

Exploitation of Public R&D

An outline of world activity in exploiting research supported by governments; close look at NRDC

BY J.C. CAIN*

Nowadays, involvement in international trade is of fundamental importance to most countries of the world. As such trade has become increasingly competitive, so each country in order to survive, or increase or maintain its standard of living, has had to make a technological audit on its local industrial companies. The technological competitiveness of a country's manufacturing industry will be manifest in a number of ways but most clearly in its ability to offer for sale new or improved products, or processes which are well designed, delivered on time, function reliably and above all are made available at a price that provides an adequate return on investment to the manufacturer and good value for money to the purchaser.

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The onus for achieving this required level of technological competitiveness lies, for the most part, with industry itself, in the sense that the penalty for a particular industry or company failing to maintain an adequate level of technological expertise is a slow, and not infrequently a rapid, falling off in its business with eventual demise and possibly bankruptcy.

Nevertheless, governments have become more actively concerned and involved in this issue from the 1950s onward. Postwar, a number of the industrialized nations, whose policy it was to maintain their own defense capability maintained a substantial publicly-funded defense R&D program which embraced a wide variety of relevant industries. Many other nations, including some developing countries, have over the years adopted a similar policy and with the same result.

At the same time social and other pressures led many countries to expand substantially, both in numbers and in scale, their higher educational establishments and particularly their universities. As a natural consequence the support of research in these centers from public funds has risen and has also embraced an ever-widening range of topics including science, engineering, mathematics, medicine, agriculture etc.

Civil Needs

With the passage of time, governments have extended the scope of their own in-house supported research and development into areas relevant to civil as well as defense needs. For instance, the impact of the motor car

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led first to the need to improve and develop road systems and methods for their construction, and then later to deal with the associated gaseous pollutants and the safety of the car driver and his passengers.

Each country has followed its own distinctive path in such matters, some with more planned objectives from the start than others.

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The volume in terms of both money and manpower resources, deployed by most governments in the pursuit of such R&D work increased significantly through the 50s and 60s. When the funds were spent in industry, the use and exploitation of the results were usually assured, as has always tended to be the case, for instance with defense R&D procurement programs.

However, when the R&D work was carried out in the government's own laboratories or in universities or similar academic centers, which by this time was increasingly the case, it posed two problems both requiring solutions. The first was how to ensure that any results of potential value to industry were recognized and passed on to "local" companies. The second, related in part to the first, was how to protect these results so that (a) access to them by third parties could be controlled, and (b) some direct financial benefit arising from its investment could be obtained by the state. To solve these* problems most countries have set up organizations often now collectively National Research Development Organizations — NRDOs — a name which fortunately, or unfortunately, depending on your point of view, is derived from the title of my own organization, the National Research Development Corporation.

Most of us would recognize NRDOs as creatures of the post-World War II period, and correctly so. But it is the case that similar objectives were created at a much earlier date. Thus, in the U.K. a government organization called the Department of Scientific and Industrial Research was around in the 1920s and although it was primarily concerned with supporting applied research in its own laboratories it had a responsibility and a rather limited ability for patenting and licensing the fruits of its research. Its role was merged ultimately into that of NRDC.

Even earlier in 1912 in the U.S.A. an academic scientist, inventor and philanthropist, Frederick Gardner Cottrell, established the Research Corporation which is still very active today. His plan was to create a foundation to ensure that practical use was made of discoveries resulting from research and which would apply any profits generated to scholarly work in the sciences. Cottrell's own invention, the electrostatic precipitator, used to reduce industrial air pollution, was the first of the inventions donated to the foundation.

Other Organizations

There were, of course, other organizations in the U.S.A., Europe and elsewhere, mainly publicly-financed, which were established in the relatively early days to which I have been referring; for example Centre National pour Recherche Scientifique (CNRS) in France, and Commonwealth Scientific and Industrial Research Organizations (CSIRO) in Australia, and which had inter alia a responsibility for protecting and exploiting their own inventions.

I cannot claim to have researched them all and in any case at the risk of being accused of bias I would like to dwell on the Research Corporation's activities for a little while longer, primarily because of this organization's long involvement with the exploitation of academic ideas, a source of invention that most of us concerned with these matters, have found to be very financially rewarding on occasions.

The first interesting thing about Research Corporation is that it did not start off by simply licensing its inventions. It set up a company to directly exploit in the marketplace the Cottrell inventions. It was not until 1954 that Research Corporation spun off this business into a subsidiary company, Research Cottrell Inc., which became a leading company in air, water and thermal pollution control. This business was sold off totally some years ago and provided Research Corporation with an endowment of 50m. dollars.

This early concept of creating a company and going directly into the marketplace to exploit an invention is a road that my own organization has followed from time to time in more recent times. Thus, we recently set up two wholly-owned subsidiaries, Compeda and Genesys, to develop and exploit directly in the marketplace a range of software packages devised by U.K. university and government laboratories.

Similarly, we have been involved as partners with one or more industrial companies in the development and attempted commercialization of certain government-generated inventions — for instance in Advanced Materials Engineering Ltd, along with Clarke Chapman, Doulton, Rosenthal and Kawecki Berylco and set up to exploit the ceramic material silicon nitride; most recently in Combustion Systems Ltd. where we joined with the National Coal Board and British Petroleum to develop and exploit fluidized combustion. The latest use of this concept in the U.K. has been by the National Enterprise Board and its financial private sector partners in setting up Celltech Ltd. to develop and exploit Medical Research Council inventions in genetic engineering and related subjects.

Partly building on its success, but also to spread its risks and/or increase its inventive base, Research Corporation has over the years increased the number of inventive organizations with which it has agreements to provide an exploitation service. At the end of 1980 the number was 282, mainly individual universities. All NRDOs, sooner rather than later, because of the very speculative nature of the majority of inventions with which they are concerned recognize the need to have as large an input of ideas as they can manage, in order to provide them with the statistical chance of having in their portfolio an invention of major commercial potential. Although Research Corporation has remained

profitable overall, which it needs to be, having no public money available to it and yet having to provide funds for its charitable programs in support of research in universities, I believe it is the case that Research Corporation has not handled another invention as commercially valuable to it as the electrostatic precipitator. It has made most of its income from a very few inventions. This again I believe to be the general experience of all the NRDOs and of other bodies similar to Research Corporation.

Canada First

I suspect that many people who are professionally involved in the protecting, developing and exploiting of public research might well say that they thought of NRDC as the first national body established specifically to do this job. It was established as a statutory Corporation in 1949 under the 1948 Development of Inventions Act. In fact, a Commonwealth country, Canada, established two years earlier than this in 1947, the Crown Corporation, Canadian Patents and Development Ltd. (CPDL), to assess, patent and license inventions arising from research in the laboratories of the Federal Government, provincial institutes and universities. A number of other then-members of the Commonwealth have subsequently set up similar national organizations, e.g. the National Research Development Corporation of India in 1953/54 and the South African Inventions Development Corporation in 1962.

The Japanese Government established the Research Development Corporation of Japan (JRDC) in 1961 and about 80 % of the ideas it develops and exploits come from either public research institutes or universities. A separate organization, the Japan Industrial Technology Association (JITA) was set up in 1969 and provides a licensing service for patents arising from the work done in the laboratories of the Ministry of Industry and Technology (MITI).

In Europe, France established a national body in the form of ANVAR, the Agencie Nationale de Valorisation de la Recherche (ANVAR) in 1967, and West Germany although it has no central body has a number of public organizations concerned with patenting and exploitation of inventions including the Instiut fur Systemtechnik and Innovationsforschung (I.S.I.) which takes care of inventions from the laboratories of national research bodies such as Fraunhofer Gesellschaft. Scandinavia, Eastern Europe and S. America all now have examples of NRDOs although their size and responsibilities vary a great deal.

It may interest you to know that when Dr. Basil Bard LES U.K. member was Managing Director of NRDC he convened in 1973 an informal meeting of NRDOs and related bodies in NRDCs offices in London to exchange information and discuss common problems. These meetings now take place every two years each time in a different host country. The last one was held in Munich in 1980. More than 25 countries and 50 individual organizations have been represented at these meetings.

I have said little so far about the U.S.A. and its mechanisms for exploiting inventions from public research, other than my comments on Research Corporation. There are a considerable number of individual university-based exploitation bodies including

some well known ones associated with universities such as Wisconsin, Stanford, Purdue, and with technological universities such as M.I.T. There is no central public body such as NRDC providing a patenting or exploitation service for any or all universities and because of the size of the country and the availability of experienced private, charitable organizations, one is probably unnecessary.

More surprisingly there is no such public body responsible for the patenting, development and exploitation of the U.S.A. Government's own inventions. In part it stems from traditional U.S.A. Government policy which took the view that all government-supported inventions would be available to any company on a nonexclusive basis, royalty-free. This unrealistic policy has been undergoing change during the last 10 years or so and it is now possible in the right circumstances for a company to obtain exclusivity or a sufficient degree of exclusivity to justify industrial investment on the development work usually required to commercialize this type of invention. This policy applies both to university inventions made with government support or inventions made in government laboratories. Rights in the former can also usually be transferred to the university.

The National Technical Information Service (NTIS) of the U.S. Department of Commerce has become the most recognizable central public body in this business. It now acts for many government agencies such as the Departments of Health, Education and Welfare, Interior, Agriculture and Commerce, evaluating their inventions for commercial potential and undertaking foreign filing programs and licensing. However, the National Aeronautics and Space Administration (NASA) and, for instance, the Department of Energy, do their own thing still.

I would like now to turn to the U.K., the scene I know best. NRDC has available to it a right to borrow up to L50m from government at normal borrowing rates but is currently funding all its activities from its own profits. It has a small office in Scotland, otherwise it is totally located in London. It has a staff of about 230, of which 100 persons are professionals, the majority being industrial scientists or engineers who are supported by patent agents, lawyers and commercial accountants. Its financial obligations are to attempt to at least break even. It has a board composed of executive and non-executive directors all of whom along with its managing director are appointed by the Secretary of State for Industry.

PRIVATE INDUSTRY, PUBLIC CORPORATIONS AND RESEARCH ASSOCIATIONS

	£ MILLION			
R & D Expenditure	1967	1972	1975	1978
Total	612	839	1,353	2,341
Carried Out Within Industry-				
Total	605	831	1,340	2,324
Private Industry	550	743	1,185	2,061
Public Corporations	42	69	124	213
Research Associations	13	19	31	51
Put Out By Industry To Other Sectors	7	8	12	17
Funds For Industry's R & D				
Total	612	839	1,353	2,341
Government Funds	178	277	414	680
Overseas Funds	23	54	85	186
Other Funds (Mainly Own Funds)	410	507	854	1,476

**TOTAL EXPENDITURE ON R&D
1967-1978**

Table 1

Table 1 shows that about 29 % (L680m) of industry's R&D is paid for by government, but about a third of that (L213m) is spent in the nationalized part of industry (public corporations). In either case inventions arising from this work would almost invariably belong to the individual company or at least it would probably have a royalty-free license. Public corporations own and protect and license their own inventions although on occasions they may ask NRDC to become involved in some way. An example is Combustion Systems Ltd. The inventions belonged to the National Coal Board and they asked NRDC to assist in their development and exploitation.

The Research Associations, which serve particular industries, also own and control their inventions and operate with NRDC in a comparable manner to the nationalized industries. Similarly, the United Kingdom Atomic Energy Authority (UKAEA) protects and exploits its own inventions and John Gay, this afternoon's Chairman, was for many years their senior exploitation officer and is still a consultant to them. There are a few other quasi-governmental bodies similar to UKAEA, such as the Health and Safety Executive, which although having independence are most likely to operate through NRDC, lacking in-house expertise.

**£ Million
(Inflation Adjusted)**

	1964	1969	1975	1978
At Current Prices	488	680	1,340	2,324
At 1975 Prices	1,400	1,513	1,340	1,566

**R&D CARRIED OUT
WITHIN INDUSTRY**

Table 2

On purely financial grounds it is worth noting that if one corrects the figures in Table 1 for inflation (1975 prices) as in Table 2 — although the differences year to year are substantially smoothed out, nevertheless — there was a real 17 % increase overall in investment in industrial R&D between 1975 and 1978 and 11 % real increase in the value of the government's contribution.

I have now dealt with those parts of the government's spending on R&D from which NRDC as such normally does not derive any benefit. It has automatic rights to inventions from all the R&D work funded by government departments and research councils either in their own or other public laboratories or in academic centers, including the universities. Of particular importance are the rights from the research councils because their own in-house work is of very high quality and a significant part of the university research is funded through this route. The scale of this national investment can be seen in the next three tables. Table 3 shows gross level of departmental spending in-house or in research council laboratories and in universities. The figure is L374m, leaving out industry/research associations and other.

Table 4 shows how this investment breaks down between the main departments. The Ministry of Defense

Actual 1977-8

	£ Million
Industry	644
In-House	300
Research Councils	54
Higher Education Institutions	20
Research Associations	14
Other	55
Total	1087

Source: CMND 7499

	£ Million		
	1979-80 Actual	1980-81 Forecast	1981-82 Provisions
S.R.C.	176	201	217
M.R.C.	69	73	102
N.E.R.C.	37	47	53
A.R.C.	30	38	42
S.S.R.C.	17	20	21
Total	329		435

**TOTAL GOVERNMENT
COMMISSIONED R&D
EXPENDITURE**

Table 3

Actual 1977-8

Department	Spend £ Million	In Institutions Of Higher Education	M
Defense	802	0.4	2.9
Industry	112	0.7	0.8
Agriculture	45	0.7	0.3
DHSS	27	18.1	4.1
Environment	27	6.2	1.7
Energy	17	1.2	0.2
Transport	14	6.3	0.9
ODM	12	16.5	2.0

Source: CMND 7499

**R&D EXPENDITURE
COMMISSIONED BY
GOVERNMENT DEPARTMENTS**

Table 4

still has the largest in-house spending (£215m), even allowing for the 73 % of its budget devoted to contracts with industry. Next comes the Department of Industry at £31m (much of the rest is with industry), and then agriculture, etc.

The Research Council spent about £300m in 1979/80. The breakdown is shown in Table 5, of which about £50m was spent in the universities. The universities also receive substantial sums of money (£200m) for R&D through another public route — the University Grants Committee — and about £30m of their own money. NRDC has no rights to inventions, except by invitation, if the work is funded via the latter two sources.

Tracing the public funding of R&D in the U.K. is very involved and the above explanation may have confused rather than clarified the position. In summary, NRDC had rights of access in 1978/79 to the inventive output of a public investment of approximately £550 or more realistically about £350 if in-house defense expenditure is excluded on the grounds that much of it will be classified and not available to NRDC, at least in the short term. Also it has to be understood that the large majority of the £350 is not devoted to work which is likely to be inventive.

**RESEARCH COUNCIL
EXPENDITURE**

Table 5

✓ Licensing inventions from public sources

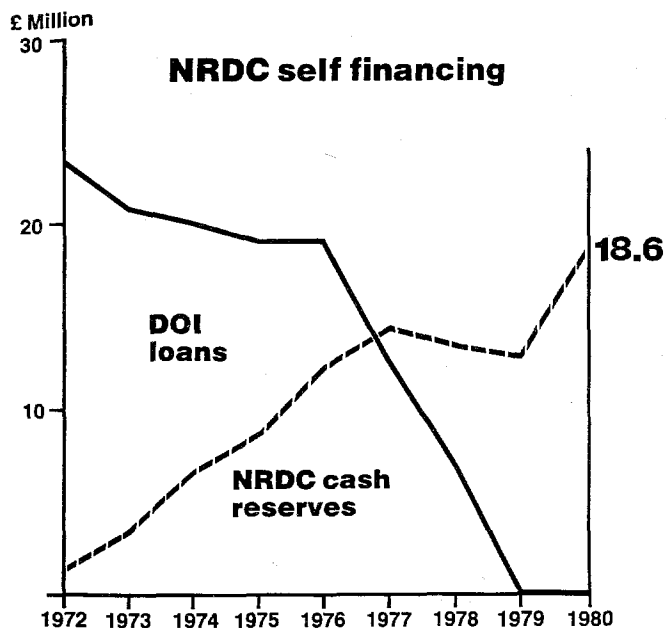
* Financing innovation by industrial companies

ACTIVITIES

Table 6

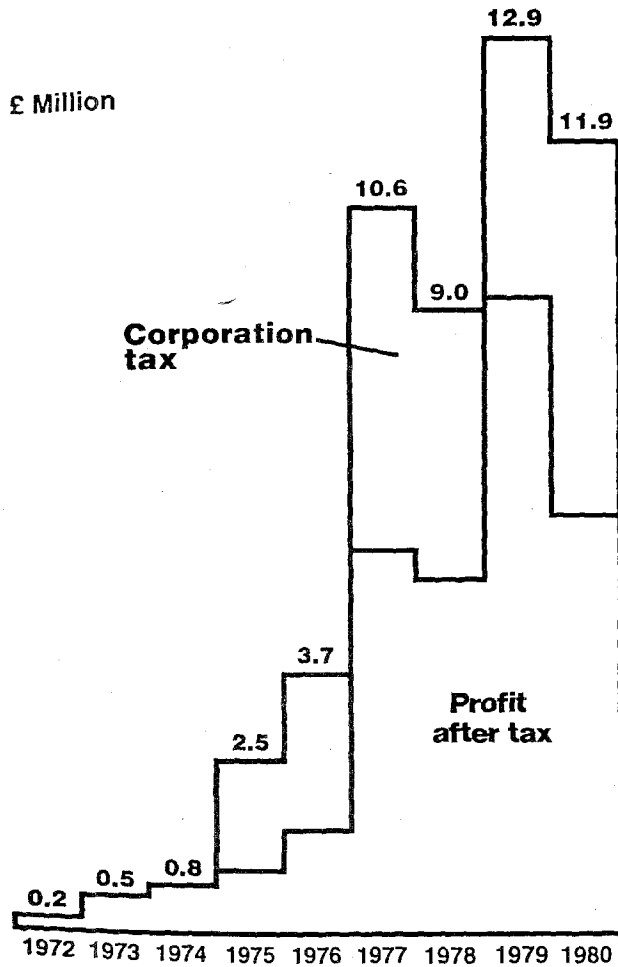
In looking at how NRDC is performing either on an annual or cumulative (over 32 years) basis, one is only looking at one of the two businesses the corporation carries out. The two are shown in Table 6. The financing of industries' own innovations is essentially an investment business, albeit a very speculative one and not very relevant to today's topic.

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FINANCE

Table 7



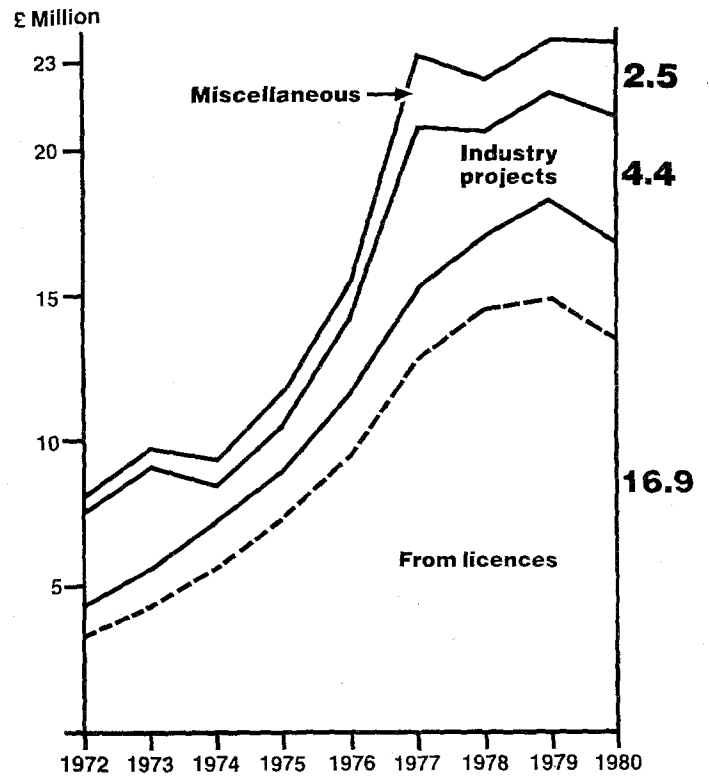
PROFIT BEFORE TAX
Table 8

Table 7 shows that NRDC has repaid all its borrowings to the Department of Industry and has substantial cash reserves from which it is funding all its operations. It has been profitable for 10 years and the size of the profit before and after tax is shown in Table 8. The figure for 1980 was L11.9m pre-tax. The source of the corporation's income is shown in Table 9 and it can be seen that the bulk of it comes from the licensing of public-sector inventions. Income from this source in 1980 was L17m. Another very crude measure of the U.K. benefit of this licensing activity is the annual U.K. industrial output resulting from it. Table 10 shows a figure of L80m in 1980.

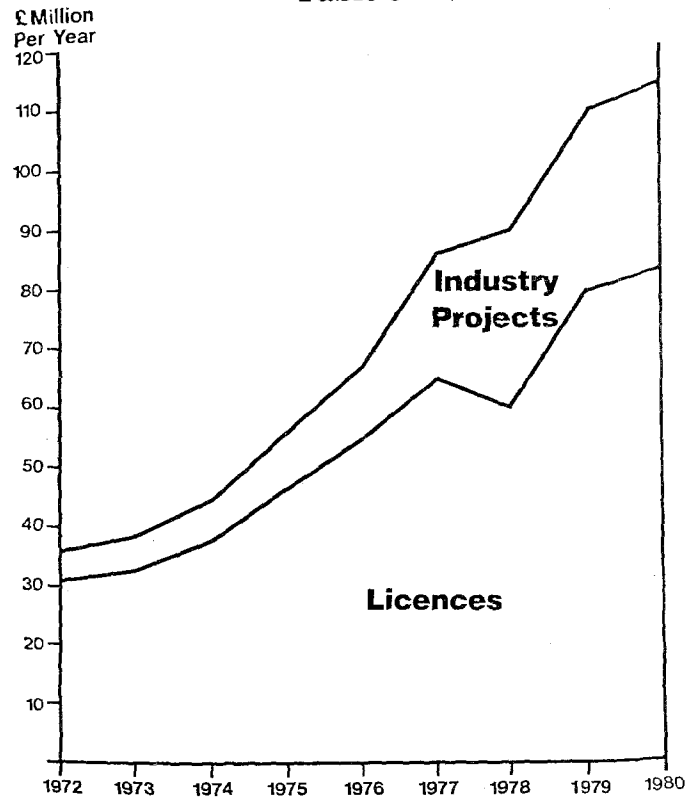
The corporation is currently financing R&D work on 300 individual projects in university, research council and government laboratories. Last year it started funding almost 70 new such projects and made an investment of L5m in R&D.

Almost 800 ideas are submitted annually to NRDC of which 50% come from universities, and the corporation typically accepts about 20-30% for further action. Nevertheless, the failure rate is very high as can be seen from Table 11 representing about a 10-year span. Many of the licenses are marginally profitable and only 349 inventions are involved in the revenue earning licenses.

Successes have come mainly in biological chemistry, Table 12. All except hovercraft on this list are from the



INCOME
Table 9



ESTIMATED U.K. OUTPUT RESULTING FROM NRDC PROJECTS & LICENSES
Table 10

public sector. Income has been dominated by the cephalosporin group of antibiotics on which Dr. Bard and I worked together for many years. But the pyrethroid

	Universities & Polytechnics	Government & Research Councils	Private Inventors
Inventions communicated to NRDC	4038	3133	7905
Patent rights assigned to NRDC	943	737	56
	1801		
New licence agreements	UK 631	Overseas 147	

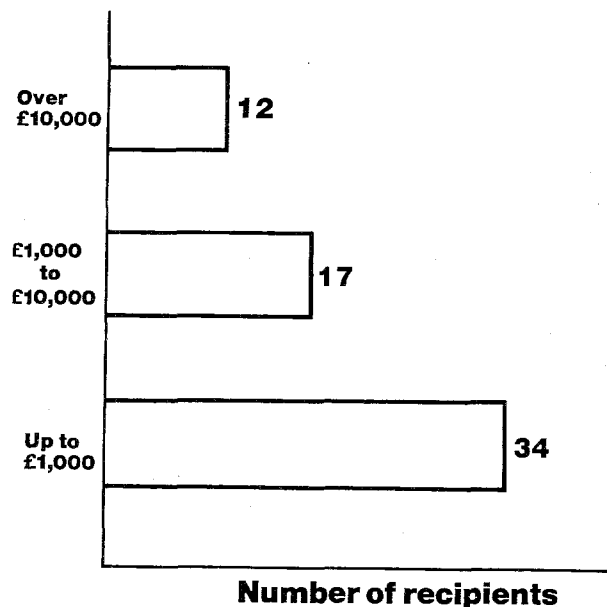
**LICENSING
1971-1980**

Table 11

- ✓ Alkali-resistant glass fiber
- * Cephalosporin
- * Cholesterol assay
- * Dental cement
- * Foot and mouth vaccine
- * Hovercraft
- * PAM electric motors
- * Pyrethroid insecticides
- * Thyroid stimulants

**MAJOR SOURCES
OF LICENSE INCOME**

Table 12



**PAYMENTS TO INVENTORS
& INSTITUTIONS IN 1980**

Table 13

insecticides represent another major invention. Items like cholesterol oxidase, a specific enzymic assay for blood cholesterol, is already generating quite large royalty income.

Government inventors are entitled to awards out of NRDC's profits and universities' and their inventors revenue share with the corporation. The current position is shown in Table 13. More than 60 inventors received awards, a few very large sums indeed.

I hope that the above has given you a picture in outline of world activity in respect of exploiting public research and NRDC's position in it.