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ASSISTANCE IN THE ESTABLISHMENT OF A
PILOT GEMSTONE PROCESSING UNIT

XP/ETH/86/063/11-52

ETHIOPIA

Terminal report

Prepared for the Government of Ethiopia
by the United Nations Industrial Development Organization

Based on the work of James F. Pollard,
expert in lapidary industry

404

Backstopping officer: H. Yalçindag, Chemical Industries Branch

Explanatory notes

The monetary unit in Ethiopia is the birr (Br).

Besides the common abbreviations, symbols and terms, the following have been used in this report:

EMRDC Ethiopian Mineral Resources Development Corporation
ESLC Ethiopian school leaving certificate

Mention of the names of firms and commercial products does not imply endorsement by the United Nations Industrial Development Organization (UNIDO).

ABSTRACT

Following a request by the Government of Ethiopia for assistance in the establishment of a pilot gemstone processing facility, the United Nations Industrial Development Organization (UNIDO) approved the project "Assistance in the establishment of a pilot gemstone processing unit" (XP/ETH/86/063) on 2 April 1986 and an expert in lapidary industry was fielded on 12 September 1986 for an assignment of three months.

The expert evaluated the data and information on the availability of gemstone materials and assessed their suitability for establishing an export-oriented lapidary industry in the country. He further examined the viability of promoting a small-scale industry which will generate foreign earnings through the export of gemstones cut to international standards and suitable for use in jewellery.

The report contains detailed recommendations for the establishment of a workshop to train local people in gemmology, lapidary and marketing, as well as for the equipment, accessories and expertise needed to carry out such a programme. Since local geologists are capable of exploring and proving known deposits of gem materials, this work should be undertaken without delay. In the meantime suitable premises should be obtained and an initial stock of quality raw material amassed.

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INTRODUCTION

At present, the economy of Ethiopia is totally dependent on the revenue generated by the agricultural sector. In order to avoid such dependency on one economic sector, the country must, inter alia, strengthen the performance of the mining sector, which, until now, has not played a significant role in the overall economy, primarily due to the lack of skilled personnel and financial resources.

In view of the above, the Ethiopian Mineral Resources Development Corporation (EMRDC) who is responsible for the commercial exploitation of natural resources, has taken steps to establish an industrial base for the promotion of the mining and gemstone-processing industries and requested the United Nations Industrial Development Organization (UNIDO) for assistance in the establishment of a pilot gemstone processing unit. The project "Assistance in the establishment of a pilot gemstone processing unit" (XP/ETH/86/063) was approved on 2 April 1986, and the expert in lapidary industry took up his assignment of three months on 12 September 1986.

Within the overall objective of the project to create a core facility for the exploration, beneficiation and testing of gemstones in the country, the expert in lapidary industry was to assist the Government, through EMRDC, to identify locally available gem materials, to determine the resource base, and to assess their suitability for establishing an export-oriented lapidary industry. In addition, consideration was to be given to the design and manufacture of jewellery to internationally acceptable standards, containing locally produced gemstones.

Whilst it is realistic to establish a pilot plant to cut gemstones for the international market, it is considered premature to establish a jewellery-manufacturing facility. In-depth training must be undertaken in all aspects of lapidary, factory management and marketing. When this has been achieved, and future viability confirmed, then consideration can be given to diversification and expansion.

The faceting division should be established first, followed by a bead-making division. This will provide a sound base from which to gauge progress, and will generate much needed foreign currency, with minimal outlay for capital equipment.

RECOMMENDATIONS

1. Phase II of this project should be undertaken and a pilot plant for the faceting of gemstones established. Other aspects of gem cutting should be deferred until the viability of the faceting division is proven.
2. Buyers and other project staff should receive immediate training in the purchase, grading and orientation of gem materials.
3. Premises should be allocated, or a new building prepared, to coincide with the arrival of equipment and accessories.
4. Adequate training should be provided when equipment has been delivered.
5. Known deposits of gem material should be explored and developed as soon as possible, to ensure continuity of supply and a variation in the product range.
6. At least two members of the planned project team should undertake a correspondence course in gemmology, from either the United Kingdom of Great Britain and Northern Ireland or the United States of America.
7. A revision of stock recording and valuation should be undertaken, and the procedures for the release of raw material to project staff should be streamlined.

I. GENERAL ASSESSMENT OF THE PRESENT SITUATION

A gemstone is usually defined as a mineral that because of its beauty, durability, and rarity, is used for adornment. This definition, of course, includes diamonds, rubies and sapphires. In Ethiopia the transparent variety of olivine, known as peridot, is available in limited quantities in addition to garnet. Deposits of beryl (which include emerald and aquamarine) and corundum (sapphire and ruby), are known, but not explored.

Many other stones used in adornment are more plentiful, less beautiful and of lower value than those above. These are referred to as ornamental stones. Agate, chalcedony, jasper, petrified wood and malachite are some of the stones available, but so far there is no information as to their quantity and quality.

Estimates of reserves of olivine for industrial purposes have been prepared, but are of little value for the gemstone project. The discovery of gemstones depends essentially on traditional prospecting methods, and the assessment of reserves is rarely meaningful because of the sporadic occurrence of stones within deposits and the scarcity of regional prospecting information. Exploration is in the most part left to individual miners or fossickers who have little interest in large-scale development.

A. Occurrences and raw material

The main locations for gemstone mining in Ethiopia are in the Sidamo province, about 500 to 600 km south of Addis Ababa, and in Shewa and Welo north of the capital.

Olivine is found in lava flows which are basaltic in their composition. The gem material is usually secreted in boulders of fist size and larger, and must be split open to extract the prize. Some of the material may be fractured, rendering it worthless. In other cases the material may be heavily interspersed with foreign substances or voids.

Only "eye clean" material of blocky shapes, and with a minimum weight of one gram, is suitable for commercial cutting. As there are no experienced cutters in Ethiopia, and larger cut stones fetch a higher per carat price, the most desirable material for this project would have a minimum weight of three grams per piece. To ensure sufficient rough stone for the first year of operation, 10 to 12 kilograms of suitable faceting material should be collected.

To utilize the second-grade peridot, it is recommended to manufacture beads and to tumble-polish stones for "gem trees". It has been suggested that the balance of the olivine production is suitable for abrasives. This view is not shared by the expert, as the hardness of olivine is less than that of traditional abrasives, quartz and garnet, and approximately the same as that of glass. The cost of collection, transportation and marketing would remove all viability.

However, EMRDC has been successful in finding an alternative use for the discarded material. If this market can be developed, then whatever price can be achieved will be a significant contribution to the overall budget of the Corporation. The gem material should be costed to reflect all expenses of buying and transportation to the cutting plant.

B. Field trip to Sidamo province

In order to become better acquainted with the existing situation, a field trip was arranged to the major gem areas, a detailed report of which is reproduced in annex I.

The corundum deposit which was discovered should be explored fully and its potential assessed. Despite many excursions to new areas, no new fields of significance could be located in the time allotted.

The buyers are operating under very difficult conditions. Their training and experience with gemstones is very scanty, and the usual tools of trade are not being provided. It must be realized that the success or failure of this venture depends upon the quality and suitability of the raw material. In most gem cutting factories around the world, the buyers are either principals, or very experienced personnel who have had cutting practice. Every effort must therefore be made to ensure that the personnel who are selected to buy on behalf of the Corporation, receive adequate training and assistance, particularly during the initial stages.

C. Current staffing

There is no evidence of gem cutting in Addis Ababa at the present time, although one man, who has had extensive experience in the jewellery trade and was trained for some years in India, is employed by EHRDC. He has operated faceting machines and is aware of current techniques. A limited amount of training would be required for him to become fully conversant with modern machinery, and this would enable him to assist in the training of production workers.

A geologist has been assigned to this project and it is expected that she will study gemmology, in addition to undertaking exploration and development work in known gemstone deposits, and locating of new gem materials.

D. The Italian proposal

In 1985, a joint venture proposal by Italian lapidaries suggested that a project to develop a gem industry should be divided into three stages over a four-year term:

- (a) Mine prospecting and exploitation. Sale of some rough stones;
- (b) Establishment of a factory and staff training;
- (c) Expansion to jewellery making and marketing of finished products.

By arranging for the sale of raw material in the initial stage, funds would have been provided to assist in financing the purchase of machinery. However, the size of that venture would entail huge sourcing and training expenses, in addition to a large workforce. No viability study has been prepared, and it is difficult to understand how the large volume of turnover that would be necessary to achieve profitability could be reached.

Following the joint venture study, the machinery listed below was forwarded by the Italian partners for the benefit of EHRDC:

- 1 faceting machine with a spare cutting head. This unit is directly driven by a 0.8 hp motor, and has a vertical 150 mm lap plate
- 2 sintered diamond laps, 150 mm, both fine grade. One is in reasonable condition, but needs cleaning. The other requires redressing
- 1 copper lap, 150 mm, which requires redressing
- 2 copper rings, 150 x 38 mm. Both require redressing
- 1 lap base plate, 150 mm
- 1 alcohol lamp
- 1 box of two-part epoxy resin
- 1 box of red adhesive wax

In general, the above items have been neglected. The faceting machine needs an overhaul to ensure its efficiency and accuracy, and as it is not of conventional design, no one is available to instruct on the correct method of operation. It would be a matter of trial and error. If the laps were reconditioned, they could be used on any faceting machine. Apart from these items, there are no other machines or accessories available.

E. Machinery and equipment

It is suggested that conventional machinery be installed so that instruction and training will not be too specialized and a greater selection of text books available for reference, should the need arise. For detailed recommendations concerning equipment and accessories, refer to annex II and for a listing of suitable suppliers see annex III.

F. Current stock

A thorough grading of all stock on hand is required, as well as a complete recosting. Many different parcels, containing stones of varying degrees of quality, are stored according to purchase and have not been amalgamated. Consequently it is difficult to determine the exact cost price of a particular quality. A suitable costing procedure is explained in annex IV.

All material should be graded into faceting quality, bead quality, and discard. Uniform prices must be determined. The under- or over-absorption of costs can be reflected in the accounts at the end of the year.

The results of an examination of the stock are detailed in annex V. It was surprising to note the small size of the material and its low quality.

Although the Italian lapidaries who visited EMRDC in 1985 selected large-size peridot, only four pieces were left over. It was later revealed that 3,151 grams of quality rough stone had been exported, thus partially providing a reason for the expert's concern over the poor yield resulting from such a venture.

II. DEVELOPMENT OF A GEMSTONE INDUSTRY

A. Stage I - Faceting

It is suggested that the setup of a faceting division, together with gemmological training, be the first stage of development. As there is no experience with gemstone industry in Ethiopia, it is considered wise to first train the personnel in basic gemmology and later in the practical aspects of gemcutting.

The aim of faceting is to produce, all over the stone, a symmetrical geometric array of polished flat surfaces (facets), which are appropriately angled to reflect brightly the light which passes into the stone and adopts its basic colour. Angles and position of facets for all common styles of cuts have been published, so that faceting becomes a matter of following numbers by rote and judging the depth of cut. Diamond impregnated metal laps are used for working the material, using diamond pastes or dust of differing sizes for grinding and polishing.

The techniques of faceting on a calibrated machine can be developed relatively quickly, but it requires a considerable degree of experience and skill to produce on an economically viable basis.

Although faceting is a skilled job, only a small part of that skill is required in the actual cutting and polishing of the facets. The most skilful part is "reading" the rough material to determine how to cut the stone to maximize the return, and still produce a well proportioned, pleasing and commonly accepted shape.

A quantity of olivine containing the faceting material - peridot - is available in the EMRDC stock. As the processed value of the peridot is higher than other gemstones on hand, this material should be cut first. Coupled with the fact that the faceting equipment and accessory cost is under \$US 30,000, this division should be self-supporting in two years, and recovery of all outlay, including the gemmological equipment, should be achieved within four years. A detailed cost study is contained in annex VI.

Other aspects of the industry can be introduced when the staff are competent to handle new work, and when the raw material is in stock. A full cost study, including a marketing programme for the new products, should be detailed before the machinery is purchased.

Although the premises for the new project have not yet been defined, some grading of the current stock should be commenced. The buyers, the geologist assigned to the project, and the supervisor, should all receive comprehensive training in grading and stone orientation. The tumbler which is on loan, should be put into operation to tumble-polish as much raw material as possible. This will make the initial grading much easier, and will enable staff to gain valuable experience without the pressure to keep ahead of production. It will also provide a correct value of the stock for accounting purposes. The proposed workplan is reproduced in annex VII.

Once the building will be available and the machinery and gemmological equipment delivered, 14 people should be employed on a trial basis. The aptitudes of that initial workforce for the tasks involved should be ascertained and, if necessary, a change in occupation effected, or, in some instances, their services terminated. Staff should be trained in all aspects of processing, and initially the aim would be to have two graders, one

calibrator, one trimmer, and 10 faceters. This will leave two faceting machines free, one for the instructor, and one for the supervisor. At the end of the first three months of operation, further two cutters should be employed to fully utilize these machines. If considered necessary, two more people may be employed to ensure a smooth running of the venture (see annex VIII for staffing levels and annex IX for the flow chart). It is envisaged that gemmological training would be given each weekday, with revision on a regular basis. A suggested training programme is detailed in annex X.

B. Bead making

Part "A" of the bead-making division could be started as a bi-product of the faceting division. The purpose is to utilize the transparent material which is not suitable for faceting, but too good to be discarded.

After primary selection of the faceting material, the remaining stock should be tumble polished. In the tumbling process, the waste material will be worn away with abrasives, and the remaining baroque shapes will have a polished surface. Through this surface it will be possible to clearly view the stones internally, and a more accurate re-grading can take place. More stones suitable for faceting will be found from that stock than first thought possible.

The balance could be drilled ultrasonically (equipment cost \$US 6,600), and sold loose strung in lengths of 400 mm and 450 mm. Depending on colour and size, prices achieved would range from \$US 2 to 5 per string. The sale of 4,000 strings should recover capital and operating costs.

Part "B" of this activity would require additional machinery to manufacture spherical beads to exact millimetre sizes.

In addition to peridot and garnet, opaque materials such as quartz, jasper, chalcedony, petrified wood and agate would be processed. Loose strung lengths would range in price from \$US 3 to 10 per string. The required staff would include one trimmer, one lapper and one tumbler operator.

However, the cost of round bead-making machinery is expensive, and the selection and preparation of suitable material time consuming. Under these circumstances it would be considered prudent to introduce this stage of development at a later date.

C. Stage II of development

This stage of development would be concerned mainly with processing ornamental materials into cabochon shapes and polished slabs. The term "cabochon" refers to the style of cutting. It can be round, oval, square, rectangular or free form, and is usually domed to reveal the pattern of the material. Most cabochons are cut to calibrated millimetre sizes, so that jewellery manufacturers can set the stones on a production line basis, rather than to make individual settings. There are of course exceptions to this rule in the case of very ornate stones.

The main steps in cabochon cutting are sawing, grinding, sanding and polishing. Personnel requirements for these operations will be one slabber/trimmer, one calibrator and four cutters. The supervisor would be responsible for the orientation of the material in addition to overseeing the overall production.

The output from the slabbing division would include bookends, boxes, clock faces, paper weights, penstands, polished slabs and similar items.

Once the stone is sawn to correct dimensions it is ground and polished on vibrating tables. A staff of two could handle these operations in conjunction with the slabbing division.

Other specialized machinery could be added to manufacture ashtrays, eggs and spheres, but it has been omitted until the full viability of the industry has been proven (see annex II for the necessary equipment and accessories, and annex III for suggested suppliers).

However, until reserves of suitable ornamental materials are established, and 5,000 kg of colourful, well structured, medium-sized boulders are in stock, it is not recommended to proceed with the purchase of stage II equipment. In the meantime, staff should become fully conversant with production techniques and be able to meet the deadline requirements demanded in the faceting division.

III. GEMSTONE FACTORY REQUIREMENTS

A ground-floor location with adequate natural light and waste disposal facilities are essential prerequisites for a gemstone factory. As this is a pilot project, consideration has been given to current commitments as well as to possible future needs.

In order to save costs and achieve maximum value and benefits, it is recommended that the floor plan of an existing EHRDC building be utilized, with a few alterations and modifications. Not only would this save construction costs, but construction time could be considerably shortened. A suggested layout for the factory, with explanations and requirement details, is reproduced in annex XI.

IV. MARKETING OF GEMSTONES AND GEM MATERIALS

There is a vast difference between marketing and selling. Marketing is the creation of a selling situation, and as this project is entering a well established commercial field, efforts must be made to plan where and how the production is to be sold. Therefore consideration must be given to the following:

- (a) The product range must be defined;
- (b) A decision has to be made whether to use agents or to sell direct;
- (c) Buyers must be made aware of the product;
- (d) The product must be properly presented;
- (e) Terms and conditions of sale must be established;
- (f) Dispatch facilities have to be established and documentation produced.

A. Product range

It is suggested to enter the export market with quality faceted peridot. The minimum size should not be less than one carat per piece which should be cut to absolutely accurate sizes in round, oval or rectangular shapes.

The local market will be the testing ground for smaller stones, tumbled beads and gem trees.

Stocks of saleable export material are expected to total 3,000 carats after six months of production. This is considered sufficient as a buffer stock. Under no circumstances should first-quality rough stone be exported, as this is the lifeblood of the project. Not only would such sales deplete processable stocks, but it would create increased competition from overseas cutters. If a stockpile of second-quality or very small stones does occur, consideration could be given to offering it for sale in Hong Kong, India or Thailand.

B. Product promotion

In order to inform the gem-buying community that Ethiopia has cut peridot for sale, an article in the American magazine, Lapidary Journal, detailing the history and source of the material, the cutting techniques and other technical information, would be desirable. If properly written and supported by photographs, it may be published free of charge. Such publication should be planned to coincide with the jewellery fair "Inhorgenta", held each January at Munich, Federal Republic of Germany, and the "Tucson" show held annually in Arizona, United States of America, during February.

Attendance at both shows to establish contacts is considered to be essential, as it would be a possibility to establish firm arrangements with agents. Sample product ranges displaying typical quality would be needed. Because there is only one product to offer, it is doubtful that buyers would go all the way to Addis Ababa. However, as gem stones are well suited for sale by mail or airfreight, the use of agents is the most economical way to start distribution.

Agents must be carefully selected, and those companies that specialize in cut stones and wish to include peridot in their range would be most suitable. A list of companies and firms that may be interested to act as agents is given in annex XII.

Depending upon results at these shows, it may be necessary to do some follow-up advertising in order to further stimulate interest. If agents have been appointed, any advertising should be done only after consulting with them; a co-operative promotion strategy may be formulated. Trade journals, such as Jewellers Circular ~~Magazine~~ in the United States of America and similar European publications may be considered.

The Ethiopian embassies in other countries should not be overlooked, and their staff should be encouraged to promote the stones whenever possible. Locally produced jewellery featuring peridot set in cuff links, tie tacks, brooches and necklaces should be made available to them.

To satisfy the growing world demand for philatelic products, commemorative stamps depicting peridot could be released at the same time as the previously suggested Lapidary Journal promotion.

Scandinavian countries produce quality jewellery, and as there are few suitable indigenous gemstones in that area, organizations from that region who provide aid to Ethiopia, should be approached for possible contacts.

Local hotels, duty-free shops and the Victory shop should be good outlets for cut stones, as most of their customers are from the expatriot community. Presentation will play a major role in achieving sales. The local jewellery trade may be able to use cut stones, but it is felt that beads would be more suited to this market.

C. Product presentation

The production should be accurately graded into AA, A, and B qualities. In most cases the larger AA material will be sold as individual pieces and packaged accordingly. Presentation will again play a key role in achieving top prices.

Smaller stones will be sold in parcels of 10, 50 and 100 pieces, whilst other stock may be matched as pairs for earrings or arranged in rows for necklaces.

It is imperative that the stones do not rub together thus damaging facet edges, or become "paper worn", i.e. rounding of facet edges making the stones appear dull as a result of abrasion in stone packaging papers.

D. Terms of sale

If the decision is to make sales through an agency network, then the terms and conditions must be clearly established. EHRDC should not sell in direct competition with agents, nor should too many of them be appointed.

EHRDC should establish which areas are to be targetted. Europe and the United States of America represent the closest and possibly the largest markets and should be tackled first.

A survey must be undertaken to establish current prices and appropriate qualities, so that the product is not under or over priced. It is preferable to supply goods at a similar price, but offer better quality and service. To this end a pricelist depicting AA, A, and B qualities, must be prepared at the agent, manufacturing-jeweller, and internal-sale levels. At this stage EMEDC does not want retail involvement.

Based on the averages calculated in annex VI, the sales prices could be:

	<u>SUS</u>	<u>Minimum carats/year</u>
Agent	2.95	2,000
Manufacturing jewellers	3.60	250
Businesses within Ethiopia	6.00	200

Consideration must be given to establishing a policy on:

- (a) Terms of payment;
- (b) Consignment stock;
- (c) Minimum agent stock-holding;
- (d) Co-operative advertising.

Z. Projected sales

If the stock of finished goods is approximately 3,000 carats by the end of 1987, then the potential of the two major shows could be realized in the following way: three agents appointed in each area, and a sale of 500 carats to each. The agents then need 20 customers to buy 25 carats each, and this may represent 10 to 15 stones per order. As the stock will be in calibrated sizes, this will appeal to manufacturers who produce standard-type jewellery.

F. Dispatch and documentation

The major sales competition will come from Asian dealers who have been trading gemstones for decades. They know the product, the market, the price, and their supporting paperwork and documentation is exact. Orders are usually dispatched by airmail within three working days of receipt, unless special cutting is requested. If a delay in supply is expected, an advice is sent immediately, explaining the reason and giving an estimated date of delivery.

EMEDC must adhere to these standards in order to survive in this field.

If there are special requirements from government bodies, such as the Ministry of Mines, the Ministry of Foreign Trade, the National Bank, insurances, postal or customs authorities, then these matters must be resolved before marketing takes place. It will not be practical to arrange for these formalities on every shipment. Procedures and documentation must be standardized, otherwise it will be impossible to dispatch goods in the required time.

G. Personnel

The manager of the project should attend to the marketing requirements well in advance, so that the necessary steps can be planned and followed. At

the appropriate time, one person should be employed to take care of the orders received, to ensure that all criteria are met, and that customers are kept fully informed about the status of their orders.

H. Concluding remarks

Marketing is an ongoing activity, and once the format has been determined, the plan and strategy must be frequently reviewed in the light of sales trends and production capacities.

Gemstone news from other countries should be available and a register detailing any activity which may affect or involve this project, should be recorded therein. Subscriptions to publications from gemmological associations in the Federal Republic of Germany, the United Kingdom of Great Britain and Northern Ireland and the United States of America, together with trade journals from those countries, will provide the information required.

Annex I

FIELD TRIP TO SIDAMO PROVINCE

The trip was undertaken from 2 to 16 October 1986, in company of Gizaw Gebre Tsadick, gemmologist, Asselefech Matiku, geologist, and several local guides who were engaged on a daily hire basis.

The objectives were:

- (a) To visit the potential gem areas and to undertake some prospecting;
- (b) To train the gem-buying group in the selection of quality gem materials;
- (c) To show local inhabitants how to extract usable material from volcanic boulders.

Due to the reluctance and a lack of understanding by local guides, item (c) could not be accomplished, as no inhabitants working in the gem areas could be found. Also, time did not permit to actually train the buyers, but it was possible to ascertain the problems they encounter, and to advise on ways of how to overcome some of the difficulties.

A. Programme

Day

1. Travel from Addis Ababa to Shakiso.
2. Visited Lega Dembi placer gold deposits and workings, the adit at North Lega Dembi and surrounding areas.
3. In company of the geologist, travel to Mega.
4. Travel to Magado, established base and inspected buying of olivine offered by local people.
5. Visited two sites for olivine in company of local guide. Nothing of significance found.
6. Discussed with buyers methods of purchase and offered advice on techniques. Returned to Mega.
7. Discussion with buyer. No sellers appeared. Meeting with Farmers' Association of Magado.
8. Visit to Hidilola and spent day prospecting for corundum, beryl and quartz. Found corundum deposit which requires further prospecting and exploration work.
9. Visited Hidilola en route to Moyale. Nothing of interest found.
10. In company of local guide, inspected an area reported to have gem material. Nothing of interest found. Returned to Mega.
11. With local guides, inspected pyrite claim.

12. Travelled from Mega to Agere Maryam. Inspected claims of garnet, amethyst and other quartz varieties en route. Nothing of interest found.
13. Discovered epidote, 10 to 12 km north-east of Coralie. Travelled to Dila.
14. Night at Shashemene.
15. Arrived at Addis Ababa.

B. Recommendations

1. Buyers should be instructed to purchase peridot, and pay a fair and reasonable price or the commodity equivalent.
2. Buyers should be equipped with sieves for sizing the material, a suitable light source, binocular head magnifiers, plastic bags, and stone pinchers for trimming.
3. The current system of receipting, recording and storage of material bought should be revised.
4. The corundum deposit should be further developed as soon as possible.

C. Findings

Magado Buying Office

The personnel consist of:

Organizer	Kiflom Gebre Selassie
Buyer	Alemayehu Tesfai
Faceter	Teklu Segew

It should be noted that Ato Teklu was the only member of the above team who had actually used a faceting machine, but he was involved in this office as an observer. The buying was in fact done by Ato Kiflom, and settlement, paperwork, and storage, carried out by Ato Alemayehu.

The sizing of material offered for sale by local prospectors was done by hand, a most unsatisfactory method. Sieves of varying sizes should be provided so that grading becomes more regular, and the supplier can see why the small material offered is not acceptable. Once the material is sieved to size it is much easier to select the top grade peridot needed for this project. The buying emphasis should be on peridot, the gem variety of olivine. At the present time everybody in the Corporation refers to the purchase of olivine. Even the office is labelled "Olivine Buying Office". Consequently, olivine is purchased.

If the Corporation is to establish a gem-cutting industry, then it needs peridot at the appropriate market price paid for the raw material.

Each buyer needs a binocular head magnifier to view the stones, and an appropriate light source. The present method of holding some stones up to the daylight does not reveal the clarity of the material. More time must be taken in buying, and the seller must be informed as to the reasons why certain material is rejected.

Although the present system allows payment for low-grade and useless material provided better grade is offered in the parcel, sellers should be encouraged to be selective, and be rewarded for collecting larger pieces of quality. Because the buyers are not quite sure as to why they have selected stones in certain categories, they are unable to satisfactorily explain their reasons to the sellers. This leads to unnecessary arguments, and when payment is effected, the seller sometimes feels cheated. Sample stones showing quality, colour and clarity, together with prices, should be displayed. Education of both buyers and sellers is most important.

The local guide was supposed to take the visiting team to a working area, so that the method of extraction could be observed and, if necessary, suggestions for improvement offered. Because of lack of confidence, the team was taken to useless areas.

The sellers are supposed to declare the sites from where the material was obtained. Nowhere in the world is this information given by fossickers for fear of "claim jumping", resulting in loss of income.

It is considered that it will be less costly and time consuming, if EHRDC continues to purchase from prospectors and fossickers, rather than undertake mining of this material. A suggestion that local fossickers move to more productive sites could be supported by EHRDC by providing temporary shelter, medical aid, together with tools to assist the proper extraction of gem materials.

In order to receive better co-operation from the local people, the expert met with the Hagado Farmers' Association and explained the reasons for his visit. In attendance were Ato Kiflom, Wt Asselefech and Ato Gezahegne from the Mega Buying Office. The farmers assured us that EHRDC was the only buyer, a point which the expert disputes, and that there was plenty of quality stone available. When asked why it was not offered to the buyers from EHRDC, we were told that the people would have to travel further afield to collect it. The expert presumes that the price is the main reason why the goods are not being offered.

The current system of payment in sugar is far better and more acceptable than payment in cash. However, other commodities should also be considered.

The buyers advised the expert that it will be possible to purchase 1 to 2 kg of quality material in the future. No satisfactory reason was given as to why this had not happened in the past.

The paperwork to record the purchases is cumbersome and does not reveal the true value of stone bought. A receipt should be given for the weight and equivalent payment. Then the material should be graded and trimmed after the seller has left. This aspect requires careful training and application. The buyer of raw material is a key person in any cutting organization, for it is his diligence which will ensure the success or failure of the venture.

If 2 kg of material were bought for birr 100, correct grading may show the following:

	<u>Per cent</u>	<u>GRAMS</u>	<u>BIRR</u>
First grade	20	400	50
Waste trimmed from first grade	5	100	No value
Second grade	50	1,000	50
Unusable	25	500	No value

This shows that the first-grade material costs birr 125 per kg.

Mega Buying Office

The buyer, Gezahegne Wakjira, works alone, and buying usually takes place on Saturdays and Tuesdays, being Mega market days. A limited amount of stone had been bought over recent weeks, but the problems associated with the Hagado office also prevail here. A suggestion is to amalgamate the two offices at Hagado, and open the Mega office only on market days. In this way the buyers could work together and assist one another and training would be more complete.

Prospecting for gem materials

Guides were reluctant to take us to new deposits, so most of the sites visited proved fruitless with the exception of the corundum area east of Hidilola, and the epidote deposit in the Coralie Hills, south-east of Agere Maryam.

(a) Hidilola area: Well formed crystals of corundum were found. Although most were weathered, the structure was stable. The best crystal measured 9 x 7 mm. Our guides were able to show us a quartz crystal group which they had collected previously, but they could not remember the location. Other "eye clean" quartz specimens, some with double terminations were also shown, but locations not revealed.

(b) Coralie area: A well-defined epidote crystal was found together with magnetite. Several chips of transparent material, believed to be corundum, were also discovered, but on testing it was found to be epidote too. It is recommended that this site be developed when time permits.

D. Conclusions

The trip enabled the expert to gain an insight into the problems associated with the reporting and collection of gem materials in Ethiopia. It was difficult to follow the planned itinerary because fuel was not always available when and where required. This necessitated additional travel and loss of time amounting to about two days. Time was also wasted trying to negotiate with local guides, and only on one occasion was the guide's information accurate and helpful.

Two sites are worthy of further exploration and development:

- (a) The corundum deposit near Hidilola;
- (b) The epidote deposit south-east of Agere Maryam in the Coralie district.

The expert believes that there is sufficient peridot available to recommend the establishment of a pilot faceting enterprise. With the possibility of further faceting materials being discovered and subsequently processed, an industry could develop from this sound base.

The buying of olivine must be revised and the buyers equipped with proper tools and utensils. The Corporation needs the gem variety of olivine, i.e. peridot, and emphasis must be placed on the purchase of this material, not on olivine.

The buying personnel must, as soon as possible, receive adequate training in gemmology, in the use of instruments and in the fundamentals of cutting.

Annex II

RECOMMENDED EQUIPMENT AND ACCESSORIES

A. Summary

<u>Division</u>	<u>\$US</u>
Faceting	28,185
Gemmological	7,590
Bead-making, part "A"	6,600
Bead-making, part "B"	11,650
Cabochoons	8,580
Slabbing	14,350
Sub-total	76,955
Contingencies (10%)	<u>8,045</u>
Estimated total cost ex works	85,000

B. Stage I - Faceting Division and gemmological training

<u>Faceting equipment</u>	<u>Quantity</u>	<u>Cost (\$US)</u>
Facetor with horizontal lap plate, fully adjustable head. Minimum 2-speed, 0.25 hp motor 220/240 V, 50 Hz	12	12,000
Trim saw, 150 mm, sliding table with indexed cutting gauge, and water pump, 0.25 hp motor, 220/240 V, 50 Hz	1	800
Grinder with preformer and diamond wheel, 0.25 hp motor, 220/240 V, 50 Hz	1	1,000
Vibrating tumbler, 16 kg capacity, 0.25 hp, 220/240 V, 50 Hz	4	<u>3,000</u>
Total faceting equipment		16,800
 <u>Accessories</u>		
Copper laps, 150 mm	36	1,100
Polishing laps, 150 mm	12	300
Lap rack, 5-slot (see figure I)	12	200
Diamond dust, 3 grades (coarse, medium, fine), total carats	1,500	2,000
Tin oxide, total kg	10	300
Aluminium oxide, total kg	150	600
Silicon carbide, 46 grit, total kg	100	500
Silicon carbide, 220 grit, total kg	100	500
Silicon carbide, 4F grit, total kg	100	500
Steel rollers	6	200
Dops, flat, 50 each of 3, 4, 5, 6 mm	200	400
Dops, cone, 50 each of 3, 4, 5, 6 mm	200	400
Dops, vee, 50 each of 3, 4, 5, 6 mm	200	400
Dop holder	5	50
Dop stands, 20 holes (see figure II)	20	200
Transfer block	4	200
Alcohol lamp	4	20

	<u>Quantity</u>	<u>Cost (\$US)</u>
Adhesive wax, total kg	20	300
Saw blades, 150 x 0.2 mm	10	300
Paraffin oil, total litres	5	20
Methylated spirit, total litres	5	20
Acetone, total litres	10	50
Stone papers and packaging materials		200
Brushes, cleaning cloths, detergent, buckets, and miscellaneous items		300
Complete sets of sieves, 2, 6 and 10 mm	10	200
Grading mirrors	5	<u>150</u>
Total accessories		9,410

Tools

Spanner and socket set	1	200
Wrench, large	1	25
Wrench, medium	1	25
Stanley knife	5	50
Screwdriver set, large	1	30
Screwdriver set, small	1	20
Lap dresser, diamond tipped	1	150
Saw-blade dresser	1	75
Vice	1	75
Hand grinder with aluminium oxide wheel	1	50
Files, set of 3	1	25
Hammer	1	25
Trimming hammer	3	30
Trimming pinchers	8	120
Dial indicator	1	125
Vernier, stainless steel	2	150
Geologist's pick	6	150
Geologist's hammer, 2 lb	5	100
Geologist's chisel	3	<u>50</u>
Total tools		1,475

Spare parts

Motor, 0.25 hp, 220/240 V, 50 Hz	1	150
Bearing assembly for facator	1	150
Bearing assembly for saw	1	100
Drive belts	10	<u>100</u>
Total spare parts		500

Geological equipment (to suit 220/240 V, 50 Hz)

Electronic balance scales, 0.01 x 150 carats	1	1,000
Balance scales and weights to 20 kg	1	200
Binocular microscope with dark field and stone holders	1	2,000

	<u>Quantity</u>	<u>Cost (\$US)</u>
Fibre optic light	1	600
Polariscope with light source	1	250
Refractometer	1	750
Dicroscope	1	100
Spectroscope	1	200
Ultra violet light, short wave and long wave, with cabinet	1	400
Chelsea filter	1	50
Desk lamps	7	300
Binocular head magnifier, 2.5 x magnification	10	250
Hand loupe, 10 x magnification	18	200
Brass calipers	18	300
Gem tweezers, locking	18	200
White board and inks	1	<u>150</u>
Total gemmological equipment		6,950

Books

Gems (Webster)	1	100
Practical Gemmology (Webster)	1	25
Gem Testing (Anderson)	1	75
Gem Identification (Liddicoat)	1	75
Gemstones of the World (Schumann)	1	30
Mineralogy (Sinkankas)	1	75
Gemstone and Mineral Data Book (Sinkankas)	1	30
Van Nostrand's Standard Catalogue of Gems (Sinkankas)	1	40
Gem Cutting (Sinkankas)	1	40
A Gem Cutters Handbook (Cox)	1	10
Faceting for Amateurs (Vargas)	1	50
Diagrams for Faceting, volume 1 (Vargas)	1	40
Diagrams for Faceting, volume 2 (Vargas)	1	40
Facet Cutters Handbook (Soukup)	1	<u>10</u>
Total books		640

Summary of Stage I

Faceting equipment	16,800
Accessories	9,410
Tools	1,475
Spare parts	500
Gemmological equipment	6,950
Books	<u>640</u>
Total cost, ex works	35,775

C. Stage II - Bead-making Division

Part "A" (for transparent materials)

<u>Equipment</u>	<u>Quantity</u>	<u>Cost (\$US)</u>
Ultrasonic drill, capable hole 1-25 mm	1	5,000
Grinder with diamond wheel	1	<u>750</u>
Total equipment		5,750
 <u>Accessories</u>		
Threaded drill bits	20	200
Wire, silver solder and tools		500
Drill horn, 6 mm	1	<u>150</u>
Total accessories		<u>850</u>
Total part "A"		6,600

Part "B" (for opaque materials)

<u>Equipment</u>		
Trim saw, 150 mm, sliding table with indexed cutting gauge and waterpump, 0.25 hp motor, 220/240 V, 50 Hz	1	750
Round bead-lapping machine capable of at least 80 beads	1	4,000
Automatic edge grinder	1	4,500
Vibrating tumbler, 16 kg capacity, 0.25 hp motor, 220/240 V, 50 Hz	1	<u>750</u>
Total equipment		10,000
 <u>Accessories</u>		
Saw blades, 150 x 0.3 mm	5	150
Additional drill horns	6	900
Aluminium oxide, total kg	150	<u>600</u>
Total accessories		<u>1,650</u>
Total part "B"		<u>11,650</u>
Total Bead-making Division, ex works		18,250

Cabochon Division

<u>Equipment</u>		
Trim saw, 200 mm, sliding table, 0.25 hp motor, 220/240 V, 50 Hz	1	750
Slabbing saw, 300 mm, with power feed, blade motor, 0.33 hp, 220/240 V, 50 Hz	1	1,000

	<u>Quantity</u>	<u>Cost (\$US)</u>
Calibrating preformer	1	500
Grinder, 200 mm, with diamond wheel, 0.25 hp motor, 220/240 V, 50 Hz	1	1,000
Grinder/drum sander, 200 mm, 0.25 hp motor, 220/240 V, 50 Hz	2	900
Sander/polisher, 200 mm, triple head, 0.25 hp motor, 220/240 V, 50 Hz	2	<u>800</u>
Total equipment		4,950

Accessories

Saw blades, 200 x 0.4 mm	10	500
Saw blades, 300 x 1.00 mm	5	600
Sanding belts, 200 mm, 220 grit	100	250
Sanding belts, 200 mm, 320 grit	100	250
Sanding discs, cloth, 200 mm, 400 grit	50	50
Sanding discs, cloth, 200 mm, 600 grit	50	50
Polishing felts, 200 mm	20	300
Tin oxide, total kg	10	300
Dops, 50 each of 3, 4, 5, 6, 7 and 8 mm	300	450
Adhesive wax, total kg	10	150
Alcohol lamp	2	10
Methylated spirit, total litres	5	20
Brass calipers	8	120
Metal templates, set of 5, complete sets	6	60
Hand loupe, 10 x magnification	4	40
Binocular head magnifier, 2.5 x magnification	2	<u>50</u>
Total accessories		3,200

Spare parts

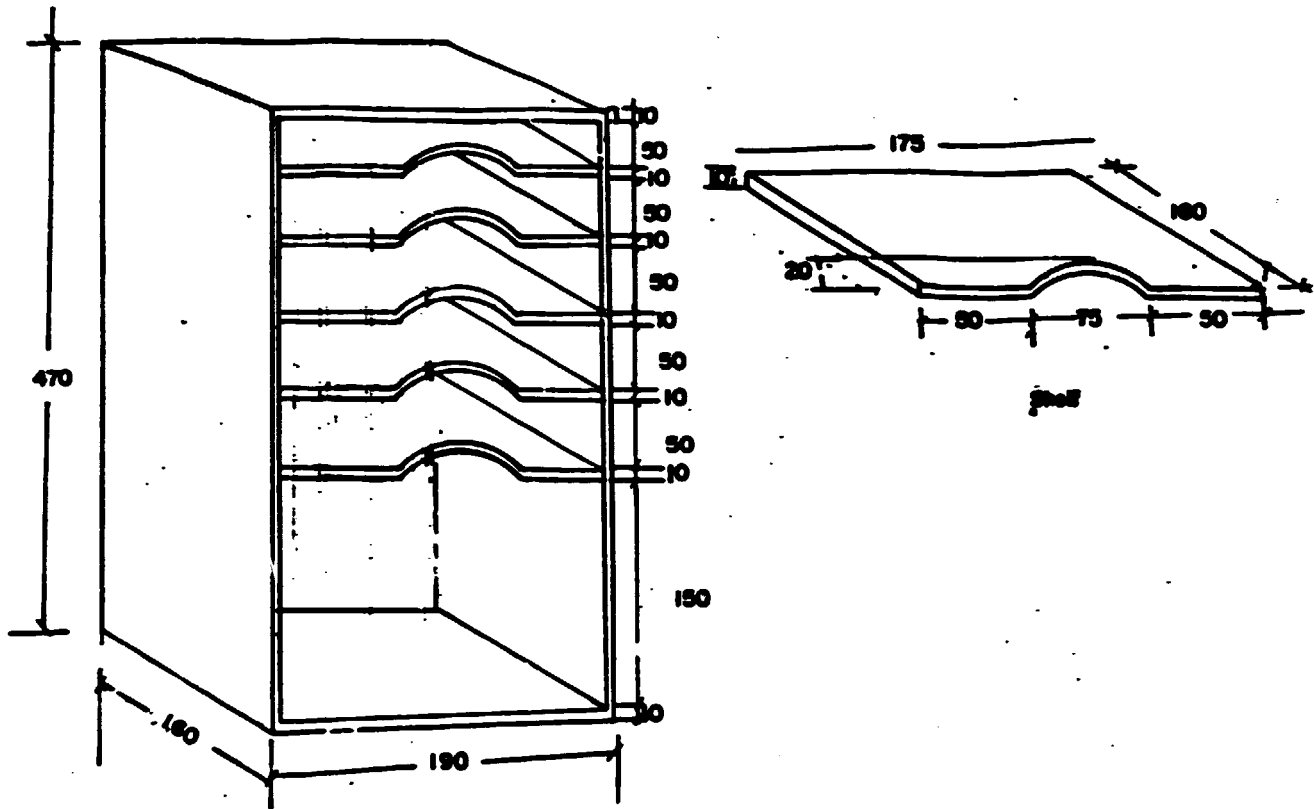
Motor, 0.25 hp, 220/240 V, 50 Hz	1	150
Drive belts	5	30
Bearing assembly for trim saw	1	100
Bearing assembly for slabbing saw	1	<u>150</u>
Total spare parts		430

Summary of Cabochon Division

Equipment	4,950
Accessories	3,200
Spare parts	<u>430</u>
Total, ex works	8,580

<u>Slabbing Division</u>	<u>Quantity</u>	<u>Cost (\$US)</u>
<u>Equipment</u>		
Slabbing saw, 600 mm, with power feed, blade motor, 1 hp, 220/240 V, 50 Hz	1	3,000
Slabbing saw, 450 mm, with power feed, blade motor, 1 hp, 220/240 V, 50 Hz	1	2,000
Vibrating lap, 650 mm, reversible cast lap motor 0.25 hp, 220/240 V, 50 Hz	3	2,000
Grinder, 300 mm, 3 speeds, motor 0.50 hp, 220/240 V, 50 Hz	1	<u>1,750</u>
Total equipment		8,750
<u>Accessories</u>		
Saw blades, 450 x 1.90 mm	3	1,200
Saw blades, 600 x 2.70 mm	3	1,800
Silicon carbide, 60 grit, total kg	100	500
Silicon carbide, 220 grit, total kg	100	500
Aluminium oxide, total kg	150	600
Grinding wheel silicon carbide, 60 grit, 300 x 38/50 mm	2	<u>300</u>
Total accessories		4,900
<u>Spare parts</u>		
Bearing assembly for 600-mm saw	1	150
Power feed motor for 600-mm saw	1	100
Bearing assembly for 450-mm saw	1	150
Power feed motor for 450-mm saw	1	100
Bearing assembly for vibrating laps	2	<u>200</u>
Total spare parts		700
<u>Summary of Slabbing Division</u>		
Equipment		8,750
Accessories		4,900
Spare parts		<u>700</u>
Total, ex works		14,350

Figure I. Five-slot lap rack

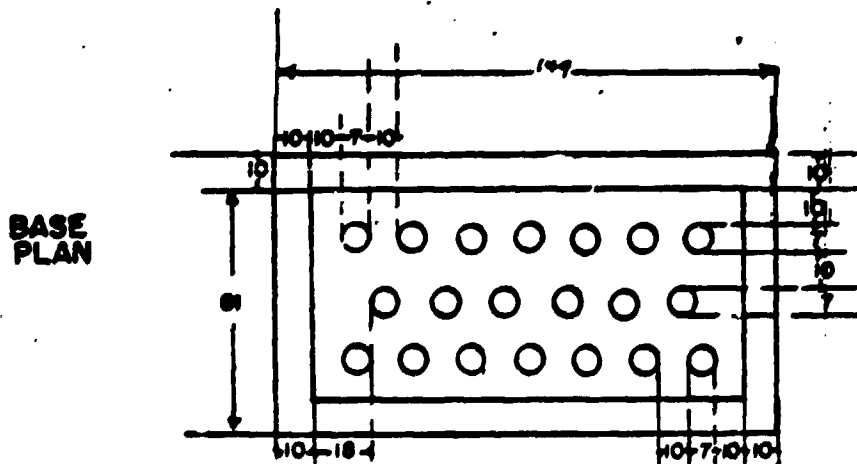
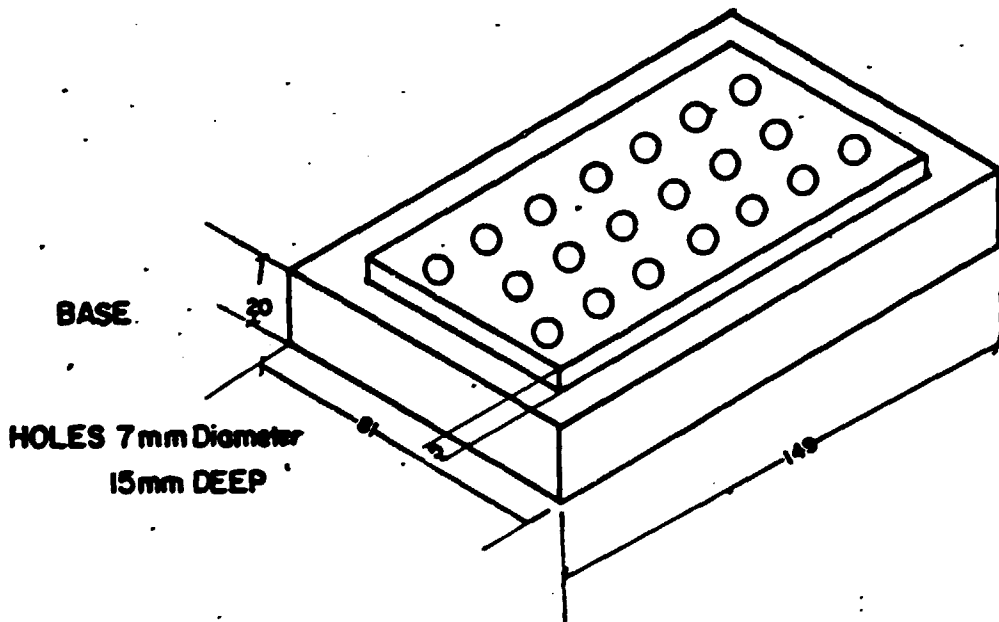
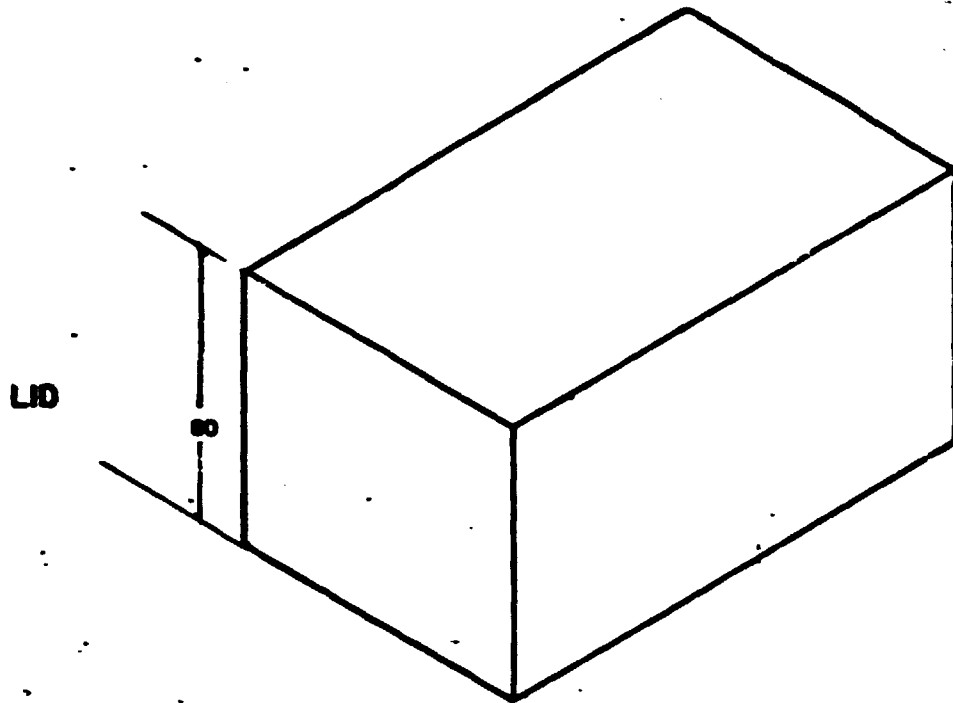


All measurements are in mm

Note

- I Timber for sides top bottom 160 X 10 or similar
- II Back hard board or ply
- III Shelf must be of material that will not warp
- IV Shelf spacing 50 mm

Figure II. Dop stand



Annex III

PURCHASE OF EQUIPMENT AND ACCESSORIES

It is suggested that the companies and associations listed below be contacted to obtain catalogues of their products. When these are on hand, an assessment can be made as to their suitability, and tenders called at the appropriate time.

Machinery

American Gem Supply, P.O. Box 156, New London, Iowa 52645, USA
Covington Machinery, P.O. Box 352, Redlands, California 92373, USA
Homberg and Brusius KG, P.B. 130140, D6580 Idar Oberstein 3, Federal Republic of Germany
Imahashi Mfg. Co. Ltd., 533 Hino, Hino-shi, Tokyo, Japan
Lapidary Wholesalers Pty. Ltd., P.O. Box 457, Glen Waverley, Victoria 3150, Australia
Lux anc Co., D6370 Oberursel, Oberurselstrasse 64, Federal Republic of Germany
MK Highland Park, 12600 Chadron Avenue, Hawthorne, California 90250, USA
Tagit, 8321 Passons Blvd., Pico Rivera, California 90660, USA
Taglieria Artigiano, Pietre Dure S-1, Via Natale Battaglia 10/12, 20127 Milano, Italy
Ultra Tec., 1025 E, Chestnut Ave., Santa Ana, California 92373, USA

Instruments and books

Estwing Mfg., 2647 8th Street, Rockford, Illinois 61101, USA
Gemological Association of all Japan, Tokyo, Japan
Gemological Association of Great Britain, Saint Dunstan's House, Carey Lane, London, EC2 V8AB, United Kingdom
Gem Instrument Corp., 1660 Stewart Street, Santa Monica, California 90404, USA
Lapidary Journal, P.O. Box 80937, San Diego, California 92138, USA
Mettler Waagen GmbH., Federal Republic of Germany
O'Haus Scale Company, Florham Park, New Jersey 07932, USA
Ruben and Son, Hovenierstraat, Antwerp, Belgium
Sciencetech Inc., 5649 Arapahoe Ave., Boulder, Colorado 80303, USA
UVP Inc., P.O. Box 1501, San Gabriel, California 91778, USA

When considering the purchase of the equipment and other items, the following points should be borne in mind:

(a) Books can be dispatched by mail, instruments best by airfreight, and heavy machinery by seafreight;

(b) If Imahashi is chosen as the supplier of the faceting machines, then it would be prudent to include the ultrasonic drill in the order. This would save considerable packaging charges, freight and other clearing expenses. If they are not selected, then the drill can wait until a later date;

(c) Some faceting machines allow for a dop size of 6 mm diameter, whilst others for 1/4 inch. Therefore, the chuck size of the grinder preformer must be compatible with the chuck size of the faceting machine;

(d) If Tagit is chosen as the supplier of the vibrating tumblers, the order should include an extra two hoppers per machine, because the life of the plastic hoppers is limited. Airfreight could be considered for this purchase.

Annex IV

COSTING PROCEDURE FOR ROUGH STONE

A. Basic data

The material usually purchased is termed "mine run", i.e. all the material found and offered by the seller. The buyer then grades it into three qualities and pays accordingly. The third grade is always present in mine-run material, but as it is of no value to this gem-cutting project, it should be costed as such. All costs and expenses should be absorbed in the first- and second-grade values.

It is estimated that the annual buying expense is birr 35,000. This figure is based on wages, per diem, travel, office rent, and a 20 per cent contribution to general overheads. The cost of buying must not include items of a capital nature, training expenses or supervision. Supervision is included in production costing.

At the end of the financial year, a review of the actual buying expenses should be made and a detailed list provided. This can be compared with the estimates, and an under- or over-absorption reflected in the accounts. Based on that information, a projection of buying expenses for the ensuing year can be compiled.

B. Procedure

Step 1. buyer

- (a) Record the weight of the material purchased in each grade and the price paid;
- (b) Regrade the material more accurately into 1st, 2nd and 3rd grades;
- (c) Send the material to the factory with details on (a) and (b) above.

Step 2. factory

- (a) Check weight of material received from the buyer;
- (b) Check the grading, adjust if necessary, and advise the buyer if significant variations are found;
- (c) Apply material standard cost as described in the next section;
- (d) Apply the expense standard cost. Initially it is suggested to use a total standard cost of birr 250 and birr 58, for grades 1 and 2 respectively.

C. Standard costs

To establish a standard cost for rough stone, the following system can be used, which should, however, be reviewed each quarter, and adjusted if deemed necessary.

Model standard cost sheet

	Quarter ended (date)			
	<u>1st</u> <u>grade</u>	<u>2nd</u> <u>grade</u>	<u>3rd</u> <u>grade</u>	<u>Total</u>
<u>Original purchase</u>				
(a) Weight (kg)	XXX
(b) Price paid per kg (birr)	<u>...</u>	<u>...</u>	<u>...</u>	<u>-</u>
Total purchase price (a) x (b) (birr)	YYY
 <u>Final grading</u>				
(c) Weight (kg)	XXX
(d) New value per kg (birr)	<u>...</u>	<u>...</u>	<u>N.A.</u>	<u>-</u>
Total adjusted price (c) x (d) (birr)	N.A.	YYY
 <u>Expense of buying</u>				
(e) Actual expense (birr)	N.A.	ZZZ
(f) Expense per kg (e) : (c) (birr)		
Cost price per kg (d) + (f) (birr)		

Notes

1. The total weights "xxx" in items (a) and (c), must be the same.
2. The value of the subtotals "yyy" must be the same.
3. Third grade will show a weight but no value after final grading.
4. The value for the 1st grade will be approximately twice that of the 2nd grade.
5. The total buying expense for the quarter will be apportioned, one third to the 1st grade and two thirds to the 2nd grade.
6. The actual expense divided by the final grading weight, will be shown in item (f).

The reverse side of the standard cost sheet can be used to record all the actual expenditures as well as details of the stone originally purchased.

Model of reverse side of standard cost sheet

Quarter ended (date)

<u>Summary expenses incl. in Actual Buying Expense</u>	<u>Birr</u>
..
.. .. .	<u>...</u>
Total expenses for the quarter	...

Original purchase of material

<u>Date</u>	<u>1st grade</u>		<u>2nd grade</u>		<u>3rd grade</u>	
	<u>Kg</u>	<u>Price paid</u>	<u>Total</u>	<u>Kg</u>	<u>Price paid</u>	<u>Total</u>
	_____		_____		_____	
	=====		=====		=====	
Average price per kg	_____		_____		_____	
	=====		=====		=====	

Annex V

ASSESSMENT OF RAW MATERIAL CURRENTLY ON STOCK

Four parcels of stone on stock at EHRDC were checked for quality and suitability for the project, and the following findings were made:

- Parcel 1. Described as "Selected rough material, weight 585 grams, peridot". Actual: First quality faceting grade 172 grams or 30 per cent. The average weight is less than 1 gram per piece.
- Parcel 2. Described as "First grade peridot, weight 309 grams". Actual: First quality faceting grade 96 grams or 31 per cent. The average weight is less than 0.34 grams per piece. It was surprising that no larger material was included in that parcel. It was alarming that this parcel of "virgin" stock contained a piece of sawn material. It is believed that the material was of a high grade, but that the top material had been removed either before offering it to the buyer, before it reached EHRDC at Addis Ababa, or before the expert had inspected the parcel.
- Parcel 3. That parcel contained 20 kg of mine-run olivine, and a quick selection revealed 52 pieces of faceting quality, weighing 62 grams. A closer examination may reflect a yield of 1 per cent.
- Parcel 4. Out of the 4 kg of garnet only 379 pieces weighing 141.2 grams were transparent and relatively free from inclusions. This represents an average size of 0.37 grams, which is not a recommended size to be included in the cutting programme.

It is estimated that at present there are between 1,600 and 1,800 kg of olivine in stock. In order to assess its value to the project more accurately, it is recommended to tumble polish some of this material in a barrel tumbler with abrasives. The cracked and worthless stone will wear away, and the material with veils and other imperfections will be easier to recognize because the external surface will be polished, enabling a clear internal view. Stones which are not suitable for faceting can be drilled and strung as beads. Arrangements have been made to borrow a tumbler for this purpose.

Only top quality and large-size garnet should be considered for this project, as there is a glut on world markets. It is unlikely that the production costs could be recovered by cutting small pieces. Clean, blocky shaped material, larger than 2 grams, should be retained for beads and gem trees, and the balance used for abrasives.

Recommended costing for the current stock of olivine

(a) Actual purchase

	<u>1st</u> <u>grade</u>	<u>2nd</u> <u>grade</u>	<u>3rd</u> <u>grade</u>	<u>Total</u>
Weight (kg)	0.089	128.787	1,586	1,715.876
Price paid per kg (birr)	<u>30</u>	<u>15</u>	<u>5</u>	<u>-</u>
Total purchase price (birr)	2.67	1,931.80	7,930	9,864

(b) After regrading

Weight (kg)	50	558	1,107	1,715
Adjusted price per kg (birr)	<u>30</u>	<u>15</u>	<u>n.a.</u>	<u>-</u>
Total adjusted price (birr)	1,500	8,370	n.a.	9,870

Fair and reasonable buying expenses

	<u>Birr</u>
Wages (2 buyers)	8,000
Per diem	11,000
Travelling	5,000
Rent of office	<u>5,000</u>
Subtotal	29,000
Contribution to overheads (20%)	<u>6,000</u>
Total expenses	35,000

Costing

	<u>1st grade</u>	<u>2nd grade</u>	<u>3rd grade</u>	<u>Total</u>
Weight (kg)	50	558	1,107	1,715
Material cost (birr)	1,500	8,370		9,870
Expenses (birr)	<u>11,000</u>	<u>24,000</u>		<u>35,000</u>
Total cost price (birr)	12,500	32,370		44,870
Add 25% profit	<u>3,125</u>	<u>8,092</u>		
Total sales price (birr)	15,625	40,462		
Cost price per kg (birr)	250	58		
Sales price per kg (birr)	312.50	72.50		

It should be stressed again that the first-grade rough stone should not be sold, but all of it kept for production.

Annex VI

COSTING ESTIMATE FOR THE FACETING DIVISION

The costing for this division has been based on the following assumptions:

(a) That is is the intention of ENEDC to establish a pilot gemstone industry with 12 faceting machines and the appropriate accessories;

(b) That, at a later date, other aspects of the lapidary industry, such as cabochon cutting and manufacture, will be introduced;

(c) That the costs of training personnel, both in gemmology and gem cutting, are not to be included.

As the market demands calibrated stone sizes, i.e. a finished product cut to an exact millimetre size, it is suggested that the production of faceted stones be concentrated on the following sizes:

Round	3, 4, 5, 6, 8, 10 mm
Oval	6 x 4, 7 x 5, 8 x 6, 9 x 7, 10 x 8 mm
Rectangular	8 x 6, 9 x 7, 10 x 8 mm

Larger material should be cut to best advantage.

In calculating the production costs (labour, material and direct expenses) an additional contribution to general overheads of 20 per cent has been included.

Summary for the first two years of operation:

	<u>Year 1</u>	<u>Year 2</u>	<u>Total</u>
Production weight (carats)	12,600	20,280	32,880
Market value (\$US)	37,100	59,840	96,940
Production costs (\$US)	<u>45,300</u>	<u>50,655</u>	<u>95,955</u>
Surplus (loss) (\$US)	(8,200)	9,18	985
Average cost per carat (\$US)	3.59	2.49	2.92
Average selling price per carat (\$US)	2.94	2.95	2.95

A. First year of operation

Labour costs

<u>Position</u>	<u>Number of staff</u>
Supervisor	1
Grader	2
Orienter/trimmer	1
Dopper	1
Calibrator	1
Cutter	12
Labourer	1

The estimated total labour cost is birr 53,000 or \$US 26,500.

Material costs

From the rough olivine on hand, it can be expected that 10 kg of first-grade faceting peridot can be extracted. For the purpose of this estimate, a price of birr 250, or \$US 125, per kilogram has been used.

If the yield from 10 kg of rough stone is 25 per cent, then it can be expected that the production will be approximately 12,500 carats in the first year. This figure is confirmed by the following exercise.

Output of 12 machines:

<u>Weeks</u>	<u>Amount cut</u>	<u>Carats</u>
1-13	10 cts per machine	120
14-26	20 cts per machine, weekly	3,120
27-52	30 cts per machine, weekly	<u>9,360</u>
Total production		12,600

It is expected that the product mix would be:

		<u>Carats</u>
Under 1 ct	15%	1,900
1-2 cts	15%	1,900
2-4 cts	50%	6,300
4 cts and over	20%	<u>2,500</u>
Total production		12,600

As the cutters are not skilled, very little saleable material will be produced in the first three months, as most of their time will be spent in training and practice.

The total material cost for 10 kg at \$US 125 is therefore \$US 1,250.

Direct expenses

	<u>\$US</u>
Machinery overhead (25% of original cost assumed at \$US 20,000)	5,000
Accessories and consumables (estimate per year)	<u>5,000</u>
Total direct expenses	10,000

Summary

	<u>\$US</u>
Labour	26,500
Material	1,250
Direct expenses	<u>10,000</u>
Total direct costs	37,750
Contribution to general overheads (20%)	<u>7,550</u>
Total production costs	45,300
Volume of production	12,600 carats
Unit cost per carat	\$US 3.59

Marketing

It is estimated that the following selling prices could be achieved:

	<u>\$US per ct</u>
Under 1 ct	1
1-2 cts	2
2-4 cts	3
4 cts and over	5

If the foregoing figures are applied to the yearly production, then the total market value would be:

<u>Production in cts</u>	<u>\$US per ct</u>	<u>\$US</u>
1,900	1	1,900
1,900	2	3,800
6,300	3	18,900
2,500	5	<u>12,500</u>
Total market price		37,100

The estimated loss in the first year of operation is therefore \$US 8,200.

B. Second year of operation

Production costs

Output of 12 machines:

<u>Weeks</u>	<u>Amount cut</u>	<u>Carats</u>
1-26	30 cts per machine weekly	9,360
27-52	35 cts per machine weekly	<u>10,920</u>
Total production		20,280

If the yield remains 25 per cent, then the rough material requirement will be 16 kg. It is expected that costs will increase by 10 per cent over the previous year.

	<u>\$US</u>
Total production cost year 1	45,300
Additional material cost for 6 kg at \$US 125	<u>750</u>
	46,050
10% increase	<u>4,605</u>
Total production costs year 2	50,655
Volume of production	20,280 carats
Unit cost per carat	\$US 2.49

Marketing

If the same proportion of product mix is achieved, and prices remain constant, then the following will result:

<u>Quality</u>	<u>Production in cts</u>	<u>\$US per ct</u>	<u>\$US</u>
Under 1 ct	3,040	1	3,040
1-2 cts	3,040	2	6,080
2-4 cts	10,140	3	30,420
4 cts and over	4,060	5	<u>20,300</u>
Total market price			59,840

The estimated profit in the second year of operation is therefore \$US 9,185.

Annex VII

WORK PLAN

	<u>November</u> <u>1986</u>	<u>Month, 1987</u>				
		<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>
<u>Training in grading</u>						
Supervisor	1					
Geologist	1					
Buyer	2					
Grader		1	1			
Orienter/trimmer			1			
Calibrator			1			
<u>Equipment purchase</u>						
Cleaning materials	X					
Sieves	X					
Grading mirrors	X					
Trimming hammer	X					
Trimming pinches	X					
Balance scales for 20 kg	X					
Desk lamps	X					
Binocular head magnifier	X					
Hand loupes	X					
Gem tweezers	X					
<u>Balance of stage 1</u>						
Equipment and accessories			X			
Premises available			X			
Faceters employed			10		2	
Instructor	X		X	X	X	

Annex VIII

PERSONNEL REQUIREMENTS

The staff levels have been kept to a bare minimum in order to test the viability of the project. Administration and non-technical personnel have been excluded, as it is felt that these functions, when they arise, can be adequately handled by existing EHRDC departments. The contribution to overheads in the costings should cover this aspect.

It must be remembered that, as in any manufacturing project, expenses and down-time will seriously effect the viability, that is if raw materials or services are not provided as and when required.

<u>Position</u>	<u>Responsibilities</u>	<u>Staff supervised</u>
Manager	Discipline and performance Liaison with administrative departments Development and planning Marketing	Technical supervisor Gemmologist/geologist
Technical supervisor	Technical training Cutting Tumbling Quality of output	Dopper Calibrator Faceters
Gemmologist/geologist	Location of deposits Development of fields Procurement of stone Grading Preparation for cutting Gemmological training	Buyers Graders Trimmers Orientater

A. Staffing levels by division

	<u>Number</u>
<u>Faceting</u>	
Supervisor	1
Geologist/gemmologist	1
Grader	2
Orientater/trimmer	1
Calibrator	1
Faceter	12
Dopper	<u>1</u>
	19
<u>Beads</u>	
Part A	
Carried out by faceting personnel	
Part B	
Trimmer	1
Lapper	1
Tumbler operator	<u>1</u>
	3

Cabochons

Slabber/trimmer	1
Calibrator	1
Cutter	<u>4</u>
	6

Slabbing

Slabber	1
Polisher	<u>1</u>
	<u>2</u>

Total personnel requirement 30

B. Job descriptions

1. Manager

Immediate supervisor: General Manager

Education: University degree in appropriate discipline

Experience and desirable qualities: Proven managerial and leadership skills, with 15 years experience.
Some knowledge of production techniques.
Marketing ability.

Duties: Responsible for discipline and overall performance of operations.
Budgeting.
Development and planning.
Market establishment.
Quarterly report to General Manager.

2. Technical supervisor (deputy manager)

Immediate supervisor: Manager

Education: Appropriate university degree or diploma

Experience and desirable qualities: Practical experience in lapidary, with particular emphasis on faceting and jewellery making for at least 10 to 15 years.
Leadership qualities with ability to meet deadlines.

Duties: Technical training of staff.
Cutting and processing of raw material to finished product stage.
Quality of finished goods.
Record details of production.
Monthly report to Manager.

3. Gemmologist

Immediate supervisor: Manager

Education: University degree in geology or diploma in gemmology

Experience and desirable qualities: Must have undertaken field project work.
Ability to organize and undertake exploration and development of new gem areas and prepare evaluation reports.
Leadership qualities with ability to meet deadlines.
An interest in gemmology.
Ten years experience in related fields.

Duties: Location of gem deposits.
Development of field sites.
Procurement of rough stone.
Grading and preparation of stone for cutting.
Undertake course in gemmology.
Provide gemmological training to staff.
Maintain appropriate records.
Monthly report to Manager.

4. Gem buyer

Immediate supervisor: Gemmologist

Education: ESLC with English

Experience and desirable qualities: No experience necessary as full training will be given.
Good eye sight and colour co-ordination.
Ability to communicate effectively.
Negotiating skills, with five years experience.

Duties: Purchase raw material suitable for the project.
Keep adequate records.
Advise management of all known sources of gem materials.
Monthly report to gemmologist.
Other duties as assigned by the gemmologist.

5. Grader, orienter, trimmer

Immediate supervisor: Gemmologist

Education: ESLC with English

Experience and desirable qualities: No experience is necessary as full training will be given.
Good eye sight and colour co-ordination.
Dexterity.
Interest in gemstones.
Five years industrial experience.

Duties: Sort stones into specific categories.
Trim material where necessary.
Mark cutting position on stones.
Record weights of material.
Maintain machinery and tools as directed.
Other duties as assigned.

6. Calibrator, dopper

Immediate supervisor: Technical supervisor

Education: ESLC with English

Experience and desirable qualities: No experience is necessary as full training will be given.
Good eye sight and colour co-ordination.
Dexterity.
Interest in gemstones.

Duties: Dop stones.
Preform to specified sizes.
Maintain machinery and tools as directed.
Other duties as assigned.

7. Faceter

Immediate supervisor: Technical supervisor

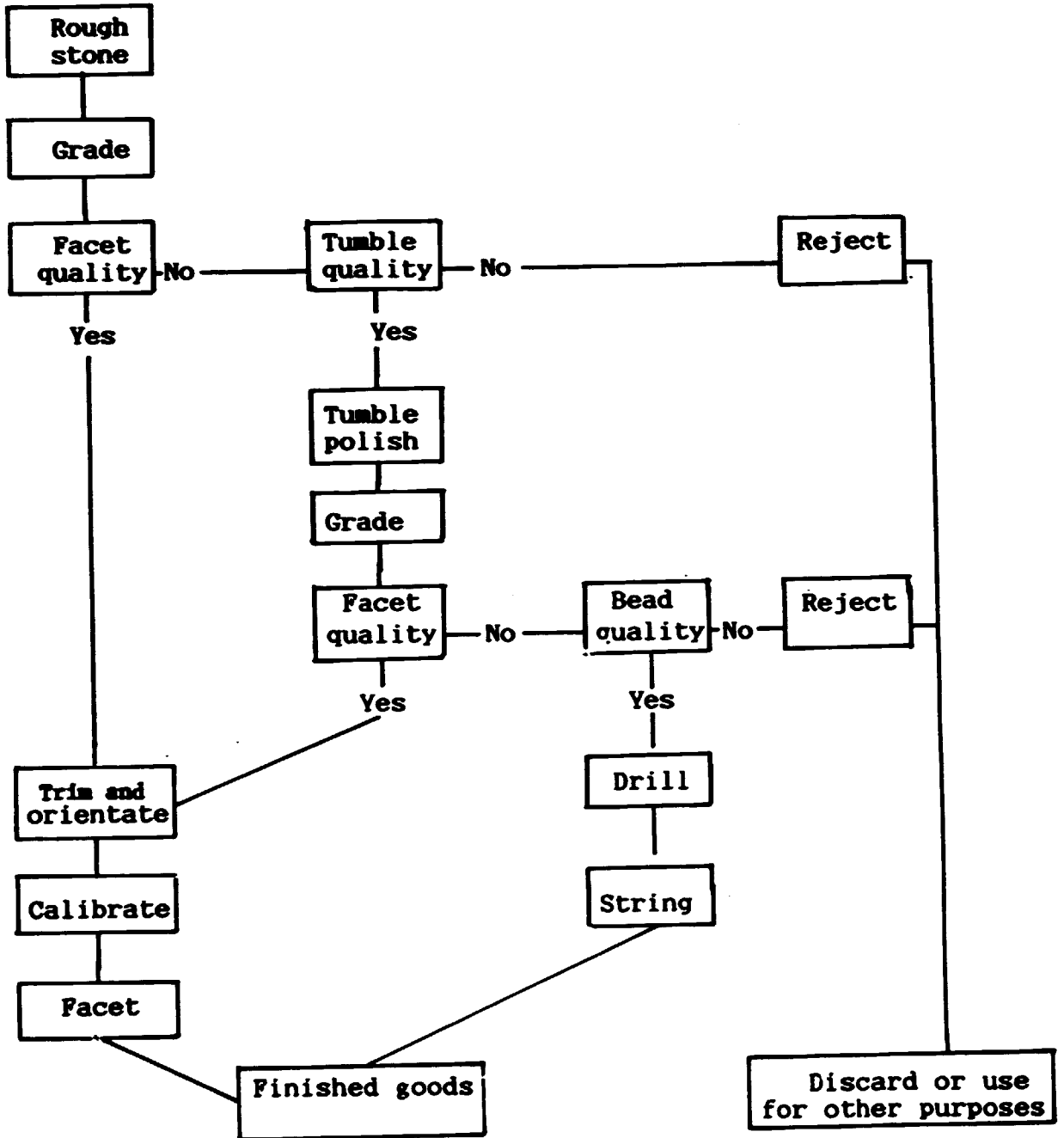
Education: ESLC with English

Experience and desirable qualities: No experience is necessary as full training will be given.
Good eye sight and colour co-ordination.
Dexterity.
Strong concentration powers.
Interest in gemstones.

Duties: Cut and polish stones to specified sizes.
Maintain machinery and tools as directed.
Other duties as assigned.

ANNEX IX

FLOW CHART FOR THE PROCESSING OF PERIDOT



Annex X

GEMMOLOGICAL TRAINING PROGRAMME

An introduction to gemmology should be given to all participants in the gemstone project. This shall include technical aspects of various gem materials, grading and orientation of stones, cutting, use and care of instruments and routine machine maintenance.

The following outline is recommended as a backbone for such a training course:

1. Introduction to gemmology
 - (a) Minerals, rocks and gems
 - (b) Chemistry
2. Crystallography
 - (a) Symmetry
 - (b) Crystal systems
 - (c) Grading
 - (d) Orientation
3. Gem instruments
 - (a) Hand loupe and head magnifier
 - (b) Tweezers
 - (c) Microscope
4. Physical properties
 - (a) Cohesion
 - (b) Hardness
5. Specific gravity
 - (a) Hydrostatic weighing
 - (b) Heavy liquids
 - (c) Specific gravity tables
6. Light
 - (a) Reflection
 - (b) Refraction
 - (c) Polariscope
 - (d) Chelsea colour filter
7. Refractive index
 - (a) Use of refractometer
 - (b) Refractive index tables
8. Colour
 - (a) Dichroism
 - (b) Use of dichroscope
 - (c) Use of spectroscope

9. Luminescence

Ultra violet light

10. Specific gem materials

- (a) Peridot
- (b) Garnet
- (c) Corundum
- (d) Beryl
- (e) Ornaments

11. Cutting

- (a) Tumble polishing
- (b) Faceting
- (c) Cabochon cutting
- (d) Vibrolapping

12. Maintenance

- (a) Care of instruments
- (b) Machine maintenance
- (c) Storage of stones

Recommended texts

Practical Gemmology (Webster)
Mineralogy (Sinkankas)
Gems (Webster)
Gem Testing (Anderson)

In order to have uniformity within the project, the following trade terminology should be used, and the grading procedures adhered to:

- (a) All measurements should be referred to in millimetres;
- (b) Grams should be used to record the weight of rough stones;
- (c) One fifth of a gram (carat) should be used to record the weight of cut stones;
- (d) Gems should be priced in United States dollars as this is done in most international gem dealing.

Grading of rough stones

1st grade

Eye clean, i.e. transparent with no inclusions in centre of stone
If inclusions exist, stone can be trimmed without much loss
Good colour
Blocky shape

2nd grade

Transparent, with slight inclusions
Colour variable

3rd grade

Opaque, cracked, many inclusions

No transparent areas of a size that would be usable if stone trimmed

Grading of cut stones

AA grade

Well cut

No inclusions

Good depth of colour

A grade

Well cut

Slight inclusion

Good colour

or

Well cut

No inclusion

Colour down

B grade

Well cut

Slight inclusion

Colour down

Legend to rooms shown on the factory layout

- A. This room will contain the tumbling and drilling facilities. As the noise from these machines is constant, it is desirable to have a separate room away from other activities. Requirements are benches, a sink, lockable cupboards and adequate power outlets.
- B. This section will contain the bead division, and bench space, a sink and power outlets are required.
- C. Slabbing division - requirements as for section B.
- D. Cabbing division - requirements as for section B.
- E. This area is reserved for the jewellery division, or for additional storage space.
- F. F1 and F2 are toilet areas.
- G. Supervisor's office with lockable storage cupboards, benches and space for a safe.
- H 1. This is the faceting section, and among the essentials for quality faceting are good light and cleanliness. It is important that the cutting laps be kept free from contamination by dust, swarf or contact with other laps.

Benches, 4 m long and 1 m wide, would be desirable. Initially, four machine stations would be located at each bench. When it is considered necessary to increase production, additional machines can be purchased and operators seated opposite original staff. Individual lighting should be provided, with electrical power and water sources under the benches. Dual outlets for each utility are required at each station. Waste water outlets would also be located under the benches. Each station should have a lap rack and a dop stand, lockable drawers for tools and personal items, and a height-adjustable swivel chair with a backrest. (For details see figure III.)

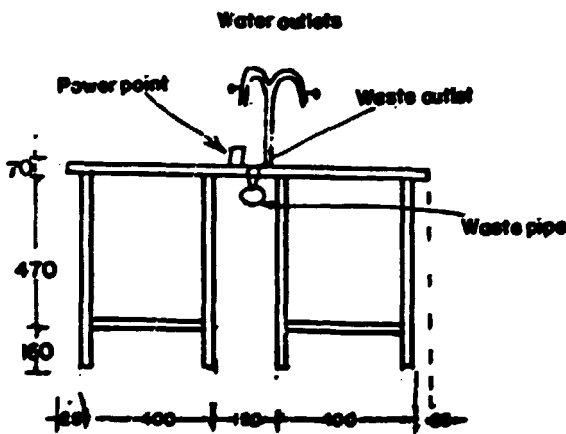
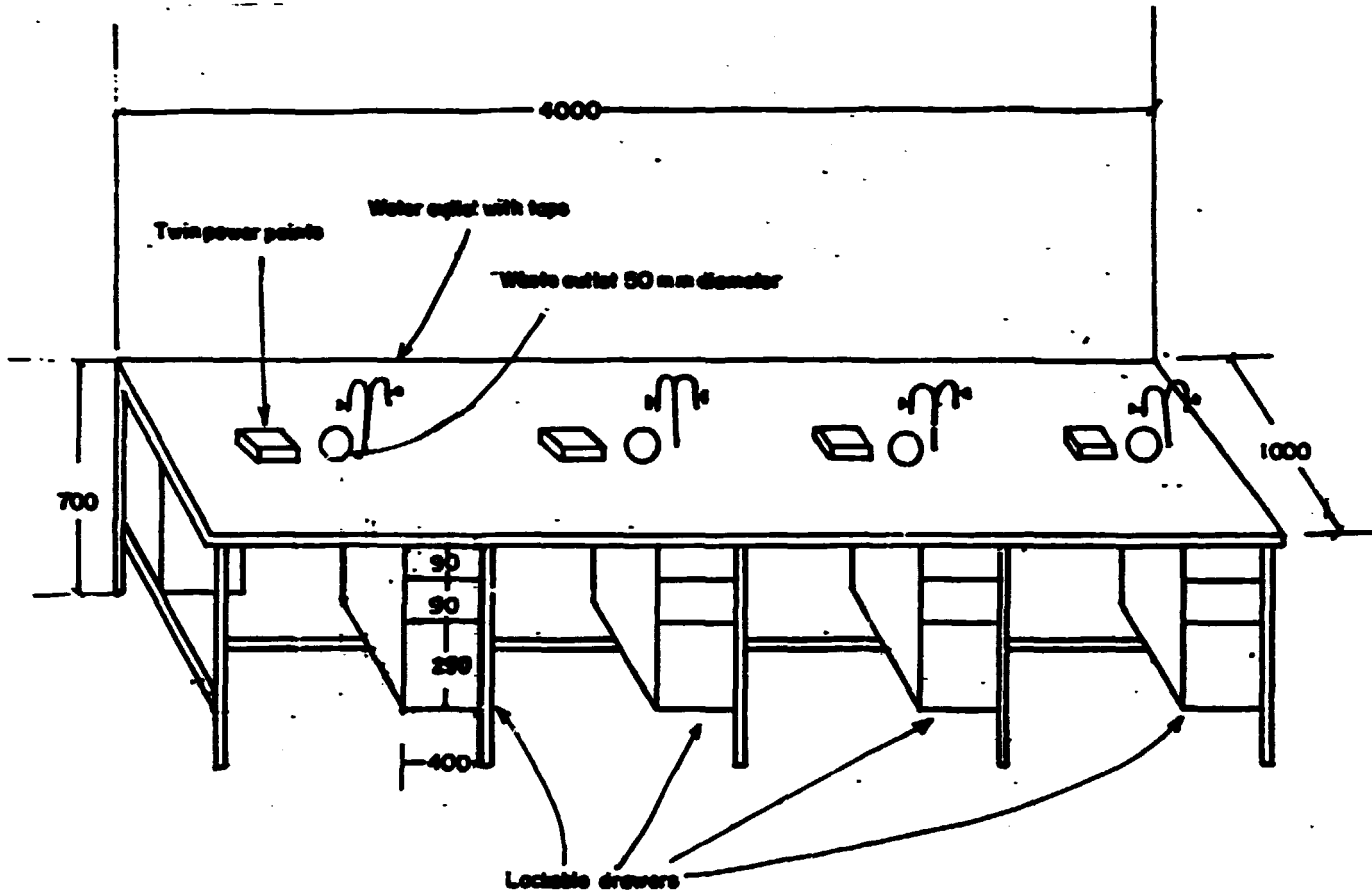
- H 2. This area will accommodate the orientation, dopping and calibrating staff and machinery.

In order to obtain maximum optical performance from the stone, the table facet must be correctly positioned so that the light will pass through and reflect off the pavillion and crown facets before emerging. If the facet angles are wrong, then the light will be internally reflected and the result will be a lifeless stone. Dopping is the method of adhering the stone to a stick so that it is easy to work by hand, or in a calibrating machine, or a facator.

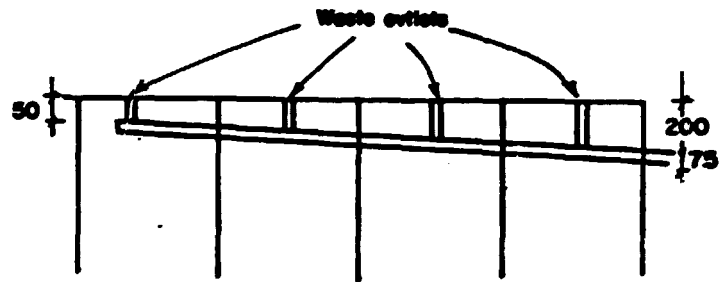
Bench space with lockable drawers is required, also adequate lighting, power outlets, water supply, and waste-water outlets.

- I. The gemmologist and the laboratory will be located here. Bench space and a sink, as for room J, is required.
- J. This room must have adequate morning light as grading and trimming of rough stone will be done here. It should have windows on two sides. Bench space with lockable cupboards and drawers is needed together with a sink and power outlets. Scales for weighing up to 20 kg should be located here to record the weight of material received and after trimming. This information is required for accounting purposes.

Figure III. Faceting benches



End elevation



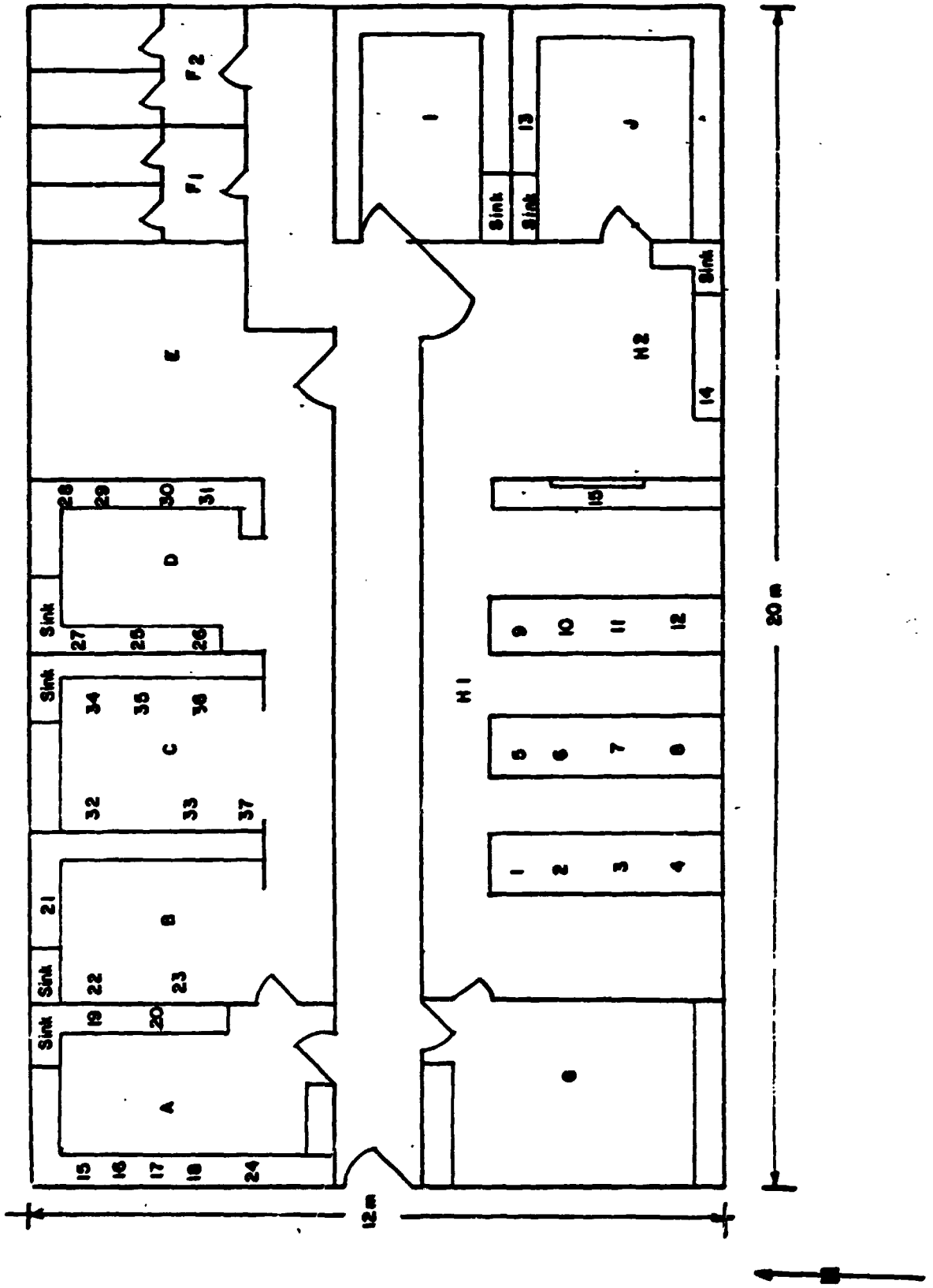
Side elevation showing incline of waste pipe

Notes:

- Steel frame
- Timber top to withstand
- Warping
- Drawers on both side of bench

ANNEX II

FACTORY LAYOUT



Legend to machinery shown on the factory layout

1-12	Faceting machines
13	Trim saw
14	Preformer
15-18	Vibrating tumblers
19	Ultrasonic drill
20	Grinder
21	Trim saw
22	Round bead-lapping machine
23	Automatic edge-grinding machine
24	Vibrating tumbler
25	Trim saw
26	Slabbing saw
27	Preformer
28-29	Grinder/drum sander
30-31	Sander/polisher
32	Slabbing saw
33	Slabbing saw
34-36	Vibrating laps
37	Grinder

Annex XII

SUGGESTED AGENTS

The companies and firms listed below may be interested in agency arrangements with EMRDC. All are well known and reliable. However, the quality offered must be of first class, as there is little opportunity to sell poorly cut stones.

Federal Republic of Germany

Julius Petsch Jr.,
6580 Idar-Oberstein

Weinz and Nebert,
6581 Idar-Oberstein, Dorfwiesenstrasse 8

Japan

Imac Corporation,
533 Hino, Hino-shi, Tokyo

United Kingdom of Great Britain and Northern Ireland

Bezalel Gems,
Hatton Garden, London

Hirsh Jacobson Merchandising Co. Ltd.,
91 Marlebone High Street, London W1M 3DE

United States of America

American Gem Supply,
P.O. Box 156, New London, Iowa 52645

House of Onyx,
P.O. Box 261, Greenville, Kentucky 42345

Lochs,
312 Main Street, Emmaus, Pennsylvania 18049