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WORKING GROUP No.8

**APPROPRIATE TECHNOLOGY
FOR LIGHT ENGINEERING INDUSTRIES
AND RURAL WORKSHOPS**

.....
[**SMALL-SCALE RURAL INDUSTRIES: LIGHT ENGINEERING WORKSHOPS .**
Background Paper

**SMALL-SCALE RURAL INDUSTRIES:
LIGHT ENGINEERING WORKSHOPS**

by

**Intermediate Technology Development Group Ltd (ITDG)*
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* This paper was prepared by V. Austin on behalf of ITDG.

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S U M M A R Y

Chapter 1

Any definition of small-scale rural industries should be used with some flexibility.

Within the rural labour force it is estimated that approximately 20% to 30% are engaged in non-farm work, and rural industries probably account for above half of the non-farm work.

Industries which might locate in a rural area include 'foot-loose' industries as well as those heavily dependent upon the cost and difficulty of travel in and out of the specific rural area.

Small-scale rural industries can make an important contribution to both employment and incomes, especially for the rural poor who have few alternative opportunities. The outputs of these rural industries can also help to supply appropriate products and services, which may be otherwise unobtainable.

Chapter 2

Small-scale rural industries produce a wide range of products, which in the case of blacksmithing, tends to be cutting edge tools and sheetmetal products. to traditional designs.

It can be shown that some of the services available from rural industries are of the utmost importance to other sectors of the rural economy, such as agriculture. When these services are given to sophisticated products there is an even stronger case for training services.

Chapter 3

Small-scale rural industries face a rural market situation of relatively small demand at a low price, which generally leads to a preference for labour intensive technologies, although in a specific situation the choice is often complex and not easy. To illustrate the wide range of choice in both manufacturing and servicing, two examples are given.

Although there may be a wide range of choice, the choice available to the rural industrialist is often restricted through lack of information.

Chapter 4

Although there are opportunities for growth, utilising appropriate technologies in virtually every rural area of developing countries, there are a number of constraints. These constraints include a poor communication of information, a lack of modern skills and an underdeveloped infrastructure. The infrastructure should include adequate services for financing, materials supply, common facilities, marketing and possibly small rural versions of industrial estates. In order to complement the services it may be necessary to develop infrastructural organisations such as youth clubs and industrial co-operatives.

Chapter 5

The proposed conceptual approach to policy is that small-scale rural industrial development should be part of a long-term

integrated approach to rural development, helping people to help themselves in industries which utilise appropriate technologies.

A national programme should include both national policy and services at the national and field level. The proposed national services directly supporting field level work would be in the subjects of market research, product development, appropriate technology and training. Field level services would include extension and training services, and infrastructural services and organisations.

It is proposed that an international programme should give emphasis to assisting national training programmes, and facilitating the flow of information between developing countries and from developed countries.

Chapter 6

The paper concludes that a massive training programme and an adequate information service must be started now, at both the national and international levels.

1. Introduction

1.1 Small-scale rural industries

1.1.1 Definition

The term 'small-scale rural industries' can be interpreted in many ways and there are a wide range of definitions in various countries, for example, in Pakistan a small-scale industry is defined as a 'manufacturing enterprise which uses no power or employs less than 20 persons', whilst in Bangladesh a cottage industry is defined as:

"(A) an industry which is carried on wholly or mainly by the members of a family either as a whole-time or as a part-time occupation; and

(B) any industry whether using family and/or hired labour which does not use motive power for any operation and employs less than 20 hired workers; and

(C) any industry whether using family or hired labour which uses motive power for any operation and employs less than 10 hired workers."

Some authors consider that it is important to have a clear definition of the 'small-scale sector' and two authors suggest that whilst it is not possible to have a uniform definition for all countries because circumstances differ, the least developed countries should have a definition based on the limit of fixed capital. (Ref. 1).

There is, however, a strong argument that the definition of size in quantifiable terms should not be strictly adhered to for the purpose of defining beneficiaries of promotional assistance. If the definition uses the term 'power' or 'fixed capital', there is a danger that small-scale industries which must utilise

a power driven/expensive machine for a certain operation may be excluded, and equally a definition using the quantity of labour may exclude labour intensive firms. The quantity of labour definition also introduces the problem of how to quantify part-day, part-week and seasonal workers of all ages and both sexes, especially in a situation where no records are kept.

There is also an equally difficult task in defining what is rural, and this is usually attempted by a definition based on population - size of communities, which may vary from 2,000 to about 10,000. A recent paper concludes:

"Therefore for purposes of considering a policy and programme for rural industries development, the 'rural milieu' should be considered more in functional terms, and if the legal definition varies considerably from functional attributes of the rural sector, then a programme for rural industries promotion can be frustrated." (Ref. 2).

It is clear that although the term small-scale rural industries can be defined in a number of ways to suit local circumstances, there should always be a certain amount of flexibility in the use of the definition for selecting beneficiaries of promotional assistance. As a general guideline the smallest industries with potential to assist in the objectives of rural development should be given the full subsidised assistance of government, and as they grow and/or become more urbanised, so they should receive less government aid.

1.1.2 Size and importance in the rural economy

Small-scale industries are a significant part of all non-farm

activities in rural areas, and a recent World Bank Paper, (Ref. 3), has illustrated the importance in rural areas.

Non-farm activities are a primary source of employment and earnings for approximately a quarter to one third of the rural labour force in most developing countries, and a significant source of secondary earnings for small and landless farmers during the slack agricultural seasons.

The above paper estimates that between 20% and 30% of the rural labour force (in 15 developing countries) is engaged in non-farm work; and 20% to 30% of the non-farm work is in manufacturing.

After making an allowance for the servicing functions of rural industries, in addition to manufacturing, the total proportion of rural industry employment in the non-farm sector probably exceeds half.

The break down of employment within the rural industry sector is more difficult to generalise and the actual proportional distribution between categories of industries varies considerably.

The World Bank Paper (Ref. 3), illustrates how the metal, machinery and fabrication category of rural manufacturing varies between 6% and 21% for five selected countries.

A more detailed examination of the data for metalworkers in two countries shows how difficult it is also to generalise within specialist categories, even for countries in the same region.

Nigeria and Sierra Leone: percentage of metalworking and allied trades in small-scale industrial employment.

International standard industrial classification	Nigeria % S.S.I. Rural and Urban	Sierra Leone % S.S.I.	
		Rural and Urban	Rural ^(d) only
37 - 38 Metal			
3720 Goldsmithing	1.5	3.2	3.7
3811 Blacksmithing	5.6	14.3	17.0
3819 Welding and fitting	0.9	0.2	0.0
951 Repair services			
9512 Radic	0.6 ^(a)	0.2	0.0
9513 Vehicle	11.6	1.7	0.0
9514 Watch	0.9	0.2	0.0
3309 Other	0.8 ^(b)	4.5 ^(c)	2.9 ^(c)

(Ref. 4 and 5).

- Footnotes (a) listed as 'electricals'
 (b) this percentage is for bicycle repairing
 (c) this includes bicycle repairing as well as hammock and basket making
 (d) a preliminary estimate, excluding urban centres exceeding a population of 2,000.

The above figures suggest that approximately a half to one percent of the rural labour force is engaged in metalworking, and the lower figure of half a percent is supported by a recent survey in Tanzania, which recorded a ratio of 0.09% between village iron and metalworkers and the total rural population. (Ref. 6).

Although half to one per cent may appear to be a relatively small part of the rural labour force, its importance cannot be measured in these terms alone. A recent report on the Development of Cottage Industries in Bangladesh, (Ref. 7), illustrates the need for qualitative as well as quantitative judgement.

"The blacksmith industry is relatively important, for in some thanas (sub-districts) it may be one of the few viable industries, and is an important local supplier of goods and services to agriculture and households, such as making and repairing knives, axes, etc.."

1.1.3 Location of industries in a rural area

Industries which might locate in a rural area can be divided into three categories:-

a) "foot loose" industries .

These industries are characterised by relatively low-weight and volume but high-value products, requiring small quantities of materials, and large amounts of labour.

These industries may perform the whole production process such as the mass production of wearing apparel, or they may perform only part of the production process such as assembling part of a watch or other intricate device. Not only are these industries foot loose within a nation, but also they do move from one country to another as relative advantages change.

b) rural industries supplying markets outside the district.

The viability of these rural located industries would depend to a large extent upon the freight rates; exceptionally

low freight rates for raw materials to go out of the district would decrease the viability of many industries to locate in the rural setting. High freight rates would give added emphasis to some of the general cases listed below:-

(i) Industries based on materials which lose greatly in weight and/or bulk during processing or manufacturing, e.g. sugar cane.

(ii) Industries based on perishable materials e.g. soft fruit.

(iii) Industries based on materials which cannot be substituted, e.g. for most crop processing there can be no substitution.

(iv) Industries based on a small number of materials e.g. primary processing of crops, timber, livestock and minerals use a small number of materials.

c) industries supplying markets within the same rural district.

The viability of rural industries supplying their own local market depends to a large extent upon both the rates of fare for both freight and passengers and the speed and ease of travel. Where the rates of fare are high and the journey slow and inconvenient the following general cases are likely to be the most important:

(i) Industries based on materials which increase in weight and/or bulk and/or fragility during processing or manufacturing, e.g. rigid boxes and barrels, large ceramic bowls and jars, and furniture.

(ii) Industries producing goods which have a high degree of perishability, e.g. bread.

(iii) Industries which require personal contact between the producer and the consumer, e.g. maintenance and repair of machinery to both individuals, and small and large industries.

(iv) Industries which supply a relatively small "local" market, e.g. animal drawn ploughs, harrows, digging spades and knives to the "local" design, and perhaps specialist local industries both small and large.

The above review of the location of rural industries is based primarily on technical and economic factors only. In practice, other factors may have a considerable influence such as the government's social and political objectives, which in turn may be re-inforced by policies to concentrate development in a limited number of growth centres.

1.2 Contribution to basic socio-economic and technological needs

1.2.1 Contributions through inputs to rural industries

There is now a general world-wide consensus of opinion that the major objective of development effort should be aimed at providing the basic needs of the poorest people in the poorer countries. In most developing countries the poorest people are the rural population, and within the rural poor the most urgent case for meeting basic needs is amongst those families which may have neither land nor capital.

Small-scale rural industries are one of the few alternative sources of employment and income open to many, either as full-time or part-time employment. Even amongst the large proportion of the rural population which has access to land and can farm,

the farm income may be insufficient to meet the family's basic needs of food, shelter and clothing. The families of these poor farming households are often unemployed or underemployed for many weeks or months of the year, in the slack agricultural seasons, and there is a considerable potential for the men to work full days and the women to work part-time after completing their household chores of cooking and cleaning.

In addition to the direct employment and income creation, there is also an indirect effect, as both forward and backward linkages.

As an example of how this might work, one can consider maize milling and processing, which in the forward linkage may lead to increases in employment and income through animal feedstuffs mixing, animal and poultry rearing and finally to wholesaling and retailing the food product. The backward linkage in some countries may lead to the construction of low cost laterite brick units for drying the maize, which in turn would require the supply of laterite and perhaps locally manufactured laterite brick making machines.

The indirect employment and income generation may be even more than the direct effect, and when the multiplier effect is also considered the total impact may be several times the direct promotion of employment and income.

1.2.2 Contribution through outputs from rural industries

Small-scale rural industries can make a significant contribution to the supply of basic needs for rural communities. Many large scale and urban industries and certainly foreign based industries

tend to supply the higher cost product range, which although it may be technically superior, may also be beyond the price range which is acceptable to poor rural people. For many basic needs, simple utilitarian products are quite sufficient to meet the requirements of rural people.

This statement can be supported by many examples from the field and perhaps the most common example is in wooden furniture.

Although urban furniture manufacturers may produce better finished products with the debateable advantage of plastic additions in the form of decorations or padding, the rural furniture maker produces simple solid wooden products which serve the function and are low in cost. A rather different example may be ceramic water filters, which may be imported or urban manufactured items with a glazed finish and a stop tap; or alternatively manufactured by small-scale rural industry with perhaps little more than a simple bowl incorporating a filter element in the bottom, which does not look so compact and neat but serves the same purpose. These two examples from the wood-working and ceramics rural industries are supplemented in the next section by further examples taken from the light engineering workshops.

2. Appropriate light engineering products and services

2.1 Manufactured products

2.1.1 Range of products

In general, the small blacksmithing industries, employing perhaps three or four persons, concentrate upon manufacturing cutting edge tools, and simple sheetmetal products to local designs. Although basically similar products are made in virtually all rural areas of the world, the local design and name may only apply in a very small geographical area. As an example from one specific geographical area, the following are traditional products of Bangladeshi blacksmiths:-

- (i) Axe
- (ii) Dha ($\frac{1}{2}$ m long knife, for cutting and splitting bamboo)
- (iii) Kachi (small sickle)
- (iv) Kudal (digging hoe)
- (v) Khunta (1m long bar with chisel point for making holes in the ground etc.)
- (vi) Plough
- (vii) Scissors for cloth and hair
- (viii) Bucket
- (ix) Karaye ($1\frac{1}{2}$ m square evaporation pan for date and sugar cane juice).

(Ref. 7, page 55).

Similar lists from other countries can be found in the literature such as typical products in Tanzania, (Ref. 6, page 41). Although many of the local products are manufactured entirely in the locality, some are only part-manufactured, and some products made by rural

industries may have been transported over long distances of up to 100 kilometres, (Ref. 6, pages 25 and 27).

A recent study of appropriate technology in forestry has revealed the often high rate of importation of relatively simple products which might be made by rural industries:

Philippine importation of spades, picks, hoes, forks, axes, hatchets, scythes, timber wedges and hewing tools and other hand tools used in agriculture and forestry. (1974 - 75).		
	Number of pieces (thousands)	Cost Insurance Freight (thousands U.S. \$)
1974	680.6	413.1
1975	414.4	586.4

(Ref. Central Bank of the Philippines quoted in Ref. 8, page 110)

In addition to the products considered above which are primarily agriculture based, there are other markets such as transport, domestic use, construction, woodworking and other local rural industries.

2.1.2 Source of product designs

The majority of product designs are traditional and handed down from generation to generation. Even if the basic design is well suited to its requirements and may be the most acceptable to the

local rural community, there is still a considerable opportunity for improvement. There is, for example, at present a study being conducted which will help to provide a guide to material specification and methods of testing for road construction tools and equipment, ranging from simple visual checks to destructive techniques.

(Ref. 9).

The communication of product designs from outside the rural locality are dependent upon information services which may be by demonstrations and exhibitions, but more commonly by literature. A good example of a literature information service drawing examples from both developed and developing countries is the Appropriate Technology Journal of the Intermediate Technology Development Group of London.

In some instances the existing local designs may be inappropriate for one reason or another, and there may be no readily available alternative design which is more appropriate. In this case the decision may have to be to undertake product development, for the local need. A recent project in Nigeria piloted a sequence of activities for local rural industrial development. The first and possibly most difficult stage was product planning which included market research and product development. The second stage was to train local master-craftsmen and help them to become independent of the project. (Ref. 10, page 66).

2.2 Rural Services

2.2.1 Range of rural services

The range of services required in any one geographical area will be dependent upon many factors. These services may range from assistance to agriculture, fishing, forestry, mining, craft, manufacturing, processing and construction industries through

to transportation, infrastructural and household requirements. For the purpose of this paper, the vast range can be illustrated by a few examples from agriculture, and then to look at one example in a little more detail.

In addition to supplying products such as hand tools and other simple devices to agriculture as listed above in 2.1.1, small-scale rural light engineering industries also provide essential repair and maintenance services. These services may be given to the simple products they have manufactured themselves, such as re-shaping and sharpening edge tools, and also to more sophisticated products manufactured outside the rural area. These products manufactured outside the area cover an immense range, from equipment required for primary operations such as jungle clearing and earth moving, followed by primary tillage such as chisel, disc and mouldboard ploughing, through to the requirements for planting, irrigating, weed and pest control, harvesting, processing and finally to storage prior to sale or own use. The importance of any one repair and maintenance service can be illustrated by taking just one product manufactured outside the rural area. The product which is most common to all agricultural systems is the agricultural tractor. It has been recorded that in a developing country the repair and maintenance cost throughout the life of a tractor may be in the order of 150% of the purchase price, and although this would include costly replacements such as tyres, there is still a large proportion which would be income to rural servicing industries.

Data for cost of repairs of tractors used for farm field operations in the United States and in developing countries

Type of tractor	Repair and maintenance cost	
	Proposed for the United States	Proposed for developing countries
 Percent of purchase price ...	
Wheel-type	120	150
Track-type	78	100

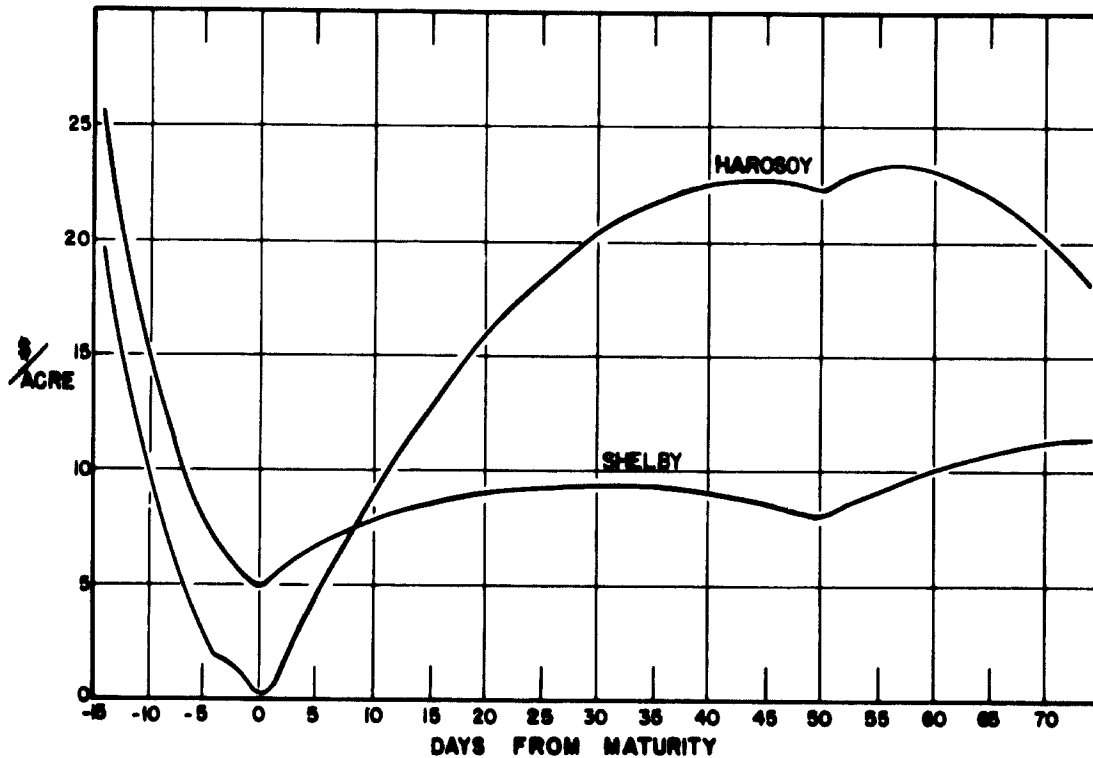
(Ref. 11, page 72).

The importance placed upon timely and efficient servicing of tractors, and hence the income effect on rural servicing in industries can be gauged from two quotations:

"Timeliness penalty costs include reduced yield from improper tillage, seedbed preparation and planting operations; losses associated with improper timing of machine operations to biological needs of the maturing plant; and any reduction in product quality that may be attributed to untimely machine operations. Some operations may have near zero timeliness penalty costs. Others, particularly harvesting sizeable acreages of highly perishable products, may have costs as high as hundreds of dollars per hour."

(Ref. 12, page 330).

Monetary loss with time by variety



(Ref. 13)

2.2.2 Sources of servicing knowledge

For those products which have been manufactured by the rural industries, there should be no real problem of maintenance and repair, but for the more sophisticated products there may be considerable problems.

The basic source of knowledge for servicing sophisticated products is a service engineer's handbook, or for major repairs, a workshop manual which is normally prepared by the manufacturer of the product. For rural industries in developing countries there are usually two major problems. The first problem is that the writers of the handbook and manuals assume that the user is

not only literate, but has also received at least elementary engineering training, for example to use a micrometer to measure the wear of working surfaces. The second problem is that the writers assume that the workshops have a range of basic equipment, and may also assume that special equipment and tools are also available.

These problems can be overcome to a large extent by training, for a trained man with an absolute minimum of facilities may be able to improvise and avoid the need for special equipment and tools. An example of servicing using the minimum of facilities is given below in 3.4.1

3. Appropriate light engineering production processes and techniques

3.1 The rural market

By the definition of rural areas, the population is relatively dispersed and therefore the markets for specific goods are also dispersed. For some products and especially those related to working with the soil and crops, there are often changes in design for essentially the same product over a relatively short distance. An example of this is the stem cutting knife (machet, cutlass, panga), used to cut sugar cane, bamboo and similar crops, which can vary in outline design although the handle and cutting edge are virtually the same length and size. The rural population is usually also relatively poorer than the urban population and hence the market demand is for relatively low cost goods. The rural market situation is, therefore, to meet a relatively small demand at a low cost.

Until the market expands, the majority of rural industries, including light engineering will of necessity use the more labour intensive techniques. This observation was also noted in a recent study on can making:

"The study on can making (Chapter 4), brings out the influence of market conditions particularly well. It is demonstrated that the small-scale more labour intensive techniques may be preferred until the market gradually builds to a level which would justify investment in a capital intensive technique".

(Ref. 14, page 318).

3.2 Factors of production

At the macro-level of an aggregated light engineering production unit it may appear that there are no capital/labour substitution possibilities, but at micro- or case-study level alternatives will become apparent. This was illustrated by a recent study on technological choice in metalworking (Ref. 15). A more detailed study of capital and labour as factors of production will reveal that neither are homogenous and that the possibilities of substitution are complex, as for example between the different levels of skills. This choice of factors of production may also vary geographically over short distances, as illustrated by construction work of a recent project in Nigeria, which experimented with laterite cement blockmaking, which is an intermediate technology between the labour-intensive all laterite method and the more expensive one using sand/cement blocks. Preliminary research showed that the optimum technology for a specific building depended on the location of the site relative to supplies of cement, sand and suitable grades of laterite,

(Ref. 10). The above observations indicate that the choice of the most appropriate factors of production and hence the most appropriate technology is often complex and not easy. More detailed examples from light engineering are given below, first for the manufacture of handtools and secondly for servicing.

3.3 An example of light engineering manufacturing: matchets

3.3.1 One-off and small batch production

Matchets are manufactured by hand in most developing countries, often under different names such as pangas and cutlasses.

The capital costs of production are relatively small for many of the manufacturing hand tools such as tongs, fullers and swages would be made by the artisan himself and he may only have to purchase the anvil and some parts of the forge. The cost of purchased tools and equipment may amount to only \$10, (Ref. 4, page 183), and with ownership of land and building may be in the region of \$200. (Ref. 7, page 56).

To equip a workshop in the price range indicated above would require very simple devices, such as an oil drum forge and anvil made from a railway line, as illustrated by a recent publication. (Ref. 16, page 24).

To improve the technical efficiency at a higher capital cost, would require a power driven forge, preferably with a water-cooled tuyere and perhaps as an added refinement, an oil bath with pyrometric control for tempering. (Ref. 17, pages 23, 24 and 93).

The typical labour force is composed of a mastercraftsman (blacksmith) and two or three assistants. With this labour force it is possible for them to produce 10 to 20 matchets a

day, which is usually far in excess of their local market requirements.

The cost of the final product is usually far less than a mass produced matchet, but the quality of the steel and the quality of the heat treatment is also usually less if the smith has access to only scrap metal and the simplest equipment.

Technically the one-off and small batch produced matchet made by simple equipment is usually inferior, although it may be to a more acceptable local design than mass produced matchets.

With a suitable Industrial Extension Service and improved equipment, this technical disadvantage could be eliminated.

Economically and socially the lower-priced, local-made matchet may be the only possible purchase for low income rural workers; and may be one of the few products which enables the village blacksmith to continue in business and ensures his services for the local households and farms.

3.3.2 Batch production

This form of production is relatively rare in both the developed and developing countries for it has difficulty in competing for either the mass market or for the local market for specific designs. To replace assistants using sledge hammers will require plant such as pneumatic hammers, which cost in excess of US \$10,000 each. An added problem is that the labour must be highly skilled and capable of working with precision at high speeds for sustained periods of work.

3.3.3 Mass production

It is possible to buy in blades which have been forged, hardened

and tempered, and are ready for polishing, sharpening and fitting with a locally made handle.

The minimum size plant for finishing only would be for an annual production of 300,000 and capital requirements would be in the order of US \$100,000 for fixed and working capital. To produce the machetes from blanks would require treble the above estimate, and both estimates are clearly beyond the definition of small-scale industry. (N.B. This data was collected by the author in preparation for a recent report to UNIDO entitled: "Technological profile on the manufacture of agricultural hand tools".)

3.4 An example of light engineering servicing: engine repair

3.4.1 Using equipment of minimum cost

Let us assume that the engine must be lifted out of the vehicle and then stripped down to component parts.

On some vehicles it may be necessary to lift the engine vertically and this can be achieved by utilising a fixed overhead point, which may be a roof joist, or even a tree if it is considered to be sufficiently strong. In the absence of an available overhead point, shear legs can be constructed from steel pipe or other sections which will not bend, or large strong timbers. Even at this very first step it is clear that there are a wide range of alternatives.

When stripping the engine, no economy should be made on various types of good spanners, for ill fitting spanners will damage nuts and bolts, and ^{even} if successful in removing the nuts and bolts, may not replace them sufficiently well for a technically acceptable finish. On other operations it may be quite acceptable to

improvise with simple home made devices, such as locally made wheel pullers, which will remove wheels without damage to the wheel and shaft, although the life of the puller may be less than a more expensive one from a specialist manufacturer.

Other cost saving devices will be known to experienced mechanics, such as a piece of wood with a vee cut in the end to replace a valve spring compressor. The decision on which technique to use should be based on the premise that the technical standards must be sufficiently high to ensure a technically successful service and that costs are saved at the expense of time only.

3.4.2 Using modern workshop equipment

The amount of capital which can be utilised in vehicle servicing is immense, and can range from high pressure water cleaners, through to equipment for manufacturing or modifying component parts, (Ref. 18, pages 27, 28).

Following the first example given in the preceding section, to lift an engine vertically may be achieved by either an overhead crane running on fixed joists in the roof of the workshop, or a portable crane on three wheels which may also have jacks to raise the wheels clear of the ground during the lifting operation. The actual lifting may be powered by an electric motor and controlled by a remote control push button switch.

3.5 Sources of technology

3.5.1 Sources of technological design

In some cases the small-scale rural light engineering industries may look to original research and/or development in their own country, but the major source of appropriate technologies are

likely to come through adaption, as illustrated in a recent paper.

"The Japanese techniques (of can making) are important because they show that efficient techniques can be found which are more labour-intensive than newer capital-intensive ones, but which can produce at a much lower private as well as social cost. These techniques are interesting also because they seem to be up-to-date variations of techniques which were used in Europe and the United States in the 1920's or before. These modern techniques, derived from older technologies, can be used to make high-quality products. They have been developed in countries where wages are low by comparison with those now paid in the United States and Europe." (Ref. 19, page 106).

3.5.2 Available sources for rural industry

For the rural industrialist there is an immense problem of restricted knowledge. The knowledge available tends to be restricted to equipment and tools which are retailed by a local agent, which in many cases are imported capital intensive technologies. To look beyond this narrow range of knowledge requires considerable effort, such as obtaining names and addresses of alternative manufacturers, which in many public libraries will be foreign manufacturers of capital intensive technology. In this situation many rural industries are faced with a choice of utilising the available local technology, or to buy from a foreign source which has been selected almost by chance of circumstances.

A recent report of a study of the engineering industry in Colombia supports the view that increasing effort should be made

to establish local sources of appropriate equipment and tools.

"An indigenous capacity for machine fabrication and some degree of development of the engineering industry as a whole are virtually essential if labour-intensive technical change is to be generated in developing countries. No attempt to increase labour intensity is likely to be successful unless it is accompanied by technical change in the labour-intensive direction. The development of a local capital goods sector is required, first in order to supply light machines for the small-scale informal sector as well as for the modern sector. Secondly, it facilitates the introduction of new machinery designs and of labour-intensive technologies and processes that are more suited to the local factor endowments of the developing country. In the absence of industries producing capital goods, the range of technical choice will tend to remain narrow."

(Ref. 20, page 241).

The above report also found that the manufacture of machinery is one of the more labour-intensive branches of industry, and that this manufacturing can be carried out on a small scale. In order to establish local manufacturing capability there is a strong case for collaborating with established manufacturers who in many cases may be foreign and already have a share of the market. This collaboration may be one or more of a range of possibilities, such as:- paid advice, consultancy for part or all of the project as in a 'turn-key' project, licencing, joint venture or partnership. The high quality of many products

manufactured in developing countries can be attributed to foreign collaboration. (Ref. 21, page 35).

4. Constraints to growth

4.1 Growth sectors

There are, no doubt, opportunities for growth utilising appropriate technologies in virtually every rural area of developing countries. In the 'rain-fed' and drought areas there is considerable potential for reducing rain run-off through measures such as chisel ploughing, retaining rain run-off by bunds, dams and weirs, and then utilising the water in the best way, perhaps by micro-land levelling. In the flood prone areas where there may also be a shortage of timber, opportunities exist for developing flood control measures, flood free buildings and communications, clean water supplies and alternative sources of fuel, such as bio-gas.

In order to meet the demand for rural industrial development there is a need to help reduce four major areas of constraint: information, skills, infrastructural services and organisations.

4.2 Constraints of information

For the rural manufacturing industrialist one of the first constraints he faces is a poor communication of market information. Within his immediate locality he may be well aware of market requirements for established products, but the possibilities of expansion and/or diversification are unknown. Even if he is aware of market opportunities he may still be unable to obtain or develop new product designs.

Similar information problems face the rural servicing industrialist. Each major piece of machinery, from small items such as an irrigation pump through to large items such as a bulldozer, will have servicing and workshop manuals; in the case of a pump it may be a few pages and in the case of a large earth moving machine, it may be several volumes with one volume for the engine, another for the hydraulic system and so on. In this situation it is almost impossible to expect each and every servicing centre to have a library of information for all the makes and models of machines which may require servicing.

This problem of servicing is of course, aggravated by the use of capital intensive technologies which are also usually complex and sophisticated. A recent paper outlines some eight points as to why developing countries import and use 'inappropriate' technologies, and concludes:

"All these points combine into a powerful argument in favour of capital-intensive technologies, often reinforced by the policies of multinational undertakings, by foreign aid programmes and by powerful private domestic interests."

(Ref. 22, page 49).

4.3 Constraints of skills

This appears to be a second major area of constraint, for even where information is available the local entrepreneur may have considerable difficulty in achieving success. At the lowest educational level, there is often a lack of modern manual skills to supplement the often high traditional craft skills.

A simple example of this is in tool grinding for metalworking machine work; although a tool may remove metal to its profile as in screwcutting on a lathe, to achieve the best finish and minimise the load on the lathe, it is essential to grind the tool to the correct rake and clearance angles for the specific metal being machined. At the highest educational level of technology and management, there are also limitations of skills; one recent paper reports:

"quantitative skills and perceptions. In a remarkable number of cases the owner/managers failed to recognise or were willing to tolerate anomalies and inconsistencies which seriously impaired profits or incurred losses. Unprofitable activities persisted despite clear signals of their existence. Readily available information which pointed to profitable changes in procedures or functions was either missed or ignored."

(Ref. 23, page 95).

Another recent paper suggests that to help overcome the problem of limited skills:

"In case of lack of response from local entrepreneurs, the state should start a few industrial units on its own and sell them to the entrepreneurs, once they start to yield profits."

(Ref. 24, page xii).

This advice is fraught with problems and contrary to the experience of a recent project in Nigeria:

"The second general observation is that in regions which, like the project area, have been drained of their more able

"people, enterprises should not be developed beyond a scale manageable by the local population unless government is prepared to provide managers for as many years as may be necessary. The project assisted the smallest enterprises by means of training, extension and common facilities but at no time took over responsibility for management; these undertakings are still working successfully without regular assistance. At the other extreme, the project started a small to medium-scale furniture factory employing between 30 and 50 people and managed by a government officer. Although the factory is successful and profitable, the workers are incapable of taking over its management and it will, therefore, continue as a government concern for the foreseeable future. In between these extremes, the project encouraged the formation of group farms, and, in due course, a co-operative agro-industrial complex. As only one product and two by-products are marketed, the management tasks are not too complex, and although the local government is still providing managers for the time being, there is every likelihood that in two or three years the co-operative will be able to take over full responsibility." (Ref. 10, pages 63, 64).

4.4 Constraints of infrastructural services

There is little doubt that all would agree that the infrastructure is of high importance and a recent paper has identified it as the major constraint.

"The implications are that an absolute pre-condition for a rural industrial development programme is that an infrastructural development programme is initiated simultaneously. We would even go as far as asserting that the infrastructural development programme is the more important programme and therefore needs to be a step ahead of the industrial development efforts. This is so because we have been convinced that the existing craftsmen are skilled and capable of developing themselves and their technology, given improved common conditions of production." (Ref. 6, page 35).

4.4.1 Financing

A very common complaint among small-scale industrialists is that they are short of both working capital and capital equipment. Observations at the firm level suggest that the contrary is often true, (Ref. 23, page 91), and a recent experiment in Nigeria indicated "that more capital equipment is not necessarily the 'open sesame' to increased production and sales" - and "the alternative approach of planning and marketing new products for the metalworking master-craftsmen produced more significant results".

(Ref. 10, pages 66, 67).

Although many proposals are made for easing financial arrangements for small-scale rural industries, (Ref. 1, page 17, and Ref. 4, page 84), the actual constraint is often knowledge as identified in a recent study in Bangladesh.

"Virtually untapped sources of capital for the individual industry enterprises, are the Divisional Development Boards

"which have money to invest in co-operation with the entrepreneurs. The main problem is the inability of cottage industry entrepreneurs to put forward feasible proposals". (Ref. 7, page 19).

4.4.2 Materials supply

One of the greatest constraints to rural industries is the shortage of materials, and to overcome this shortage many are forced to work with inferior materials. This problem has been illustrated by a recent paper from the Philippines:

"- Most of the deficiencies of hand tools made in small rural workshops are related more to lack of suitable materials and facilities than to any shortcomings of craftsmanship.

- The metal used to make planting hoes, brush hooks, and debarking spuds is not uniform from one piece to another. Discarded leaf springs from motor vehicles are the principal raw material, and these originate from different and unknown sources. In general, the silicon content of most spring steels is too high to make a blade that can be kept sharp with a file, and that will not crack or split under hard use. Although perfectly adequate for traditional bolos and knives, spring steel is not as satisfactory in fulfilling the more rigorous demands of planting hoes, brush hooks, and debarking spuds, all of which are subjected to greater strain.

- It is not evident that small workshops would be able to take advantage of economies of scale for production in large quantities. Handling is on a piece-by-piece basis,

"and this individuality is particularly accentuated in view of the heterogenous materials used."

(Ref. 8, page 111).

The above paper continues with a recommendation for the purchase of uniform batches of metal. A similar plea for bulk-purchase programmes for raw materials is made in another recent paper from Kenya. (Ref. 25, page 45).

In addition to facilitating a raw materials supply, consideration should also be given to the essential consumables which may have to be imported, such as high speed steel twist drills and milling cutters. A recent study in Bangladesh also observed this need for other rural industries:

"Often the major constraints were relatively minor miscellaneous imported items such as good quality cotton thread, scissors, machine and hand needles and spare parts for sewing machines."

(Ref. 7, page 18).

4.4.3 Common facilities

The paper from the Philippines quoted above combines a request for the purchase of uniform batches of steel having a known composition and specifications suitable for the intended purpose, with a request for final heat treatment of the pieces so produced in an electric furnace or similar facility on a co-operative or sub-construct basis. This second request is based on the following observation:

"- Without proper analysis of the metal or quality control other than subjective trial-and-error, existing methods of heat treatment in an open flame make some of the pieces

"too brittle and leave other pieces too soft. Sometimes a single piece may be both too brittle and too soft in different places. The rural workshops do not possess - nor can they justify as individual small-scale producers - the facilities and equipment ideally suited for final heat treatment of the metal at very high controlled temperature (such as in an electric furnace)."

(Ref. 8 pages 111-112).

The world-wide experience of common facility centres appears to be very mixed, some report moderate successes (Ref. 10, page 68), others report fundamental problems of management, (Ref. 25, page 45), and some report inactive centres (Ref. 7, page 17).

The answers would appear to be careful planning at the feasibility studies stage, and good continuing management.

4.4.4 Industrial estates

Industrial estates are essentially integrated infrastructural institutions in specific geographical locations providing land, buildings, access roads, drainage etc., on a rental basis, and supplies of electricity, water and perhaps gas on a metered purchase basis. Other infrastructural services may include an advisory service, banks and post offices. In turn, the above may attract private enterprise services such as toolmaking, and repair and maintenance specialists.

The title 'industrial estate' suggests a rather large area of land and partly to counter this impression, some alternative names have been introduced such as 'Industrial Promotion Areas' (Ref. 24, page 37), and 'workshop clusters', (Ref. 2, page 38).

As with common facility centres, the world-wide experience of industrial estates in rural areas is very mixed, and the key to success may once again be careful planning and good continuing management. (Ref. 26).

4.4.5 Marketing

A summary of the situation in Bangladesh reflects the situation for many small-scale rural industries throughout the world:

"Local sales are usually through private enterprise's middlemen and/or shopkeepers, whilst export sales are through a wide range of bodies from private enterprise to voluntary groups. There are at present virtually no marketing services for cottage industry entrepreneurs although there are limited services for exporters. Equally there is no systematic market research for handicrafts and other cottage industry products either in the local or in the foreign markets."

(Ref. 7, page vii).

Another recent report from Kenya mentions the success of direct assistance to groups of rural craftsmen to enable them to get orders, such as through tenders, (Ref. 25, page 45). Many large wholesalers in developing countries may be persuaded to give some preference to rural industries, as reported from a project in Nigeria:

"It should be placed on record that one large firm gave preference to rural producers for goods of equal specification and price."

(Ref. 10, page 66).

4.5 Constraints of infrastructural organisations

Two important infrastructural organisations which can help to promote small-scale rural industries are youth clubs for those at school and perhaps in the transitional stage to adulthood, and industrial co-operatives for adults.

To organise and manage these organisations requires both professional skills and dedication, as illustrated by the following quotations:

"Combining the collective manufacture of goods with a system of regional distribution under the control of the producers themselves has proved to be a most necessary and effective way of coping with competition from outside industrial products. The experience of the People's Collective Industries suggests however, that co-ordinating these two functions within a single organisation is a difficult task. The distribution function becomes particularly complex once the organisation expands into the national market, where competition is stiffer and the infrastructure required to sustain a marketing effort by a collectively run organisation is largely lacking."

(Ref. 27, page 61).

"The desertion of qualified cadres (from co-operatives) to enterprises at a higher concentration level is a difficult problem which small industry has to cope with."

(Ref. 28, page 11).

A sensible summary of the role of industrial co-operatives related to small-scale rural industries is given in the same paper.

"Industrial co-operatives in developing countries must expand along ways corresponding to the economic, social and cultural levels of each country. It is necessary, in many countries, to start with simple forms of co-operation. The implementation of co-operative forms must be very flexible, one has to accept elements that are feasible from a pragmatic point of view and not rigid principles that could be appropriate in developed countries."

(Ref. 28, pages 31-32).

5. A policy for appropriate and balanced growth

5.1 A conceptual approach

A concept which should be dispelled first, is that a policy or series of policies can be designed to meet the needs of all rural areas in all countries. At a recent UNIDO meeting of rural industrial development experts from a wide range of countries and experience, it was agreed that:

"Each country must design and construct its own strategy, preferably with plenty of opportunities for the trial of new approaches, according to its own objectives and the means at its disposal."

(Ref. 29, page 8,
para. 28).

Small-scale rural industrial development is so closely interwoven with all the other sectors of rural life, that it must be considered part of an integrated approach to rural development. This entails integration in national macro-planning, district level micro-planning, field level integrated rural development projects and the rural infrastructure.

A second concept is that small-scale rural industrial development should be a long-term venture, if the rural industries are to become self-sustaining and continuing enterprises. This is particularly true if the long-term objective stresses assistance to the younger generations, both male and female - as recommended in a recent paper by the author, (Ref. 10, page 68).

A third concept which is proposed is one of helping people to help themselves. This can be applied equally to field-level services assisting individual rural industrialists, to national services backing-up the field level service staff, and international technical co-operation supporting both field-level and national level service staff.

The final concept advocated in this paper is that appropriate technology should be a priority goal for policy makers of developing countries which have a large number of rural poor. It has been suggested in a recent report that government policy should attempt to improve both the feasibility and availability of appropriate technology. (Ref. 22, page 52).

5.2 A specific action programme

5.2.1 A national programme

For the purpose of this brief paper it is convenient to divide a national programme into three parts - national policy,

national services and field level services.

A number of recent reports have emphasised the need for suitable policies which will assist the growth of small-scale rural industries and appropriate technology, through, for example, the removal of legal constraints, (Ref. 23, page 107), redesign of fiscal measures (Ref. 22, page 53), and the introduction of technical skills and their appreciation into the general educational system. These policy measures are fundamental to an environment in which rural industrial development may take place, but equally important are the services to small-scale rural industry.

In order to organise and support a field level service, it is essential that there is an adequate national service. This may be comprised of four main components:-

- (a) Management and administration
- (b) Market research and product development services
- (c) Appropriate technology research and development services
- (d) Training programme development services.

These components have been discussed at length in many sources of literature, such as a regional technical meeting of ILO, in collaboration with UNIDO and ESCAP. (Ref. 30).

The third component of a national programme is the provision of field level services which will actually reach down to assist individuals engaged in small-scale rural industrial development. Field level services can be considered under four main activities:-

- (a) Extension services to non-factory rural industries,
(e.g. cottage industries).
 - (i) Mass contact
 - (ii) Group contact
 - (iii) Individual contact
- (b) Services to factory rural industries.
 - (i) Advisory services
 - (ii) Consultancy services
 - (iii) Training services
- (c) Infrastructural services
 - (i) Financing
 - (ii) Materials supply
 - (iii) Common facilities
 - (iv) Rural versions of industrial estates
 - (v) Marketing
 - (vi) Management information
- (d) Infrastructural organisations
 - (i) Youth clubs
 - (ii) Industrial co-operatives

5.2.2 An international programme

For many developing countries the one major constraint to implementing or expanding any national programme for the development of small-scale rural industry, is the shortage of trained and experienced personnel. In order to overcome this problem there is a need for a massive training programme, to help train the national trainers, and then to assist these trainers within their own national training institutions.

The national trainers could be trained in a whole range of activities necessary for rural industrial development, and then by selecting suitable modules, specific courses could be given in their national training institutions, such as for:-

- (a) District level planners
- (b) Integrated rural development project managers
- (c) Rural industrial development national organisers
- (d) Rural industrial development field organisers
- (e) Rural industrial development extension officers
- and (f) Rural bank officers, etc.

An important and major part of the training course would be in-the-field project work and/or on-the-job training.

The second major constraint which might be assisted by an international programme is the availability of information. This problem might be met by applied research to collate information on small-scale rural industry and appropriate technology in particular, followed by information and advisory services. Although there are some organisations collecting information in often specific and limited ranges of rural industry there is still great difficulty for a national service officer in a developing country to obtain specific information on a specific appropriate technology for any specific rural industry. There is, therefore, a great need for improved facilities for the flow of information between developing countries and from developed countries.

5.2.3 Designing and implementing action programmes

A recent assessment of international technical co-operation projects designed to promote small-scale rural industrial development has drawn three important conclusions which should be borne in mind by future action programme designers:-

- (a) Project management
 - (i) "the necessity for care and luck in the recruitment of experts."
 - (ii) "autonomy from political interference and bureaucratic struggles."
 - (iii) "the timely provision of inputs."
- (b) "The relatively successful projects have generally sought to provide a single missing ingredient or to remove a single bottleneck."
- (c) "Large scale multi-expert projects seldom work well" because of:-
 - (i) attempts to build new capacity, which in turn, attracts (ii)
 - (ii) increased outside interference
 - (iii) severe management problems.

(Ref. 31, pages 351-352).

Following the careful design of an action programme which might include several projects, there is a need for considerable skill and experience in the implementation. This was brought out in the conclusion to a recent paper, which stressed the many factors and especially human factors of power, contacts and wealth which

can influence decisions. The paper concludes:

"The only way in which administrators can function is by recognising the realities of the situation, and indeed by utilising them and by incorporating them into their own activities. Any attempt to bolster the egalitarian aspects of the programme by re-designing the rules of access or distribution would be futile, given the existing structures of power."

(Ref. 32, page 51).

6. Conclusion

Small scale rural industries can make a major contribution to assist the poor and especially the landless, in the rural areas of developing countries. At present, the amount of assistance given by national and international programmes is relatively negligible, and from the author's experience, virtually all rural industrial activities at the field level in developing countries are without adequate direct government assistance. If a modest start is to be made to help provide some additional employment and incomes for the poor of rural areas through non-farm activities, a massive training programme must be started now, and supported by adequate information services, at both the national and international levels.

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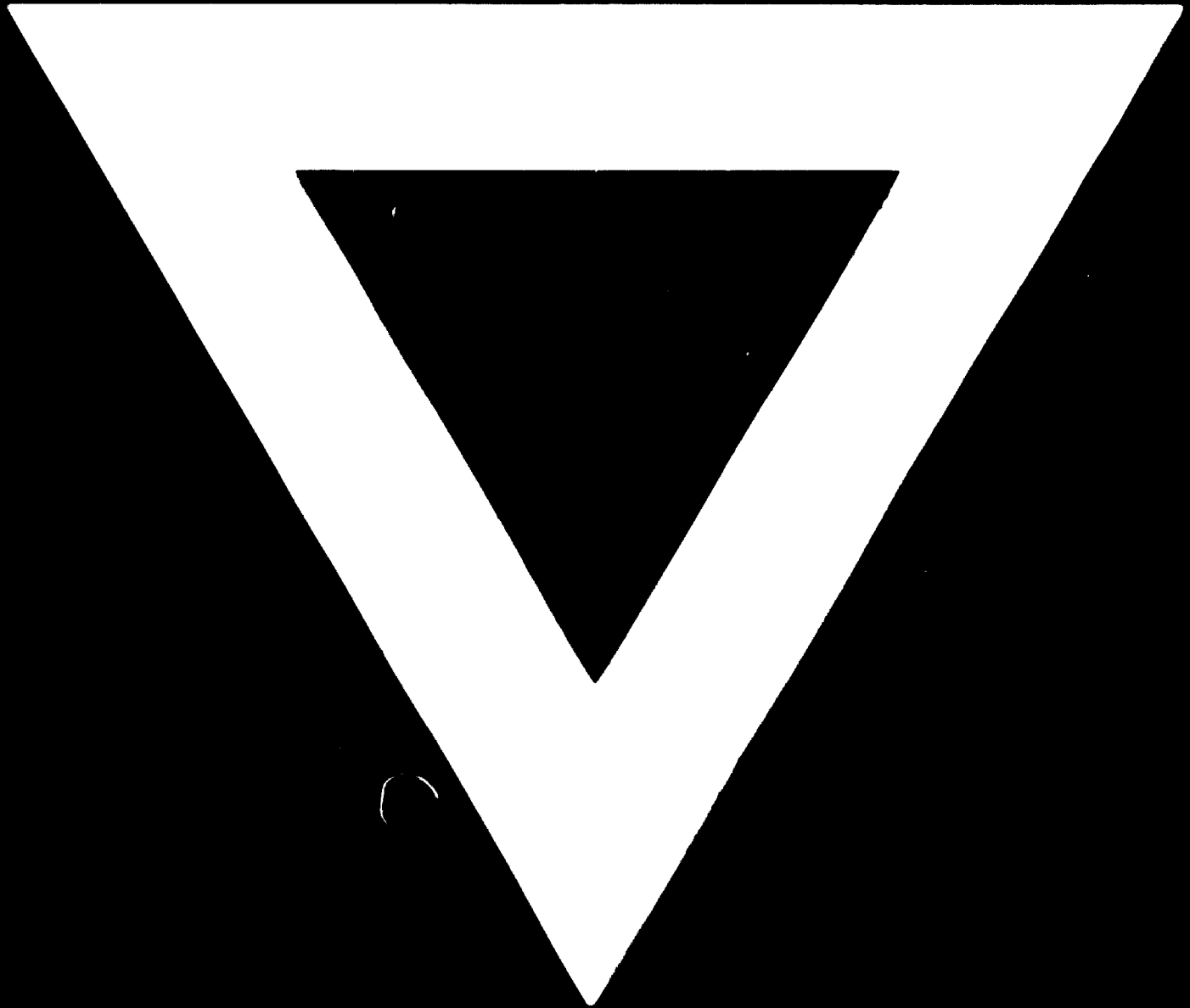
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