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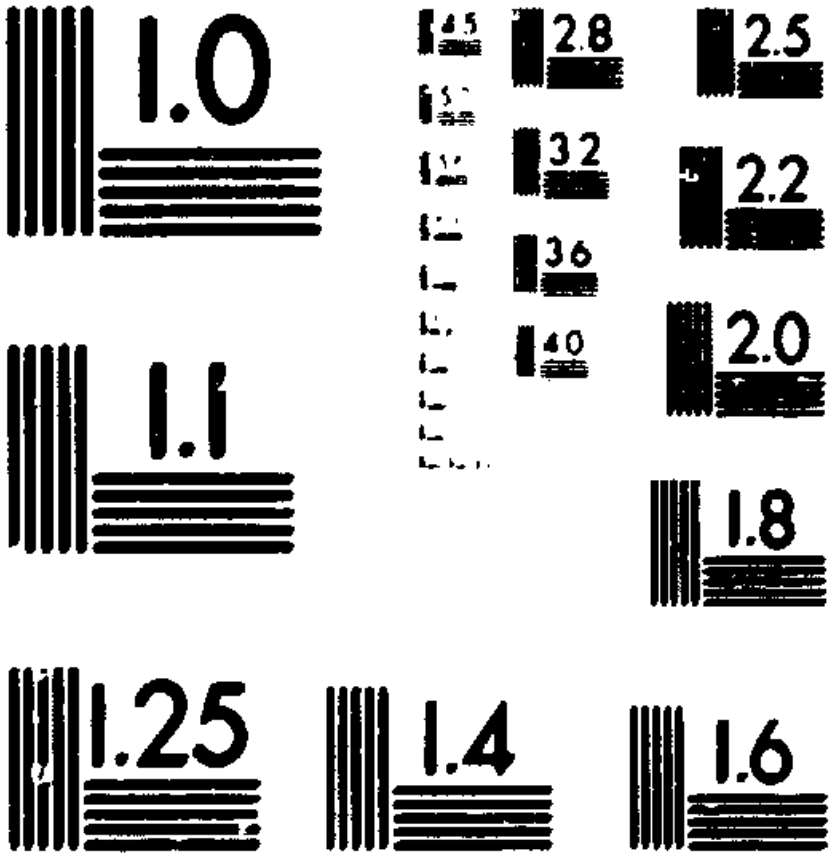

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ASSISTANCE TO THE DEVELOPMENT PROJECTS STUDY AGENCY

DP/ETH/80/005

ETHIOPIA

Technical report: Matches Manufacturing Project for Ethiopia, choice of appropriate technology*

Prepared for the Government of Ethiopia
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. S. Ramachandran,
Consultant in Safety Match Technology

United Nations Industrial Development Organization
Vienna

24,16

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1. SUMMARY

The consultant worked in close collaboration with the economists of the Development Projects Study Agency, preparing the feasibility study for a match factory in Ethiopia. All necessary technical information was provided to enable proper financial evaluation of the project.

A number of offers from different machinery manufacturers were studied and recommendation made of technological processes in manufacturing appropriate to Ethiopian conditions.

On technical and cost considerations, a mix of Swedish and Japanese technologies is recommended to optimise utilisation of raw materials and labour and for simplicity of machinery maintenance. Japanese machinery are suggested for box and splints making processes, and Swedish machine for match making. Machines are not required for packing and use of manual labour is recommended instead.

Future UNIDO technical assistance may be required for restoring Asmara Match Factory to normal operation. UNIDO assistance may also be needed to prepare detailed tender documents for machinery.

I N T R O D U C T I O N

The Government of Ethiopia launched in 1978 a National Revolutionary Development Campaign in order to mobilize and co-ordinate the efforts of the Government, public institutions and mass organizations. It attaches high priority to the development and strengthening of the capabilities of the ministries and public institutions for generating and preparing investment projects and therefore established in 1980 the Development Projects Study Agency (DPSA).

Technical Assistance was requested to UNDP for a project of "Assistance to the DPSA" (ETH/80/005/A/01/37) in carrying out its functions, focussing on those activities that would help DPSA develop self-reliance in generating viable investment projects and advising and assisting ministries, public institutions, large-scale organizations and private sector, thus ensuring their effective participation in the promotion of a balanced and co-ordinated development programme based on central planning.

One of the industries for which DPSA has been preparing a feasiblity study is the match industry. On 5 July 1983, it has requested UNDP/UNIDO assistance in order to carry out this study, through the assignment for one month of a Consultant in Safety Match Technology to advise the Head of the DPSA and the Match Corporation in the establishment of a match factory in Ethiopia using labour intensive technologies, after evaluating various former offers made to the Government, reviewing research results and assessing the current situation.

The UNIDO consultant Mr. S. Ramachandran undertook this mission from 23 December 1983 to 18 March 1984 (split mission). It was originally planned for a duration of one month. His origiral duties ..... are given in the Job Description in Annex 1. It was however extended

by 0.7 m/m so that Mr. Ramachandran will be able to accompany Ethiopian officials on a two-week study tour to match factories in Thailand, Malaysia and India and upon the mission's return to Ethiopia discuss the mission's findings and finalize his recommendations.

3. BACKGROUND

The Ministry of Industry of the Government of Ethiopia conducted feasibility studies in 1981/82 for a new matches manufacturing plant in the country. As the result of the study the technical and economic viability of the project was established and enquiries were sent out to different machinery manufacturers and offers received. A Canadian firm of Consultants, Messrs.Carroll-Hatch International Ltd., was appointed to technically evaluate Swedish Match Company's offer and make recommendations.

While considering the project, the Supreme Council of the Government of Ethiopia decided to refer the project to the Development Projects Study Agency (DPSA) for intensive economic and technical analysis, with special emphasis on utilisation of local raw materials, use of a substantial mix of labour-intensive operations with mechanised operations to provide employment and minimising the foreign exchange component of the project.

The senior economist of the DPSA, Mr. Getachew Mamecha was assigned to conduct an intensive and extensive economic analysis, including:

- forecast of country's demand for matches projected till 1995
- estimation of current consumption
- financial analysis of the project
- investigation of raw material sources and availability

This work is in progress.

Samples of five different species of timbers:

Croton macrostachyus

Albizia spp

Polyscias ferruginea

Podocarpus gracilior

Ekeburgia capensis

were sent to the laboratories of Swedish Match Company in Sweden for assessment. The Swedish Match Company recommended 2 species, ' ALBIZIA ' and ' PODOCARPUS GRACILIOR ' as good for splints production.

The DPSA wanted to obtain expert opinion to determine the appropriate choice and mix of mechanised and labour intensive match making operations suitable to conditions in the country, the appropriatness governed by level of mechanisation of plant relevant and adequate to the needs of the country, keeping in mind level of skills available, employment potential etc. A wide range of possibilities exist, from completely automated plants to highly labour intensive cottage factories, with different intermediate levels of mechanisation of operations. UNIDO assistance was sought to provide the services of a consultant, to advice on the appropriate choice of systems of manufacture of matches. This report will deal with the technological aspects of the proposed match manufacturing plant for Ethiopia.

Before discussing the production processes, a brief consideration of the studies made already and report of the firm of Canadian Consultants may be appropriate.

Feasibility Study for Establishing a Match Factory Conducted by the Ministry of Industry of the Provisional Military Government of Ethiopia August, 1982

The salient points in the study are the following:

(1) The country experiences an acute shortage of matches.

(2) Adequate quantities of suitable soft wood, the major raw material, are available in the country.

(3) Inadequate statistics of imports and possible smuggling of matches across borders make it difficult to establish correctly the present matches consumption in the country.

(4) Two methods were used to project matches demand in the country.

a. Past Supply: Statistics of supply and sales of matches during period 1973-81 indicated erratic supply figures and inefficient distributing system. Still a growth rate of 15.8% was registered. For demand projection purposes a growth rate of 13% was employed.

b. End Use Method:

(i) Cigarettes Consumption - One match stick to light one cigarette is assumed. On this basis an increase from 36.4 million to 65.8 million boxes annually from 1980/81 to 1989/90 is reckoned. An average growth rate of 6.8% is taken.

(ii) Candles Consumption - It is assumed that each candle requires 2 match sticks to light. Average supply of 15.4 million candles accounts for 0.62 million boxes annually.

(iii) Household Use - One rural household using one match stick per day and one urban household using four match sticks per day is assumed. On this basis, the matches consumption increases from 80.7 million to 113.8 million during 1980/81 to 1989/90.

The total of these figures registers an annual demand of 117.7 million in 1980-81 rising to 179.6 million in 1989/90.

(5) Asmara factory produces 40 million boxes per year. So need for additional match production capacity is established.

(6) Local raw materials, timber, cardboard, and wrapping paper constituting the major part can be used for production. The Ethiopian Pulp and Paper Factory has additional capacity available to manufacture cardboard for inner and outer boxes.

(7) Site at Assela in Arsi region is proposed from considerations of access to raw materials, mainly timber and cardboard.

(8) A realisable production capacity of 140 million boxes per year is assumed.

(9) The production process chart is given.

(10) Construction cost for 2000 square meters building is reckoned at 1.2 million Birr.

(11) Total fixed investment cost of 11.7 million Birr is planned, of which 9.1 million Birr would be in foreign currency and the rest in local currency. Adding working capital of 2.3 million Birr which includes 552,000 Birr in foreign currency, the total project cost is 14 million Birr.

The study concludes with financial survey including pricing, cash flow projections, operating costs, profitability and lists machinery requirements and prices based on Swedish Machinery.

(12) Raw materials imported at Asmara factory constitute 66% of cost of production. This could be substantially reduced when local raw materials are used.

(13) The following cost price break down is worked out:

Cost of production of one box	-	Birr 0.05
Excise Charges	-	" 0.04
Transaction Charges	-	" 0.0084
TOTAL :	-	Birr 0.10 excluding Income taxes.

adding Birr 0.02 ad hoc, an ex-factory price of Birr 0.12 is assumed.

.../

(14) Presently matches sell at between Birr 0.15 and Birr 0.25. As per projected income statement, the project yields 2.1 million Birr in first year through 4th year, 4.3 million Birr in fifth year and then drops to 2.5 million Birr when income taxes come into effect. Internal rate of return is reckoned at 37.5%.

(15) Project will provide employment to 91 persons.

Evaluation of Swedish Match Company's Offer by Canadian Consultants

1. Swedish match company's offer of machinery is considered adequate to meet fully, production needs of the proposed plant. Splints production would meet needs of Asmara Factory as well.
2. The Consultants suggest review of workshop equipment offered and reexamination of building layout.
3. On the whole they consider the Swedish match technology suitable for Ethiopia. But they consider the outer box making machine, inner box making machine and wrapping machine technologically inappropriate.
4. They consider production capacities of all the other machinery manufacturers offers inadequate. Other offers considered are from Hering, Roller, C.ITOH & Co, Union Engineering,

Sumitomo Corporation and Hanshin Shaving Co. Evidently the consultants do not know that except for Hanshin Shaving Co., the other Japanese offers are from traders who offer the same product produced by one Japanese manufacturer. Hanshin Shaving Co. manufactures different designs of match machinery. Koller and Hering are well known German machinery manufacturers.

5. All the offers are compared in respect of financial outlay. They consider prices quoted by Swedish Match Co. inordinately high.
6. Steam Turbo generator is recommended.
7. Machine tools offer for workshop is extensively discussed.

The evaluation is an elaborate affair with considerable repetition of facts. They consider the high speed inner and outer box machine and wrapping machine inappropriate to Ethiopian conditions since they adopt complex systems demanding superior technical skills and know-how and they are sensitive to quality of cardboard because of the high speed operation. The writer considers the latter point as well taken. But the question of technical skills is not relevant to Ethiopian conditions.

Again the need for a Turbo Generator cannot be justified since quantities of waste wood available are inadequate. A small steam boiler is necessary to supply process steam and can be operated with waste fuel and auxiliary oil firing facility. Power supply is not expensive in the region where the plant will be located. The consultants visited the Asmara Match Factory, a Saw Mill and Plywood Factory in Ethiopia and Swedish Match Plants at Vetlanda in Sweden, Eddy Match Ontario, Canada and Bryant and May in U.K., before submitting their report.

They recommend the Swedish match offer subject to some modifications and clarifications.

DPSA Study

This study is now in progress. It will incorporate elements from the UNIDO Consultants report, with comments on the report and will be submitted to the Government for final decision concerning the project.

Production Capacity of Projected Unit

In a study made in 1976 of consumption of matches in various countries, the writer found a close correlation existing between per capita GNP and per capita consumption of matches. On that basis the consumption for Ethiopia works out to 7-8 boxes per capita or

about 250 million boxes per year. This does appear somewhat higher to projections made by Government studies. The Asmara Factory is now operating at 50% of normal capacity. There is a scheme to initiate steps for bringing the production up to 70 million boxes annually from the present production of 40 million. This result should be achieved by the time the newly planned factory is commissioned. So the production capacity of the new manufacturing plant may be 150 to 170 million boxes/year. This more or less conforms to the standard capacity of an automatic match machine in 2 shifts operation. Automatic match machines of all types are produced to this standard capacity, which in turn governs the matches production of a factory. Single shift operation will produce half this capacity. The number of working days per year is taken as 265.

Raw Materials

The discussion with Paper Mill Engineers and Management at Wonji has confirmed the fact that the Mill has:

- Adequate surplus capacity to meet the match factory's requirements of cardboard for outer and inner boxes and wrapping paper for packeting.

- The equipment can produce right quality of cardboard for boxes. The mill can produce cardboard up to 350 gms substance, well above requirements for matchboxes underclose tolerances of thickness.

Timber

Albizia and Podocarpus Timbers, adequate for 30 to 35 years of matches production are available from forests located near towns of Bahai Dar and Awasa. This would take care of possible expansion of production after 10 years. Scheme of afforestation will ensure continuous supplies of timber.

Chemicals

Most of the chemicals and glue will have to be imported. Locally available glass powder and iron oxide can be used.

Location of Plant

Bahar Dar is currently proposed as possible location of the factory. This is chosen from considerations of:

- nearness to forests where Albizia is available.
- power supply is good and cheap.
- plenty of water is available from Lake Tana.

- excellent workshop facilities are available for fabrication of spares and even for factory construction purposes.
- all-weather net work of roads will ensure distribution facilities for matches produced.

Production Technology Appropriate to the Country

Before making a choice of technology suitable to Ethiopian conditions, it would be relevant and appropriate to discuss briefly the various match manufacturing operations and choices available to execute each of them.

4. ANALYSIS OF MATCH MAKING OPERATIONS

Cutting Logs To Billets

A portable chain saw is good enough for the number of logs to be cut daily. The chain saw has the advantage of portability. A circular saw has to be erected in one location and the logs brought to it for cutting. In both cases frequent grinding of saw teeth is necessary. Any one of these saws will serve the purpose.

Debarking

This can be done manually if the bark is easy to remove. Bark is strongly adherent in some types of fresh green timber. And so it would be worthwhile buying a debarking machine if it is not too expensive.

Splints Peeling

Rotary peeling of timber to veneer of splint thickness is performed by this machine. This is a fairly simple operation and any well designed and built machine can perform this function adequately and efficiently. Japanese machines are as good as German and Swedish machinery, and probably cost much less.

Splint Chopping

There are 3 systems in use:

1/ A number of veneer lengths, about 75 to 80 of them are piled up one over the other and a layer is built up.

This layer is then fed to the chopping machine. The layer is gripped on both sides, at a location near to the chopping knife, by a pair of milled rollers, milled to provide sharp rows of teeth, and driven by a system of gears by the machine. After every chopping by the knife, the layer is propelled forward by these rollers to the extent of the thickness of the veneer, to produce splints with square section. Naturally the squareness depends upon the accuracy of movement of every length of veneer in the layer. Usually some sliding of veneers over one another takes place, due to dust between veneers, inadequate gripping by the rollers and resistance to propulsion offered by the pressure roller on top of the layer. So this machine generally produces rather non uniform splints, as much as 15 to 20% often, the higher figure resulting from blunting of edges of the milled rollers.

2/ The Swedish machine is an improved type. Here the veneer layer is built over a wooden plank, at the bottom of which a long rack is screwed on. A pinion engages the rack and moves the entire plank by distance equal to exact thickness of veneer. Two smooth rollers on the sides of the layer maintain the symmetry of the layer as a whole and

a pressure roller on the top of the layer, close to the knife keeps the layer firm and tight for chopping. This improved design does reduce the percentage of non-uniform splints considerably. But still they constitute 5 to 7%.

3/ The Japanese machine cuts each veneer length separately with a rotary cutter. The splints produced are dimensionally more accurate and percentage of non uniform splints are negligible. This is certainly the best of the 3 systems in use.

Impregnation

Once uniform quality splints are produced, there is little that can go wrong in this process. The main considerations are:

(a) All Splints should completely dip into the impregnating solution, usually ammonium phosphate 3% solution maintained at a temperature of 40 to 45°c.

(b) All Splints should remain completely immersed for a period of 40 to 45 seconds, no more and no less. The exact time can be determined by trial.

The efficiency of impregnation is measured by ash content of the burnt splints, which should be 12%. Absence of after-glow can be easily tested by firing the splints.

The impregnating device usually consists of a tank into which the chopped splints are thrown in and their residence time in the

solution determined by the speed of the belt conveyor which removes them from the solution and carries them forward to the drier. Any machine which meets these conditions can be used.

Splints Drying

There are a number of driers available. Wet impregnated splints are fed on to a stainless steel perforated sheet conveyor, perforations usually about 2½mms in diameter to enable hot air to flow through the holes. The conveyor is usually about 30 metres long, with the conveyor moving at 0.55 metre per minute. Hot air is used to dry splints, the drying controlled over sections of the conveyor to ensure complete drying at the end of the conveyor. Forced and induced draft fans are used to ensure a balanced draft of air over the bed of splints. Recirculation of air is resorted to for economising steam consumption. The width of the conveyor usually determines quantity of splints dried. Inlet and exit temperatures, outlet air humidity, pressure drop of air across the bed of splints etc. are parameters employed in design of the drier.

Basically the drier should get rid of all moisture in the splints and produce well dried splints to enable proper polishing in the subsequent operation. Any drier that does this job is acceptable.

The considerations involved in buying the drier are:

(a) Capital cost of drier.

(b) Cost of fuel to operate the drier.

(c) Total fan power used.

The type of fan used, propeller type or axial flow type makes a difference to power consumption. Since the factory will have considerable wood waste to dispose of, a steam boiler using waste fuel, with auxiliary oil firing facilities to maintain boiler pressure at times of excessive wet fuel would be the ideal choice. The steam can be generated at pressure of 8-10kgm/sq.cm to heat paraffin to temperature of 150°c and provide low pressure steam using a pressure reducing value to supply process steam to the drier. If these results can be achieved with lower capital investment in the drier, then the choice becomes obvious.

Polishing Splints

This is a simple operation. Dry splints get nicely polished by scrubbing against one another in a rotating drum about 4 metres long installed at an inclination to provide movement from one end of the drum to the other. Usually, with well dried splints of good soft wood, polishing is completed in 10 to 15 minutes. There is very little to choose of this equipment from one manufacturer to another. The cheapest should be good enough.

Cleaning Splints

In this operation broken splints and splints of shorter length are removed for splints of standard length, 42 mms. This is usually achieved by a perforated aluminium plate, perforations usually of diameter 2 to 3mms over 1/3 of splint length and symmetrically made to ensure that every splint passes over two or three holes. The plate is subjected to a reciprocating movement, by which splints of shorter length fall through the holes and are rejected. Correct length splints pass over the holes and are then conveyed to the next operation, namely sieving.

The efficiency of this machine depends upon:

(a) Regulating splint feed to ensure that each and every splint passes across two or three holes. Excessive quantity of feed will enable defective splints to pass along with good splints. Low feed will reduce production.

(b) Design of size of holes. Too large holes will result in a quantity of good splints getting rejected. Smaller holes will pass defective splints into production.

(c) The reciprocating stroke length is another important determinant.

Any machine will serve the purpose, since all the three factors mentioned above can be locally adjusted and rectified by a few trial runs.

Sieving Splints

This operation eliminates splints of higher thickness and deformed or crooked splints. Unfortunately it cannot screen thin splints, which will pass into production. Usually such thin splints will be rejected by the automatic match machine later. Again this is a simple machine. Splints fall on to a moving screen with perforated holes and vibrated to ensure that all good splints pass through the screen and get transported to the bin at the automatic match machine. Since the moving screen is endless, the thick splints drop off when it passes the bottom.

There is nothing much to choose from. All manufacturers build reasonably good machines.

Outer Box Making

Various possibilities exist in practice. The outer box carries the trade label, advertisement slogans and also coating of striking surface composition at the sides of the box. Different methods are available to execute these operations.

Alternative A : The label can be made separately and affixed to the box in a separate labelling operation or it can be printed on the material of the box i.e. cardboard. The striking surface composition can be applied to the sides of the box in a separate

operation. If a printed label is to be affixed to the outer box we need a separate machine for doing this. Some German machines do have a printing unit attached to the outer box machine, where a reel of cardboard passes through printing stations, a drying unit, then the creasing operation, folding and glueing before ejection on to a conveyor. But no machines are available that are built integrally with the outer box machine where the side coating chemicals are also printed. In this case the striking surface coating is applied in a separate machine as a subsequent operation after filling of sticks into the boxes. So here we have 2 or 3 separate operations in making an outer box.

In some Japanese and German systems, the label is printed on sheets of cardboard in an offset printing machine. After drying, these sheets are fed into a side coating chemicals application machine where strips of chemicals are applied at the appropriate locations. These sheets then move up a conveyor for drying. After drying the sheets are slit and cut into skillets and subsequently fed to a box making machine. Here 4 machines are involved. The printing unit, the chemical coating unit and drier, the slitting m/c and the cutting machine. All these are small machines, whose total cost will add up to less than 30% of the cost of a "CHAMBON" machine. In some modern machines the label and side coating are printed by screen printing process on to the sheets of cardboard.

This is well worth investigating.

Alternative B : The striking surface coating can be printed on the cardboard at the same time the trade label is printed. This is perhaps the ideal way to perform the operations. But it is certainly very expensive. At present only " CHAMBON " Co. in U.K. make the machine for printing label and side coating chemicals on to the cardboard reels, from which box skillets are slit and cut, for feeding to outer box machines. There are 2 machines involved, the printing and box making. The cost of the chambon printing machine is believed to be around 2 million dollars.

Probably an important criterion in evaluating the outer box making machine is operating speed. For the output visualised for the new match factory, about 180 million boxes/year. only one Swedish or German make machine is adequate, since they operate at high speeds of 1000 boxes per minute. Japanese machines operate at 200-250 boxes per minute and so six machines will be required.

The following considerations are relevant in choosing the appropriate machine for Ethiopia:

(a) In case of a breakdown, the entire factory production will come to a halt. In a daily output of over 700000 boxes, the quantity of buffer stock that can be held in storage is limited by considerations of overhead storage space and quality deterioration in storage. Excessive weight of boxes will tend to crush and deform boxes at the bottom. On the contrary, acquiring a number of slow speed machines will not affect production in case of breakdown of one machine.

(b) Slow speed machines are much simpler in operation and easy to maintain. Spare parts could be locally fabricated.

(c) More workers can be employed by using slow speed machines.

(d) Longer glueing time helps reduce waste with slow speed machines.

(e) The price of the high speed machine is high. So acquiring standby capacity is expensive in initial investment cost.

Inner Box Making

Usual practice is to punch out blanks from reel of cardboard and then crease and fold the box and finally glue the end flaps. Different patterns of folding and glueing determine the profile of punched out blanks. But basically the process is the same. The waste of strips rejected while punching varies with the pattern used, between 0.8 to 1.2%. Again we have high speed machines operating at speeds of 1000 boxes/minute and slow speed machines at 200-250 boxes/minute. In determining which type machine is appropriate to Ethiopia, all considerations mentioned under outer box making apply equally to inner box machines. There are three additional important considerations:

1/ Most of the spare parts for the machine have to be imported. Because special alloy steels are used for the punching unit and the box conveyor system where the folding takes place, ordinary steel would wear out fast at such high speeds. All cams have to be imported. A substantial inventory of spares should be maintained to ensure trouble free operation.

2/ Need to supply cardboard of good stiffness and low moisture content to the inner box machine to ensure sharpness of high speed punching of blanks and reducing waste. Swedish Match Co. for instance stipulates pre-treatment and conditioning of cardboard reels in warm chambers to reduce moisture, just before feeding the machines. The writer installed six JUL 2 inner box high speed machines in Algiers and two special chambers were built for conditioning cardboard.
The Swedish Match Company's test report on Ethiopian cardboard indicates machine direction stiffness at 90% relative humidity and 23°C temperature as 100 for 300gms substance and 160 for 350gms substance against IMS standard of 250 and 380, which is obviously low and will cause problems during high speed punching. The cross direction stiffness is compatible. Creasing quality is inferior and thickness of board higher.

3/ While considering floor space requirements, it is necessary to take extra pre-conditioning chamber area as addition to actual machine space. It is interesting here to make an approximate comparison. Six Japanese combined inner box and outer box and closing machines take up 6 x 7.3 = 43.8 square meters space. 1 high speed outer box and 1 high speed inner box machine take up 20 square meters floor area. Besides the inner box machine requires duct to carry off punched out pieces which takes up some additional area. If we add area of cardboard conditioning, it would exceed the floor space requirements of six sets of slow speed machines.

Chemical Dipping - Automatic Match Machine

There are a number of operations involved in this machine:

1/ Splints Levelling - Splints are filled into a bin located on top of this machine, by pneumatic conveyor. The splints are then ' STRAIGHTENED ' onto the machine splints magazine by a levelling device. This is a fairly simple device and system used is the same. Only control of splints level in the bin is photo electrically controlled in Swedish machines, whereas in Japanese and other machines this is visually controlled and pneumatic conveyor actuated every time level becomes low in the bin.

7/ Charging of Splints - In this operation the 'STRAIGHT-SIDED' splints descend in the magazine, are vibrated mechanically to fall into a set of plates with grooves that hold one set of splints at a time. The groove plates move forward, with the grooves exactly aligned to tapered holes in a steel bar which is part of an endless chain of bars, about 1800 of them in the machine. The set of splints in the groove plates are locked in position by a system of steel 'COMBS'. The loading bar moves forward to enable the splints to be physically pushed into the bar holes to a depth of about 4 to 5mms. As the loading bar retracts the chain plate bar moves, bringing into position a fresh set of holes in the bar to receive further set of splints. This is a very important operation. Poor alignment of holes to groove plates will result in breakage of splints and considerable waste. Excessive depth of pushing will break splints even if alignment is good. There are broadly two systems in use. The Swedish system is perhaps the simplest and best, in the way splints are treated. As the groove plate retracts and a fresh set of splints are vibrated into the grooves, a set of 'GUIDE COMBS' gets into position over the length of the splints and a set of 'BOTTOM COMBS' rises to prevent splints from sliding back. Now the

splints are locked and cannot move except in forward direction. This movement is provided by the loading bar which moves an exact distance to enable splints penetrate about 4mms into chain plate holes. As the loading bar retracts a set of 'CLEANING COMBS' descends right inside the grooves to press and remove any thick splints that are lodged into the grooves and thus prepares for a fresh set of splints to fall into grooves as the retraction is completed. These cleaning combs rise up, when the forward movement commences. The Japanese machine has copied this system sith some trivial variations to overcome possible patent infringement. The German machines employ a different system altogether. Here two sets of combs, one behind the other with a gap in between, move flush to each other while charging of splints takes place and separate during retraction. Technically, this system is more complicated and charging of splints over a period of time gradually deteriorates and maintenance is somewhat more difficult, according to the experience of the writer.

3/ Dipping In Hot Paraffin - This operation is critical in determining quality of matches produced. The chain plates carrying splints pass slowly over a bank of hot plates, to reduce the moisture content of the splints. Then they dip in hot paraffin at a temperature of 140°C to a depth of about 5mms for a period of 4 to 5 seconds. As they come out they again pass over a set of hot plates, subjecting the splints to an ambient temperature of 50-60°C, to enable all paraffin to be totally absorbed inside the cells of the wood and prevent formation of a thin film or coating of paraffin on the surface of the splint. This is extremely important. Otherwise the match head which is fixed in a subsequent operation, can, after drying, easily slip off the splint, not adhering to the wood due to the thin film of paraffin.

The important conditions in this operation are:

(a) Moisture content of splints.

(b) Temperature of paraffin.

(c) Depth of dipping in paraffin.

(d) Period of dipping in paraffin.

There are broadly three systems in use. The Swedish machines employ two methods, one by allowing the splints

dip about 5mms and move inside a tank of hot paraffin for a period of 4 to 5 seconds, splints clearing the tank after the period or have a pressure bar press a certain number of chain plates, eight of them generally on to the surface of the paraffin tank, keep them pressed for a period and then lift up. The depth of dipping is naturally controlled. In the Swedish machines the dipping period can be adjusted from 3 to 7 seconds, depending on the nature and hardness of wood used in making splints.

With some types of German machines, the entire paraffin tank is lifted up to enable splints in a set of 8 to 10 chain plate bars to dip to required depth. The major disadvantage is that the period of dipping is not adjustable. The 'HERING' type German machine barely allows one second dipping. The 'ROLLER' machine permits 3-4 seconds dipping. The Japanese machines also allow 3-4 seconds dipping, but the period is not adjustable.

4/ Dipping In Chemical Head Composition - Splints conditioned after dipping in paraffin move on to the chemical dipping station where match heads are affixed, by dipping the splints into a bed of chemicals about 5mms deep.

After lifting from the bed, the splint conveyor chain plates pass into a drying chamber or section where they are slowly dried. There are at least three systems in practice for chemical dipping.

(a) Rotating Round Table - This is the old Swedish system. Chemical composition is manually fed to a container situated at one location on the round table. By means of a levelling device, a uniform thickness of the chemical composition is spread over the surface of the table as it slowly rotates. The table stops for about 5 seconds every time dipping takes place. A heavy pressure bar presses about 8 chain plate bars at a time, right down on to the table to effect dipping. After the bars lift up, the table moves, bringing in a fresh layer of chemical composition for the next dipping. There is a defect with this system. Fresh chemical composition is not presented to one half the chain plates, because the table cannot be rotated faster to ensure that chemical composition is being pushed to the periphery by centrifugal force. Due to slow speed of rotation of the table, fresh chemical composition is not presented to one half section of the splints carrying chain plates, while dipping. Increasing speed of rotation of table would push the composition outwards to the periphery by centrifugal force resulting in very uneven dipping.

(b) This defect was rectified by Swedish Match Co., by a new system. Here composition from a tank is picked up by a moving endless rubber belt, moving across the plates. The belt stops at the moment of dipping and moves on again, bringing fresh bed of composition for the subsequent dipping. The system has the additional advantage of constantly keeping the composition mixed, preventing stratification of the chemical batch. This is the best system in practice today.

(c) A third method used by German and Japanese machinery manufacturers is to have a long rectangular table with a chemicals levelling device moving over the table, after every dipping operation. The table as a whole is lifted hydraulically on to a set of chain plates full of splints to effect fixing of heads. Quality of dipping is quite good, but weekly maintenance of the table and the levelling device is absolutely necessary.

5/ Drying Of Match Heads

This is usually achieved by moving the chain plate match sticks conveyor in an S-movement over a length of about 8-9 metres in both directions to conserve floor space, for a period of 40 to 45 minutes

before the sticks are pushed out of the holes. Two systems are in use. In one system used by Japanese machine makers, the chain plate conveyor assembly is enclosed on both sides and front of the machine and warm air at temperature of 40°C is circulated to effect drying. In the Swedish and German machines, only the top two rows of chain plate conveyor are enclosed and hot air at 50-60°C blown over the sticks. So in this system ambient air drying takes place for about 30 minutes and hot air drying for the rest of the period. Both systems are good.

6/ Ejection Of Match Sticks - This is effected by a bar of steel needles working through the holes of the chain plate conveyor. In Swedish and German machines fitted with automatic filling, the sticks are directly received by inner boxes coming on a conveyor, stopping at three locations across the width of chain plates, to complete filling in three stages. In Japanese machines, sticks are received in trays and then transported to separate box filling machines, where filling into boxes is effected.

7/ Box Filling - The two methods employed are automatic, filling from the match machine and separate filling in box filling machines.

(a) Automatic Filling - Swedish and German machine manufacturers offer automatic filling devices, directly connected to the match machines. These are very efficient devices and filling quality is excellent. In a box of 48 sticks, filling is effected in three stages, 16 sticks at a time. Sticks gently drop into the boxes and compacting is effected by vibrating the inner boxes.

(b) Separate Filling Machines - The Japanese offer box filling machines, where trays of well compacted match sticks are fed into a magazine, from which they descend on to receiving carriers along six different channels. Pairs of knives fixed on either side of the channels work through slots in the channels and cut into the rows of descending match sticks, portioning off bunches of 50 sticks in each channel. Then the sticks carrier descends with the bunches of sticks, six pushers move over the surface of the carriers and push the sticks into receiving boxes through a row of 'CUPS'. The function of the 'CUPS' is to sit over the inner boxes, holding their sides taut while sticks are pushed in. A row of pressers then firmly press the sticks into the box, to enable closing the box. Since 'CUPS' often damage inner boxes by cutting the box edges,

the Japanese now offer a much improved system of 'FLAPS', by which the flaps open up and hold the box sides taut only after descending into the box. By this method, damage to boxes is almost fully eliminated. The machines are also equipped with screen to protect the machine operator from possible fires.

The advantages of an automatic filling system over separate filling are:

- Fire risk in minimal, since filling is effected by gently dropping sticks into the box, not forcing them in.
- Separate box closing operation is unneessary.
- Much manual labour is avoided by directly conveying filled boxes to packing machine.
- Labour requirements are much less.

The disadvantages are:

- Unless charging of splints is not less than 96%, box contents will be lower. With proper machine maintenance and good quality imported splints, the charging would be excellent, and filling realised to 2% of normal box contents. With locally manufactured splints, unless they are of excellent quality, charging cannot be guaranteed to 96%.

- Changing of box contents to say 50's or 10's involves stopping the machine for full day, to block groove plates. Alternately separate sets of groove plates for different box contents should be kept in inventory. Set of groove plates is expensive.
  With separate box filling machines these disadvantages do not exist. Contents can be changed by machine adjustment.

8/ Friction Coating Of Chemicals - There are three possibilities:

(a) Printing of skillets with trade label and side coating by 'CHAMBON' machine as discussed earlier.

(b) Friction composition application and drying of ready printed cardboard sheets in a separate machine. The sheets are then slit and cut to outer box skillets.

(c) Passing outer boxes filled with sticks through a separate friction machine equipped with drying channels.

All three methods are in practice.

9/ Packing of 10's - This can be done by machine or manually. The machine requires only one operator if fed by conveyor or two if fed manually. Hand packing would require about twelve workers for the same speed of packing.

There is no change in quality.

10/ Packing Into Cartons or Cases - While machines are available for this purpose, common practice is manual packing. Packets are filled into corrugated board cartons and sealed, or they are arranged in a former, holding water proof ocean paper and packed. Usually cartons take 1000 boxes or 100 packets of 10's. Ocean paper cases are packed with between 500-720 boxes i.e. 50 to 72 packets of 10's. This is purely dictated by market preference.

5. CHOICE OF APPROPRIATE TECHNOLOGY

All processes can be broadly classified under the following headings:

1/ Boxes Production

2/ Splints Production

3/ Matches Production, Filling and Striking Surface Coating

4/ Packing

1/ Boxes Production

The choice is between one set of high speed machines and six sets of slow speed machines. Slow speed machines are preferable.

2/ Splints Production

There is no technological difference in splints manufacture. The processes and performance of machines from different manufacturers are more or less the same. There are subtle variations in machine design. Cost of splints drier is a major component in the overall cost of the splints line. Swedish and German driers are quite expensive. Japanese driers are much cheaper. The Japanese offer should be modified for steam heating of air instead of oil fuel heating. Since, ultimately

the purpose is production of good quality splints, a result that can be achieved by machines from all machine makers, the overall cost of the splint line should dictate choice of machines.

3/ Matches Production, Filling and Striking Surface Coating

The performance of the automatic machine can be analysed according to the following table:

	Swedish	Machinery Roller	Hering	Hanshin
Splints charging system	Excellent	Good	Good	Excellent
Paraffin dipping	Excellent	Good	Poor	Good
Chemical dipping	Excellent	Good	Fair	Good
Drying ejection	Good	Good	Good	Good
Automatic Filling into boxes	Excellent	Good	Good	Not available
Separate Filling in box filling machines	Not offered	Poor	Poor	Good
Friction printing	Excellent	Good	Good	Good
Separate frictioning m/c	Good	Good	Good	Good

The paraffin dipping in Hering machine is only one second and hence not acceptable on quality considerations. Splints from different

species of timbers require different periods of time for absorption of paraffin, depending on their resin and moisture contents. Swedish machines permit variation from 4 to 7 seconds. Roller and Hanshin machines have fixed time of 4 seconds which is normally adequate for most species of timbers.

For chemical dipping, the Swedish system is excellent. Roller and Hanshin are definitely next best. Hering system does cause frequent maintenance problems, as experienced at Asmara Factory and in a factory at Amman, Jordan in the experience of the writer.

The writer recommends the Swedish type machine, with the reservation that automatic filling device attached to the machine, does require special skilled attention and demands excellent quality of cardboard boxes for optimum results. There are a number of automatic electrical controls built into the machine, which require services of a well qualified electrician. Additional employment can be provided by use of separate filling machines. In such a case the Japanese match and filling machines come second best.

Application of friction chemicals to the sides of the box has been extensively discussed earlier in this report.

If printing is resorted to, "CHAMBON" machines or screen printing devices are used in practice. "CHAMBON" machine is extremely expensive.

Alternately, separate friction chemicals application machines are available. The Japanese machines are cheap and good.

4/ Packing

Packing into packets of 10's and further into larger packets or cartons of 1000 boxes, consisting of 100 packets of 10's, can be done manually, providing employment to a substantial number of workers.

Factory personnel requirements for plant using above recommendations is provided under Annex D.

6. POSSIBLE FUTURE TECHNICAL ASSISTANCE NEEDED

(a) The report of visit to Asmara Match Factory under Annex 5, highlights the major technical problems of the factory. The factory manufacturing processes are in a deplorable condition. Box filling machines purchased at great cost and operated for very short time are lying idle and large force of labour is employed to fill boxes by hand. The automatic match machine is running at 40% rated speed and output. The chemical processing and laboratory require immediate attention. The management should demand from the machinery suppliers that the automatic match machine be restored to normal production. New box filling machines employing 'FLAP' filling like the Japanese machines should be procured to increase production. Technical assistance is badly required to restore this factory to normal running.

(b) Once the implementation of new match factory is approved, detailed tender documents for machinery require to be prepared. The services of a UNIDO consultant could usefully be utilised for this purpose.

7. NOTE ON LABOUR INTENSIVE COTTAGE MATCH FACTORIES

Over 4000 such match factories exist in India. The method of operation is as follows:

Splints are manufactured by machine peeling and chopping, with sun drying effected in the open. No impregnation is made. Splints are packed into gunny bags and despatched by lorries to match factory locations. The match factory owners buy the splints by weight and use them for making matches by manual methods of frame dipping. Similarly outer and inner box veneers of wood are peeled, chopped, treated with "PENTACHLOR" or "FORMALDEHYDE" to prevent algae and fungi attack. These are packed into bundles, wet, sealing off air and despatched by lorries to match factory locations. The factory owners buy these veneer bundles, and distribute them to number of families, supplying cut blue match paper bits, flour for making paste. The families boil the flour in water to make paste and all members of the family work in folding the veneer to boxes and wrapping them with paper, applying paste. The boxes are dried in the sun and delivered to factory owners who pay them piece rate of wages at a few cents per 1000 boxes. The boxes are weighed and thus number of boxes computed.

The factory workers then fill sticks into boxes, label them, apply friction chemical coating by brush, dry the boxes, pack them into

dozens, stick a label on, pack them again into gross packets and despatch matches to the market.

This is the way the system operates. It has evolved into a profitable system over a period of 50-60 years.

Would such techniques be applicable to Ethiopian conditions? The writer feels that it would not be possible for the following reasons:

1/ Over hundred such match factories should be located in specific areas in the country.

2/ Drying of boxes and splints depend on year long sunlight available and absence of rainfall.

3/ Logistics problem of supplier of splints and veneers to different match factories from factories located near forests, because of topography of the country.

4/ Production can be built up from token level to full demand level only over 15-20 years, because training will take time.

5/ Brushing of friction coating chemicals is a very risky operation. A little carelessness can cause serious fires and burns to consumers. Such accidents are common in India.

6/ Impregnation is an important operation to provide safety. This is not done by cottage factories in India, nor can this be done by cottage factories in Ethiopia.

UNITED NATIONS

ANNEX 1

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO

19 August 1983

PROJECT IN ETHIOPIA

JOB DESCRIPTION

DP/ETH/80/005/11-53/31.6.A

Post title	Consultant in Safety Match Technology
stion	One month
Date required	As soon as possible
Duty station	Addis Ababa, with possible travel in the country
Purpose of project	To contribute to the development efforts of the country by strengthening and developing national, institutional and human capacities for designing, screening and selecting optimal investment projects.
Duties	The consultant will advise the Head of the Department of Projects and the Match Corporation in the establishment of a match factory in Ethiopia using labour intensive technologies.

In particular, the consultant will be expected to :

1. Study and evaluate the various offers available to the Government;
2. Review the research results obtained from various species, and, if appropriate, propose other species to be tested;
3. Study possible factory locations, and recommend the optimal area, bearing in mind raw material locations;
4. Review the current market demand and its rate of growth;
5. Assess the economic size of production facilities;
6. Review the existing technologies for producing safety matches of adequate quality with low investments and using labour intensive methods, and select the most appropriate one;

..../..

Applications and communications regarding this Job Description should be sent to:

Project Personnel Recruitment Section, Industrial Operations Division
UNIDO, VIENNA INTERNATIONAL CENTRE, P.O. Box 300, Vienna, Austria

V.83-59869

7. Based on the above, prepare the technical specifications of tender documents and assist the authorities of the country in preparing the feasibility study.

8. Prepare a technical report, identifying therein the technical assistance which may be necessary to ensure the correct introduction of the technology selected;

The consultant will also be expected to prepare a final report, setting out the findings of the mission and recommendations to the Government on further action which might be taken.

Qualifications — Engineer or chemist with considerable experience at the policy-making level in the production of matches. Experience with the use of labour-intensive technologies in developing countries and with a wide range of equipment is highly desirable.

Language — English

Background Information — After the 1974 Revolution, the Government of the country embarked upon the National Democratic Revolution Programme. In order to promote the development efforts of the country in line with the above Programme, it is necessary to prepare and implement a co-ordinated and balanced development programme based on central planning. To this end, the Government launched a National Revolutionary Development Campaign in July 1978, in order to mobilize and co-ordinate the efforts of the Government, public institutions and mass organizations. The first action programme which ended in July 1979 succeeded in raising the rate of growth of GDP by 5.2%. The second action programme under the Campaign, which is planned to end in July 1980, is expected to further raise the rate of growth of GDP to 7%.

In order to maintain these notable rates of growth in future years, the Government attaches high priority to the development and strengthening of the capabilities of the ministries and public institutions for generating and preparing investment projects. These are at present weak, as is manifested by the inadequate flow and level of investments. In order to redress the situation, the Government established the Development Projects Study Agency (DPSA) by Proclamation No. 175 of 30 January 1980. The Proclamation sets out the objectives of the DPSA as follows :

i. to identify, study and prepare projects which are relevant for the implementation of the central plan;

ii. to ensure that projects which are identified, studied and prepared by offices, public and private organizations meet the required standards;

iii. to provide consultancy services to offices, large-scale and private organizations when requested, when they undertake project identification, study and preparation activities;

iv. to fix standards applicable to all projects.

Accordingly, the DPSA is entrusted inter alia with the functions of setting standards for the preparation of projects; rendering guidance and consultancy services to ministries, large-scale

organizations and the private sector; acting as the focal point for the Government in the provision of information related to projects, technology and investment; carrying out pre-investment studies when necessary; and organizing training programmes for project personnel.

The proposed project is intended to assist the DPSA in carrying out these functions. It will especially focus on those activities that would help DPSA develop self-reliance in generating viable investment projects. Thus the project will place particular emphasis on the elaboration of standards and criteria for project preparation and evaluation; on the development of mechanisms and approaches for mobilizing and co-ordinating resources and efforts directed towards formulating and preparing investment projects and monitoring the results obtained thereof on a continuous basis; and on the training of counterpart personnel by means of fellowships, seminars and on-the-job training through direct participation in the preparation, evaluation and selection of projects.

An important feature of the project will be the advice and assistance it is expected to provide to the ministries, public institutions, large-scale organizations and the private sector, thus ensuring their effective participation in the promotion of a balanced and co-ordinated development programme based on central planning.

One of the industries for which DPSA is preparing a feasibility study is the match industry. It has requested UNDP/UNIDO assistance in order to carry out this study, through the assignment for one month of a Consultant in Safety Match Technology.

ANNEX 2

ASWAN MATCH FACTORY - VISITED 29/30 DECEMBER 1983

The consultant observed the various manufacturing operations in the plant, and would like to offer the following comments:

CARDBOARD PROCESSING

1. Outer Boxes - Process

Imported bundles of sheets of cardboard are stacked in the factory shed. The sheets are fed into a 'HEIDELBERG' printing machine where the company's slogan is printed. The sheets are then fed into a striking surface coating machine where the friction chemical composition is applied in strips. The sheets pass through a drying tower, are received, fed into a cutting machine where they are cut into outer box skillets, by a punching unit. The skillets are fed into the outer box making machine magazine, for creasing, folding and glueing into finished outer boxes.

COMMENTS

(a) Cardboard is humidity sensitive and easily picks up moisture from the air to the extent of upto 8% depending on the relative humidity. High speed outer box machines operating at 1000 boxes/minute require dry cardboard for satisfactory operation. So cardboard is usually maintained in separate heated chambers under controlled humidity conditions before being fed to the machines. The chamber is equipped with a hydrostat, fans with

dampers. Since Asmara factory outer box machines run at low speed, such elaborate conditioning is not necessary. But it is a fact that punching of the sheets can be more accurate if the sheets are in dry condition. Two things can be done. The cardboard bundles can be kept in a separate closed godown by building a wall across the width of the shed, and placing a false roof with particle board or some other material, to protect the cardboard from humidity to a certain extent. Secondly the sheets coming out of the drying tower should be punched out immediately, since they will have no time to absorb moisture. This may ameliorate the present situation somewhat. At present the punching is rough and edges not sharp. Six workers are solely employed for brushing off the cut edges. The job is messy and the work place dirty. Utilimately it will be necessary to replace the machine which is quite run-down.

(b) The chemical coating is coarse, uneven and inadequate. Swedish match standard is application of 40 gms/sq. metre chemicals on the sides of the box. An estimate of present application is about 10 - 12 gms/sq. metre. Modern practice is to print the coating on the sheet in a separate

printing station built integrally into the printing machine. The printing is carried out in tandem or at the same time depending on the type of machine used, letterpress or offset. An ultraviolet-cured offset printing ink containing red phosphorus is used. It is supplied, I believe by ' LORILLEUX LE FRANCE INTERNATIONAL, 161 RUE DE LA REPUBLIQUE, 92301 PUTEAUX, FRANCE'. Swedish match uses UV cured acrylic resin blended with red phosphorus in the ink. While this is still considered a secret technique by Swedish match, I have seen the process used in Japan by Hanshin Shaving Company Limited. Swedish match uses 'CHAMBON' machines for this job, costing almost a million dollars. It is my considered view that a suitable machine can be obtained from Japan and the ink from France. By this method, there will be a spectacular improvement in quality, application will be uniform and substantial economy can be realised from raw materials use. Further the machines for making friction composition and for application of coating and fire hazard can be eliminated.

The present 'HEIDELBERG' printing machine can be sold to a printing press for a fair price.

(c) The box making machines need to be thoroughly overhauled. The creasing and folding are incorrect and consequently deformed shape boxes are produced. This leads to poor quality of packing dozens and gross packets. Unless the outer box is folded square packing cannot be improved. The folding mandrels need to be checked and if necessary replaced. The glueing is quite inefficient. A deformed box cannot be glued efficiently. The pressing after glueing requires to be looked into by the mechanics.

2. Inner Boxes - Process

Reels of cardboard feed into the machine, where blanks are punched out for folding and glueing into inner boxes over a mandrel. The end flaps are glued and pressed before ejection.

COMMENTS

(a) Box quality is generally good. One machine appears new and runs at a higher speed. There is no reason for this difference in output between the two machines. It is evident the second machine requires proper maintenance.

(b) Punching out of blanks will be much sharper if cardboard is dry.

(c) While placing the purchase order complete technical specifications should be provided to the supplier, like substance weight, tensile strength in direction of travel and across, etc. I shall furnish these in a separate note.

Splints Processing

Poplar splints are imported from Russia. They come packed in rings bound by wire. These are opened up and discharged into a chute, transported by pneumatic conveyor to a bin. From bin a vibratory feeder sends a regulated supply of splints to the machine bin through a second pneumatic conveyor. At the automatic match machine the splints are again levelled or straightened into the splint magazine. Splints descend to the charging unit which pushes them into holes in an endless chain plate system or 'Bars'. The bars pass through a paraffin dipping station where the splints dip to the extent of about 10 mms. in hot paraffin at 140°C. Then the bars pass on to the chemical dipping station where the match heads are fixed. The bars pass through drying ducts and the match sticks are finally ejected by needle bar on to receiving trays. The trays of match sticks are taken to filling tables where girls manually fill boxes with the sticks.

COMMENTS

(a) There is absolutely no purpose served in opening well levelled splints from the rings and relevelling or straightening them in the automatic match machine, without any process in between. This involves waste of labour, power consumed by pneumatic conveyor systems and valuable floor space. The rings can be opened directly at the machine splints magazine. It can be done simply by removing the plastic cover at the front. The machine is running at the low speed of 75 chargings per minute. At this speed this manual feeding of rings can be done in leisurly fashion. There is need for these pneumatic conveyor system if splints are produced locally. Then they have to pass through cleaning and sieving operations. With imported splint that has already passed through these processes, and well levelled into rings, there is no need for conveyor systems. The levelling machine above splint magazine can be stopped.

(b) The automatic match machine is in a deplorable condition. The machine runs at half rated speed producing half normal output. The machine needs thorough overhaul. The machine manufacturers appear to have convinced the technical personnel of the factory that there is no alternative to running

this machine at present speed, and the only way things can be improved is by buying a new machine and scrapping existing one. The chief technician told me that the manufacturers have asked for replacement of existing hydraulic system by a new hydraulic system of their manufacture. But will installation of this new system facilitate running the machine at normal speed and produce normal output? This question should be addressed to the manufacturers. In my opinion, it cannot. The malady requires more drastic treatment, a complete overhaul of the machine, which is completely run down. Overhaul can be done in 2 to 3 weeks, if all spares are ready.

(c) I reckon a waste of 10% splints at the charging station of machine. This is partly due to shearing off metal of groove plates which happens when some iron screws of steel bits get entangled with splints and descend down to groove plate level. It is very easy to reduce this risk by installing a long magnet across the splint magazine at the lowest level possible. Such a magnet is standard equipment supplied with 'ARENCO' and 'ROLLER' machines. I examined the waste from the machine at charging. I found a considerable percentage of broken splints. This is due to misalignment

of grooves with bar holes. This is the job of the mechanic. Attention given to this is inadequate. Roughly 8% of waste is due to poor maintenance.

(d) I saw the damaged groove plates. They can be repaired. This is a common occurrance. In India we have over 37 automatic 'ARENCO' match machines. The groove plates are invariably repaired locally. I explained how it can be done. It appears the technician is not convinced. He told me it cannot be done in Asmara. I am of opinion it can be done where a good welder is available. Nothing more is needed. One set groove plates costs about US$ 9000. If, as the technician feels, groove plates have to be replaced everytime this happens, an outlay of between £18000 to maybe £36000 a year may be needed for this alone. The very concept appears ridiculous to me. The mechanics should be ready for some hard work. It may well be, they need training in this kind of repair work.

(e) There is a percentage of oversize splints which get stuck to groove plates and prevent further charging of splints in that line. With the best of machinery, such splints will pass into normal production of splints. The splint suppliers cannot do anything about it. The

cure is simple. Stop the machine for a minute, open the back combs, using an iron hook, the splint which is wedged in the groove is removed, the back combs closed and machine started. There is no need for a sieving machine at present, since the % of over-size splints is negligible.

(f) China produces very good quality 'ASPEN' splints which are softer than 'POPLAR'. It is my opinion that 'ASPEN' splints will run better with the 'HERING' machine at Asmara factory.

(g) The paraffin dipping time in the machine is just one second. Normal dipping time for soft splints like 'ASPEN' is 3 to 4 seconds. With harder 'POPLAR' splints it should be at least 4 to 5 seconds. During rainy weather, under high humidity conditions, splints pick up moisture to the extent of 10%. While dipping in paraffin at 140°C, this moisture first gets boiled off before paraffin is absorbed. If paraffin is not absorbed properly, the matches will fizzle out on firing. This is a design defect for which the machinery manufacturers are responsible. We can improve the time to 2 seconds by modifying the cams that lift the paraffin tank. The manufacturers will have to redesign this system.

(h) The chemical dipping table is shaking badly while lifting, the movement of chemical spreader is jerky, the composition level is uneven. This is responsible for variations in sizes of heads and unevenness in dipping. This has to be thoroughly overhauled. The quality and consistency of chemical composition has to be improved as well. I will deal with this aspect later in this report.

(i) The absence of positive linkage between chain bars is a basic defect in this machine. The bars are being pushed instead of being smoothly positively driven by gears. This causes uneven movement which can build up to a stage when the bars twist and drop down. The pickup gears at the front and rear of the machine may lock on to only one end of the bar sometimes due to uneven linear movement and this leads to twisting and breakdown. This appears to be a common occurrance. Thorough overhaul of machine may ameliorate the situation somewhat. Nothing much can be done otherwise.

FINISHING - PROCESS

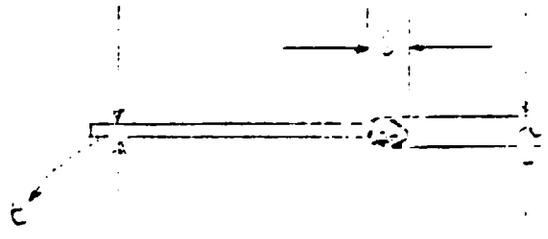
The inner boxes are nested into outer boxes manually. At the filling section, girls fill sticks into these

boxes manually. The filled boxes are then packed into dozens and gross packets.

COMMENTS

(a) Since girls are paid piece rate wages, they are naturally anxious to earn a reasonable wage. So in their hurry, they sometimes fill boxes inadequately and so boxes with below average contents result. Box contents vary from 34 to 48. More often girls are not responsible as the sticks have large or deformed heads. In such a case, the box cannot carry more than 30-35 sticks without buldging. The responsibility for this falls squarely on the mechanic or dipping table operator of the automatic match machine.

(b) Size of match heads can be controlled to close tolerances by proper chemicals processing and thorough overhaul of the dipping table. Swedish match company has established standards for size of match heads, as follows:



l = length of match head
d = diameter of match head
t = thickness or splint

l/t should be 2.4

d/t should be 1.5 to 1.55

For 2.2 mm splints used at Asmara, diameter of head should be 3.4 mms and length of head should be 5.3mms. With composition of right density, a 'PEAR SHAPE' match head will form, conducive to accurate filling and average contents 48 to 50 sticks per box.

(c) The box filling machine was not working, I was told, because of breaking of match boxes in the machine. I saw it in trial operation and did find unacceptable breakage level. But why is it not repaired? I was told that even the mechanics from 'HERING' could not repair it. Surely in such a case, they should take back their machine. I know, that, once the machine is sold, and after a few months time, the manufacturers will not accept responsibility. They would blame the local mechanics and quality of boxes for the damage. I found the quality of boxes reasonable enough. So that would leave the blame on the mechanics. This question ought to have been taken up with 'HERING' as soon as the machine was installed and started running. Now probably it is too late to take it up with them. It is my considered opinion that the machine can be made operational by overhauling and repairs, to a level that waste can be controlled to below 1%. I did observe a number of defects

in settings in the machine. But it is beyond scope of this report to go into the technical details. Suffice to say, the machine can be made operational after 3 or 4 days repairs work and adjustments. The machine has not been given proper attention. Maybe, the mechanics have not had adequate training. The machine can produce upto 50000 boxes in 8 hours. I must mention here, that operation of this machine carries considerable fire risk to the operator. So rigorous training of the operator is essential and responsibility for it devolves on the management.

CHEMICALS PROCESSING

1/ Head Chemicals - Process

The different chemicals are weighed out, glue solution is added, the whole batch mixed, then fed to a conical grinder. The composition is then superficially examined by the operator, who adds water if he considers it too thick. Then it is mixed by hand and sent to the machine for dipping.

COMMENTS

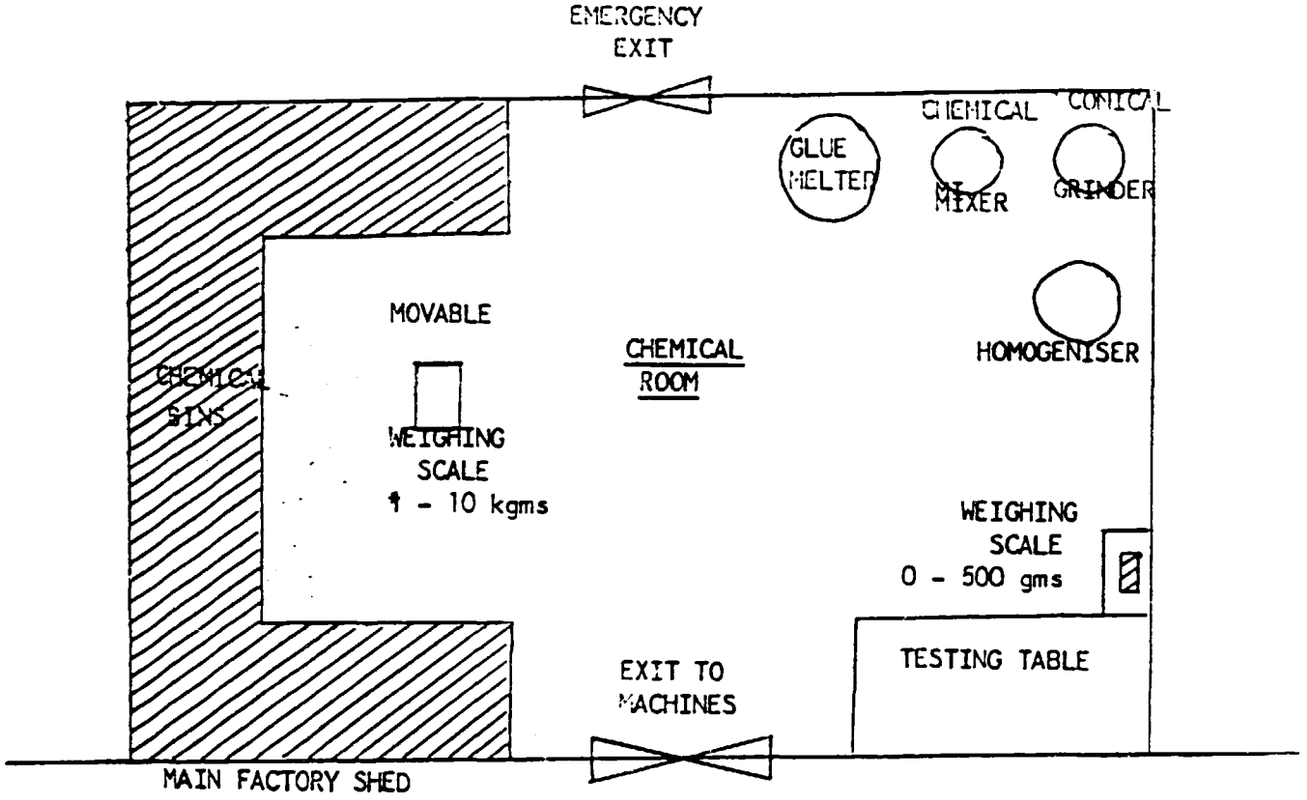
I regret very much to mention that conditions in this section are primitive and there is no reason for it to be like this. No chemist can function efficiently under such circumstances.

(a) The room is boxed in. It must be realised that small fires are always possible in this room from dried up chemical composition. If such a fire is unattended, it can lead to the chlorate, sulphur, glue etc. catching fire and then the room will be burnt out. Since a lot of smoke results from even a small fire, proper ventilation is necessary. I recommend construction of a separate room just outside the existing room of dimensions 5 metres by 8 metres, equipped with exhaust fan and emergency exit door.

(b) The following equipment are minimal to satisfactory operation:

Concial grinder	- 1
Mechanical Mixer for Chemicals	- 1
Homogeniser for controlling specific gravity of composition	- 1
Glue melter thermostatically controlled for operation between 55°C and 60°C	- 1
Weighing scale range 1 to 10kgms	- 1
Weighing scale range 0 to 500gms	- 1

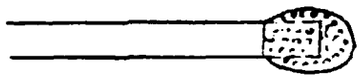
The layout maybe as given below:



Besides, the following laboratory equipment are required.

1 litre glass measuring cylinders	- 6
½ " " " " "	- 6
1 litre measuring conical flasks	- 6
½ " " " " "	- 6
250 ccs " " " "	- 6

(c) I have mentioned the homogeniser. The purpose of the homogeniser is to blow air into the composition to ensure a porous match head. The match head should be 20 - 25% porous to ensure smooth burning instead of explosive burning and throwing out of embers that can cause serious personal accidents to consumers.



Air holes in match head 20 to 25% by volume.

So generally the practice is to make the composition of specific gravity 1.36 and reduce it to 1.33 by blowing air in the homogeniser. It should be remembered that in the composition, while grinding, already a certain percentage of air is absorbed.

(d) A number of unnecessary chemicals are used in making the head composition, like lead oxide, calcium carbonate, gum arabic, kalophony etc. They do not have any function. The mechanism of a match is to initate an ignition reaction by bringing potassium chlorate and red phosphorus into contact under controlled conditions. Normally they react explosively. Once ignition takes place, a flame is generated by burning of fuels. Potassium chlorate is the oxygen giver, sulphur and glue are the fuels.

To sustain a flame, a flame transfer agent is necessary, in this case paraffin in wood. A sustained flame is given ultimately by the burning of splint. There is no harm in adding many chemicals like lead thiosulphate, ammonium acrylate, lead oxide etc. But they have really no function. I have provided the chemist with standard formulations for black heads and coloured heads, eliminating superfluous chemicals.

A table of formulation presently in use and formulation recommended by me is given below:

MATCH HEAD COMPOSITION

	Formulation In Use		Formulation Recommended	
	Weight Kgms	%	Weight Kgms	%
Potassium Chlorate	2.250	43.19	2.704	52.00
Infuscrial Earth	0.040	0.77	0.234	4.50
Glass Powder	1.150	22.06	0.912	17.54
Potassium Bichromate	0.150	2.88	0.052	1.00
Sulphur	0.400	7.68	0.208	4.00
Zinc Oxide	0.125	2.40	0.310	5.96
Lead Oxide	0.125	2.40	-	-
Iron Oxide Black	0.450	8.64	0.050 Lampblack	0.96
Umber (Iron Oxide Red)	-	-	0.210	4.04
Kolophony	0.020	0.38	-	-
Animal Hide Glue	0.300	5.76	0.520	10.00
Gum Arabic	0.200	3.84	-	-
	5.210	100.00	5.200	100.00

(e) The chemical proportions used now are incorrectly matched. There are certain norms. Potassium chlorate should be between 50 and 55% depending on colour of match head and the speed of match, consumers like. Arabs in Middle East like fast matches. Europe and Japan prefer slow matches. India, East Africa, U.S. prefer medium speed matches. Potassium chlorate used at present is 43.19%. Potassium bichromate used is 2.88%. It should always be 1%. Glue used is 5.76%. It should always be 10%. Sulphur used is 7.68%. It should be between 3 and 5%, depending on speed of match required. Zinc oxide used is 2.40%. This can be from 2.5 to 7.5% depending on speed of match. Zinc oxide controls speed of flame. I have explained all this to the chemist.

(f) There is no control over addition of water. The total water used including water used for glue solution should be 33 to 35% by weight of dry chemicals. Since no measuring equipment are available, this is being done arbitrarily. Once chemical composition is made, then addition of water is a very difficult proposition to control specific gravity. Laboratory equipment is necessary.

(g) Making glue solution is crude, incorrect. It should be remembered that glue is the critical raw material for match heads. Match glue is specially made with controlled grease content, P_H, ash, foam etc. There are a number

is made only by a few manu… U.S.A. make special match… know names and addresses o… Finch is an authority on a… and other Polymer Glues. … and addresses if written to.

Dr. C.A. Finch M.A (Oxon), Phd (Oxon)
Pentafin Associates
18/20 Weston Turville
Weston Turville
AYLESBURY Bucks. HP22 5TT U.K.

We recently co-authored a book on Matches Manufacturing Technology, published in U.K.

Glue should be dissolved at a temperature of 55 to 60°C. 60°C is maximum. Above 60°C the glue starts to lose its adhesive qualities. Glue is animal protein. So a thermostatic controlled glue melting water tank is urgently needed.

Line Fitters For 2 Shifts	Bench Fitters Daytime Only
1	2
1	1
1	1
1	1
1	1
1	1
1	1
1	3
8	10

Adjustments and Repairs to Machine to Keep This Running - Grade B

Parts, Major Repairs, Over-hauling Work. Grade A Mechanic.
ation, Intelligent, Capable of Being Trained To Adjust and Run
ill Lead Workers of His Group.
Taking Place of Skilled Worker For Short Periods, in His
Capable of Being Trained.
Necessary.

(b) It is standard practice to check every batch of chemical composition for specific gravity before sending it for dipping. The specific gravity should be 1.33 to 1.36 i.e. 1 litre composition should weigh between 1330 to 1360 grams. This is an extremely important parameter and should be done at Asmara. Measuring jar and an accurate weighing scale are required.

2/ Frictioning Chemicals - Process

Various chemicals are weighed into the ball mill, water added, ground for many hours, finally red phosphorus and gum Arabic solution added, further grinding effected and composition removed, strained through a sieve and sent to machine for coating on cardboard.

COMMENTS

(a) Some chemicals like iron oxide and calcium carbonate used are unnecessary. The essential material glass powder is not used.

(b) Proportion of chemicals used is not correctly matched. Red phosphorus used is 41.27%. This is too low. Not less than 50% and not more than 52% should be used

(c) Gum Arabic is no longer used in most factories of the world. PVA Glue or Poly Propionate in 50% solids emulsion is generally used, to provide improved moisture resistance to matches. I have found propiofan 50 made by BASF ideal for the purpose. If interested, the address is:

Badische Anilin - & Soda Fabrik A.G.
D-6700 Ludwigshafen/Rhein

I have provided the chemist with the correct formulation.

The table below gives formulation now in use and formulation recommended by me:

STRIKING SURFACE FRICTION COMPOSITION

	Formulation In Use		Formulation Recommended	
	Weight Kgms	%	Weight Kgms	%
Antimony Trisulphide	8.00	32.85	9.120	31.0
Black Iron Oxide	1.20	4.93	-	-
Potassium Bichromate	0.80	3.29	0.290	1.0
Calcium Carbonate	0.30	1.23	-	-
Gum Arabic	4.00	16.43	2.941 PVA Glue Emulsion, 50% solids	10.0
Red Phosphorus	10.05	41.27	15.000	51.0
Glass Powder	-	-	2.059	7.0
	24.35	100.00	29.41	100.00

(d) For the size of ball mill in use, at least 60 kgms weight of balls should be used, for proper grinding. Now only 16 balls weighing about 25 kgms are used. For proper application of chemicals, the composition should be really uniform and smooth. This requires good grinding. Antimony trisulphide is difficult to grind. The importance of weight of steel balls can be appreciated when one computes the grinding pressure on chemicals. Assuming a contact area of ball with chemicals as 0.04 sq.mms, the pressure exerted by a 2 kgms ball is $\frac{2}{0.04} = \frac{200}{4}$

= 50 kgms/sq.mm or 5000 kgms/sq.cm i.e. 5 tons/sq.cm. If the weight acting is 4 kgms then the grinding pressure will be 10 tons/sq.cm.

(e) The ball mill in use is the wobbling type. The wobbling only provides impact grinding which is ineffective and inefficient. Modern factories use cylindrical rolling ball mills. I recommend purchase of a normal rolling ball mill of double present mill capacity and use of 150 kgms balls, of which 80 kgms should be 60 mms diameter balls and 70 kgms of 50 mms diameter balls.

SOME GENERAL REMARKS

1/ I see no justification whatsoever for the plant running at roughly 50% normal operating capacity, considering

the fact that all raw materials are imported, barring one or two filler chemicals and the machinery are not really too old comparable with other plants I know of. The company only loses money daily by not utilising capacity. This situation should be handled vigorously and expeditiously without further delay. The company should be generating profits by doubling output, to finance modernisation of the plant.

2/ A letter may be sent to 'HERING' asking them to:

(a) Supply a long magnet to be fitted across splint magazine with full installation instructions, to minimise breakdowns to automatic match machine.

(b) Clarify if, by replacement of existing hydraulic system in the machine with their new system, the machine could be run at 140 rpm i.e. rated speed.

(c) Quote for complete overhaul of automatic match machine and running it for a month at rated capacity, with information about period for which stoppage of machine is required.

3/ Machinery manufacturers are constantly upgrading their machinery with improved gadgets, output, electronic controls, automatisation etc., a degree of sophistication

unsuitable for developing countries. Western countries have no alternative due to high labour wages. I am personally familiar with over 20 automatic match 'ARENCO' machines running in India since 1957, providing good quality matches. If quality is poor it is due to poor quality raw material, timber. I believe the Asmara ma machine was installed in 1968, barely 15 years running life. It is very difficult to justify replacement of the machine. The machinery suppliers have the obligation to come down and overhaul the machine, run it to capacity for a month, train the mechanics on the spot and go. While negotiating with 'HERING' for overhaul it may be useful to keep the West German Embassy in the picture, since indirect pressure is always necessary and worthwhile. With promises of future modernisation held out, the manufacturers may come up with a reasonable quotation. I see no purpose in running down the machine further.

4/ While buying raw materials, technical specifications should be furnished to suppliers. If interested, I can prepare a separate note on specifications.

5/ It is essential to build up a quality control department in the match factory. Two educated young men can operate the department, reporting directly to management, not production manager. If interested, I can prepare list of standards for various operations in the manufacturing processes.

Finally I should like to thank the management of match factory for giving me an opportunity to see the factory.

31.12.1983

S. Ramachandran

ANNEX 3 VISIT TO BAHIR DAR - JANUARY 4/5, 1984

The consultant spent the whole day of January 4, going round the workshops of Bahir Dar Textile Mill and the Government Polytechnic.

BAHIR DAR TEXTILE MILL

The workshop is large and very well equipped.

(1) There are 7 lathes of different sizes, the largest of which could take in work upto 3 metres length;

(2) 3 milling machines are installed, horizontal, vertical and universal types. Any type of gears, spur, helical etc. could be cut;

(3) There are 2 shaping m/cs and can take work upto 400 mms length;

(4) A number of drilling m/cs are available;

(5) There is a good welding shop. Welding of stainless steel can be done as well;

(6) A large electrical workshop with facilities for re-winding motors upto 15 HP and for testing purposes is in service. The workshop carries a good inventory of super enamelled winding wire of different guages;

(7) A very well equipped carpentry shop is available;

(8) Two furnaces for heat treatment work are in use;

(9) A large foundry is under construction and will be operational in 6 months time. Ferrous and non-ferrous casting work will be undertaken;

(10) Good forging facilities are available.

From our conversations with the manager and technical manager, it was evident that the workshop has considerable surplus capacity to handle fabrication of the entire spare parts requirements of the proposed match factory. Very competent machine tool operators are employed by the mill and quality of work appeared to be good.

BAHIR DAR POLYTECHNIC

Here again, extensive facilities are available. 7 lathes, 3 milling machines, 2 shapers, 1 surface grinder, 8 drilling machine, 1 vertical boring machine, a forge, heat treatment furnace and sundry workshop equipment like metal cutting saws, compressors are installed. Equipment is brand new and appeared little used.

The Russian engineer told us that these were intended basically for training students. But external jobs could be undertaken. Further there are carpentry, electrical and sheet metal fabrication shops. Equipment are new and sparingly used.

A very well equipped chemical laboratory with lots of test instruments like flame photometers, PH meters, polarimeters, centrifuge, furnaces, ovens etc. are available, all equipment brand new and sparingly used.

WATER SUPPLY AUTHORITY

He met the Municipal Water Authorities and was assured of adequate regular supply. Factory requirement will be around 70 cubic metres daily, including personal allowances for workers and staff.

POWER SUPPLY

The factory, while running at full production, would require 150KVA i.e. 127.5 KW at power factor 0.85. Supply at this level is assured during most part of the year. When the new turbine unit is commissioned in 1985 power supply would be adequate.

We found staff at both the institutions friendly, cooperative and eager to be of help.

It is evident, that, if the match factory is built at Bahir Dar, there will be absolutely no need for a separate workshop or chemical testing laboratory. Some very basic tools like metal cutting saw, a small lathe, arc and gas welding equipment and a compressor will be adequate.

JANUARY 6, 1984

S. Ramachandran

ANNEX 4

Visit to Paper Mill at Wonji, Nazareth and State Farm Workshop at Awasa

First he visited the State Farm Workshop at Awasa. The workshop is equipped mainly with equipmeht for repair and overhaul of tractors, bull dozers, trucks and other earth moving equipment. There are some basic machine tools. But from a discussion with the Technical Manager, it was evident that no surplus capacity was available to undertake fabrication of even minor spare parts for a possible match factory located in the area. There are no milling machines in the workshop.

The Paper Mill visit was very fruitful. The paper produced in the mill is of high quality. Cardboard upto 250gms substance is produced on specific orders. The Technical Manager told us that the mill could easily produce cardboard of upto 380 gms substance with pure cellulose pulp lining of one side, provided a minimum order of 1000 tons was placed. The mill has an excellent workshop. But it would be over 180kms from possible location of match factory at Awasa.

ANNEX 5

FACTORY OPERATING PERSONNEL REQUIREMENTS

BASIS: 100 million boxes:year or 400,000 boxes in 2 shifts or 7 hours each

OPERATION	No. of machines	Skilled workers	Semi-skilled workers	Unskilled workers
Splints production:				
Logs transport	Manual	-	-	20
Cross Cutting	1	1	1	--
Billet transport	Manual	-	-	1
Splint peeling	1	2	2	6
Layer Transport	Manual	-	-	2
Spling Chopping	1	2	2	--
Impregnation	1	-	2	2
Drying	1	-	-	2
Splints transport	Pneumatic + manual	-	-	4
Polishing	1	-	-	2
Cleaning	1	-	-	2
Sieving	1	-	-	2
Splints levelling	2	-	2	--
		5	9	43

Operation	No. Of Machines
Boxes Production	
Cardboard Transport	Manual
Slitting & Printing	2
Skillet Cutting	1
Outer Box Making	6
Inner Box Making	8
Boxes Transport	Pneumatic
Matches Production	
Automatic Match Making	1
Chemicals Making (Friction Chemicals also included)	2
Trays Transport	Manual
Finishing	
Box Filling	2
Packing	Manual
Gross Packeting	"
Carton Filling	"
Internal Transport	"
	TOTAL:
	GRAND TOTAL:
	TOTAL WORKERS:

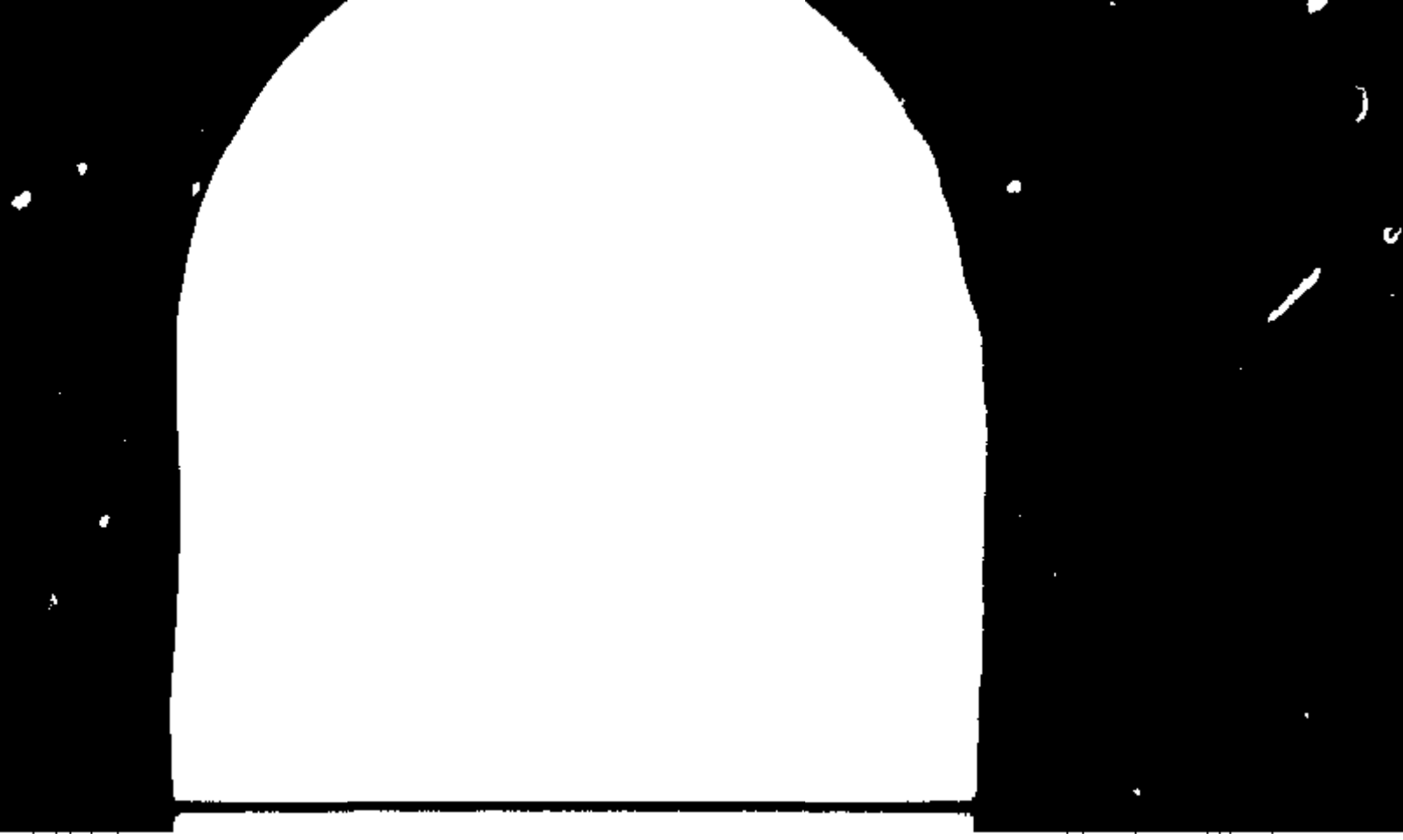
Skilled Workers	Semi-Skilled Workers	Unskilled Workers
-	-	2
2	2	-
2	-	-
6	-	-
8	-	-
-	-	2
4	6	-
4	2	-
-	-	2
2	4	-
-	-	30
-	-	4
-	-	1
-	-	8
28	14	49
33	24	92
148		

PRODUCTION STAFF

Supervisor	- 2	Controls labour and production in each shift.
Checkers	- 8	Account and check production in each section, quality checking, control labour in respective sections.
Electricians	- 2	One in each shift to handle electrical faults etc.
Chemists	- 2	One in each shift.
Quality Controllers	2	One in each shift, report directly to factory manager.
	16	

OFFICE

Factory Manager	- 1
Administration Officer	- 1
Accountant	- 1
Accounts Clerks	- 2
Cashier	- 1
Purchase Clerk	- 1
Store Keepers	- 1
Store Clerks	- 2
Sales Clerk	- 1
Secretary	- 1
Office Boys	- 2
Car Driver	- 1
	15



ANNEX 6

STUDY TOUR OF MATCH FACTORIES IN OPERATION IN THAILAND, MALAYSIA AND INDIA

In the process of preparing a match factory project study, the Government of Ethiopia requested UNIDO to assist in choosing the appropriate match production technology for the country. Usually, this involves the study of various systems in use in production processes. As such, it was found necessary to visit some factories in operation in different developing countries in order to make first hand observations of some of the technologies in operation. To this effect, the Government of Ethiopia requested UNIDO to make a study tour possible for a group of three people. This consisted of the Head of Policy, Planning and Co-ordination from the Ministry of Industry, a Project Analyst/Senior Economist from the Development Projects Study Agency, and a Match Technologist from UNIDO (on contractual basis). UNIDO approved the study tour and a brief review of the tour experiences is given below.

THAI MATCH COMPANY, BANGKOK

Thai match company is a subsidiary of Intermatch Sweden AB, Jonkoping. The company is operating two factories at present, an old one

using pretty ancient machinery in Bangkok and a new factory using more modern machinery. It is their intention to gradually reduce production in the old factory and close it and shift all operations to the new plant. Both factories were visited by the mission.

1/ The factories use splints imported from Sweden;

2/ Boxes are mainly of cardboard. High speed machines are in use. Since a section of the market still prefers wooden boxes, about 25% of production is with wooden boxes;

3/ The cardboard outer box skillets are ready printed with trade label and side coating chemicals and imported from the Philippines Match Co., also a subsidiary of Intermatch Sweden AB;

4/ KD and KH type continuous match machines, over 60 years old, equipped with automatic filling are running very well in the old factory. One KL2 machine about 15 years old, with automatic filling is running in the new factory. A second KL2 machine is under erection;

5/ Pre-mixed chemicals imported from Sweden are used in both factories.

The quality of matches produced is excellent. All operations were studied in some detail. Since splints are imported there are no timber processing operations.

SALA SUBARNA MATCH FACTORY, BANGKOK

This plant uses Japanese automatic match machines, Japanese cardboard box making machines, Japanese closing machines and a mix of Japanese and German box filling machines. Packing is done manually.

1/ The factory uses splints of local manufacture located in a remote area;

2/ The splints are coloured but of fairly good quality;

3/ The charging in the automatic match machine was about 92-95%, very good indeed for locally manufactured splints. The dipping is of good quality as evidenced by burning quality of the matches and the correct filling of boxes with sticks;

4/ Quality of boxes produced was good. Slow speed box making machines are used;

5/ Filling of boxes in the Japanese box filling machines was good and waste was minimal. Waste in German box filling machines was higher. This is evidently due to the fact, the German machines are very old and employ the " CUP " system of filling. Japanese machines are new and employ the " FLAP " system of filling;

6/ All packing operations are manual. Water proof ocean paper is used for making containers carrying 600 boxes each.

This is an old factory which has evolved from a purely labour intensive cottage industry to a semi-mechanised plant. So the layout of machinery is somewhat lop sided, located in 3 different buildings.

MALAYSIAN MATCH CO. PERAK

An old factory was purchased and second hand machinery from Europe brought in and installed. But the machinery used are a mix of new and old type Arenco machines.

The box making machines are the latest high speed ones. Cardboard is imported from Sweden. The outer box bar machine uses ready printed skillets, with friction coating also printed. The skillets are imported from Philippines.

Boxes go by conveyor to a VAT dozen packing machine. 100 such dozen packets are filled into cartons by hand. There is considerable competition from other manufacturers and so the company is making wooden outer boxes as well, to satisfy customers in a section of the market. The wooden boxes produced are of poor quality. A separate frictioning machine is used to coat the sides of the wooden outer boxes with striking surface chemical composition.

MATCH FACTORY AT KUALA TRENGANNU, MALAYSIA

This factory was closed for two days due to some local festival and could not be seen. A talk with the managing director over the phone, revealed that it was a completely Japanese plant and the directors were satisfied with the performance of the machinery.

M.I.M.CO.LTD. MADRAS, INDIA

This is a subsidiary of Intermatch Sweden AB. The factory is over 50 years old. There are 6 continuous automatic match machines installed but only 4 were in operation. The factory produces 3.5 million boxes per day.

1/ All splints used are of indigenous manufacture, procured from a host of splint making factories operated as cottage factories;

2/ Box making machines are the latest high speed type and cardboard produced in India is used;

3/ Outer box skillets are printed in a ' CHAMBON ' machine installed in air conditioned room. Friction chemicals are also printed on the sides of the outer boxes.

On the whole, the visits to factories were educative and the mission obtained a good appreciation of the techniques involved in match making.

Timber processing operations could not be seen, since all factories visited used either imported or locally produced splints from different factories located at remote places.

We should like to mention here that we had little time to study factory operations in great detail because of the time schedule of the tour. All match factories in Thailand and Malaysia are located at distances of 100-250kms from towns and much time was spent travelling by car to the factories. The factory managers concerned were kind enough to provide us transport from town to factory and back.

We wish to express our sincere thanks to the factory managements for the cooperation and courtesy extended to us.

Tadewos Harege-work

Getachew Mamecha

S.Ramachandran

MARCH 6, 1984

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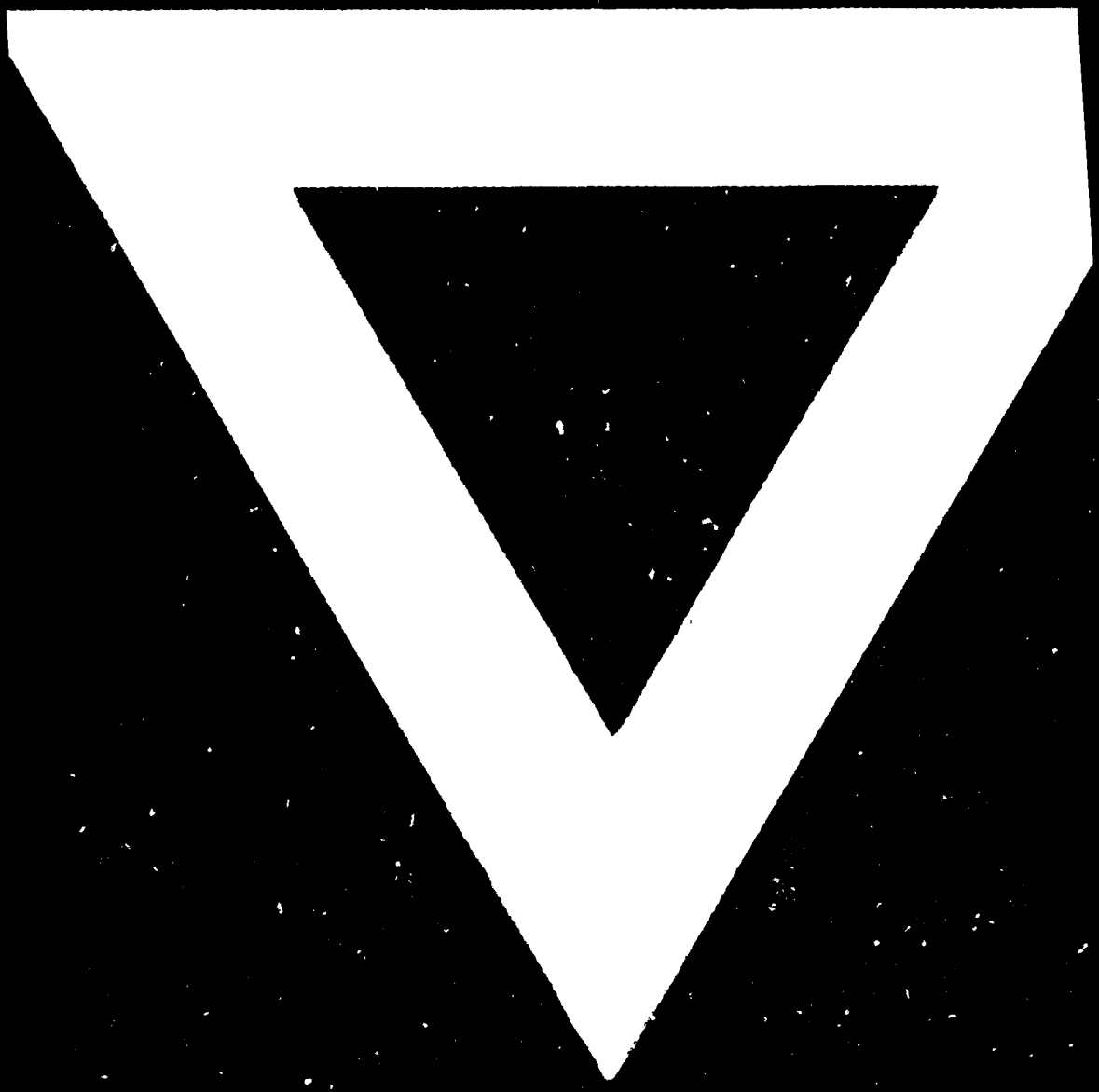

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