NML Technical Journal
Vol. 18, August 1976, pp. 42-46

The Transfer of Technology from R & D Laboratory to Industry

P. A. WOODROW

The functions of National Research Development Corporation of UK relating to transfer of technology have been stated in the paper. In this connection the programme of work followed by the industry and government sponsored R & D Laboratories of UK, the problems encountered, the suggested solutions and the case studies of NRDC have been enumerated.

Introduction

IT would be a remarkable coincidence if it could be claimed that the National Research Development Corporation of the United Kingdom had any ties with the National Metallurgical Laboratory in India. There may be an indirect bond which goes back to the immediate post partition period when the late Lord Blackett who was connected with the birth of National Research Development Corporation of UK and was its founder Member and served in its Board from 1949 to 1964, had been advising the late Pandit Nehru on the organization of modern scientific research applied to India's needs at that time.

The National Research Development Corporation was established in 1948 by an act of Parliament to safeguard the interest of British inventions against foreign exploitations. Since then NRDC has become a major force in UK in the transfer of technology from laboratory to industry and is showing considerable surplus of income over expenditure during the last six years through licensing agreement, patents and development projects.

Research and Development Laboratories

In the UK there are two main types of research and development laboratory : those that are industry sponsored, and those that are Government sponsored. Industry sponsored laboratories are either in-house laboratories or indepent research companies, consultants or research associations devoted to sponsored research.

Research and development laboratories set up within a company exist for commercial reasons :

(a) to develop new product lines
(b) to improve the performance, quality or appearance of existing products
(c) to reduce manufacturing costs or to solve problems in the manufacturing process
(d) to give prestige to the company.

Such laboratories are directed by company policy and as a consequence there are links within the company which assist the smooth flow of technology from laboratory to production.

Independent research companies such as Battelle in the USA and Europe, and Fulmer in the UK, are paid by the customer to carry out a defined programme of work. The customer requires definite results and therefore organises the most appropriate way of disseminating such results within his company, ensuring good channels of communication with the laboratory.

Research Associations in the UK tend to be aligned to one particular technology, be it welding, machine tools, textiles, etc. They obtain their funds from annual subscriptions from member companies although there is frequently also a Government contribution. Research and development work in Research Associations is aligned to members requirements and the transfer of technology is usually initiated by the circulation of confidential technical reports. Member companies can then send employees to discuss the report with the scientists at the Research Association and can arrange for further technological know-how to pass over to the company. Research Associations will also carry out confidential sponsored work for a company much as an independent research company would.

In all these cases it is up to industry to define what it requires from the laboratory in the way of documentation, samples, development rigs, and any other hardware or know-how, and to appoint one of its employees as a main channel of communication with the laboratory. The choice of a suitable person to carry out this task can contribute much to the successful transfer of information to the company.

The industry sponsored R & D outlined above has one common theme — industry initiates the work and pays for it. Industry tends to value what it pays for because it has had to justify the expenditure in the first place. Thus there is an obvious financial stimulus for the company to organise the smooth transfer of technology from the source to the user in order to achieve the anticipated benefits.

Mr. P. A. Woodrow, B.Sc., A.I.M., Chief of Production Technology, National Research Development Corporation, U.K.

Editor's Note: — The paper was presented by the author at the Symposium on 'Problems on Transfer of Technology from R & D Laboratory to Industries' organized by National Metallurgical Laboratory and Indian Institute of Metals on the occasion of NML Silver Jubilee and 13th National Metallurgists' Day held on 14th November 1975 at NML. The 'Introduction' of the paper has been modified and an 'Abstract' added at the Editorial Office.

The Problem Areas

Once industry is not able to direct R & D for its own benefit, major difficulties may arise in the transfer of technology into industrial companies. This is sometimes the case with Government laboratories and University research departments.

Even before the problems of the transfer of technology arise, the "public" technology itself has to satisfy certain criteria to stand any chance at all of successful transition:

(1) It must be attractive to industry (i.e. there must be some chance of the technology leading ultimately to some financial benefit)

(2) It must be sufficiently developed for industry to be able to appreciate its value.

These criteria immediately rule out much of the work carried out in Government sponsored laboratories, whose objectives are determined on wider issues than simply commercial success. Many laboratories' main function is to investigate such problems as defence and military requirements. Other laboratories will be developing methods of using the country's energy and natural resources more efficiently or maintaining national standards. University departments on the other hand exist mainly to teach while simultaneously exploring the frontiers of science; their results are not all necessarily going to be of immediate interest to industry.

In the UK, a report on R & D by Lord Rothschild in 1971 advocated the adoption of the so-called "customer/contractor principle" for Government laboratories. This principle, has already encouraged them to become more closely involved with industry's requirements. The fundamental philosophy behind the Rothschild principle is that a Government laboratory should carry out development work for a *customer*. The customer may be another Government department or an industrial company. If it is carried out for a company, then laboratories are encouraged to obtain financial support for the development project from that company.

The setting up of Research and Development Requirements Boards in 1973/74 has also resulted in a more coherent approach to R & D within the many Research Associations and Government laboratories. There are seven such Boards covering the broad spectrum of technology and not only have they been effective in financially controlling the amount of R & D within Government research laboratories on certain projects, they have also been successful in identifying areas requiring further work and have made funds available to carry it out.

The Requirements Boards act as a 'proxy customer' for research establishments. They approve the work to be carried out in such establishments, or stimulate certain areas of R & D. The Boards are made up from distinguished industrialists and academics, and can provide funds in order to benefit a sector of UK industry and not just one company.

Because of recent trends, some Government laboratories could now be regarded as falling within the group containing Research Associations, consultants and independent research companies. However, it is acknowledged that there is a place for research and development for which there is no immediately identifiable commercial motive (and therefore no industrial sponsor) and a certain proportion of funds are still available for this.

In the UK Universities there has also been a trend towards carrying out research projects for industry which means that there has been much competition for industry's research funds over the last few years. However, University research work is still largely funded by the Science Research Council which has succeeded in bringing experienced industrialists on to the various committees which approve research expenditure. Thus the proportion of work having relevance to people outside the arena of strictly academic science is increasing and the proportion of R & D being duplicated in the Universities is decreasing significantly.

The major difficulty in transferring technology arises when a laboratory has carried out its own research and development which is thought by those employees of the laboratory to be of significance to industry. How should it exploit the technology?

The Solutions

There are two main solutions to the problem. Either one can set up a new department in the laboratory to carry out commercial exploitation or one can use an outside agency which specialises in exploiting technology on behalf of such laboratories. In either case the exploitation organisation will need commercial, legal, financial and sales personnel. Some activities such as patent business can be handled by employing outside patent agents but the internal staff must have, at least, a basic appreciation of these areas of knowledge.

One disadvantage of setting up a new exploitation department is that the quantity of technology innovations has to be above a certain level in order to justify the running costs of the department. This means that only large and industrially orientated laboratories are likely to take this route.

The alternative is for an R & D establishment to approach an organisation whose function is to exploit inventions arising from sources outside its own organisation. There are many private enterprise and Government sponsored organisations throughout the world of which NRDC (UK) and NRDC of India are but two examples.

NRDC and Technology Transfer

It is fortunate perhaps that NRDC of India was set up as a Government of India enterprise much the same way as NRDC had been set up earlier as a public corporation. This means that most of the information regarding the functions of NRDC is, in principle, relevant to either body. However, my experience is with the UK organisation and therefore when I mention NRDC it is the UK Corporation to which I refer.

There have been many examples of situations where British inventions had been taken up by foreign interests in the past. For example, in the nineteenth century Michael Faraday carried out some outstanding research on the chemistry and physical properties of optical glass. The UK industry failed to build upon his discoveries, but German technologists quickly realised the value of Faraday's work.

Sir Alexander Fleming discovered penicillin in 1928. Subsequent events are beyond the scope of this paper, but the net result has been that, because production was perfected and patented by an American company whilst Britain was at war with Germany, Britain has had to pay millions of pounds to purchase the drug and for the licences and know-how to produce the drug in the UK.

These two examples help to explain why, in 1948 the National Research Development Corporation was created in the UK by an Act of Parliament which also made available from the Treasury up to £ 5 million over a five year period for the support of inventions. Several Acts have followed since 1948, including the Industrial Expansion Act of 1968, and today the limit of NRDC's borrowing from the Treasury has been raised to £ 50 million. At its peak borrowing, the Corporation had availed itself of £ 25 million in 1970/71 and has subsequently reduced this to £ 19.95 million by repayment of capital.

The Functions of NRDC

The Corporation's two main functions are financing development, and licensing inventions. Figure 1 shows diagrammatically how the Corporation generates its income from both activities.

NRDC's income from licensing in the UK and overseas arises from companies paying for the right to use an invention based on patents belonging to NRDC. The invention may have come from a Government laboratory, a University, some other body supported from public funds, or a private inventor. If the invention is not at such a stage that it can be offered directly to industry, the Corporation may decide to finance further development in order to bring it to such a stage.

The other side of the Corporation's activities is financing risk development. Although some of this finance goes to Universities and similar organisations (usually to enable them to develop an invention to a stage suitable for exploitation), by far the largest proportion of NRDC's financial investments in development projects are made on a joint venture basis with industry. Figure 2 attempts to show the flow of money into a company carrying out such a development helped by NRDC finance.

Having briefly described the functions of the Corporation, what has an organisation like NRDC to offer a laboratory wishing to have its R & D exploited? We believe the Corporation to have the following attributes:

(1) It expects industry to pay for the technology it passes on, and will therefore share the proceeds by prior arrangement with the R & D source.
(2) It can fund developments to the stage at which industry can take them over and can also fund further developments in manufacturing companies if necessary.
(3) Its own patents department can organise or take direct responsibility for obtaining patent protection.
(4) It employs commercially orientated engineers and scientists with a special knowledge of particular technological areas, economists and accountants who help with the appraisal of licence and development situations and has a legal department to draw up agreements and to advise on overseas licensing policy.

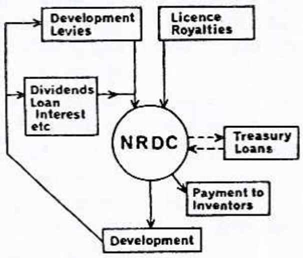

Fig. 1 — NRDC cash flow.

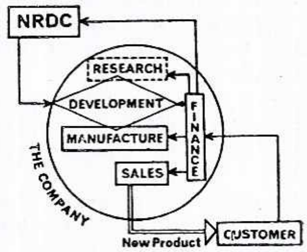

Fig. 2 — Flow of cash in joint venture.

(5) It has regular contact with many industrial companies, both through its publicly activities and direct contact by employees.
(6) It has a good track record and has been self financing for the past three years. It can thus demonstrate that it has the financial and commercial experience necessary to secure a reasonable commercial deal on behalf of its clients.

A Further Method of Technology Transfer

Mention has been made of the possibilities of R & D laboratories setting up their own exploitation departments, and the alternative of utilising the resources of an organisation which specialises in exploitation. There is a third method which perhaps carries the transfer of technology to its ultimate efficiency. That is, where the nucleus of the R & D team breaks away from its parent organisation to set up a new company to develop a business based on that R & D.

There are basic problems of ownership of the rights in any invention which this new company wishes to use, due to the probability that the invention was made, or experience and knowledge gained, whilst working for the former employer. However, even when these have been regularised, there still remain difficulties which the team has to overcome. These can be broken down into three main headings: courage, capability and cash.

Perhaps courage is the most important, as it takes a great deal of this ingredient to leave the security of one's employers in order to build up a new venture.

Capability is another 'must' which the team should be able to demonstrate to its financial backers. Entrepreneurial skills need to be inherent in at least one of the team members; commercial flair and technical ability are also vital ingredients. Somebody will usually need to negotiate finance to run the company, and when this has been arranged there will then be negotiations for premises, interviews for potential staff, legal matters to sort out and overall, the intangible qualities of leadership required to stimulate the efforts of the staff towards the new company's objective.

The last, but no means the least, prerequisite is cash. If the team approaches conventional sources of finance, each member will often need to be prepared to put up some of his own cash. Certainly some demonstration of faith in the new company is necessary, and cash is a good way of showing it. Alongside the cash advanced by the team there usually will be finance from another source. This may come from a wealthy individual, a company, a merchant bank or an organisation which specialises in financing such situations.

This method of technology transfer is perhaps the optimum, as the individuals responsible for the original R & D become directly responsible for the commercial exploitation. However, once the transfer has been completed, the running of the company becomes the new problem area. Because of the background of the R & D team, which has rarely been subjected to general management problems, it is often the case that the team which started the company is not ideally suited to running a commercial business. This will not be obvious to them, and will therefore require a determined but appreciative financial partner in order to sort out the problems without creating damaging effects on morale.

NRDC Case Studies

Case A : Spray Rolling of Metals

Conventional sheet metal production is basically the same in all countries of the world. After casting a large billet or continuously casting a slab, it is then progressively rolled thinner, with interstage anneals where necessary. The capital cost of the plant required to produce thin sheet is considerable, even where the volume of output is not large by current standards.

Professor A. R. E. Singer of University College, Swansea, considered that energy was being wasted in casting large billets where a thin section was required. Ideally the solution would have been to continuously cast thin sheet, but this is not possible by existing continuous casting routes. Professor Singer therefore conceived the idea of converting the molten metal direct to strip by spraying on to a cooled substrate, and stripping the product from the substrate prior to rolling. After some laboratory trials, NRDC was contacted. This resulted in the Corporation applying for patent protection and also providing funds for further development of the technique within the Metallurgical Department at Swansea.

Soon after this programme showed the feasibility of the process, NRDC interested a potential plant manufacturer, Davy Ashmore Ltd, in the technique, and provided further funds for the development of a prototype plant capable of depositing metal on a 20 in wide substrate.

As might be expected, the major problems of the development were concerned with obtaining an even deposit over the full width of the substrate and preventing oxidation of the metal, particularly in the case of aluminium and its alloys. However, several of these problems were well on the way to being solved when NRDC demonstrated the benefits of the process to a potential user. Now a major development programme, for which NRDC is contributing half the development costs, is being carried out by this company on the Davy Ashmore prototype equipment. If successful, the potential user will pay NRDC a levy on throughput to recover the Corporation's contribution to the joint venture development. In addition the company will pay a royalty on throughput in recognition of the non-exclusive licence granted under the NRDC patents. The latter income will be shared with the University College of Swansea after recovering the patent costs and certain other defined costs of the Corporation and the University.

Analysing this case, NRDC has been involved in the process of transferring the technology from the University from the stage of filing the first patent applications through to the provision of finance to a commercial company. NRDC usually finds it prudent to interest a company in such a development at an early stage and, in this case, Davy Ashmore was approached to build a small production plant soon after the Metallurgical Laboratory had proven the technique. This case also demonstrates the value of continued liaison with the inventor, Professor Singer, who was involved in the NRDC sponsored programme of work at Davy Ashmore at the same time as he was carrying out further relevant experiments in the University laboratory.

Case B : Deep Drawing with Radially Oscillating Dies

Many workers in Austria, USA, Russia have been working over the past 15 years on the effect of applying ultrasonic energy to various manufacturing processes. The main UK research in this field started in 1963 at the University of Aston in Birmingham where Dr. D. H. Sansome studied the effect of drawing wire through dies vibrating axially at frequencies of 50 Hz to 20 kHz.

Later in the sixties, Dr. Sansome and his colleagues started to consider applying some of their results to other industrial processes. NRDC was in regular contact with Aston at that time, as the Corporation could foresee some commercial benefits arising from the work. So in 1971, when further development work had been carried out, several patent applications were filed by NRDC in return for agreeing to share the income with the University once various expenses had been recovered.

During this period one of Dr. Sansome's colleagues, Mr. M. J. R. Young, carried out some investigations into the use of radially oscillating dies for deep drawing for his Ph.D. thesis. His successful results clearly demonstrated that it would be worthwhile to build a rig plus special tooling in order to test the theory in practice. NRDC wholly funded an agreed programme of work which led to the demonstration of deep drawing to industry a year later.

Throughout this period of activity, Dr. Sansome had been in contact with Ultrasonics Ltd., a company which had supplied the University with nearly all its ultrasonic generators and associated equipment. The company, having kept a continuing interest in the work at Aston, was ideally suited to exploit deep drawing. Fortunately Ultrasonics at that time was considering expanding its product range, and readily agreed to become a licencee of the Corporation under three of the patents that were likely to be granted on various inventions that had originated within Dr. Sansome's department. It was obvious to the company that the new metal forming activity must be managed by someone who knew the technology and who had experience in industry. It was also obvious that the development costs necessary to transform the technology from rig stage to a production unit were likely to be a burden on the company's resources. NRDC therefore agreed to fund half the costs of the new metal forming team at Ultrasonics Ltd. for two years, in return for a levy on sales of equipment sold from the work. So in 1971, when further development work had been carried out, several patent applications were filed by NRDC in return for agreeing to share the income with the University once various expenses had been recovered.

Results and Statistics

NRDC's success in the transfer of technology can be measured to some extent by the fact that it has shown a surplus of income over expenditure during the last 6 years, perhaps the only UK public Corporation to do this so consistently.

The selection process within NRDC is vividly demonstrated by the fact that whereas there was an input of 1,700 inventions during 1974/75 (400 above last year's figure) the number of patent rights actually assigned to the Corporation was 225 (6 less than the previous year). At the end of March 1975, the Corporation and its subsidiaries held 6,508 patents, and there were 521 licence agreements in force.

On the development side, joint ventures with industrial companies at the end of March 1975 numbered 327 of which 63 were accepted during the last year. During that period, the Corporation spent £ 3.17 million on such projects and authorised £ 4.30 million more.

These figures support the opinion that NRDC is a major force in the UK in the transfer of technology from laboratory to industry. Its employees note with some pleasure that, far from being a drain on Government funds, it can still show a surplus of £ 845,000 after providing for £ 1.7 million Corporation Tax.

Conclusions

Given the prerequisite that the technology within a Government sponsored R & D laboratory is of commercial interest in the first place, there is much to commend the use of an independent organisation in order to transfer it into industry.

I hope that, as a result of my visit to India, I may practise what I have preached and find a way of successfully exploiting in the UK the aluminium alloy PM2 which has been developed at N.M.L. The distances between our two countries and the problems that this brings should be a real test of technological transfer. Let us hope we are successful.