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THE EAST AFRICAN INDUSTRIAL RESEARCH ORGANIZATION

An International Co-operative Research Institute 1/

by

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SUMMARY

The limited resources of manpower and finances available to the EAIRO have been insufficient for it to adequately meet the challenge of its aspirations in encouraging the development of industry in East Africa. This is partly due to the widespread range of technologies that are required in an industrialized society and partly due to the rapid rate of development.

Nevertheless, by careful selection of limited objectives the Organization has been associated with the establishment of a number of industrial enterprises e.g. brickmaking, pottery, edible oils (refining and hardening), and vegetable dehydration. The Organization is also helping to provide adequate acceptable food for the region by its work on sorghum processing and evaluation. Most recently a spectacular success has been achieved in its work on coffee processing whereby the foreign exchange earnings from coffee are expected to be significantly improved.

The Partner States of the East African Community, i.e. Kenya, Uganda and Tanzania, have decided to expand the E.A.I.R.O. and give it sufficient manpower to increase its field of activity.

Three institutes are to be established, one in each Partner State, to operate co-operatively with a regional co-ordination centre answerable to the Partner States through the East African Community. To ensure that the work carried out is relevant to the perceived needs of East Africa a research board will be established to give overall directions to the EAIRO. This board will have representatives from industry, commerce, development bodies and government committees drawn from each Partner State. The individual institutes will also have research committees drawn from industrialists academic institutions and government to advise on the detailed nature of their work in the sectors of industry in which they specialize.

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INTRODUCTION

The East African Industrial Research Organization (EAIRO) is the present day successor of a body set up in 1942 to promote the local manufacture of goods that were in short supply in East Africa due to the exigencies of war. It is supported co-operatively by the three sovereign states of Kenya, Uganda and Tanzania through the medium of the East African Community.

While originally it was charged with the technical examination of schemes for the local manufacture of goods or substitutes for goods in short supply, it has also provided facilities for the development and control of manufacturing processes in East Africa. The Organization has also maintained an interest in existing processes and, for example, operated a fuel technology section to give advice on the reduction of processing costs by the efficient use of oils and indigenous fuels.

The EAIRO is also concerned with assisting local producers of crops to realise the greatest value from their efforts. Three areas of this work were described by the present author in a paper presented to the Joint Consultation on the Promotion of Industrial Research and Services in Africa organised by UNIDO in Lagos in September 1975. These were:

(a) drying of mild arabica coffees;
(b) development of widely acceptable sorghum foodstuffs;
(c) extraction of hecogenin from sisal wastes.

The Organization has always held its links with other research institutions and development bodies in the highest regard. Facilities for the co-operative development of promising lines of work have been provided at EAIRO and advantage has been taken of opportunities of expanding the experiences of EAIRO staff by training and working in other institutions.

I. Aims and activities

The EAIRO aims to provide technological facilities to foster the development of industries in East Africa. Industry is understood to include the non-agronomic activities of farmers and villagers as well as factory-based manufacturing processes. Individuals, associations, companies, organizations and government departments can call confidentially upon EAIRO for assistance with a project process or product. Alternatively the Organization may canvass likely persons or bodies with an idea that is believes to hold promise of development for East Africa.

Background information on many processes and products is readily available by reference to the technical library and files of the Organization. These, together with the experience of its staff provide an advisory service for local manufacturers in negotiations with overseas purveyors of equipment, plant and processes. They also provide a valuable basis for the assessment of proposals.

The range of technologies involved is very wide for we are concerned with, for example, the quality of coffee that is sold competitively on international markets as well as the problems of providing charcoal for domestic use in East Africa. Chemical analyses are made of waters, gases and raw materials required by local manufacturers. These may range from the application of routine methods to the exhaustive screening of clays on which a brickmaking industry may be based. Physical and chemical assessments of materials for pottery and heavy clay products are made on behalf of manufacturers and craft workers. 'Trouble-shooting' services to rectify processes that develop faults and the provision of sample quantities of materials that may be used to give a higher local content to manufactured goods are also included. The provision, storage and distribution of wholesome, acceptable and nutritious foodstuffs, both locally and internationally is another subject which absorbs much of our efforts. The Organization is also concerned with the applicability and adaptation of technology to the particular conditions of East Africa. In this area, for example, the choice of appropriate methods for manufacturing textiles is studied in relation to local conditions and the aspirations of government agencies and industrialists.

With such a wide range of technologies involved it is clear that we cannot ourselves be in the forefront of them all. The Organization therefore keeps in touch with other institutions and when appropriate acts as an intermediary.

An inquirer is put in touch with the best source of advice known to us and frequently we assist in framing the inquiry and in interpreting and implementing the advice received. To maintain our ability to act in these capacities we participate in international conferences and seminars to share the results of our own researches with others and avoid duplication of effort by co-operative sharing of work when we find institutions with similar interests to our own.

II. Resources

A. Financial

The prime source of support for the EAIRO are the Partner States of the East African Community, i.e. Kenya, Uganda and Tanzania. They provide the bulk of the financing which has amounted to approximately E.A. Shs. 2 million annually in the last three years. A token payment of fees is made by manufacturers and individuals using our services when specific investigations are required but consultations using our accumulated experience are given freely. These fees do not contribute directly to the income of the Organization but go into the revenue of the Community and give a small measure of the interest our work generates in East Africa. Work done for governmental departments of the Partner States is not specifically paid for as they are in the position of being our paymasters.

Support is also received indirectly by the provision of expatriate specialists through overseas government agencies who supplement payments made by us according to local salary scales up to international standards. Equipment and facilities for training are also donated to the Organization when our requirements meet with a favourable reception by potential donors.

B. Personnel

Within its severely restricted budget the Organization has an establishment for 68 members of staff, excluding trainees. This number includes 11 graduate research officers, 12 laboratory technicians, 6 laboratory assistants and two artisans. The remainder are administrative and auxiliary staff.

Administratively the Organization is over provided but this is inevitable with a small Organization as the functions of accounts, stores, maintenance and the auxiliary services would require little or no more staff to serve two or even three times the present scientific personnel.

At present three specialist graduates have been engaged through the British Ministry of Overseas Development whilst during the last three years specialists from the United States of America (through the U.S. Agency for International Development) and Denmark (through the Danish International Development Agency) have also worked in the EAIRO.

These specialists help us to specify the equipment necessary to meet our requirements and develop the expertise to continue work in their fields after they have completed their period of appointment with us. Locally recruited officers are given appropriate on-the-job training to familiarize them with conditions in East Africa followed by specialist courses or experience overseas to broaden their outlook. These courses are often arranged with the agency providing the specialist to ensure the proper establishment of a viable section within the Organization.

C. General

The Partner States of the East African Community agreed in 1975 to a substantial expansion of the East African Industrial Research Organization both in staff, to a total of about 90 graudate research offioers, and facilities.

The expanded Organization will comprise three co-ordinated institutes, one in each Partner State. Each institute will carry out researches in different specialized fields, provide a general national 'trouble-shooting' service and act as a linking agency between the national industry and its sister institutes.

The work of expansion is beginning this year and we are looking forward to the improved facilities and opportunities that will become available in the next three years.

III. Research Programmes

A. General

The activity of the EAIRO is organized between and within five categories, each of which has a section head. Some of these sections are small one-man units e.g. chemical engineering, or in the course of development e.g. fibre technology. The established sections are designated as industrial chemistry, analytical, food processing and ceramics. These sectional designations provide a suitable framework for the description firstly of our recent and current work and then the immediate future and longer term plans.

Our work is closely related to the immediate needs of industries in East Africa as well as the investigation of longer term problems and opportunities that are revealed to us. The small-scale industries that are economically viable in the East African market call upon our services for technical assistance in resolving operational difficulties. We are concerned with the adaptation of manufacturing processes to the local conditions of market size, raw materials and available personnel in East Africa. The availability of technical facilities within EAIRO enables small enterprises to function effectively without having scarce and costly technologists of their own. The Organization also helps local industry with problems of production and quality for international markets.

B. Industrial chemistry

This section consists of three graduates and is headed by an expatriate organic chemist. The prime responsibility of the section is our researches relating to the processing of coffee, principally the mild arabica coffees of Kenya and Tanzania but recently extended to consider problems of the robusta coffees grown mainly in Uganda.

A long series of investigations has been carried out since 1954 involving a succession of scientists in co-operation with the Coffee Boards of Kenya, Uganda and Tanzania. These began with the investigation of the effects that artificial dryers and processing conditions appeared to have on the quality of their produce. They have continued with investigations of various possible origins of the highly deleterious, socalled 'stinker' beans that appear sporadically in otherwise high quality coffees. These cause a down-grading of the coffee with a consequent loss of revenue to the farmer and foreign exchange to the respective countries.

During the last two years the section has assisted a manufacturer in the U.K. to design and develop a sorting machine based upon our observation that the deleterious beans were associated with certain types of fluorescence. We have shown that at least 50 per cent of the Tanzanian and Kenya crops would benefit from sorting, and that sorting can be expected to raise the quality of the sorted coffee by at least one full standard. The value of such upgrading has been assessed by retrospectively valuing the improvement as if it had been applied to the 1973/1974 coffees at the prices then realized at auction in the market. This evaluation indicated an increase in value of some $2\frac{3}{4}$ per cent or K.Shs. 20 million (US$ 2.4 million). Based upon these expectations Kenya has acquired four of the sorting machines and is considering the proposition that they should install enough machines to sort the whole crop as a routine measure.

The value of the above improvement for one year in Kenya alone is seen to be equivalent to the total cost of running the present EAIRO for about ten years. This particular piece of research has given a spectacular pay-off not only to our own efforts but also to the efforts of the coffee industry and governments that have supported and co-operated in our experiments.

C. Analytical section

This section is run by a locally recruited graduate assisted by technicians to provide a service to manufacturers and organizations in East Africa as well as the other sections of the Organization. A steady stream of samples that is maintained from year to year testifies to the value placed upon this service by manufacturers and other organizations. In addition to routine analyses specific investigations of the origins of faulty products are undertaken with a view to helping with the rectification of the manufacturing processes. Adaptation, verification and development of analytical procedures are also required from time to time in order to perform analyses with the equipment available in our laboratories.

The manufacturers and organizations that call upon this section reap the benefit of having analytical services on hand and an experienced analyst with whom to discuss the results. The provision of the service in our industrially orientated organization makes other specialists available for consultation.

D. Food processing

This section comprises three locally recruited graduates, one of whom heads the section. The multifarious processes applied to foodstuffs between harvesting and presentation to humans or animals are the concern of the section. Three continuing lines of research carried on in this section are:

(1) The utilization of presently wasted produce for animal or human consumption;

(2) The evaluation of sorghums produced by the East African Agriculture and Forestry Research Organization (EAAFRO) in a breeding programme to enable selection for good food qualities;

(3) The development of low cost, acceptable, nutritious foods using readily available crops.

An example of the utilization of wasted produce is the manufacture of a marketable juice from cashew apples which are normally discarded when cashew nuts are harvested. The necessary processes for removing the natural astringency of the juice, normalizing its acidity and sweetness and preservation by pasteurisation have been worked out to produce an acceptable drink.

The programme of sorghum breeding trials carried out by EAAFRO is supported by our investigations of the value of their grains according to their performance and yield when milled. The characteristics of the test varieties are given quantitative values to help in the selection of the most promising for further breeding trials. In this way the characteristics of colour, size and texture of the grain, which influence the acceptability of milled products, and the content of limiting amino-acids such as lysine, which affect their food value, are improved during the subsequent breeding and selection.

In conjunction with the above programme methods of preparing sorghums for consumption, by polishing and milling have been demonstrated by the EAIRO at villages in Tanzania. In this way we have demonstrated that the chosen sorghums can be made widely acceptable components of the staple diet. This has encouraged the consideration of a widespread production of this cereal over large areas of that country. In these areas the production of maize or wheat is at best marginal and the more certain production of a crop of sorghum is valuable only if it is an acceptable alternative to the presently preferred grains.

The production of low-cost nutritious foods by means of an extrusion cooker was brought to our notice by the USAID. A co-operative programme of research was set up with them which demonstrated its potential value using locally procured materials. This demonstration has led one of the Partner States to seriously consider the use of this process for the manufacture of baby foods and we understand that they have negotiated to obtain a full-scale production unit of their own.

E. Ceramics

This section, headed by a local graduate who has received specialist training overseas and supported by an expatriate specialist and local technical staff, provides a consultancy service to local ceramics industry and craftworkers.

Since the earliest days of the EAIRO the section has been concerned with the utilization of various clays for the manufacture of building and refractory bricks, tiles, drainpipes, meerschaum tobacco pipes, table-ware, ornaments, beads and the like. The definition of suitable materials, their refining and blending for specific purposes as well as ascertaining the methods of drying and firing to be used have all been the concern of this section. The Organization also provides small quantities of raw materials to craft workers as a service to encourage the appropriate background from which technically competent industrial enterprises can spring.

A locally occurring socalled soapstone that is readily carved and machined to quite precise shapes has been found to consolidate and gain considerable strength when suitably fired. The product can be glazed satisfactorily and a possibility of use as electrical power insulators has been opened up.

The carving of the above stone is a local craft industry and we have shown that the waste that is produced can be milled and used in the production of school 'chalks'. A satisfactory formulation has been developed and a small production unit designed for use in the rural area in which the stone occurs. This will provide a further source of income for the villagers.

The section investigates complaints of poor firing in kilns and has developed a service of reconditioning furnaces and kilns for government departments, industrialists and craft workers.

F. Planned Researches

Industrial Chemistry

This section has reached a satisfactory conclusion on its principal problem, that of eliminating the small quantity of deleterious beans that occur in high quality coffee. The solution of sorting itself throws up an interesting problem, viz. 'what to do with the separated-out, waste, 'stinker beans'. Although these are valued at nothing in the above valuation exercise, Kenya expects to separate out some 650-700 tons of such beans and finding a use for them would be worthwhile. This is presently claiming our attention.

The immediate industrial problem of 'stinker' beans has found a solution but the actual definition of how such a bean develops has not been achieved. We have a number of correlations with other bean and growth characteristics and hope to resolve this question. A solution to the question would offer the possibility of preventing the production of 'stinker' beans at source.

While the prime problem of the down grading of coffee due to major deleterious factors has achieved a measure of success, we are still largely ignorant of the factors that contribute valuable or 'positive' characteristics to the coffee. These are assessed consistently by liquorers (i.e. skilled tasters) but their identification by objective methods is presently not possible. We hope to study these 'positive' characteristics with a view to helping with their enhancement by monitoring whatever breeding or agronomic practices are found to influence them.

Chemical Engineering

Locally available deposits of chromite, sodium carbonate and limestone offer the opportunity of satisfying the local demand for basic chromium sulphate and related compounds without recourse to importation. The demand is too small to interest a foreign firm and it is our hope that we will be able to develop and demonstrate an appropriately scaled plant within our Organization so that it can be handed over to a local manufacturer.

Similarly, a demand exists for sodium sulphate and local supplies of sodium carbonate and calcium sulphate are available. The preparation from these raw materials leads to the coproduction of precipitated calcium carbonate or whiting. We hope to determine the viability of such a production route at the scale demanded by the immediate market.

Fibre Technology

The production of sisal fibre is a major industry in East Africa and it is facing severe competition in international markets from synthetic materials, especially polypropylene. Part of this competition is due to the high labour cost of making useful end-products from sisal as compared with the synthetic. We hope to develop low-cost methods of manufacture applicable to sisal that can be operated in East Africa.

Another way of supporting the sisal industry is to enlarge the number of products that can be made from the fibre. By present methods only coarse fabrics and bags can be made with sisal. It is our intention to develop close-woven structures that can be used for bags to hold small grains and, perhaps, even granulated sugar.

The major manufacturing industry in East Africa is the manufacture of textiles from cotton, synthetics and blends of these materials. We hope to demonstrate improvements to the present methods of production that will improve quality and reduce costs.

C. Longer term plans

These are associated with the aforementioned expansion of the EAIRO to comprise three interrelated institutes. These institutes will each contain a basic 'trouble-shooting' or service capability in analytical chemistry, food technology and chemical engineering. In addition they will have divided between them the sections devoted to particular technological disciplines. These disciplines will include the present sections of Ceramics, Food Technology and Industrial Chemistry, and the units of Chemical Engineering and Fibre Technology developed to full sections. Further sections will be introduced to cover the industrial sectors of machine tools, tropicalized instrumentation, chemistry of natural products, extractive metallurgy and fuel technology.

It is expected that the new institutes should start becoming operational in about three years' time. As these institutes come into operation we foresee a need for an expert group of assessors to advise the EAIRO on the feasibility of the results obtained by the institutes. This will concentrate primarily upon the costs and benefits of proposed research and the evaluation of its application in practice. The group would assist industrialists and governmental

development bodies to make use of the institutes output by providing data on which financial decisions can be made.

It is possible that such a group could initially be set up through an international agency such as UNIDO with the financial management and technical economic skills that are required.

IV. Problems of industrial research

The principal difficulty faced by the Organization in carrying out useful developments has been its small size and consequent narrow range of experience among its staff. It can, to give a particular example, be a minor catastrophe for a switch to break down in a vital piece of equipment when we have no resident technician competent to rig up an adequate substitute. More generally the implementation of a production scheme that can be justified on paper, and appears to work satisfactorily in the laboratory, has to be translated to the appropriate industrial scale, perhaps with an intermediate stage of pilot scale operation. These different stages have distinct problems and a successful development normally requires the interactions between colleagues with different backgrounds as is found in team work. Developments that we have applied successfully have had this characteristic.

It is attractive to consider co-operation between institutes as a possible way in which to achieve the required spread of expertise. However, effective co-operation requires such close team work that the researchers have either all to be located at one site or spend considerable time together working at the various sites. The former is to be preferred. This requirement implies that one institute acts as host for the visiting staff of the other(s) for the duration of the development.

An alternative solution to the problem of co-operative research is that now being adopted by the EAIRO. This is to make each of its componen institutes specialize in different, particular sectors of research and to co-ordinate the researches on a regional basis. With institutes of comparable strength we believe this approach to hold promise of success.

This solution may also resolve another difficulty that has been experienced by EAIRO as presently constituted. The bodies that are responsible for industrial development in each country naturally assemble to discuss propspects and the course of development on a national basis. A remote industrial research

institute then hears of a possible project only when the idea has been crystallized. Alternatively, a project put up by the institute will be discussed in its absence and cannot be readily defended or modified to meet particular circumstances. With institutes distributed nationally, but co-ordinated on a regional basis, we expect to be able to concentrate expertise sufficiently to achieve worthwhile results and disseminate them regionally.

Co-operative work between autonomous institutes on an individual project is seen to be possible when it is clear that both institutes will benefit from the outcome. An example would be for one institute to provide a scarce or expensive facility to another that needed to use it in its research. Thus, for example, access to fresh tropical produce might be provided to an institute from a temperate climatic zone to test a process in exchange for information about the utility of the process. Otherwise, when only single projects are considered the inevitable imbalance of individual contributions and gains can lead to difficulties.

With institutes of widely differing capability co-operation will take the form of a transfer of expertise and may be used in order to develop a technology that is wanted in the weaker institute. No difficulty has been experienced by the EAIRO in making such transfers.

The implementation of research findings is very difficult for a small research organization, especially if its staff have not had extensive industrial experience. We have found that we often have to interest commercial firms abroad in our results before they can be translated into relevant hardware. These firms often dismiss the proposition for the reason that the project is neither large enought nor sufficiently valuable to pay for their design costs. Nevertheless, considerable economies can be foreseen by comparing imported costs with local operating costs, especially when hazardous chemicals are under consideration. A design team dedicated to the design of small-scale plants would be a very useful aid to industrial development. But is is unlikely for one or a small group of countries or institutes to be able to brief a design team sufficiently frequently to keep it occupied. The work of a plant design team should therefore cover the requirements of a region. Such a team might operate under the aegis of UNIDO in much the same way as the industrial study and development centres but with explicit contacts with the indigenous industrial research organizations.

V. Relations with other research institutes

The EAIRO has always had an open channel of communication with the research association network in the United Kingdom through the medium of the Tropical Products Institute in London. This derives from the origins of the Orgnization and has been maintained by the exchange of publications, visits of personnel and exchange of experience.

The World Association of Industrial and Technological Research Organizations (WAITRO) has proved to be a fruitful source of contacts with like-minded organizations. These have led to the secondment of members of staff from our Organization for periods of training or experience in Brazil and in Canada.

Our Organization is ready to provide bench space and local facilities to workers from other institutes who wish to study a problem relevant to, or of potential use in, the industrialization of East Africa. In this way we provided facilities for the Medical Research Council of the United Kingdom to investigate the occurrence of hecogenin in sisal. This was instrumental in establishing the process of extraction in Tanzania and Kenya.

Within East Africa we mount joint researches with our sister institutes whenever this is seen to be advisable. Thus the agronomic and breeding research on sorghum varieties at EAAFRO is complemented by our assessment of their value as foodstuff from the points of view of nutrition and acceptability. The governmental ministries of agriculture maintain their own national research stations and we liaise closely and moint joint research programmes when questions of utilization arise. The departments of mines and geological survey are natural collaborators with our Ceramics Section when promising clays and earths are considered for exploitation.

VI. Areas amenable to joint research

Researches that we believe would benefit by workers in separate institutes exchanging information on their progress are suggested below:

1. Village level threshing

   Much effort is expended in villages threshing grains. A mechanical contrivance to reduce the labour of threshing maize, finger millet, sorghum rice and even wheat would be valuable. It should not require such large quantities of grain that its installation disrupts the community.

2. Hygenic storable traditional beers

Traditional beers have a different flavour to the introduced lager and hop-flavoured beers, they also have nutritional value. As brewed traditionally these beers have a short life and require immediate consumption. Preservation by small-scale processes is highly desirable.

3. Clay and cement-based building materials

Manufacturing process and selection of materials requiring little or no consumption of fuel are highly desirable for rural development. Pozzuolanic earths with lime that can be obtained by relatively low temperature burning are an example of such materials.

4. Water pumps

Simple, robust, manual, wind and water driven pumps are required to make potable and irrigation waters available where they are needed.

5. Household water purifications

Fine filtration is a robust, low energy method of producing potable water. The production of suitable ceramic filters from locally available materials is desirable.

6. Improvement of fuels

Slow burning, dense fuels are often desirable. Wastes can often be carbonized only into lightweight charcoals. Briquetting offers a means of overcoming this disadvantage. Suitable methods of briquetting require development.

7. Grain drying and storage

Inadequate prestorage drying and/or improper storage result in unacceptable losses in foodstuffs, especially grain. Simple procedures for rural use on a relatively small scale are required to avoid these losses.

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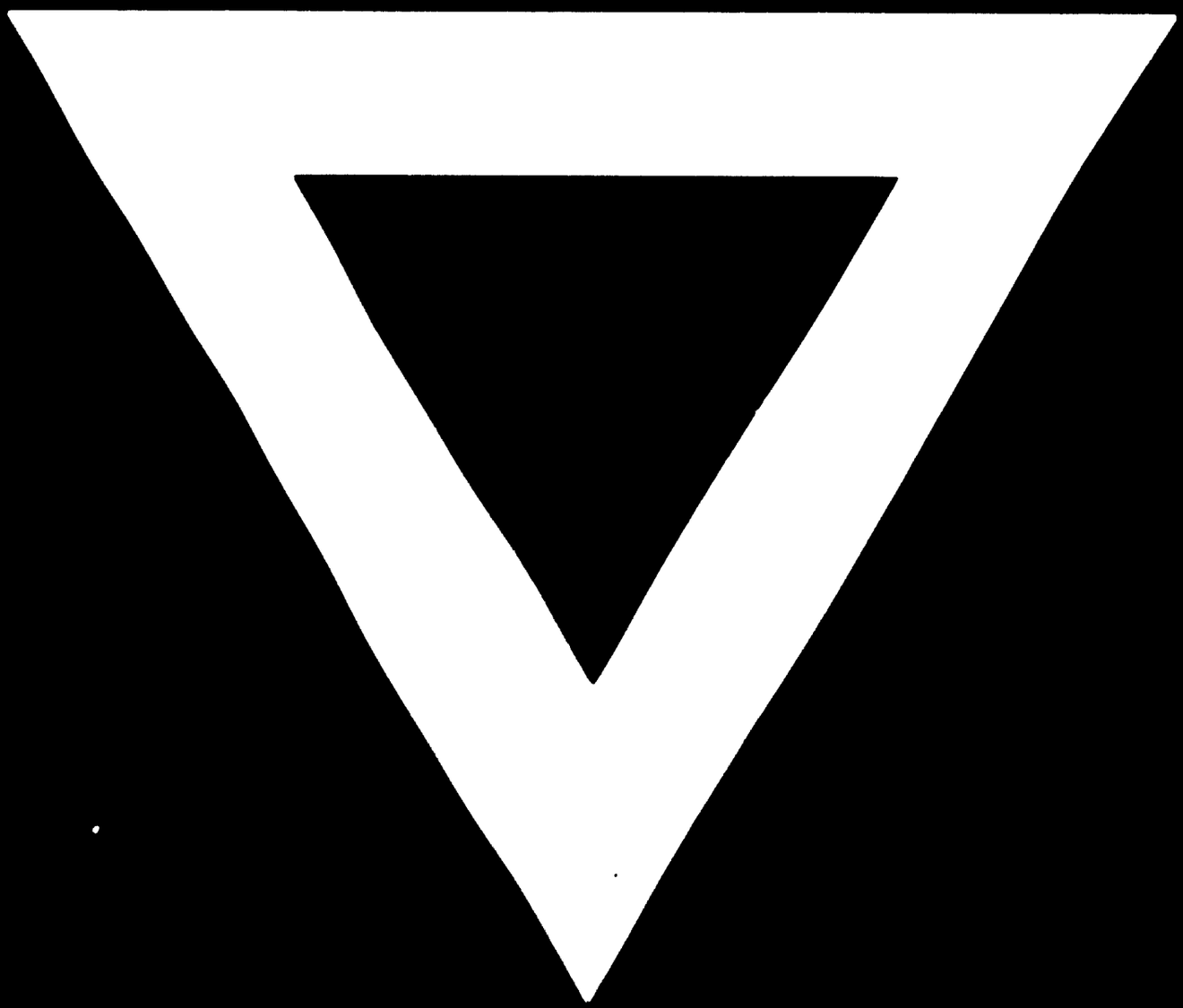

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