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IMPROVED PACKAGING FOR CEMENT AND MINI CEMENT 1/

by

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C O N T E N T S

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ROLE OF INDUSTRIAL R&D ORGANIZATIONS IN THE PROCESS OF TECHNOLOGY TRANSFER TO INDUSTRIAL STREAMS

by

Dr H C Visvesvaraya

PREAMBLE

Technology transfer to industrial streams has been recognised as an organized activity only in recent times. Thusfar the essential domain of activity of most research institutes has been technology generation; the research papers produced or other forms of documentation during or at the end of a scientific pursuit have been by and large the only tools provided by those institutions for transfer of technology. As science and technology are coming to play a more and more important role in industrial progress, attention is required to be paid to all activities covering identification of technological issues, generation of technological solutions and their proper transfer to the industry after necessary transformational, translational, conductive, coordinative, promotional and/or disseminational work.

The role that industrial R&D establishments have to play in this process of technology transfer to industrial streams would vary depending upon the nature and the technological status of the industry and the general environment obtaining in the country.

1 THE FUNCTION OF INDUSTRIAL R&D

The function of all industrial R&D is to do or cause all that is necessary to provide increasingly better technological support to the industries concerned. Industrial R&D work has therefore to be visualised as a close-ended effort fulfilling this purpose. Such of the links in this close-ended orbit as are already available from elsewhere are taken in to form the orbital loop and such of the links which are not already available are produced by those who are charged with the task of industrial R&D. At one extreme end there have been cases where the missing links in the loop are those which call for basic or fundamental research of a very high order; and at the other extreme end are cases where most of the links of the loop have been readily available, and all that an industrial R&D unit need to do is to put them all together to get a complete loop. Thus, industrial R&D is not only complicated in its nature depending on the basic concept of the complete orbit but also covers several varieties of situations which have to be met with.

2 THE CONCEPT OF TECHNOLOGY TRANSFER

Every link in the orbit referred above is essential and each link represents some transfer of technology. The transfer may be conceived as from one link to another or as direct links forming complimentary components of the total orbit.

The most important factor which would contribute to the success of technology transfer is the creation of proper interfaces in the system. In any given circumstance, every centre of technology has four clear interfaces - two in the vertical direction and two in the horizontal direction as illustrated in Fig 1 (Page 23)

In reality the vertical transfer illustrated results in the pure science at the top face leading through successive interfaces to more applied forms of technology combined with economics, social aspects etc till finally the last output of technology results in concrete hardware or a definite usable service to the society or industry.

Whilst this concept of interfacing is a basic one and the philosophy of interfacing is an essential pre-requisite in any effective system for transfer of technology, it is not always necessary that the centre of technology be a separate institution or organization. It is possible to bring about such a transfer even within the framework of a single institution. These institutions need not necessarily be those devoted only to technology transfer; they could just as well be industrial R&D organizations, universities, information centres, technological institutions or industrial establishments.

Amongst the various means of technology transfer the following are of particular relevance and importance from the point of view of the role of industrial R&D establishments in the process of technology transfer to industrial stream :

i/ Industrial Information
ii/ Norms and Standards
iii/ Systems Design and Project Engineering
iv/ Productivity Enhancement Programmes and
v/ Training for talent generation and updating

They could be practised collectively or on the basis of individual projects; in the system of projectwise technology transfer the detailed drill is tailor-made to suit the individual case. This system is becoming more and more important.

3 ORGANIZATIONAL INTRODUCTION TO CRI

3.1 General

Before proceeding to specific case studies to illustrate how technology transfer activities in an industrial R&D establishment could work, a brief introduction to the particular industrial R&D establishment - which in this case is the Cement Research Institute of India (CRI) - is necessary.

CRI is the national centre in India for providing intensive and coordinated technological support to the cement and allied industries; allied industries include lime, asbestos, industrial wastes, precast concrete, and construction industry. The R&D activities of the Institute cover the entire spectrum with cement as the pivotal theme, starting from the chemical elements available in nature and their exploitation towards making cement - through the manufacturing processes, engineering design and development of cement plant and machinery - to cement technology and concrete technology - ending in concrete structures where cement finds its final place of rest.

3.2 Organizational Structure

The objectives of the Institute having been clearly set out in the context of the nation's industrial, economic and social needs, all the resources available with, to and for the Institute, are intended to be converted into concrete results for the purpose of fulfilment of the objectives.

The organizational system in CRI is conceived on the basis of the self-evolved "Matrix System of R&D Management by Objectives", the crux of which is to bring out a conceptual distinction amongst the various activities of the Institute whilst retaining the infrastructural wholeness of the equipment, environment, technical and general services, management controls and talent and achieving the objective through a balanced integration of these inputs through the operational structure.

An important feature in this System is the identification of Projects through the processes of technological forecasting, references from industries and the Government, special studies, communications, colloquia and seminars - all contributing to specific rolling plan of objectives from which would flow mission oriented project programmes.

3.3 Projectised Management

In the operational structure all activities of the Institute have been projectised as :

TG : Technology Generation Projects
TT : Technology Transfer Projects
TU : Technical Facility Upgrading Projects
ID : Infrastructural Development Projects

The project execution itself is carried out by non-hierarchical multi-disciplinary project teams charged with specific tasks with time and cost targets and defined end-products and their quality.

4 CASE STUDIES

In the above background two specific case studies are taken. Both these cases are traced from their origin to the present status.

4.1 Case Study I - Improved Packaging for Cement

4.1.1 Identifying and Commissioning of the R&D Project

Eventhough supply of cement in bulk is being more and more extensively resorted to - especially in advanced countries, bagged supply of cement continues to be the most widely used mode of handling. In the situations obtaining in India, especially in view of the vastness of the country and its widely scattered demand areas, bagged supply of cement will remain an important form of supply. Even on a conservative basis, India presently needs over 350 million bags per year (new and used both inclusive) and this figure may go up to as much as 600 million bags per year by 1980. In addition bags are also required for export.

Quite often attention has been drawn to the loss of cement due to seepage from the plain jute bags generally used in India. This seepage not only causes a loss of cement but also causes nuisance of dust. It was estimated that by avoiding this loss there may be a gain of as much as Rs 100 million every year to the nation as a whole. These problems were worrying equally the manufacturers of cement, the consumers of cement and the Government. CRI was therefore asked jointly by the interests representing the manufacturers, the consumers and the Government to study these problems indepth and arrive at a solution which would be appropriate to the country during the next few years. The R&D project was thus taken up in CRI in early 1971.

4.1.2 Identifying Basic Requirements for Packaging Cement

In the joint exercise of all those interested, the basic requirements for packaging of cement were first formulated as follows :

i/ The bag should be sufficiently proofed against ingress of water or dampness on the one hand and leakage or seepage of cement on the other.

ii/ The bag should be strong enough to withstand the stresses and strains of handling under the prevalent conditions in the country. Either provision should exist for hooking or it should be possible to eliminate hooking in industrial practice with no adverse effects on productivity.

iii/ The bag should not present difficulties in filling, either qualitatively or quantitatively especially with the existing expensive packing machines.

iv/ The material of the bag should be such as to withstand the high temperature of cement - which could be of the order of 90°C - 110°C at the time of packing.

v/ The total cost of the bag should prove sufficiently economical taking into account re-usages, if any.

vi/ The material used and the processes adopted for the manufacture of the bags should be such as to ensure continuity in the supply of bags, and

vii/ The material used should have good frictional characteristics to avoid slippage on the conveyors.

4.1.3 Plan of Action and Involvement of Users of Research Results

Keeping in view the needs as above, the inputs which were likely to be made available, and the resources then available, a total plan of action providing an end-product, cost and time bound project was thus launched in 1971.

After surveying the views expressed earlier and the endeavours made to develop an improved bag, CRI sought the views of the Indian cement industry through a questionnaire issued to each of the cement manufacturers in the country and also of the Cement Manufacturers Association, the Cement Panel of the Government of India, the Indian Standards Institution and the consumers of cement. It became clear from a study of these views that the present jute bag has certain shortcomings and therefore has to be modified and improved, or even altogether a new one designed. The data obtained also indicated the specific needs which had to be satisfied by the bag.

4.1.4 Project Progress

After reviewing the work done earlier, the investigations started with a study of the relative properties, availability and techno-economics of the three packaging materials widely in use in different parts of the world, that is, jute, paper and plastics. An analysis of the available information and data indicated that as a first step towards evolving a suitable bag for cement packaging, bags from each of these as well as composite constructions should be [illegible] further. As a result it was overwhelmingly [illegible] that any large scale usage would require it to be jute based. Indepth technical studies were then started. As a result of these studies certain systems and designs including special airvalves were evolved and some of them patented.

After the laboratory tests were completed successfully, CRI scientists were sent to three cement works to test the bags under the conditions obtaining in the plants. After these tests were satisfactorily completed CRI made out a plan of testing the bags by the cement works themselves. A bundle of 41 bags were sent to each cement manufacturer in the country, covering some 58 cement plants, with detailed guidelines and instructions for testing. On the basis of the results thus received, and a study of the bags tested and returned to CRI, the technical feasibility of the improved bags and their meeting the required performance criteria were proved.

The above research work and industrial trials led to the development of such a somposite material for packing cement which could be designed and modified to cater to specific needs.

4.1.5 Techno-economic Studies

Whilst a few of the bags were manufactured in the laboratory itself by hand most of the bags were manufactured in the premises of a laminator-cum-bag manufacturer whose cooperation was enlisted in the early stages of the project itself. Once the feasibility having been proved beyond doubt data and parameters were collected to enable a techno-economic assessment of the improved performance vis-a-vis the additional cost involved in the packaging. This was studied in the context of overall savings that would accrue with reference to conventional heavy cee jute bags as well as with reference to kraft paper bags used in many other countries. A typical summary is given in Fig 2 (Page 24) as an example.

4.1.6 Industrial_Trial_Studies

Having thus established the techno-economic aspects of the project, the first pre-commercialisation stage discussions were held with the industry, the industry was convinced that the proposition was worth industrial trials and as a part of this about 35,000 bags were supplied to five cement companies for regular commercial use. In this industrial usage, data was collected from both the cement plants where the bags were used as well as from the consumers who received the bags. A comprehensive questionnaire was used for this purpose.

4.1.7 Transfer_to Industrial_Practice

Industrial trials having been successful from the point of view of both the manufacturer and the user, commercial use of these bags has commenced. CRI bags are now finding way in increasing numbers into the export market as well as the internal market.

As to the know-how fee, CRI had clearly two alternatives before it -

i/ to look at this issue as a national problem. Since the benefit of the use of such a bag will accrue to all concerned, treat it as a national contribution and provide the technology free of cost, or ii/ to fix a charge either on the basis of an outright sale of know-how and/or on a per unit basis.

Since CRI, the Government, the manufacturers and the consumers have all been equally keen that the improved packaging should replace the existing packaging, for the present the first method indicated above has been adopted but the matter will be reviewed in due course.

4.1.8 Post-transfer Advisory Services

In the transfer of technology there have been occasions where both the manufacturers and the users have needed advice or technical assistance. This has been provided by CRI.

The technology transfer and advisory services are in fact being funded as a project cost by a special committee of the Government of India and CRI is able to provide these advisory services as part of this programme.

4.2 Case Study II - Mini Cement Plant

4.2.1 Identifying and Commissioning of the R&D Project

In general, in industrial practice, the sizes in which industrial processes and operations are being carried out are being continually increased in most industries with a view to reaping the benefits of scaling up. The scaling up approach has, however, led to certain drawbacks which vary from industry to industry and country to country. In the case of the cement industry in India the problems faced with large plants are :

i/ the capital cost of a viable size of cement plant is very high (of the order of Rs 250 million for 1200 tpd plant and Rs 5000 million for 2500 tpd plant) and is quite beyond the means of an average entrepreneur;

ii/ large plants require relatively longer time (of the order of 3 to 5 years) for machinery fabrication and plant establishment;

iii/ difficulties in transportation and other infrastructural facilities for transporting large size machinery is a situation obtaining in many developing countries;

iv/ limited infrastructural services such as power and water in certain areas; interruptions in the required inputs cause interruptions in the operation of the plant with consequent large losses;

v/ limitations in the availability of raw materials in sufficient quantity.

In fact, many small deposits of limestone spread all over the country have remained unutilised because they are not large enough to establish a viable large size or even medium size plant.

If appropriate technologies are developed to make them techno-economically feasible, small size plants would not only overcome the above limitations and drawbacks of large plants but would in addition offer the following advantages :

a) Bring the cement industry within the financial access of smaller entrepreneurs

b) Invest a sense of ownership in men with relatively smaller means

c) Lower capital investment (about 15% to 20% Lower) per unit capacity

d) Help realise quicker returns on capital invested because of low gestation period (about 18 months).

e) Enable development of cement industry in terrains where movement of machinery and cement are difficult

f) Make it possible to exploit small deposits of limestone scattered all over the country

g) Avoid wasteful movements of materials and thus help bring down the average unit cost of transportation of cement in the country

h) Eliminate packing charges where the utilization point is localised

j) Reduce strain on nation's transportation infrastructure

k) Create employment opportunities in rural areas on a well dispersed basis

m) Contribute to uplifting local economics and development.

4.2.2 Plan of Action

With the above objects in view an R&D project with an end-product, time and cost bound basis was commissioned in 1972.

4.2.3 Project Progress

As the theoretical and bench studies were under progress in the laboratories, a sick mini plant attempted as a pioneering one by the Government of Tamil Nadu State in India in 1956 was gifted to CRI in June 1974 for R&D studies. CRI set up a regional unit which to start with was required to study the particular problems and later function as a regional centre. As a result of these studies, the entire vertical shaft kiln of the mini plant along with its accessories was redesigned and restructured by incorporating the know-how developed in the laboratory studies. This stage of the study could be considered either as a pilot plant study or more appropriately as a prototype study itself. After making a large number of trials the innovations were confirmed by October 1975 as technically feasible and practical. The question of the quality of the clinker produced, and hence of the cement, became the primary issue at this stage and the experimentations done on the plant from October 1975 to June 1976 established that the process was capable of producing consistently good quality clinker well above the requirements of the national standards and in most cases better than the clinker or cement produced with similar raw materials in conventional rotary kilns.

4.2.4 Techno-economic Studies

Thus the technical feasibility of the innovation having been established and the quality of the product produced having been assured, stage was set for commercialization of the results. This was done by launching continuous operation of this plant from July 1976.

Simultaneously investment and profitability studies have also been done as a general guidance to prospective entrepreneurs. In a favourable situation a net return of over 16 per cent is anticipated on the capital.

4.2.5 Industrial Trial Studies

Since July 1976 the plant has been running almost continuously and the cement produced is being sold to the consumers. In this process the various industrial parameters relating to long term running are also getting fixed up.

4.2.6 Transfer to Industrial Practice

Even as the project was in progress, in view of the importance and usefulness of this development, the Government of India commissioned CRI to conduct a study of techno-economic feasibility of putting up such plants in North-Eastern region which has been completed. As a result a number of proposals are under consideration. One in the State of Assam, at Garampani, has advanced to an extent that a project report is expected to be finalised by CRI soon.

As the project progressed, literally hundreds of enquiries poured into CRI and wide interest was shown in this technology. CRI had a choice of commercialising the technology -

i/ by transferring it through the National Research Development Corporation of India (NRDC) ii/ by engaging private agencies such as consulting engineering organizations and giving them the know-how

iii/ by providing the design know-how and arranging the supply and erection of plant and machinery through plant fabricators and erectors

iv/ through its own infrastructure.

CRI has chosen the last of these and has agreed to undertake projects on turn-key basis to be executed in phases -

a) feasibility studies

b) detailed project report

c) project engineering with detailed specifications

d) construction and erection

e) commissioning and

f) training of personnel

Infact, CRI assumed such a total responsibility not because it wanted to do so for commercial reasons but because the technology developed was so involved that it touched -

1/ the raw materials and the raw materials processing;

2/ the systems design of the plant and machinery;

3/ the design of some of the plant and machinery; and

4/ the process and operational parameters for which the training of personnel was absolutely essential.

There was a fear that passing on the know-how either in the form of a documentation, a design drawing specification or a detailed guideline would not be enough until a sound nucleus unit of entrepreneurs and skilled men have been created. There was yet another factor: since some of the features of the design were new, quotations received from the machinery manufacturers or fabricators could be unreasonably high because of their non-familiarity with the new design. Therefore it was decided that CRI should take the responsibility for the supply of plant and machinery by getting them fabricated, buying them out or fabricating them in CRI's own workshops.

The mini cement plant technology and the operational details are such that the operators at the various levels have to be properly trained. Those who have experience of operating and working in large cement plants would also need to be retrained. The responsibility for training these operators also falls on the shoulders of CRI as a part of its technology transfer activity and in particular as a part of the process of commercialisation of the results of its study.

For each mini plant whether it is in the public or in the private sector, in to-day's practice an overall fee of Rs 10,000/- is charged for preparing a feasibility report, a fee of Rs 75,000/-

for preparing the detailed project report, a fee of Rs 115,000/- for detailed engineering and Rs 25,000/- for training of technical personnel. The total technology transfer service includes all aspects necessary for the successful establishment of the plant and its satisfactory operation; the know-how is a part of this technology transfer deal and no separate charges are made either by way of royalty on use of patented items or otherwise. In other words, a total consultation is provided and the technology generated as the know-how is provided as part and parcel of the detailed engineering of the project.

5 CONCLUSIONS AND RECOMMENDATIONS

i/ Identification of specific needs in a given situation and selection of R&D projects with clear cut objectives make transfer of the generated know-how easier.

ii/ In the processes of selection of an R&D project the user of the results should be fully involved. It is not enough for him to cooperate; he should be involved in every sense of it. In major projects Government should also be fully involved.

iii/ Exercises in the selection of projects and assignment of priorities to them are usually inadequate. Infact R&D programming exercises should be given due importance and there should be no hesitation in expending the necessary resources on this part of the drill before embarking upon actual R&D work.

iv/ R&D projects should be defined on and product-time-cost basis and pursued as multi-disciplined endeavour unless it is clearly established that all the inputs necessary for the final product will come from only one or two disciplines which is rarely the case in modern science and technology.

v/ Monitoring of progress of projects should be on the basis of modern systems of operational controls, though flexibility may be provided for deviations because technology generation is essentially an intellectual pursuit.

vi/ Pilot plant studies are not always essential in the transfer of bench scale technology to industrial practice. Avoiding pilot plant studies wherever possible and reasonable would result in considerable saving in time and cost. Instead, industrial trial runs may be made at relatively lower costs to establish industrial parameters for a given technology.

vii/ Necessary engineering and industrial economics inputs, if not already available with the R&D organization pursuing a project, should be secured through consultants and other experts by associating them closely even during the generation of technology. If the R&D establishment itself has the capabilities for providing the inputs there is no need to go in for outside consultants.

viii/ The R&D organization responsible for the generation of technology should also be responsible for the transfer of technology to industrial practice in the first one, two or three cases. Once the technology has thus gone on stream, the R&D organization should leave the further implementation to consultants or industry itself and revert to the position of functioning as expert consultant to consultants providing advisory services.

ix/ Training of personnel at all required levels would be a part of the responsibility of the industrial R&D organization dealing with technology transfer to commercialization.

x/ Commercialization aspects in technology transfer should also be considered as active inputs in the pursuit of R&D but the terms of commercialization to exploit the know-how should be related to socio-economic values of the results and the terms may be from one extreme of free exploitation to the other extreme of heavy charges.

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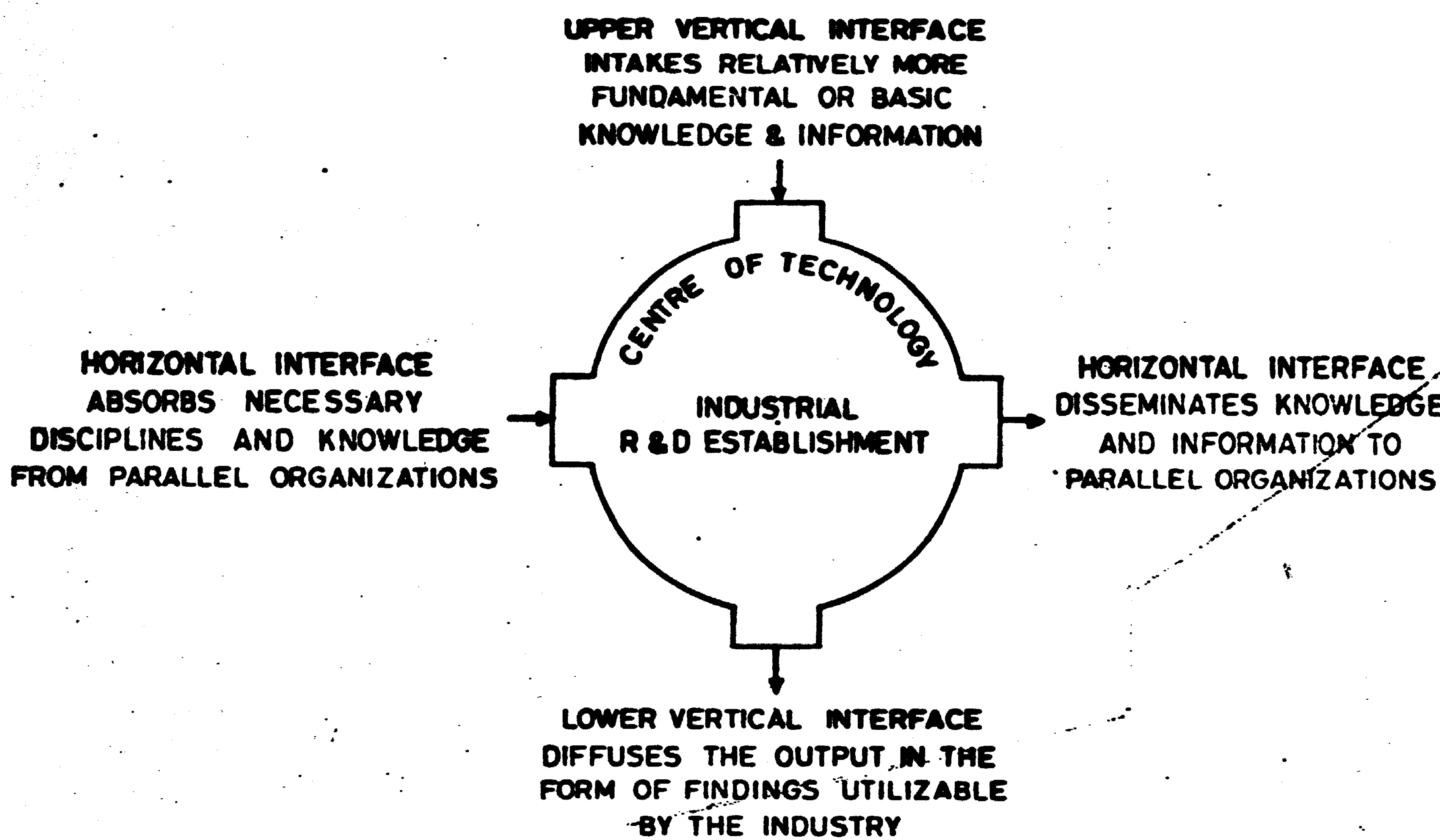

THE TECHNOLOGY TRANSFER INTERFACE SYSTEM

FIGURE 1

(Ref Section 2)

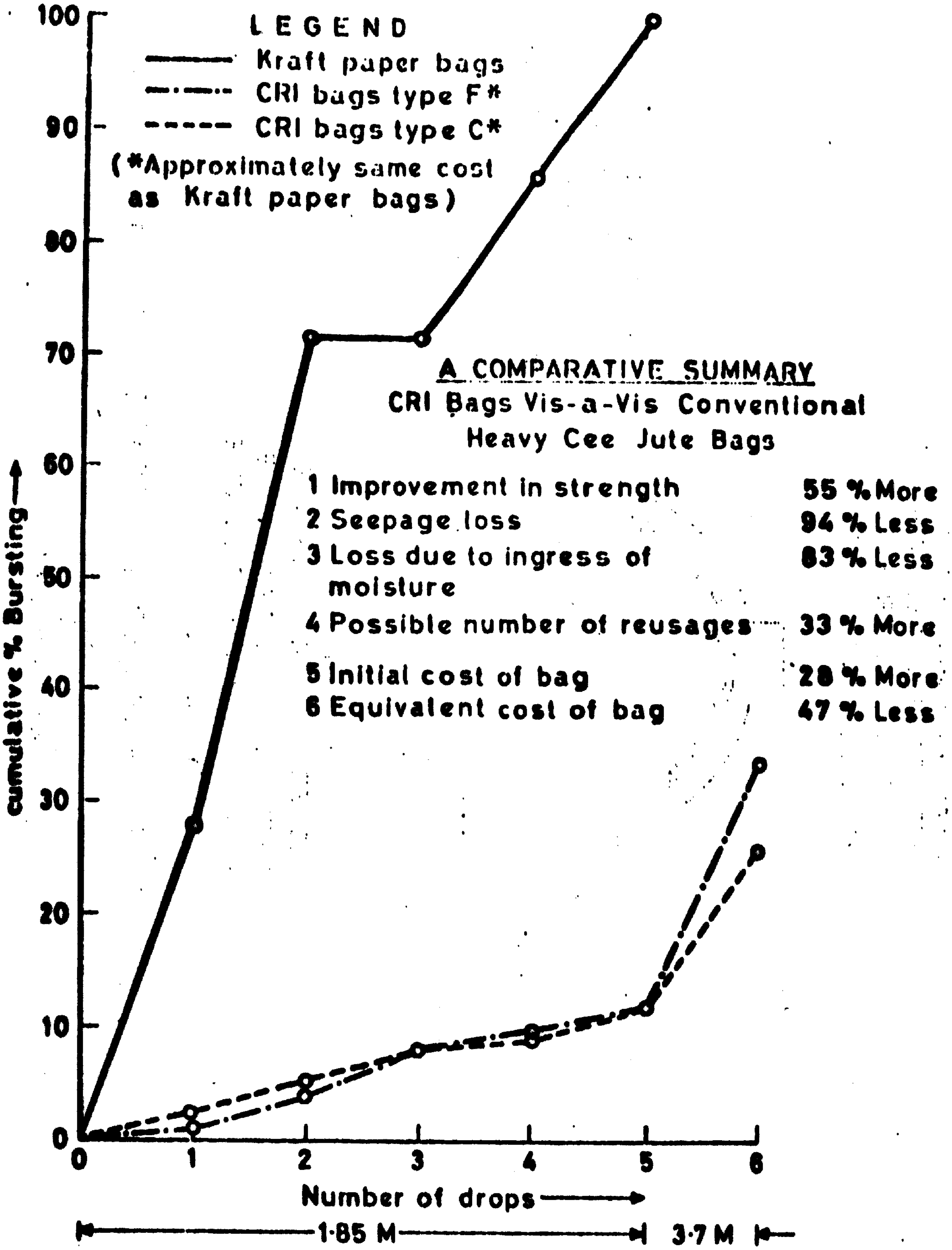

FIGURE 2 COMPARATIVE PERFORMANCE OF CRI BAGS VIS-A-VIS KRAFT PAPER BAGS
(Ref Section 4·1·5)

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