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THE ROLE OF THE RESEARCH ORGANIZATION IN THE ACQUISITION AND ADAPTATION OF FOREIGN TECHNOLOGY 1/

by

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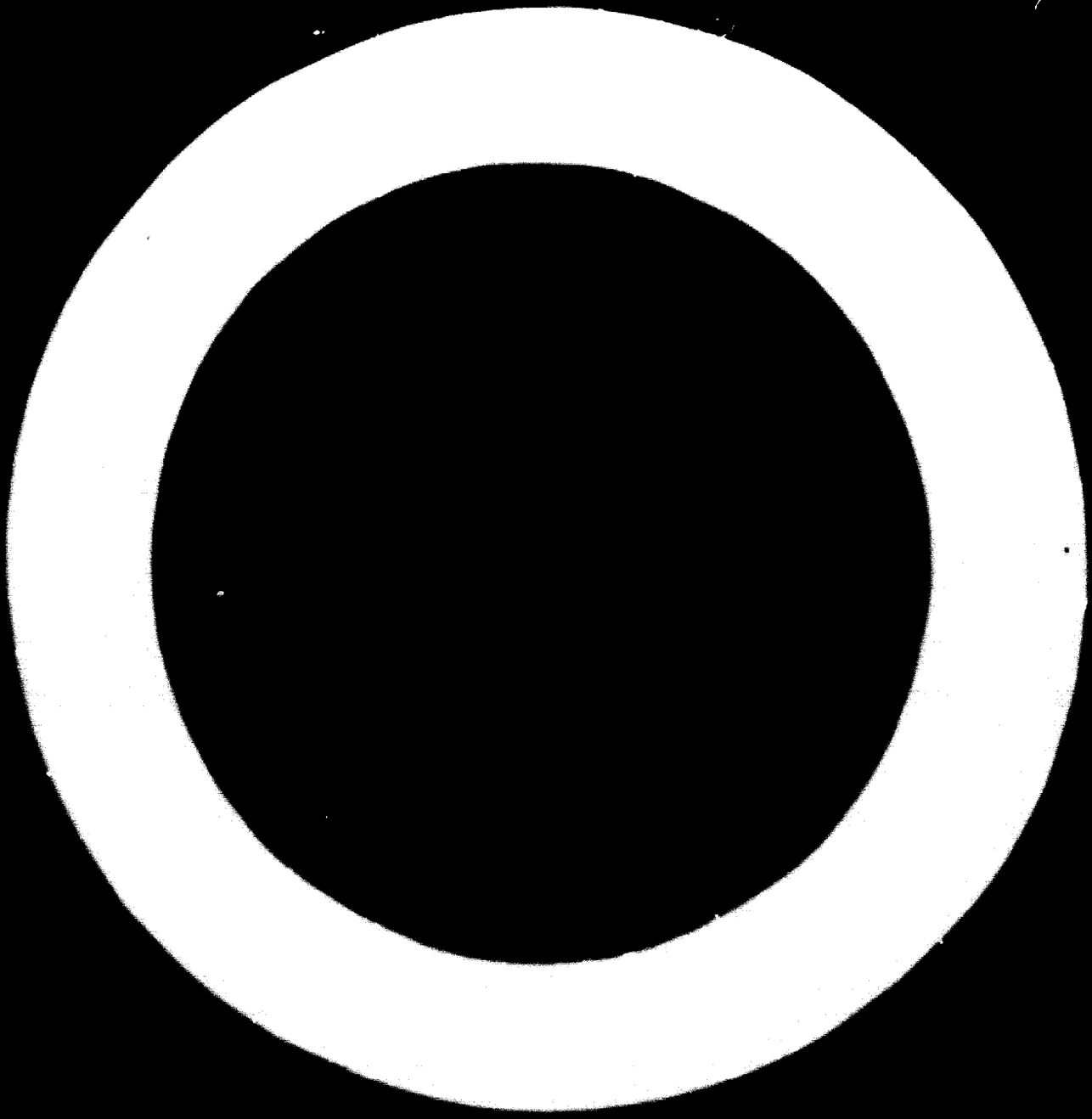

Introduction

1. A great deal of thought and attention has recently been devoted to the subject of transfer of technology from developed to developing countries, and one would refer in particular to the meetings and discussions of UNIDO and UNCTAD and the study by Charles Cooper of the Science Policy Foundation of Sussex University (UK) in this context*).

Attempts have been made to differentiate between technology the subject of patents, and that commonly known as "know-how".**) In fact in most realistic situations both forms of industrial property are involved and in consumer goods registered trade marks and trade names may also be relevant. A more important differentiation is whether the arrangement is essentially a commercial transaction, or whether the question of aid is seriously involved. In the former case, for the purpose of this paper, it is assumed that normal factors and incentives operate in licensing and related busines policies. That is that one party (the licensor) is willing to transfer his technology to the recipient (the licensee) at an agreed price and in relation to an agreed market or markets, i.e. the classical economic situation exists in which each party expects to benefit from the transaction, and each is in principle content with the relevant consideration. In the

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*) And see book - "The Role of Science and Technology in Developing Countries", by Graham Jones, published by the Oxford University Press.

**) Definition of "Know-how":
(a) Techniques, drawings, process data, confidential technical information.
(b) Specific designs and specifications of components, materials and/or equipment including registered designs.
(c) Confidential market reports and surveys.

preliminary negotiations leading to the business or licensing agreement, each party has the opportunity of satisfying himself as to the ability of the other to carry out his side of the bargain and meet his requirements, and the normal relationship between licensor and licensee involving a measure of mutual confidence, emerges from the negotiations. In the latter case i.e. aid, other factors are of course involved.

In a typical developing country, often through aid provided in various ways, a maturing of technological and innovative capability evolves in order that, on the one hand, there may be a reduction in its dependence on external technology and know-how, and on the other such technology can be adequately adapted to local needs as opportunity permits. This process obviously has to be correlated with the development of local industry, and an early objective within a developing country should be the evolution of the ability to form some judgement as to what types of technology and know-how should be imported, and under what conditions, including what degree of adaptation would be required to meet local industrial and/or agricultural environmental criteria.

2. Decisions in developing territories, whether made by Government, public authorities or private groups, that they will acquire new technology from the developed world, are not made lightly. Most such decisions relate to capital goods or equipment, or consumer goods, or techniques for their manufacture or else they are concerned with agricultural machinery or process. Once made they set in train a complex mechanism of arrangements and involvements, each link of which has to be sound in order that the project should succeed. In this analysis of the role of the research organization in this context

it is presumed generally that any necessary Government approvals have been secured, that finance is available, and that where questions of industrial property (e.g. patents, know-how, technical reports etc.) are relevant these have been dealt with as indicated above on a professional and mutually satisfactory basis.

Other papers presented to this Conference dealt with many of these aspects and I would propose therefore to concentrate on the specific roles and responsibilities of the technological arm as such without straying into these related matters, tempting though this may be. It should be noted therefore that for the purpose of this discussion the question of whether or not the transaction is wholly trade or wholly aid, or contains ingredients of both, becomes largely irrelevant. Unless a sound programme is laid down using to the full the co-operation of the R + D organisational facilities which are available, the project will be gravely handicapped. Where commercial considerations exist these should in themselves provide both a spur and a check and so balance the dedication of official involvement and responsibility where the item is mainly "aid".

Even if the project to be transferred is not itself particularly "advanced", nor possesses any high technological content, the question of the role of the research organisation or facility cannot be ignored. There are always a number of small differences in the local environment which are of significance when even a standard piece of equipment or an industrial process or mechanistic system, is transferred into a new region. These include not only such matters as differences in standards, levels of accuracy, equivalent materials, and inspection,

but also manner of use in the market, differences in preferences and tastes among customers and users, not to mention availability of specially qualified staff. All, or any, of these aspects may require technically competent people based on an established organization to evaluate and resolve.

How much more is this the case when the item is essentially of a technological character which has been evolved and utilized in some part of the mature world under the locally prevailing environmental conditions, from which the technical expertise has been built up. Nevertheless in principle the normal trend of events leading to a new prototype or piece of equipment or technique or process being introduced into a developing country is not essentially dissimilar to that experienced elsewhere, that is to say basically problems have to be identified and resolved, general and local limitations recognized, and where possible deficiences overcome. There are in addition as is well known, the special supplementary problems, for example technology transfer to developing countries may involve "desophistication" and cost saving, recognizing that local conditions in developing countries normally involve cheaper labour, less capital equipment, particularly of an automated or sophisticated character, and selling prices must be kept to the lowest practicable levels for markets which are normally less prosperous.

The most common, and most serious, problem normally encountered is the lack of personnel with special qualifications and experience in the realm of technology. This is often associated with the absence of local laboratory and engineering facilities. Technology in the

mature countries is mostly evolved for temperate zone conditions, and implementation in a developing country, under the very different climatic conditions which are normally encountered, necessarily presents many teething problems. In the solution of these research laboratories or organizations are required; they are indeed an essential pre-requisite for the success of the enterprise.

Accordingly, in order to acquire and adapt foreign technology for developing countries, various facilities must be available to the project, so that these requirements can be met:

(a) An organizational structure for administration and planning of such operations.

(b) A source of expert knowledge on local conditions.

(c) Qualified local staff to comprehend and then implement the foreign technology.

(d) Local laboratory and engineering facilities to carry out studies, tests, analyses and on the spot modifications of equipment during field trials to meet any special conditions peculiar to the area.

Furthermore, for the successful large scale implementation of technology once such field evaluations have proved feasibility and utility the following are required:

(a) Trained local personnel capable of undertaking trouble-shooting, and providing and analyzing data for quality control etc.

(b) Trained local staff to feed back significant information to the foreign technology sources, and continue to liaise.

(c) Trained local personnel to provide the continuing momentum and initiative for implementation, and occasionally perhaps to help to educate local businessmen in the value of utilizing the new innovations.

These facilities or people are often found in local Government offices.

The objective of the whole exercise is obviously the successful introduction of the new scheme in the markets contemplated. These may be a specific developing territory itself and/or other developing territories, as well as more developed countries - particularly where the new project is based on some raw material indigenous to the producing territory.

There are accordingly two sides to this coin:

(a) The research organization in the developed territory whence the technology emanates.

(b) The research organization in the developing territory in which the technology is to be utilized.

Let us consider the role of each separately, and then their interrelationship, taking into account technical, commercial and local factors.

The Research Organization in the Technology Exporting Territory

Important factors include:

(a) Whether the laboratory is the progenitor of the technology in question or whether some third party was concerned in this capacity, but it has been brought in specially to assist in this particular situation because of its relevant scientific and technical expertise.

(b) A further relevant aspect may be whether or not the laboratory is one which is normally involved in technology transfer to developing territories.

(c) Whether or not there is an adequate reception centre in the form of a research organization in the developing territory or territories in which the innovation is to be utilized; with which it can associate and liaise.

The foregoing variable parameters will all affect the job which the research laboratory in question has to fulfill; nevertheless although these points are useful for analysis, in the long run each situation is special and unique. This laboratory's main tasks may be summarised as follows:

(a) To identify and define coherently the technology in question, including

(b) its potential applications and limitations in the developing country.

(c) To produce a clear picture of what is required to be done for successful technology transfer under a number of headings, including:

(i) scientific and technical;

(ii) performance and specifications (for materials, process equipment and products);

(iii) capital and other physical equipment required;

(iv) labour and supervisory skills and training;

(v) special expert and other professional manpower required;

(vi) production, performance and maintenance tests in the environment of the relevant developing territories;

(vii) marketing needs;

(viii) any other special problems, whether technical or commercial.

During the initial development/production phase the role of this laboratory is vital because all concerned will be leaning on the knowledge and expertise of its technical team, in order that they may absorb information and understanding for the subsequent key phases of transfer.

These phases are in themselves divisible into two stages:

(a) Where the initiative is still with the laboratory, and
(b) Where it is being transferred into the developing territory.

The former can often be prolonged and may well require an inter-relationship with a laboratory or other equivalent facility in a developing territory. The second stage, although possibly more complex, is easier to define in terms of responsibilities. Essentially these concern carrying through everything that is necessary for efficient and effective transfer, so that apart possibly from recourse back in relation to unexpected snags or problems, the developing country personnel, with the assistance of its own laboratory or other facilities may be able thereafter to stand on their own feet during the subsequent phases of manufacture, initiation and commercialization of the project. This phase is likely to involve the temporary transfer of key personnel from the laboratory into the developing country and it is essential therefore that such individuals be selected with particular care, not only as to their knowledge and understanding of the project but also for their personal capability to develop effective human relationships with responsible individuals in the developing territory. Questions of language, psychological approach and environmental background appreciation are all relevant in this context.

The Role of the R + D Laboratory in the Receiving Country

It is clear from the aforesaid that there is a major need for a "receiving centre" in developing countries which wish to absorb and utilise technology from outside, and that a local R + D organization can *inter alia* occupy the role of such a reception centre.

Let us consider first the responsibilities of such a centre, and then how they can be grafted into an R + D organization which would obviously carry out other duties within these overall responsibilities.

The duties of such a "reception centre" would comprise the following:

(a) Expert relevant local knowledge coupled with an ability to seek out, comprehend and apply supplementary information which could be relevant to this particular development; and

(b) The technico-economic capability to evaluate actual and potential projects and so provide a service to the decision arm, or arms, in the country on whether projects are (i) appropriate and (ii) acceptable to the particular local environment and market.

(c) An infra-structure for training management, production leaders and workers in the particular skills necessary for such new project.

(d) Participation in field trials and pilot plant studies to ascertain, and then demonstrate, the utility and economic feasibility of the new scheme under local conditions, including recommending any modifications or adjustments which may prove necessary for this purpose.

(e) The provision of the vital link for continuity to achieve large scale production and use (this is often the point at which the majority of external technologists engaged on the work are withdrawn).

(f) The provision of quality control analyses and trouble-shooting services.

(g) Liaison in the feeding of information to and from the originating source.

There are many developing countries in which an organisation with no further terms of reference than these would find difficulty in sustaining itself, partly by reason of fluctuation of work load and partly by reason of the variation in the scientific and engineering facilities and services required from time to time. It would make better sense in many countries for this responsibility to become an integral part of a major R + D laboratory concerned with understanding relevant technology.

Such an association of responsibilities possesses the following advantages - continuity, the ability to carry out appropriate back-ground programmes, the possession of wider contacts in the R + D field, and the ability to recruit better calibre people who would appreciate the significance of the problems involved in technology transfer, including that of liaison. Such a group would also of course be able to involve themselves earlier in such ventures and where appropriate indeed invite the submission of new projects, apart from organising its own coherent programmes to redeploy technology for the benefit of the local territory, and evolving meaningful priorities.

Such a Group would constitute a realistic and highly valuable "Reception Centre" aforementioned, but against this of course there would inevitably be significant extra cost. It is to be hoped that aid programmes of various kinds would give priority to the provision of funds for such purposes.

In practice where only a developed country's research organization is involved in a project, due to lack of such facilities in a developing territory, the task of establishing feasibility, after the need for a process, plant or piece of equipment has been recognised, through the design, manufacture and initial testing of prototype equipment has to be carried out in a laboratory thousands of miles from where the equipment will eventually be used. Following the satisfactory completion of this stage the project is transferred to the developing territory for field trials and evaluation and to begin training local personnel. The lack of facilities makes this section of the project difficult to manage and invariably it takes far longer to achieve satisfaction.

The expenditure incurred in this type of project is thus far in excess of that which would be incurred were there local facilities and services. The necessity to duplicate trials, to incorporate modifications on site under difficult conditions, to transport equipment over long distances and to provide additional personnel, are factors which have to be taken into consideration when the overall costs of the project are being estimated.

Following the argument thus advanced for the need to establish such R + D laboratories in developing countries it is worth considering the benefits which could be derived by the setting up of a special section within an international organization such as UNIDO which would have the responsibility of collecting information relating to important projects between developed and developing territories as well as those undertaken independently by the developing territories themselves. Without such action there is a danger of considerable duplication of effort, particularly at community level where simple but more or less universal innovations are evolved. Such a facility should posses a mobile nucleus of experts in a variety of disciplines, and could be the receiving centre for problem situations recognised by developing territories and would assist in identifying solutions. It might well be that some of these problems had already been solved in other countries, and a facility to arrange for an interchange of information in such event could become a standard procedure. This unit would thus be able either directly or indirectly to offer a technical service and managerial guidance, and also provide a means of co-ordinating development and facilitating the introduction of appropriate innovations on a broader scale than heretofore.

Summary

It can be seen from the foregoing that research organizations in developed territories have overcome many of the problems at their end of transferring technology originating in their establishments to developing territories but it is a complex and expensive operation

which could be made simpler by the existence of local "reception centres" in the territories concerned.

Reception centres with laboratory and workshop facilities could reduce substantially the cost of many projects by eliminating the necessity to duplicate parts of the programme and also the high costs of shipping prototype machinery.

It can also be seen that an international agency can have a part to play in this sphere by liaising across the board and being a central source of assistance and information.

APPENDIX

I am indebted to the Tropical Products Institute of Great Britain for a few of their case histories where the local R + D organisation has been able to carry out an invaluable co-operative role.

Development of Essential Oil Industry in Thailand

Following consultation between the Applied Scientific Research Corporation of Thailand and the Institute, a project emerged for the development of this industry based on the processing of certain local aromatic plants. The TPI carried out quality analyses and economic evaluation and suggested suitable distillation techniques and modifications to the pilot equipment. Subsequently a local company was formed in Thailand and production of one or two oils has now started and two are under investigation.

The acquisition of foreign technology in this project was greatly facilitated by the existence of the ASROT. Botanists were available for identification of plant material, and laboratory facilities were at hand for on the spot chemical analysis of crude products. TPI provided two officers under Technical Assistance to train ASROT staff in specialised procedures concerning both distillation and quality control of oils. This training has enabled appropriate action to be taken at source to maintain the production of basil oil to a consistent quality.

Development of African Fresh-Water Fish Industry

Following investigations between the TPI and the Fisheries Departments of a number of Central African countries a Fish Training Institute was established in Uganda, a TPI officer becoming its first Principal. This direct link has been invaluable in providing facilities for investigations under local conditions and as a source of information. Processes developed by TPI are demonstrated directly to local personnel who are being trained for field work.

Current investigations at TPI for the above purposes include: studies of preservation processes for tropical fish, which have greatly differing requirements to fish in the temperate zones; studies of nutritional effects of quality and yield in various tropical fish species; processing of trash fish into animal feed.

Storage Projects in Africa

The Storage Department of TPI is concerned with all aspects of tropical stored products problems. There has been a close association for many years with the National Agricultural Laboratories, Ministry of Agriculture, Kenya. This liaison has facilitated a valuable exchange of information, and has provided the necessary infra-structure for implementing projects such as development of mesh metal silos, large scale semi-underground hermetic silos, and railway truck fumigation techniques.

The association of the Storage Department with the Mount Makulu Research Station, Ministry of Rural Development, Zambia, through the

secondment of a TPI officer has led to the setting up of a "Food Conservation and Storage Unit". This functions to train agricultural extension staff and farmers in good storage techniques and to carry out research into problems associated with the storage of durable produce. This unit greatly facilitates the acquisition and adaptation of technology developed by TPI.

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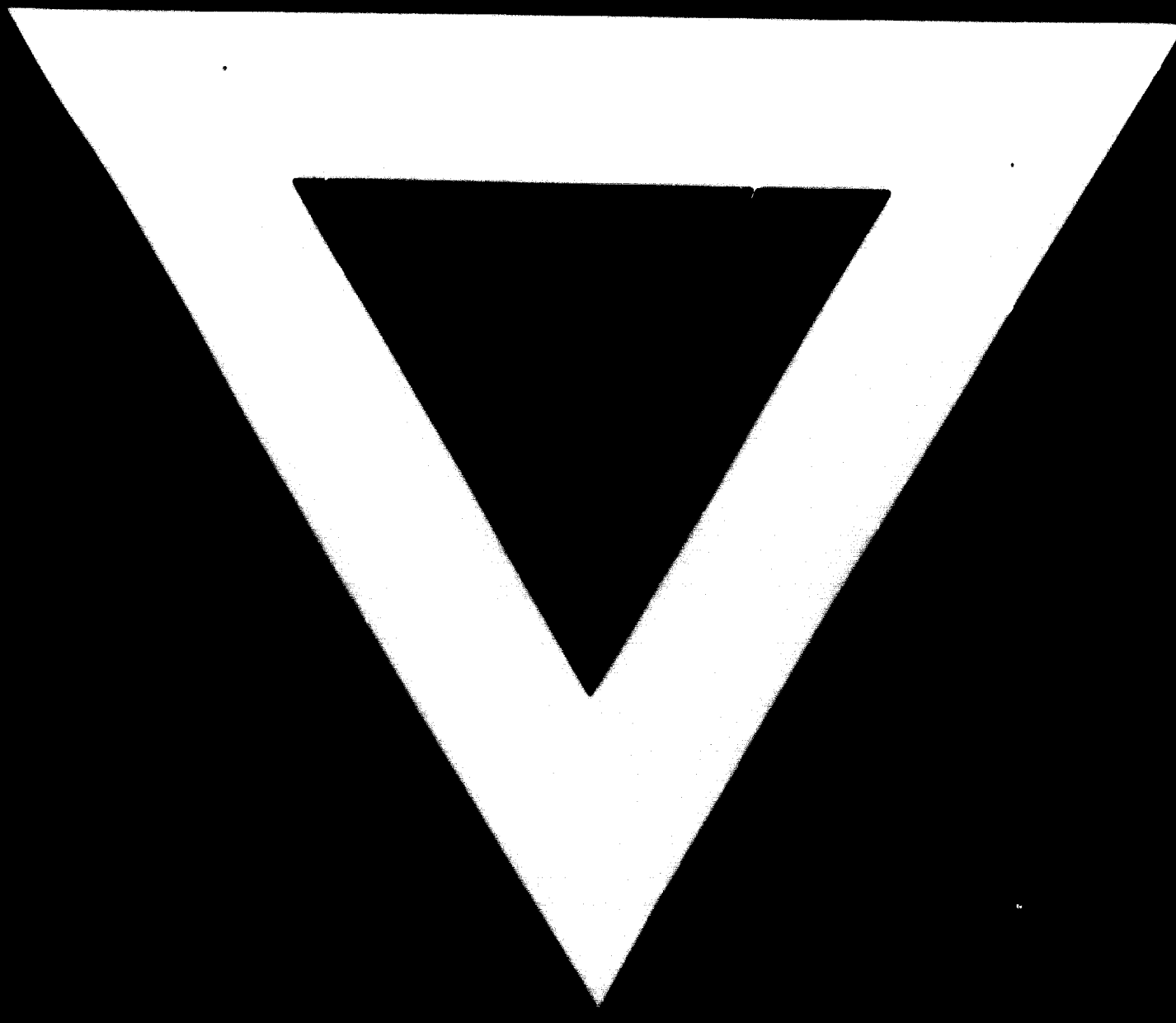

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