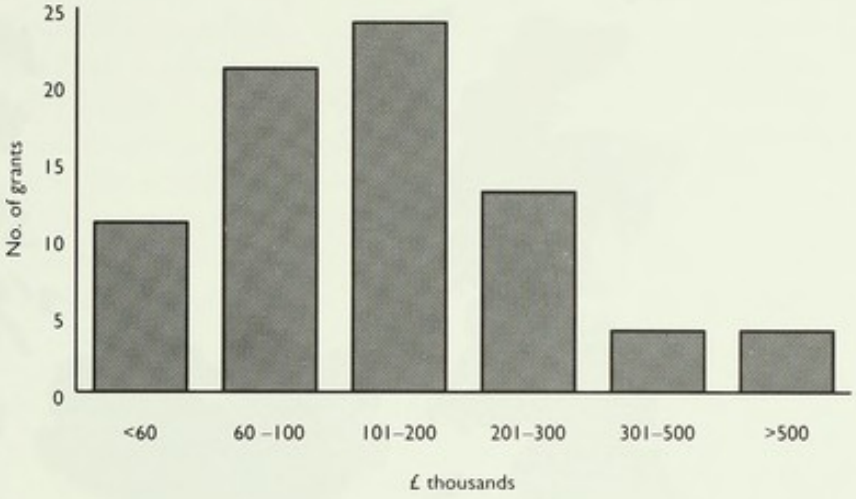


It is noticeable that the peak in applications occurred some six months after the scheme was openly advertised in *Nature* and the *Lancet*. In addition, evidence from a sample of grant holders interviewed suggests that the majority heard about the scheme through informal mechanisms (i.e. by word of mouth). The decline in applications, therefore, is more likely due to the low level of awareness of the scheme among the research community (discussed in more detail in section 5.1) than a lack of need for equipment.

3.2 Average size of grant

Figure 2 shows the distribution of equipment grants by amount. The average grant awarded was £160 323 with most grants falling in the range of £60 000 – £200 000. Most of the awards below the £60 000 cut off point were supplements to existing equipment grants.

Figure 2 **Distribution of equipment grants by amount**



In comparison, the cost of an average Wellcome Trust project grant in 1993/94 was in the region of £140 000. Within this an average of 11% was accounted for by equipment, although there is large variation in the portion of a grant allocated to equipment costs.

3.3 Most commonly requested/granted instruments

The most commonly requested/granted instruments were automated DNA sequencers either as single items or as part of a facility and imaging equipment, such as phosphor imagers, confocal microscopes, electron microscopes and high-field NMR spectrometers (19 of the 22 grant holders interviewed had purchased at least one of these items). Computing equipment for NMR or graphics for X-ray analysis also featured.

Most equipment came into the category of 'purchasing the latest technology' or 'updating existing equipment' (although there is some overlap between these categories). Much of this equipment was supporting a range of projects, many of which are funded by other agencies. Only two applications (subsequently awarded) came into the category of 'developing new equipment'.

3.4 Geographical distribution

The geographical distribution of applications to the EWP and awarded grants is shown in Figures 3 and 4. London, Oxford and Cambridge accounted for 42% of applications and 40% of awarded grants. The top ten institutions by amount awarded (shown in Figure 5) accounted for 80% of the total funding from the EWP.

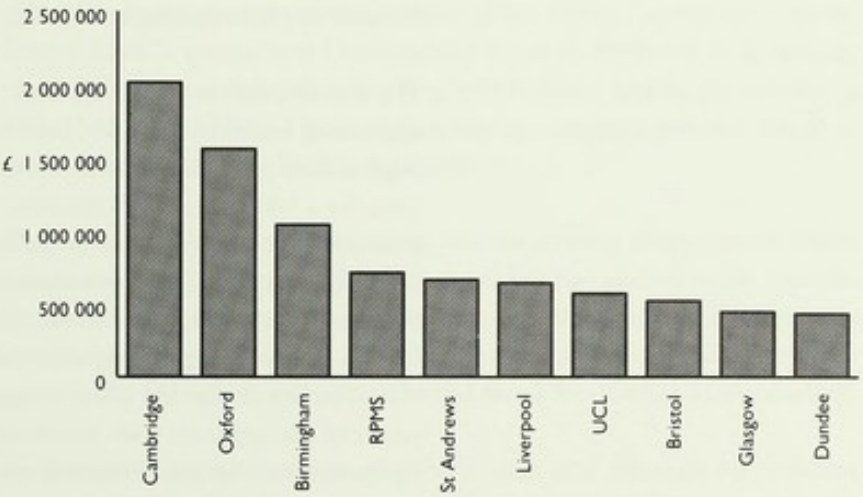
3.5 Staff supported by the equipment scheme

A total of 19 staff were funded by the scheme in its first two years. Six of these were technicians and 13 were research assistants (of which two were at postgraduate level and 11 at postdoctoral level).

Figure 3 Geographical distributions of applications to the equipment scheme

Figure 4 **Geographical distribution of equipment grants**

Figure 5 **Top ten institutions by amount awarded**



This section briefly reviews past equipment needs as revealed by previous studies and describes the types of grants awarded by the Trust scheme with specific examples.

4.1 Background

The studies by Georghiou *et al.* in 1989 and 1991 identified equipment shortages in UK HEIs, particularly in terms of 'basic' equipment such as centrifuges and scintillation counters. These items were usually too expensive for individual departments to acquire from their departmental budgets, but were likewise difficult to obtain on individual research council grants as the funding bodies often considered it the responsibility of the host HEI to provide a 'well found laboratory'. The decline of the dual support system is unlikely to improve this situation.

The objectives of the Trust scheme (see 'logic diagram', Scheme 1 in section 2.3) were to fund equipment in three main areas:

- purchase of new technology,
- updating/upgrading existing equipment, and
- customizing and developing equipment.

A fourth category emerged from this study, facilities and infrastructure, to cover instances where the scheme has effectively created a new facility as a result of providing equipment funding. The following sections give examples of each of these categories, though some overlap exists. Updating equipment, for example, often involves the purchase of the latest technology. One item of equipment was awarded on a sharing basis, and the progress of this award is also described.

4.2 Purchase of latest technology

Of the 22 grants in the sample considered, 18 stated that their requirement was for the purchase of the latest technology. This applied at all levels of grant. Two examples from either end of the spectrum will serve to illustrate typical requirements in this category.

The first example is one of the largest grants in the sample considered. The application was from a shared NMR facility in a School of Biochemistry. The original bid, for approximately £1 million, was submitted by five co-applicants for a 500 MHz NMR machine. The EWP awarded the applicants just over £600 000 and this proved sufficient to enable them to negotiate sufficient discount with the manufacturers, to purchase a 600 MHz machine. Some additional funding was also provided by the university. This is typical of large grants through the scheme and illustrates two common indirect benefits. The first is that the award of a grant greatly strengthens the bargaining power of the applicant with the manufacturer. Substantial discounts or extra equipment may be negotiated and similarily the host university/ institute can often be persuaded to supply top up funding or extra facilities once funding from the Trust is guaranteed (see section 5.8).

The second example is the smallest from the sample, £20 000 for a replacement scintillation counter. The existing equipment had 'died' and with a whole range of studies requiring the use of this instrument, a replacement was vital for the efficient running of the laboratory. The new instrument represented the latest technology and greatly improved the overall efficiency of the laboratory. Many items of equipment have been awarded through the scheme for similar reasons, common examples being DNA sequencers and phosphor imagers.

4.3 Updating/upgrading existing equipment

For UK science to stay at the leading edge of internationally competitive research, there is also a constant need to update/upgrade more expensive items of equipment such as electron microscopes and NMR machines. Some items in this category are becoming extremely expensive e.g. a 750 MHz NMR machine can cost well over £1 million. Several interviewees asked if the Trust would be willing to fund such expensive items. If so, some consideration might be given to the establishment of some form of 'superfund' for the provision of the most expensive instruments/facilities. The alternative would be to share the cost of these items with other funding bodies such as the research councils and host institutions.

4.4 Customizing/developing existing equipment

Only two interviewees categorized their award under this heading. The first was a small grant for essential computer software to assist in the interpretation of data from an NMR machine. The second was for development of a completely novel instrument from one which itself was originally supplied by the Trust. A third grant holder, not interviewed, received a grant to customize a confocal microscope to increase sensitivity.

This category has received little funding from the EWP mainly due to the paucity of applications of this type. Part of the explanation may be that development work is rarely carried out in biomedical departments (indeed the second example, above, is based in a Nuclear Physics department). For example, chemistry and physics accounted for 61% of applications to the former SERC's Instrument Development Fund in 1990–92. It is unlikely that applications under this heading will increase unless the scheme is advertised more widely. The exception here is computer software which in the biomedical sciences is often expensive.

4.5 Shared equipment

Only one grant in the sample selected was for an item of equipment shared between separate institutions. Both grant holders had applied to the Trust for the same item. Given their geographical proximity, the equipment was awarded to one institution on the basis of equal access for both research groups. The second applicant was awarded funds for travel and consumables.

This sharing arrangement was at an early stage and although no problems were reported, some issues were raised. First, although allowance was made for expenses, travel was still a problem for researchers without their own

transport (notably PhD students). Second, the problem of training researchers to use a particular piece of equipment was raised. In order to exploit the benefits of the instrument to the full, users require access to knowledge and skills. Much of this information is tacit (i.e. not available in manuals) and requires ready access to technicians or other researchers familiar with the equipment. This posed potential difficulties for researchers coming from outside the institution where the equipment is housed and could put them at a disadvantage. These problems could be mitigated by the provision of a dedicated technician with responsibility for maintenance and usage.

4.6 Facilities and infrastructure

In one example in the sample, the Trust grant had effectively created a new shared facility. A large university biomedical site had in the region of 20 electron microscopes (mostly from the 1960s/70s), some half of which were inoperable. Those that were working were only being used on average 10–30% of the time and researchers needed to travel to find suitable equipment.

Within this complex an old facility, which was used by many departments, was receiving very little support from the university. An initial meeting with Trust staff encouraged the applicants to consider the establishment of a shared facility with state-of-the-art equipment and discussions began with up to 18 other research groups in the area to ascertain user needs. A core group of four departments applied to the Trust for £1 million and received £720 000. The university 'top sliced' all departments and made up the shortfall (£200 000) not provided by the Trust. The Trust grant covered the purchase of:

- transmission electron microscope,
- confocal microscope,
- ancillary equipment,
- image analysis equipment,
- building renovation,
- postdoctoral fellowship for three years (linked to confocal microscope).

A scanning electron microscope was purchased from the funds provided by the university.

The applicants obtained a sizeable discount from the manufacturers, having put considerable efforts into negotiation. It was also important to make sure that the equipment was 'multi-user friendly' (i.e. accessible to researchers from different groups). Many of the participating departments have already decided to close down their own facilities rather than maintain them independently.

4.7 Future trends

Equipment demand in all disciplines has a tendency to be cyclical due primarily to technological breakthroughs. This appears to be the case in the biomedical sciences. The 1980s saw a significant increase in the use of instrumentation within these disciplines. Technologies such as NMR spectroscopy, and developments within electron microscopy, both enabled and encouraged research in new directions.

The results of the interviews indicate that the most commonly perceived need is for the replacement of basic equipment and relatively inexpensive peripherals (e.g. work stations), items which increasingly may be regarded as commodities. Many interviewees expressed concern and confusion as regards the provision of this basic equipment following the decline of the dual support system that traditionally underpinned the 'well found laboratory' in universities. The point was made several times that basic equipment, which is often of use to all members of the department, is more difficult to tie to a specific project and so obtain on a project grant. The results of the analysis of most frequently requested items, presented in section 3.3, shows that the most commonly requested items are in fact multipurpose 'basic' equipment items, albeit latest technology.

Several interviewees in specific fields indicated that the future was likely to see the development of ever more sophisticated (and expensive) equipment items such as 750 MHz NMR spectrometers. This then raises the question of how such 'mega-items' should be funded. Two options emerged from this analysis. The first is joint funding by the Trust with other funding bodies. The second is the establishment of shared facilities. Indeed it would seem likely that the future in many areas of science will see both of these areas being developed.

This section discusses the effectiveness and impacts of the equipment scheme in its first two years. The results are based on interviews with grant holders, EWP members, referees and non-participating Heads of Department. The views of the unsuccessful applicants are described separately.

A Effectiveness of the Trust's equipment scheme

5.1 Awareness/dissemination

The general level of awareness of the scheme was low. The initial advertisement in *Nature* and the *Lancet* was only seen by 8 of the 22 successful applicants interviewed, the majority (14) heard about the scheme through colleagues. It was not unusual for interviewees to believe that the scheme was a 'one off' initiative and many were surprised to discover that it was still current.

Analysis of applications and grants revealed a number of universities that had not applied or which appeared to be under-represented in applications or grants. To assess the general level of awareness among the research community, 18 departments in 12 institutions were contacted. The departments contacted included Physiology, Biochemistry, Chemistry, and Biological and Molecular Sciences.

Of the 18 Heads of Department contacted, 12 had not heard of the scheme, two knew vaguely of its existence and four had heard of it. However, even among those who had heard of the scheme, there was a degree of confusion about the details. One did not know that the scheme was ongoing and another was unaware that the scheme included provision for staffing and maintenance. There was also a perception that the Trust was only interested in supporting 'novel or inventive equipment'.

Although the sample was small, the survey suggested that information about the equipment scheme is not reaching the research community. A number of those contacted expressed interest and requested further information. Attention should be given to ways of improving information about the scheme as a matter of urgency. This is also necessary to address the perception among some interviewees that funding agencies often behave as 'clubs', supporting selected groups or institutions only.

5.2 Peer review process

Equipment grants are currently reviewed in the same way as all other grants at the Trust, namely through a process of peer review. Applicants may nominate reviewers if they wish, with Trust staff making the final decision. Each application is sent to a minimum of three reviewers at least one of whom should be from outside the UK. There was a degree of confusion regarding feedback to applicants. According to Trust staff, reviewers' comments are normally sent back to applicants in edited form. An exception is made if reviews run contrary to the views of the panel or are obviously abusive. However, just under half (10) of the grant holders interviewed could not remember receiving feedback from their reviewers.

Opinions were mixed among grant holders and panel members on the value of the peer review process for equipment grants, although this depended on the nature of the equipment. Applications for equipment, which is obviously linked to a coherent piece of research (e.g. NMR), were thought easier to referee. But more basic equipment that underpins a number of different projects was less straightforward. Two grant holders also questioned the rationale behind extensive peer review of grants for equipment underpinning work that had itself already been peer reviewed. This view was dismissed by members of the committee who did not believe that it was reasonable to expect to receive a large grant without having to present a detailed justification.

A survey of referees revealed that the single most important criteria in judging applications were the quality of the science and the suitability of the equipment for the proposed research. The reputation of the individuals was also taken into account. 'Need' was considered of secondary importance by most. No other criteria were considered.

The peer review system represents a traditional and (from the perspective of the scientific community) an acceptable means of adjudicating between grant applications. However, it is not clear if peer review is appropriate for all classes of equipment or whether applications for single items of basic laboratory equipment (such as ultracentrifuges or DNA sequencers) could be handled by an alternative mechanism. In the absence of any advice to the contrary, the reviewers for the Trust's scheme (all of whom routinely reviewed other types of grant) approached equipment grant applications in the same way as any other application. But the emphasis on scientific excellence to the exclusion of other factors meant that no account was taken of the natural depreciation of equipment, and even where an instrument was old enough to merit replacement, applicants were required to construct a detailed scientific case. In interviews, the point was also made that it was difficult to judge an application without knowing the broader context. For example, was the same equipment available in a nearby institution? Where large facilities were requested, was there a local strategy in place to encourage open access? In the long term, some broad guidelines for referees may promote consistency in the review process and consideration of non-scientific criteria would encourage more effective use of resources.

5.3 Appropriateness of a special scheme for equipment support

There was striking unanimity to the responses to the question "Is there a need for a scheme of this type?" In fact, all of the grant holders interviewed perceived a strong need for a scheme specifically for the provision of research equipment. Some interviewees expressed a wish that the lower limit be reduced so that 'basic' equipment, say, in the range £20 000 – £60 000 could also be appropriated through the scheme. Although equipment items may be added together to 'make up' the total up to £60 000, this was disapproved of by one grant holder, who felt that it encouraged dishonesty and inflated bids.

There was also confusion regarding the upper limit for the scheme. For example, would the new generation of instruments in many fields costing £1 million – £2 million be available through the scheme?

Grantholders and EWP members were asked about the appropriateness of a special scheme as a means of funding equipment. With the exception of one grantholder who would have preferred an increase in his programme grant "to do with as he pleased", all those interviewed thought that this was a highly appropriate means of dealing with equipment needs. The main reason given for this was the perception that support for equipment needs to be 'protected' from other forms of support. Large pieces of equipment can distort a normal grant round, forcing decisions between support for a number of smaller grants (which may include research posts) and support for an expensive item of equipment. Several interviewees also believed that the equipment component of a grant application was frequently reduced or eliminated in an effort to cut costs. For that reason, a mechanism by which funds for equipment were ring fenced was considered particularly important. It also 'sent a message' to the research community that equipment needs were being taken seriously. Finally, the need for technical expertise among the committee or panel awarding grants was also acknowledged, in view of the increasing sophistication of equipment.

5.4 Views on the Equipment Working Party

Knowledge of the makeup of the panel was generally very low. Where the members of the panel were known to the grantholder, the spread of expertise was thought to be sufficient, though few interviewees had a broad enough spread of interests to give a comprehensive viewpoint. Only four of the 22 grant holders interviewed had received direct help with technical advice/ purchasing. But an increased role for the panel or for referees in recommending equipment was not favoured. The possibility of a conflict of interest was raised where panel members or referees had commercial interests with equipment suppliers/manufacturers. In general, researchers felt that they were the best judges of equipment and did not want to be directed by awarding committees.

5.5 Overheads

There were very few shortfalls in overheads not covered by the grant. Where shortfalls occurred, it was often because the grantholders were not familiar enough with the equipment at the time of application to envisage changes in local infrastructure, costs of consumables and maintenance, or the need for additional software. However, the majority of grant holders interviewed were satisfied.

5.6 Application process

The administrative aspects of the application process met with few complaints from the grantholders and few delays were reported. Nineteen had their applications processed in 3–6 months. The reminder were processed in 6–9 months.

With one exception, those grantholders who experienced a site visit were satisfied with the process, taking advantage of the occasion to explain their case more fully. The dissenter considered it a waste of his time. From the committee's perspective, all agreed that site visits were invaluable for illuminating the case for or against an application.

Several grantholders drew attention to differences between funding agencies with respect to administrative bureaucracy. In general, efforts to reduce bureaucracy were appreciated by all applicants.

Most of the successful applicants interviewed (17) felt that there was sufficient guidance given on the application form and that the criteria were fairly clear. However, most had talked directly with Trust staff before completing the application form. Furthermore, the application form is similar to that used for project grants, with only a short space allocated to the justification of equipment. This is potentially confusing for an application dedicated to equipment. Some found the selection criteria confusing and several stated that they were unaware that applications could be made for staff funding under the scheme although such information does appear in the Trust's Grant's Handbook. Suggestions for clarification included guidance on the level of technical help available, whether facilities and infrastructure could be upgraded, and more general guidelines on the scope and limits of the scheme. More broadly, this illustrates the wider point that application procedures and criteria for support should be as transparent as possible.

5.7 Unsuccessful applicants

A total of 20 unsuccessful applicants to the equipment scheme were interviewed by telephone using the interview schedule in Appendix 2. In general, the results of this exercise were in line with findings from the grantholders.

The range of equipment that had been requested was broadly similar to the successful applications, including 11 basic multi-user items and 9 specialized project-specific items. Most requests (16) were for the purchase of latest technology and the rest were for updates of existing equipment. Half of the failed applicants (10) had heard about the scheme 'by word of mouth' or from departmental circulars. The remainder had seen the advertisement in *Nature* or the *Lancet*.

There was unanimous agreement among the unsuccessful applicants that there was a need for a special equipment scheme, with only one interviewee expressing reservations. The application form was regarded as adequate by 17 of the interviewees, the remainder suggesting that more specific guidance on the selection criteria would be useful. For example, would proposals with multiple applicants be viewed more favourably than those with single applicants? The processing of the applications was rapid enough for all but one of the interviewees.

The peer review system was felt to be fair and reasonable by 14 of the unsuccessful applicants. Of the remainder, two felt that the referees misunderstood the main thrust of the proposal, possibly due to a lack of technical understanding; two others felt that the level of feedback was inadequate or unclear. Another commented that the projects he had submitted were too wide ranging, making refereeing very difficult. The final applicant believed that he had been turned down for ethical reasons because his work involved the use of human tissue. Finally, of the 12 interviewees who subsequently reapplied to other bodies for the same equipment, nine were successful.

All the interviewees were positive about the scheme and believed that it fulfilled a need not met by any other funding body in terms of scale of funding and flexibility. Most were philosophical about the outcome of their application: "you win some, you lose some" was the most common response.

In summary, the study found little difference between successful and unsuccessful applicants in their views on the merits of the scheme suggesting that the grantholders were not unduly influenced in their opinions by their success in receiving funding.

B Impacts of the Trust's equipment scheme

5.8 Immediate impacts

The 'logic diagram' (see scheme 1, section 2.3) describes the impacts that the equipment scheme might be expected to have. The immediate impacts of the scheme include improved equipment provision and improved support or facilities; these are described in section 4. Another immediate impact proposed was the possibility of increased support from host institutions. Current grants in the scheme were analysed to assess the success in attracting such support.

Table 4 shows a summary of the contributions towards the cost of funding and servicing equipment made by the host institutions as a result of obtaining a grant under the scheme. Of the 77 grants awarded up to October 1994, 20 included contributions from the universities. This amounted to £602 596. In the most recent round of awards under the scheme, the university contribution was £430 000. Thus, to date, the total financial contribution from universities has been £1.03 million or in excess of £1.5 million if the provisions of two additional NMR machines is taken into account. A further contribution has been the provision of staff. Three technician posts are to be taken over by the respective universities at the end of their grants; a further three technician posts and a lectureship have also been made available by universities in receipt of equipment grants. This collaborative element is a particularly successful feature of the equipment scheme to date.

Table 4 **Details of 'value added' by universities to awards funded through the Equipment Working Party (November 1992 – October 1994)**

Below are details of contributions made by universities (and departments) towards the cost of funding and servicing equipment provided by the Trust through the Equipment Working Party. The first figure given is the amount awarded by the Trust. It can include salaries and running costs as well as the equipment itself. The second figure is the 'local' contribution.

Bath	Cell Sorter	£250 000	Technical Post
Birmingham	Phosphor Imager	£83 238	£25 000 (from MRC)
Birmingham	500 MHz NMR	£638 381	£60 000 for upgrade to 600 MHz
Cambridge	Cell Sorter	£330 678	£30 000
Cambridge	Imaging Laboratory	£718 117	Will take over Level 3
Charing Cross and Westminster	DNA Sequencer	£71 805	£40 000
Glasgow	DNA Sequencer	£160 000	Will take over Technician
Leeds	Phosphor Imager	£78 770	£27 000
Leicester	Phosphor Imager	£76 120	£30 000
Newcastle	Mass Spectrometer	£474 892	£61 278
Newcastle	Electron Microscope	£132 953	£44 318
Newcastle	Confocal Microscope	£308 643	Refurbishment and £100 000
Nottingham	Ion Vision Machine	£85 125	£30 000
Oxford	Electron Microscope	£170 150	£25 000
Oxford	Imaging Laboratory	£622 267	£80 000 and take over of technician
Oxford	Cell Sorter	£145 000	£80 000
Sheffield	Cell Sorter	£170 000	Room and Technician
St Andrews	500 MHz NMR	£664 722	Two further NMR machines (500 and 300) and refurbishment
Surrey	DNA Sequencer	£121 490	Will take over Technician
UCL	Molecular Biology Facility	£200 700	£70 000 for refurbishment
UEA	Diffractometer	£399 931	Provided lectureship
UEA	500 MHz NMR	£600 000	£300 000 for refurbishment and £10 000 per year
Warwick	DNA Sequencer	£92 138	Technical Post, £30 000

5.9 Intermediate impacts

The grantholders interviewed were asked to list the benefits of obtaining equipment under the scheme according to four categories: generating ideas for new research projects, increasing efficiency, increasing accuracy, and synergies with other departments or researchers.

A total of 12 interviewees cited the generation of new ideas as a benefit, in particular with more sophisticated items of equipment. Indeed the initial requirement for these instruments was usually to enable the researcher to explore new avenues of research. In contrast, increased efficiency and

increased accuracy, were attributes of more 'basic' items of equipment such as phosphor imagers and DNA sequencers. In both cases 12 interviewees perceived significant advances under these categories. Researchers often found that the overall efficiency of the laboratory had been increased due to the new equipment speeding up the implementation of routine procedures.

Only eight of the grantholders cited synergies with other researchers or departments as being a perceived benefit of the new acquisitions. The vast majority of these synergies were with other researchers within the host department or ones closely allied to it. This may be due, in part, to the fact that very few of the instruments had been operational for more than a few months. Many researchers commented that priority initially must be given to co-applicants and fellow researchers within the department, but that eventually the number of outside users would increase, allowing the possibility for greater synergy with other groups.

5.10 Ultimate impacts

The equipment grants were at too early a stage for analysis of publications. However, one grantholder noted the importance of a well equipped research laboratory in the ability to attract and retain high quality staff.

5.11 Assessing the outcomes of equipment grants

The current means of assessing the outcome of equipment grants is by means of a standard end of grant report. Given the multi-disciplinary nature of many of the grants and the fact that many pieces of equipment are basic (albeit sophisticated) laboratory tools, this is less than ideal. Interviewees were asked for their opinion on the best way of gathering output data. The majority of grantholders and panel members agreed that outputs should be measured. In particular, some systematic way of assessing the performance of equipment was thought to be useful. The Trust is addressing this question already by requesting information from grantholders on equipment supplied under the scheme. This request is contained in a letter sent to all grantholders that also requests a standard end of grant report.

Publications were suggested as one measure of success; however, this was considered of limited use with certain categories of equipment and concern was expressed about establishing an appropriate time point for assessment. The possibility of acknowledging Trust supported equipment on publications was also raised although this would only be appropriate for certain types of equipment. Another indicator suggested was pattern of usage (i.e. who used the equipment, for what, and for how long). For such equipment as NMR machines or sequencers, factual data on the numbers of bases sequenced or spectra run, and time details from the machine log books could also be included. In general, a short report form requesting quantitative data was considered more appropriate than the standard end of grant report that requests detailed descriptions of the research.

A common perception among those interviewed was that there were few sources of funding for research equipment in the UK. The evaluation sought to explore this further by reviewing alternative sources of funding for research equipment and comparing the approach taken by other funding bodies with that taken by the Trust.

6.1 The Medical Research Council

In 1994 the MRC launched a pilot of an Infrastructure Initiative. The scheme is limited to departments or groups of departments where the total current grant value from the MRC exceeds £2 million in total. It is designed to meet the costs of major strategic research facilities including major items of expensive equipment, and for the maintenance and running costs including staff closely associated with the facility. The idea is to create a partnership between the MRC and the university. The scheme is intended to fund infrastructure that a university may find difficult to finance from a standard combination of Funding Council allocations and research grants. Equipment may also be requested in the usual way, on project or programme grants.

One difference between this Initiative and the Trust's equipment scheme is that the MRC does not intend to repeat peer review of current grant-supported work; instead, applicants are expected to demonstrate:

- an explicit strategy for the facility that would take into account the added value this would bring to current research;
- explicit personnel and career development policies for staff to be employed on the infrastructure;
- explicit arrangements for management and accountability to the university and to the Council for the infrastructural funding;
- details of current and projected grant support from the MRC and from other sources, and of why the facility cannot be funded from existing sources.

Applications are considered by a special panel drawn from different Boards and Committees within the MRC. A shortlist is then submitted to the Council for final consideration. The Infrastructure Initiative does not have an ear-marked budget. Applications are considered in competition with other proposals going forward to the Council. By the end of 1994, 17 applications had been shortlisted.

6.2 The Biotechnology and Biological Sciences Research Council

Funding for the Research Councils specifically for equipment in the biomedical sciences has tended to be ad hoc and to take the form of single initiatives rather than ongoing programmes. Under the 'old' system (pre 1993), substantial items were obtained through the Biological Science Committee and the Chemistry Instrumentation Committee of the SERC; some was channelled through the Molecular Recognition Initiative supported by SERC Biological Sciences and Chemistry Committees.

The BBSRC funds equipment through the normal responsive mode

(via six research committees). One such committee, the Biomolecular Sciences Committee, was carried over from the SERC. Previously, this Committee funded some facilities containing considerable amounts of research equipment. The council is aware of the problems of equipment provision and, in 1994, set up an Equipment and Facilities Advisory Group to review the situation and to assess whether any changes are required in the existing structure to cope with current equipment needs in the biological sciences. The Group will report to Council in July 1995.

The BBSRC has also carried out some one off exercises to support equipment in universities and institutes. The first initiative, announced in November 1994, was designed to support equipment in the range £100 000 – £200 000. The initiative was open to 36 institutions only. A total of ten applications were supported in the initial round, with a value of £1.5 million. A further four applications with a value of £500 000 were supported after matching funds from industry had been secured.

6.3 The Office of Science and Technology

The budget allocation for the year 1995–96 included a special commitment to funding expensive equipment such as nuclear magnetic resonance spectrometers and electron microscopes. Under the scheme, the OST will provide £1 million each for the BBSRC, the EPSRC and MRC, to be supplemented by matching funds. This is to be used to provide 50% funding to universities provided that they find the other 50% from industrial partners.

6.4 The Royal Society

The Royal Society has a small grants scheme under which equipment may be supported. This is limited to grants under £10 000 and is, therefore, confined to smaller items only.

6.5 The National Health Service

The main focus of the National Health Service (NHS) is on the provision of service equipment rather than research equipment, although there can be some overlap. Only approximately 1% of the annual NHS budget is designated as R&D funding (£250 million – 300 million). The NHS is administered via its Regional Health Authorities each 'Region' having responsibility for a number of District Health Authorities. The North Western Regional Health Authority, for example, currently has responsibility for equipment with an estimated collective replacement value of £100 million. It also has an annual equipment budget of £10 million. The Region provides the capital cost of equipment; it is the responsibility of the individual Districts to maintain it. Each District submits a prioritized annual bid to the Region. The Region then aggregates these bids and may reprioritize them in the light of currently available funds and other relevant factors e.g. priorities arising from their centralized purchasing policy.

6.6 The National Institutes of Health

The National Institutes of Health (NIH) is a federally funded agency responsible for all government-funded medical research in the USA. It has a total budget of approximately $12 billion per annum. The extramural budget,

which accounts for 80% of the total, covers universities and medical schools.

NIH runs a comprehensive sharing scheme located in the intramural programme, the vast majority of which is based at the Maryland complex. This employs 12 000 employees and houses research equipment worth approximately $300 million – $400 million. The sharing scheme enables the provision of basic research equipment on a self-funding basis. This has advantages for both users and Government. Users can obtain the equipment they want immediately, for any length of time required. They can also apply for new specialized equipment. From the government's perspective, the scheme increases the efficiency of utilization of equipment and reduces overall costs. The sharing scheme at NIH operates primarily in reactive mode. Requests for equipment are normally met from in-house stores (current capital value is approximately $12 million). A recurrent budget of $1.5 million per annum adds to this stock, to replace worn equipment or fulfil specialized requests. The value of equipment items in the scheme ranges from $200 to $500 000. All items in the scheme must be moveable.

The rental scheme accounts for only 5–10% of equipment use and most purchasing is still funded out of personal research budgets. At present, the scope for the introduction of such a scheme by the Trust is limited, given that its main mode of funding is extramural.

6.7 Summary

This review of other funding bodies revealed that the UK research councils are beginning to address the problem of equipment provision. However, there are some differences between these initiatives and the Trust scheme. In the case of the MRC and the BBSRC initiatives, only those institutions that already have substantial funding from these agencies are eligible to apply. Budgets for these initiatives also appear to be set at a lower level than that of the Trust's scheme. Finally, in both of these initiatives, the funding agencies are applying explicit criteria additional to scientific excellence, such as creating a partnership with the university or encouraging access to the equipment by researchers in other institutions.

The ability to carry out innovative scientific research has become increasingly dependent on access to advanced instrumentation. The provision of equipment is now an important policy issue for research funding agencies, both nationally and internationally. In the UK, changes to the way that Government funds are allocated to Higher Education Institutions over the past decade have had a profound influence on support for research equipment.

A number of funding bodies, notably the Medical Research Council and the Biotechnology and Biological Sciences Research Council, have recently launched equipment or infrastructure initiatives. This report presents the findings of an evaluation of the largest equipment funding scheme in the UK, namely the Wellcome Trust's Equipment Scheme. The scheme was established in 1992 for a three-year period in response to concerns over the state of research equipment in UK universities. Although equipment is supported through a number of funding mechanisms at the Trust, this special scheme is targeted at items of equipment costing in excess of £60 000.

The main aim of this study was to evaluate that scheme two years on from its inception. The evaluation collated quantitative data on the scheme and canvassed the views of grant holders, unsuccessful applicants, referees and panel members on the appropriateness of a specialized scheme for the support of research equipment. Alternative sources of funds for equipment were also assessed. In the course of the study, a number of issues were raised with relevance to the wider problem of equipping UK universities.

A review of funding sources of support for equipment revealed that the Trust's equipment scheme is currently the largest such scheme in the UK. Recent equipment initiatives launched by the Research Councils are more limited in terms of both budget and eligibility requirements. In turn, changes to the dual support system have made access to equipment more dependent on Research Council grants.

The most comprehensive study of UK academic instrumentation (Georghiou *et al.*, 1989) produced a database of 16 000 items of research equipment with detailed data on usage and condition. The survey found that 37% of the national equipment stock was over 10 years old, 14% was no longer adequate and that 17% was in poor condition or inoperable. An update of this study in 1992 suggested that specific action was needed to address the problem of general items not eligible for support under a single grant.

In this evaluation, interviews with the research community revealed a great deal of concern over the issue of research equipment. There was a unanimous belief that the dual support system had collapsed and that equipment needs now had to be met almost exclusively through research grants. This posed several difficulties for researchers. First, where the equipment request formed part of a project grant, it had to be closely linked to the proposed

research. If the equipment was needed to underpin a variety of projects (or was a basic laboratory tool), the cost could not always be justified in one grant. If the application was turned down, the equipment was not funded.

Second, the cost of state-of-the-art equipment often equals or exceeds that of a single project grant. In many cases, the cost may dwarf that of an average project grant. This is a reflection of the fact that in terms of cost, research is now becoming more capital intensive and less labour intensive. Finally, in the experience of the research community, the equipment portion of a standard project grant application was often deleted in the award for cost saving purposes. For all of these reasons, the concept of a scheme dedicated to the support of equipment was highly popular. A survey of other funding agencies revealed that although some equipment schemes exist, they currently make a relatively small contribution to the supply of research equipment.

The equipment most commonly requested/granted came into the category of 'purchasing the latest technology'. However, the most commonly perceived need for the future was for replacement of basic equipment. There was a great deal of concern over access to equipment in the £20 000 – £60 000 range. Items in this range form the basis of a 'well found' laboratory but fall outside the remit of the equipment scheme.

However, there was also concern about ever more sophisticated equipment at the top end of the scale. Two options seem worthy of consideration. The first is joint funding by the Trust with other funding bodies. Since equipment obtained under the Trust's existing scheme is often used to support projects funded by other agencies, this 'collaboration' is already taking place. Similarly, the scheme has already been successful in terms of leverage, having persuaded universities to supply top up funding or extra facilities once funding was guaranteed, although this was not an explicit aim of the Trust's scheme at the outset. A second option would be to encourage the use of shared facilities. As well as being cost effective, such arrangements would encourage wider access to state-of-the-art technology and contribute to closer interactions between groups.

Both the application and administrative processes were found to be efficient. However, there was some confusion among applicants over the criteria by which applications are judged. This related to the unusual nature of the equipment scheme where a number of different projects may be described in support of the application. Although applicants were aware that scientific merit was the most important criterion, they were unsure about the weight accorded to each project. They were also unsure about the relative importance of 'need'. For example, where an item of equipment had been used for a long time and was clearly obsolete, many applicants believed that this would be taken into account. Panellists and referees, however, judged applications solely on the basis of scientific merit. The confusion among

applicants suggested a need to clarify the criteria making it clear to applicants that their applications will be judged solely on the basis of scientific merit. If any other criteria are to be taken into account, this should also be made clear to reviewers and to applicants. There was also some confusion about the scope for applying for staff and maintenance under the scheme, despite references to these issues in Trust literature and letters to applicants.

Despite concern about equipment, applications to the scheme have been falling. A sample survey of institutions not supported by the scheme revealed very low awareness. Many universities had not heard of the scheme or believed that it was a 'one off'. Most grantholders had heard about the scheme by word of mouth, some from panel members. Although this type of informal dissemination is common, it is inadequate for a major scheme and could lay a funding organization open to charges of exclusivity. Urgent attention should be given to advertising the scheme to as many institutions as possible.

Many of the potential impacts of the equipment scheme described in the 'logic diagram' (see Scheme 1, section 2.3) are already being observed. As well as improved equipment provision, the scheme has succeeded in attracting increased support from host institutions. Although it is too early to measure the ultimate impact of the scheme, a number of intermediate impacts are already in evidence. These include greater efficiency and accuracy in the related research, improved synergy with other researchers, an increased ability to attract and retain good staff and a 'feel good' factor. Most interviewees agreed that outputs should be measured, although this should be as simple a process as possible. The standard end of grant report is oriented more towards discrete research projects and was considered unsuitable for the grants under the equipment scheme. The favoured option was a questionnaire that covered quantitative data and an assessment of the performance of the equipment.

Concluding remarks

The evaluation of the Trust's equipment scheme raised a number of issues with wider implications for the support of equipment in UK universities. Support for equipment is increasingly linked to individual grants and although this is appropriate in many cases, it is not always possible to justify basic or multi-user items of laboratory equipment in this way. Special equipment schemes, which allow researchers from different groups or disciplines to make a multiple application for a specific item, are a good mechanism for maximizing the use of equipment, as well as an efficient use of a funding body's resources. Other advantages include the ability to draw on special technical expertise in a multidisciplinary awarding committee and the scope for leverage with the host institution and suppliers. It is unlikely, however, that such schemes can address the more fundamental problems of under investment in basic equipment and infrastructure in UK universities or act as a substitute for a coherent national equipment policy.

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Interview protocol for grantholders

Date:
Interviewer:
Name:
Organization:
Tel:
Grant:

Background

1. General description of organization and circumstances leading to initial grant application.

Needs

2. How did you hear about the scheme?

3. What was your requirement in terms of equipment?

   - Purchase of latest technology.
   - Updating/upgrading existing equipment.
   - Customizing/developing existing equipment.

4. In your opinion, is there a need for a scheme of this type?

5. How does this scheme compare to those offered by other funding agencies?

6. What are your views on the appropriateness of this scheme for meeting your equipment requirements?

7. Are there still areas of research that you are unable to undertake due to equipment needs?

8. Would you say that the department has 'well found' laboratories by:

   - UK standards,
   - International standards.

Effectiveness of EWP

(i) Process

9. Is the current application form appropriate/adequate?

10. Were the requirements/criteria made clear to you?

11. Was the peer review system appropriate/transparent – any feedback received?

12. How high was your awareness of the scheme?

13. In your opinion, is the structure/makeup of the EWP appropriate?

14. If not, what would be the most appropriate form for such a panel?

15. Is the application process rapid enough to keep up with changes in available equipment?

(ii) Output

16. Did you experience any delays with the application process?

17. How/from where was the equipment obtained?

18. Should the panel advise on suppliers?

19. What is the use pattern of funded equipment?

    - Dedicated to a particular experiment?
    - General purpose research instrument?
    - Research and teaching instrument?

20. For what percentage of average working time is the equipment utilized?

21. Who are the major users?

22. What additionalities has the award produced?

    - New research projects?
    - Synergies with other researchers/departments?
    - Improved efficiency?
    - Improved accuracy?

23. What additional overheads not covered by the grant?

24. What outputs should be assessed in your opinion?

Other mechanisms

25. What experience have you had of other relevant funding mechanisms?

26. How could the present scheme be improved?

27. Any other comments?

Interview protocol for failed applicants

Date:
Interviewer:
Name:
Organization:
Tel:
Grant:

Background

1. General description of organization and circumstances leading to initial grant application.

Needs

2. How did you hear about the scheme?

3. What was your requirement in terms of equipment?

   - Purchase of latest technology.
   - Updating/upgrading existing equipment.
   - Customizing/developing existing equipment.

4. In your opinion, is there a need for a scheme of this type?

5. How does this scheme compare to those offered by other funding agencies?

6. What are your views on the appropriateness of this scheme for meeting your equipment requirements?

7. Are there still areas of research that you are unable to undertake due to equipment needs?

8. Would you say that the department has "well found" laboratories by:

   - UK standards,
   - International standards.

Effectiveness of EWP

9. Is the current application form appropriate/adequate?

10. Were the requirements/criteria made clear to you?

11. Was the peer review system appropriate/transparent – any feedback received?

12. How high was your awareness of the scheme?

13. In your opinion, is the structure/makeup of the EWP appropriate?

14. If not, what would be the most appropriate form for such a panel?

15. Is the application process rapid enough to keep up with changes in available equipment?

16. Did you experience any delays with the application process?

Other mechanisms

17. Were you given the opportunity to re-submit?

18. Did you re-apply elsewhere, if so, were you successful?

19. If not, how has your research been affected?

20. What experience have you had of other relevant funding mechanisms?

21. How could the present scheme be improved?

22. Any other comments?

Interview protocol for EWP members

Date:
Interviewer:
Name:
Organization:
Tel:
Grant:

Background

1. General description of organization and circumstances leading to initial grant application.

Needs

2. What are your views on the role of the EWP and rationale behind it?

3. What do you see as the major benefits of the scheme in terms of:

   - Purchase of latest technology?
   - Updating/upgrading existing equipment?
   - Customizing/developing existing equipment?

4. In your opinion, is there a need for a scheme of this type?

5. How does this scheme compare to those offered by other funding agencies?

6. What are your views on the appropriateness of this scheme for meeting equipment requirements?

Effectiveness of EWP
(i) Process

7. Is the current application form appropriate/adequate?

8. Are the requirements/criteria made clear to you?

9. Is the peer review system appropriate/transparent?

10. In your opinion, is the structure/makeup of the EWP appropriate?

11. Is the spread of expertise sufficient?

12. If not, what would be the most appropriate form for such a panel?

13. Is the application process rapid enough to keep up with changes in available equipment?

14. Are you aware of any specific problems with the application procedure?

15. What, in your view, is the general quality of applicants?

(ii) Output	16. What outputs should be assessed in your opinion?
	17. Should the panel advise on suppliers?
Other mechanisms	18. What experience have you had of other relevant funding mechanisms?
	19. How could the present scheme be improved?
	20. Any other comments?

Interview Protocol for Referees

Date:
Interviewer:
Name:
Organization:
Tel:
Grant:

Background

1. General description of role
2. How did you become involved in the peer review process?
3. How many equipment grants did you referee?

Needs

4. What were the common needs among applicants (if more than one grant refereed)?
5. Is there a need for a panel of this type?

Process

6. Is the application form appropriate?
7. Are applicants clear about the criteria for selection?
8. Is the peer review process appropriate?
   - Were there sufficient guidelines for referees?
   - Were the selection criteria clear?
   - Was there sufficient time to review the applications?
9. Do you know what the makeup of the panel is? If so, is it appropriate?
10. How cross disciplinary/multidisciplinary/technical were applications which you refereed?
11. What are your views on the application procedure in general?
12. Were there any hold ups?

Outputs

13. Should the Trust assess outputs from these grants? If so, how?
14. Should referees advise on suppliers or purchasing?

Other mechanisms

15. What experience have you got of acting as a referee for other agencies or funding modes?
16. Any other comments?

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